DIARI SEGMENTAL PHONOLOGY

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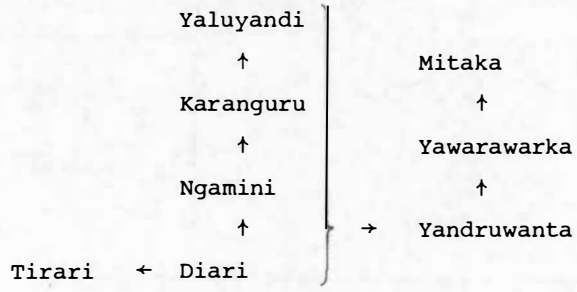
1. INTRODUCTION

1.1 Background

Diari[1] is a dialect of an unnamed language belonging to the Karna group of languages extending north and east from the east coast of Lake Eyre, South Australia. The actual number of linguistic communities which existed in the region prior to European contact is uncertain, as is the degree of relationship between each of the groups. J.G. Breen and P. Austin[2] have both done preliminary work in sorting out the relationships, and on the basis of their work, together with my field notes, it seems that in terms of cognates a diagram indicating the degree of relationship between Diari and other Karna communities will look like the following. (See map.)

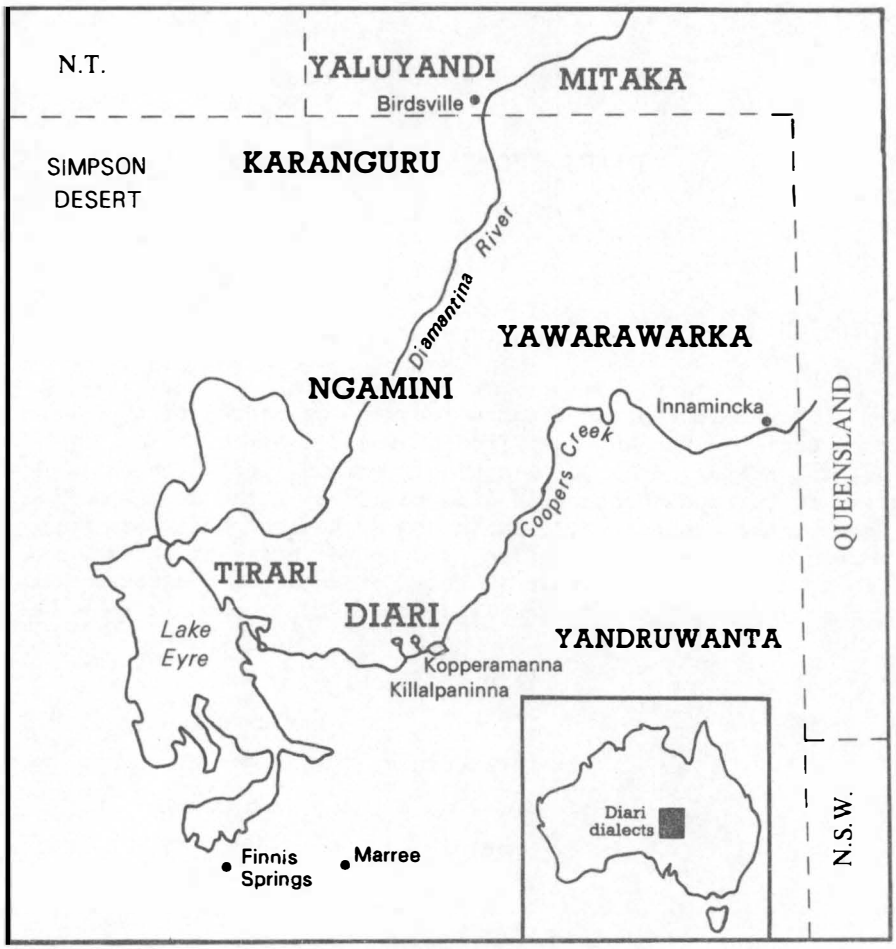


This probably means that there are two languages each containing various dialects, but see Breen and Austin.

In 1861, it was in Jandruwanta country that the explorers Burke and Wills perished during their return from a south-north crossing of Australia. A few years later, (1867), the Lutheran Church established a mission station at Killalpaninna, a lake along the course of Cooper's Creek. The lake was in land occupied by people who spoke the Diari dialect, and as the mission adopted this speech form for communication with the Aborigines, it soon became the best-known one in the area.

The fortunes of the mission varied over the years, largely according to the weather pattern of the region. Years of rainfall were good years for the mission, years of drought were bad years. Unfortunately, years of drought were more frequent than years of plenty so the Lutheran Church soon felt the need for a more favourable site. Such a site was found at Hermannsberg, west of Alice

Papers in Australian linguistics No. 16, 171-327.
Pacific Linguistics, A-68, 1984.



Map 1: Geographical location of the five Diari dialects

Springs, and the development of this new site meant the eventual abandonment of the work among the Diari.

Though missionary endeavour among the Diari was destined for extinction, it did persist for fifty years, and was quite successful as far as climatic conditions would allow. Compared with other places the Killalpaninna/Kopperamanna mission showed good judgement in its method of communicating with the local population. Schooling and religious instruction was conducted in Diari. The missionaries learnt Diari rather than expecting the Aborigines to learn English. Fifty years after the demise of the mission it was possible to converse with Mrs Mary Dixon, a Diari, a Christian, literate in Diari, in English, and relatively fluent in German.

The work in Diari was largely sponsored by churches in Germany. At the outbreak of World War I, the mission has to contend with lean finances as well as inclement weather and soon went into debt, but the final blow was dealt by the South Australian government, which for reasons of patriotism closed the German-run mission in 1917. The property was sold to graziers. The Diari people

dispersed and fifty years later it required considerable effort to locate five fluent male speakers able to be subjects for the spectrographic study included in this monograph.

Of the five adult male speakers, Mr Alec Edwards was exceedingly helpful, and he became the main language consultant. His father, an itinerant helper to an Afghan camel driver, left Alec at Killalpaninna on the death of his wife. According to Alec he was about 'knee-high' when he arrived. Information gleaned from Mary Dixon and the two younger Murray brothers[3] makes it seem probable that he was about three years of age. When the mission closed he was a young man working as a drover. In 1968 he was a fluent reader of English and also of the Diari religious writings.

The Lutherans published several religious writings in Diari, the chief of which was the New Testament. The most linguistically important, however, is the Reuther manuscripts, held at the Museum of South Australia, which contain an extensive dictionary, and accounts of the mura mura, or dreamtime ancestors. Though the dictionary is important, Reuther sometimes failed to differentiate between Diari vocabulary and the vocabulary of neighbouring languages, with the result that occasionally the information is misleading.

1.2 Eliciting the material

Diari language material was initially elicited for three reasons, to gain access into the language, to check previous work, and to be the corpus for a phonological study.

Elicitation in order to gain access into the language was at various levels. Informants were asked to give Diari equivalents of English words. They were also asked to translate English sentences, usually in sets of sentence frames, where each sentence differed in only one aspect from its predecessor. Later, text material was recorded, the narrator simply being asked to talk on a topic that interested him. The material was then carefully transcribed in the presence of the narrator, and with his help. At this stage any performance errors were corrected and a literal and free translation was taken down. Conversations were also recorded and dealt with in the same way.

At first, vocabularies by previous investigators were checked to get cues to help in interpreting their orthographies, but it proved to be more a measure of the credibility of their material. The work of four people was checked; that of S. Gason, C.A. Meier, Rev. J.G. Reuther, and T. Vogelsang. Vogelsang's work was essentially that of editing the earlier material of Meier. Gason was a police trooper stationed among the Diari during the 1860s and 1870s. Meier was a lay missionary from 1878 till sometime in the mid 1880s. Reuther was a missionary from 1888 till 1906, and Vogelsang was the son of one of the original missionaries to Killalpaninna. He was born at the mission and spoke Diari as a child. His alteration of Meier's work was done in the early 40s.

In order to obtain suitable material for acoustic analysis, words of two syllables were elicited. These were of the pattern CNCN, where C equals one or more consonants, and N (nucleus) equals one or more vowels. The pattern was chosen because of the relative frequency of its occurrence, and the relative ease of analysis of this type of word. To get sufficient number of words of this pattern, Reuther's dictionary was culled and those of this type, together with a few others located previously, were brought to the attention of Alec Edwards for his comments. These reduced an original list of 484 words to 462.

The words deleted were either meaningless to Alec or were words belonging to other dialects or languages. Initially it was intended to record the informants saying each word in a sentence frame, but it proved difficult for some of the informants to do this; not only would the frame be varied but often a close synonym would be substituted for the target word. In the end it proved satisfactory to have Alec say each of the words on the list three times. This established a 'shopping list' type of rhythm which gave a fair degree of constancy. The list was then shortened to 200 words and the four other available male speakers[4] of Diari were asked to record the words in a similar fashion.

1.3 The analysis

The analysis is essentially concerned with the phoneme structure of Diari. The first part involves the segmentation of the speech stream. Non-ambiguous vowels and consonants are isolated, and then, on the basis of the pattern set by them, the other contoids or vocoids are specified as consonants or vowels. Other elements are examined to determine whether they should be interpreted as single segments or as sequences of segments.

Part two is concerned with establishing the contrasting set of consonant phonemes, including allophonic variations when applicable.

Part three determines the set of vowel phonemes, then with the use of data obtained from acoustic equipment, decides the limit of variation allowed for each phoneme, and the degree to which the variation is conditioned by the linguistic environment.

2. THE SEGMENTATION OF DIARI SPEECH

The segmentation of Diari speech is possible because words are divided into syllables. Syllables are considered to be breath pulses[5], which are normally characterised by sequences of increasing and decreasing amounts of energy caused by the control of the flow of air from the lungs during speech.

Though syllables, or breath pulses, are based upon physiological conditions affecting the air-flow from the lungs, once a pattern is established in phoneme sequences, these sequences can exert structural pressure upon the physiological syllable so that another identity which Gimson refers to as a 'linguistic syllable' may become functional within a language.[6]

2.1 The basic Diari syllable

Within the syllable each energy peak is called the nucleus, and the trough between peaks is called the coda/onset. That part of the trough which leads into the nucleus is the onset, and that which occurs during energy decay is the coda. Therefore, each syllable will consist of an onset, a nucleus, and a coda. Vocoids[7] typically occur as nucleii of syllables, and contoids[7] as the onset or codas. As vocoids are defined as central resonant orals, it is easy to understand why they should typically occupy the nucleus position in the syllable. In their production there is no impediment to the air-flow once it is past the larynx, so it may readily increase in volume with a consequent increase of

energy. Contoids on the other hand restrict the air-flow and therefore reduce the energy, unless extra force is exerted at some point along the way, or the air can readily escape through another channel. In Figure 1, mingograms of three Diari words demonstrate the ideal syllabic structure. Each mingogram gives three tracings. The top tracing indicates the relative intensity of the speech wave during the time interval of the word. The second gives an oscillograph reading during the same time interval, and the third indicates the fundamental frequency of the speech wave during the period the vocal folds are vibrating.

An examination of the mingogram tracings enable an observer readily to discern the onset, nucleus and coda pattern, and from this the contoids can be segmented from the vocoids, and by reduction [ŋ], [n], [p], [k], [t], [i], [ʌ] [ʊ] and [u] can be extracted.

Other contoids can also be segmented in this way. For instance, the mingograms shown in Figure 2 enable [t̪], [t], [m], [n̪], [l̪], [l] and [ɾ̆] to be isolated.

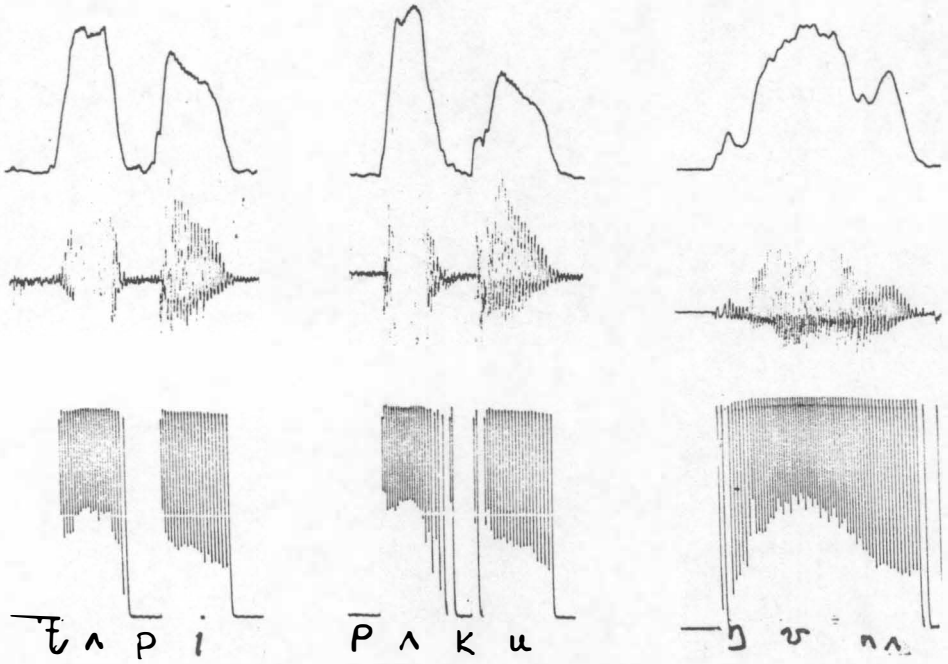


Figure 1

Mingograms of three Diari words, [tʌpi] *calm*, [pʌku] *purposeless* and [ŋʊnʌ] *arm*, illustrating the syllable structure of onset, nucleus and coda.

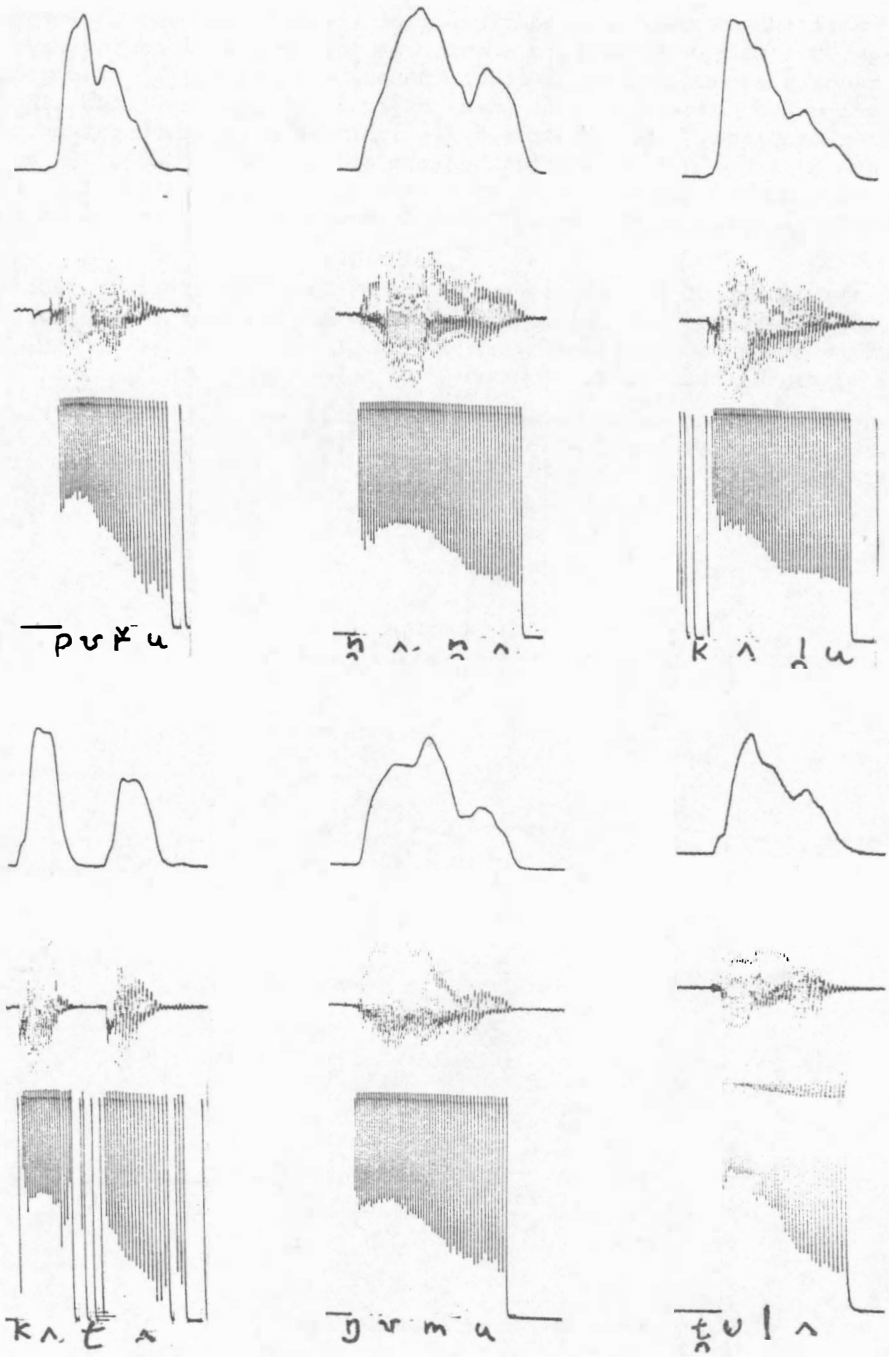


Figure 2

Mingograms of [puřu] *dew*, [n̥ʌn̥ʌ] *her*, [kʌl̥u] *liver*, [kʌtʌ] *louse*, [ŋumu] *good*, and [t̥ulʌ] *stranger*, illustrating syllable structure and justification for segmenting [ř] [n̥] [l̥] [t] [m] [l] and [t̥]

2.2 The basic linguistic syllable

As has already been stated, not all syllables follow the ideal pattern. Resonant contoids such as nasals and laterals can be produced with a considerable amount of energy, for, though the air stream is obstructed it still has an easy escape route. This results in the ideal syllable structure not always being realised, with

1. The onset/coda no longer appearing as a trough between nucleus peaks.
2. The contoid functioning as the nucleus.
3. The contoid functioning as a combination containing the nucleus and the onset or coda.

Figure 3 gives examples of Diari words where resonant contoids behave in these ways.

Provided it is accepted that the linguistic syllable need not be identical with the phonetic one, a satisfactory explanation can be given for the discrepancy between them. Phoneticians have shown that there is a linguistic principle in language which results in non-suspicious syllabic patterns exerting phonemic pressure upon the rest of the language.[8] In Figure 3 the resonant contoids must all be interpreted as consonants occupying the medial coda/onset position, because of the structural pattern already established.

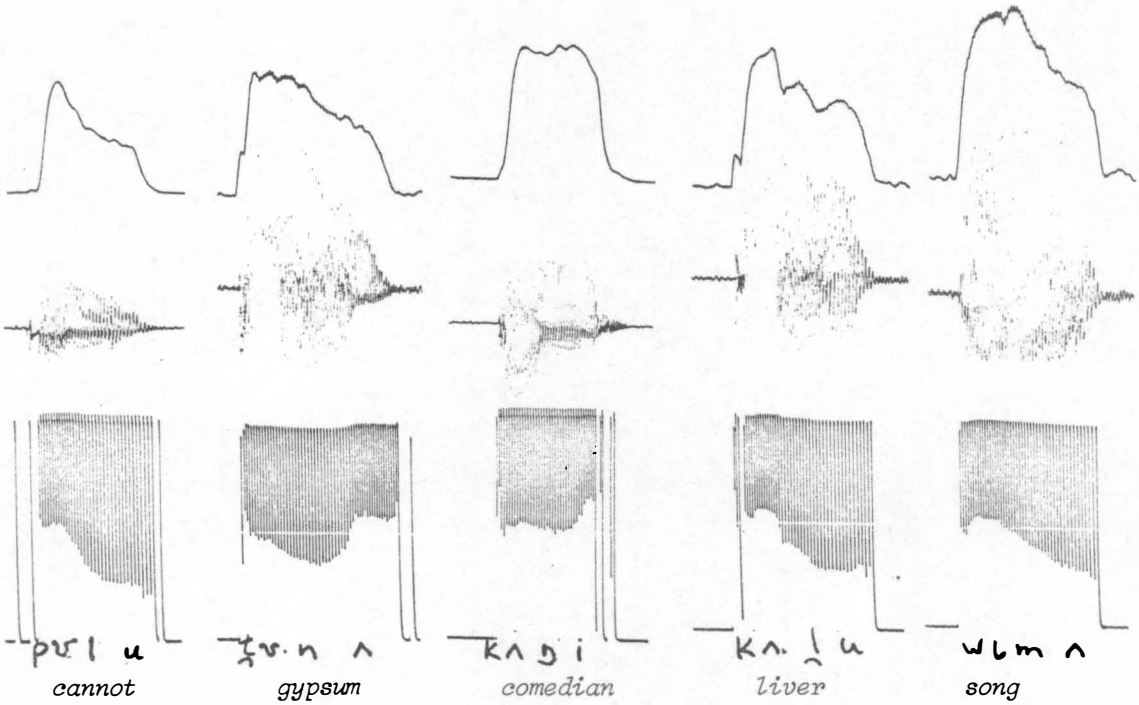


Figure 3

Mingograms of words containing medial resonant contoids not occupying trough positions of the 'ideal' syllable type.

2.3 Contoid clusters and the Diari syllable

It was stated that the Diari phonetic syllable consists of an onset, a nucleus, and a coda, and when two or more syllables come together in a word, the medial contoid can function as the coda of one syllable and the onset of the next. There is another possibility however, for two syllables of the pattern ONC[9] coming together will make the new pattern ONCONC. So far in the discussion the medial -CO- combination has consisted of only one contoid. However, often this is not the case, for the onset of the second syllable may be a different contoid from that forming the coda of the first syllable. In Figure 4 Diari words of this type are illustrated.

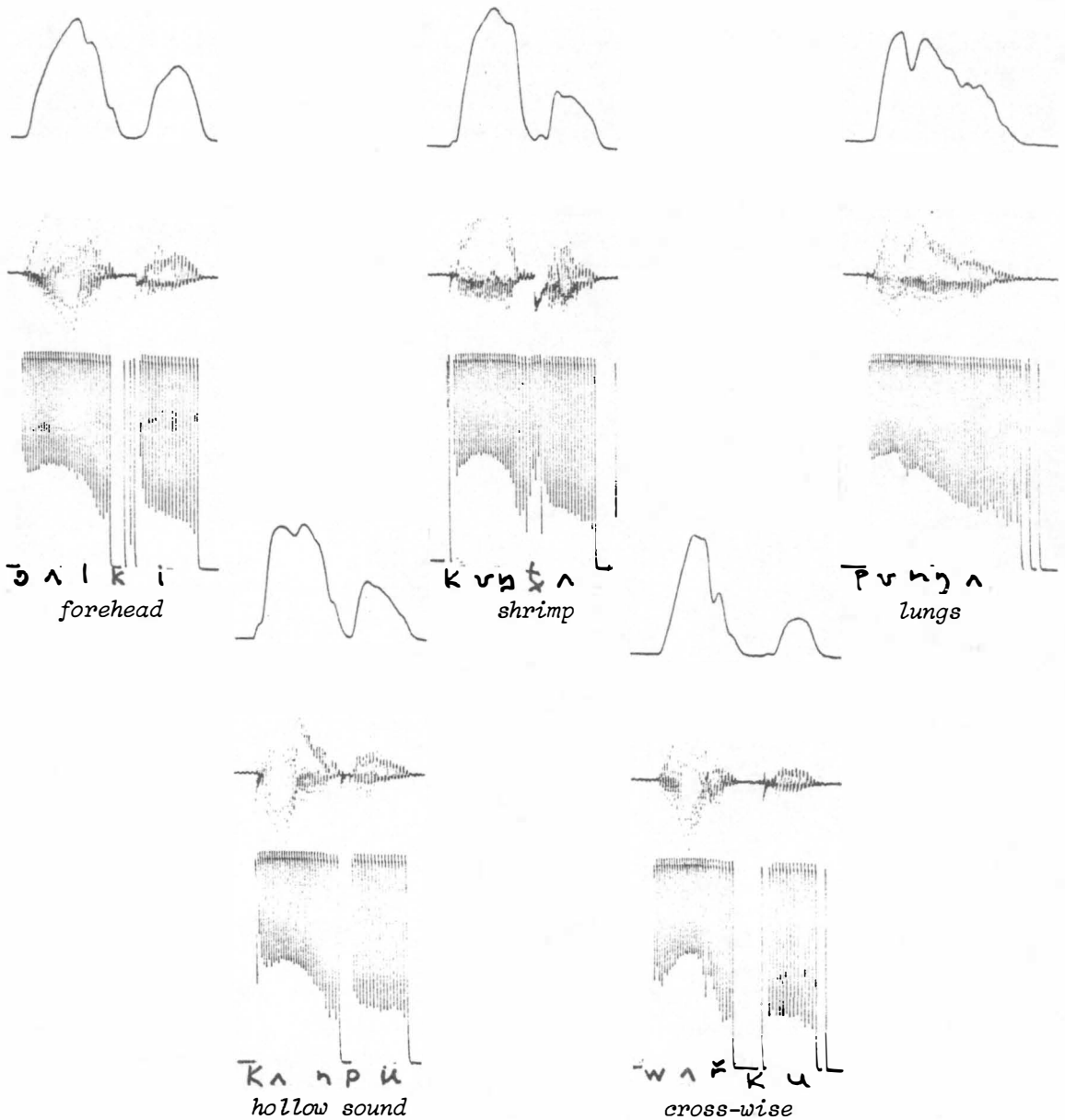


Figure 4

Diari words with medial contoid sequences, where the first contoid is the coda of one syllable and the second is the onset of another.

2.4 The interpretation of a suspect contoid

In Figure 2 the alveolar flap [ɾ̆] was presented as a medial coda/onset. Sometimes, instead of a single flap, a sequence of three or four flaps are produced rapidly in a word medial position. (See Figure 5) This sequence of flaps is considered suspicious because it could be interpreted as a single complex segment, or as a series of segments. In this analysis it has been interpreted as a single segment for three reasons.

1. The number of flaps in the sequence varies, which suggests that providing there is more than one, the actual number is not significant.
2. The absence of any other supporting evidence of geminate clusters makes it unlikely that this one sequence should be interpreted as such a cluster.
3. As is displayed in Figure 6, sequential flap occurs in sequence with other contoids and no more than two non-suspect contoids occur in sequence. Therefore, it is unlikely that sequential flap can be considered to be anything but a single complex segment.[10]

It is therefore interpreted as the alveolar trill [r̃].

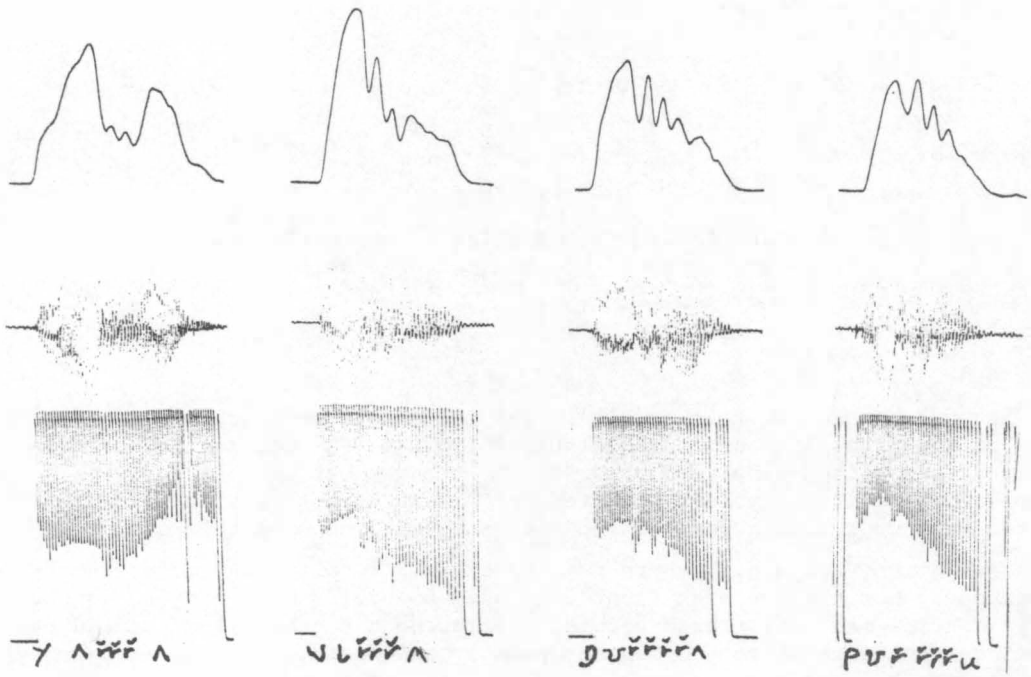
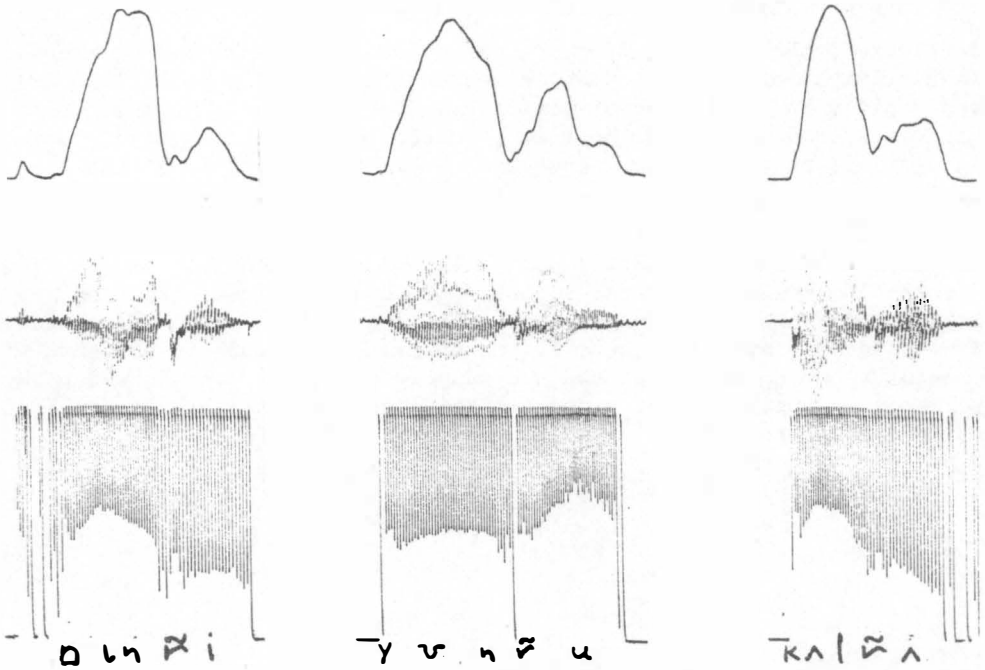


Figure 5

Mingograms of [ɣʌɾ̆ʌ] *away from here*, [wɪɾ̆ʌ] *wattle type*, [ŋʊɾ̆ʌ] *continuous*, [pʊr̃ʊ] *exclamation*, illustrating sequences of alveolar flaps produced rapidly.



the entirety (of a plant) *you* (ergative) 'human voices'

Figure 6

Alveolar trill [r̃] occurring as an onset when it follows a contoid in word medial coda position.

2.5 Non-syllabic vocoids

It has been shown that atypical contoids sometimes occur during the energy peak of a syllable. Vocoids can also be atypical. Instead of occurring as syllabic peaks they sometimes occur in the troughs between peaks. When this happens in Diari, the vocoid is interpreted according to the structural pressure of non-suspect syllable patterns and is assigned a consonantal role.

As in many languages, there are three Diari vocoids that occur in the consonantal position: a high front unrounded vocoid, a high back rounded vocoid, and a central mid retroflexed vocoid. Following the generally accepted practice of linguists, when these vocoids occur in a consonantal position they are given the consonant symbols usually ascribed to them. The high front vocoid is interpreted as the palatal consonant [y], the high back rounded vocoid is interpreted as the labio-velar consonant [w], and the central retroflexed vocoid is interpreted as the retroflexed resonant consonant [r]. Figure 7 shows mingograms of words containing these vocoids in medial coda/onset position.

Two of the above vocoids also occur as onsets in word initial position. In this position they are interpreted as the consonants [w] and [y]. Their interpretation in word initial position depends less upon the fact that they are onsets, than upon the fact that non-suspect vocoids never occur word initially. The established Diari word pattern always has one, and only one consonant at the

beginning of every word. Figure 8 and Figure 9 display mingograms of words beginning with high vocoids. In the figure, the initial vocoid is always different from the one in the nucleus, but the words shown in Figure 9 have only one high vocoid in the initial syllable. In these instances the vocoid is interpreted as consisting of a consonant vowel sequence, in order to agree with the non-suspect CV pattern and will be written [yɪ] or [wʊ].

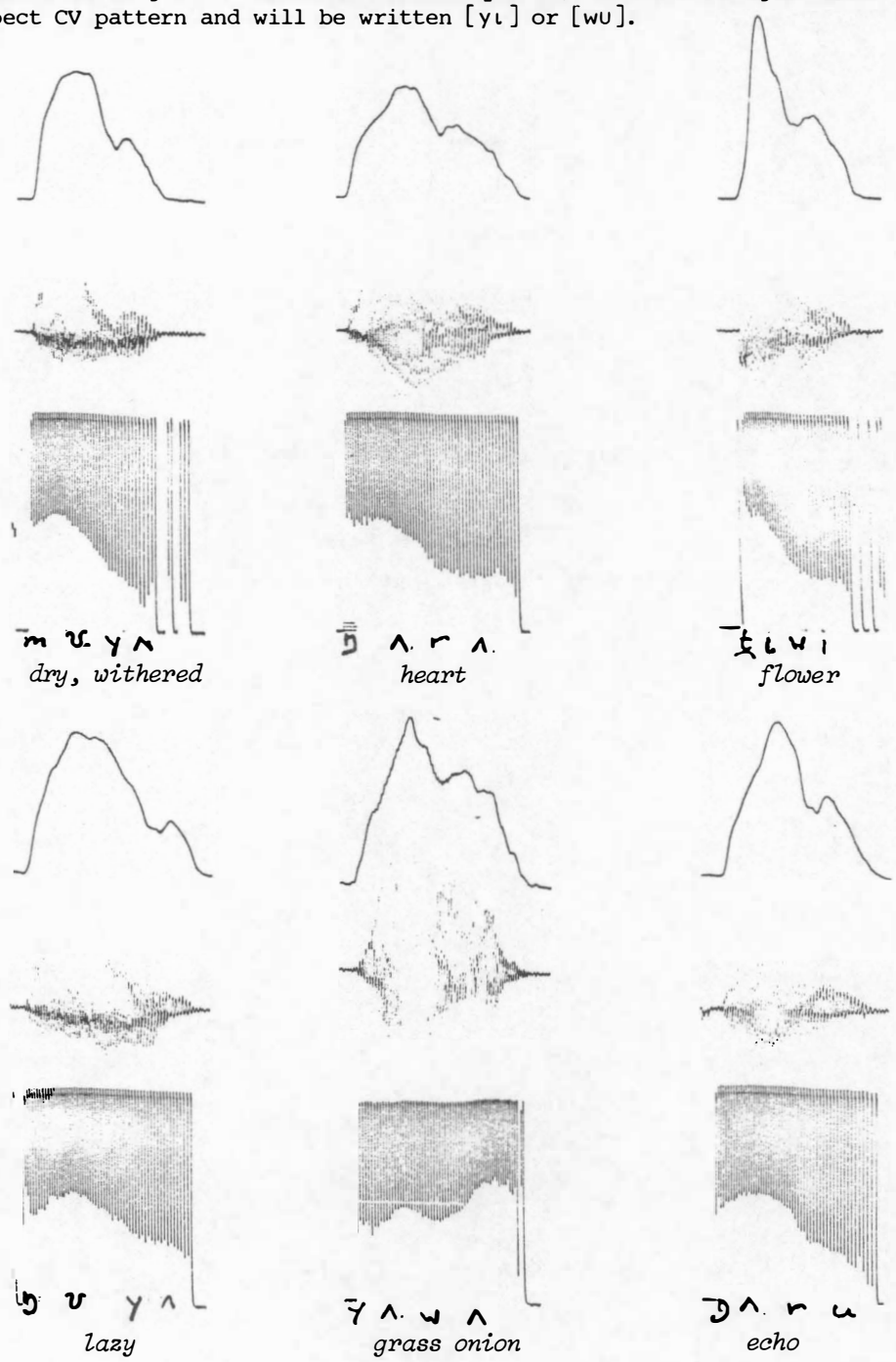


Figure 7

Vocoids occupying consonantal positions in the syllable structure and therefore interpreted as the consonants [y], [w] and [r].

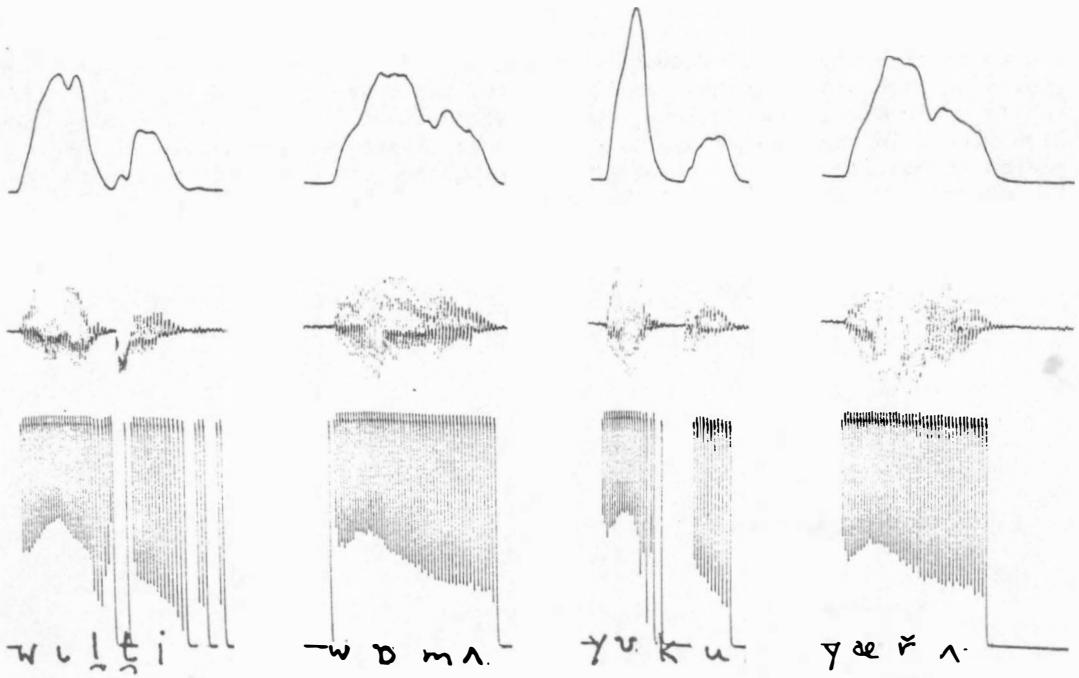


Figure 8

High vocoids occurring as word initial onsets.

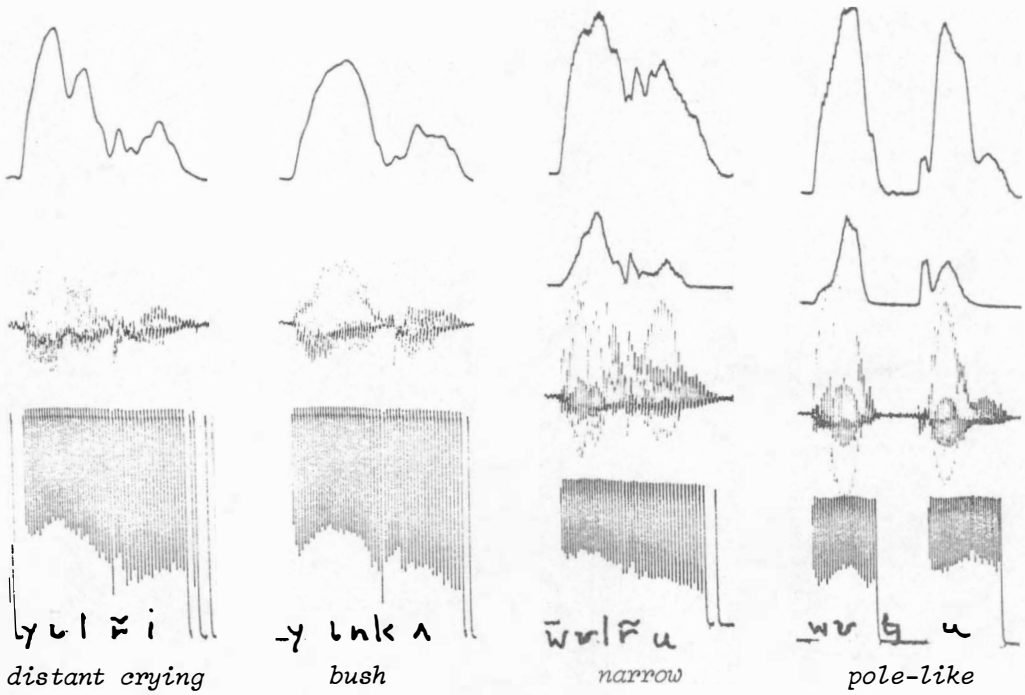


Figure 9

Word initial high vocoids interpreted
as consonant vowel sequences [yɪ] and [wʊ].

2.6 The interpretation of vocoid sequences

Interpretation procedures so far discussed have included vocoids which occur in typically consonantal positions, either at the beginning of the word, or in the troughs between syllables. These have been interpreted as sequences made up of consonant-vowel (see Figure 8), vowel-consonant-vowel (see Figure 7), or consonant-vowel-consonant-vowel (yʌwʌ *grass onion*, Figure 7).

There are other words in Diari with vocoid sequences that do not obviously fall into this consonant-vowel, or vowel-consonant-vowel pattern. Such sequences are interpreted differently, but their interpretation depends on a prior statement of the non-suspect Diari word pattern. All Diari words begin with a consonant and end with a vowel, and consonant clusters of two can occur word medially, but not initially. These facts of the language are substantiated by the examples given so far, and they become the basis for further interpretations involving vocoid sequences.

In the discussion so far it has been shown that high vocoids occurring in sequence with the low vocoid [ʌ] are interpreted as [w] or [y] when they occur at the coda/onset border of syllables. Some vocoid sequences, however, do not occur across syllable borders but occur within the nucleus of the syllable and should be considered separately as they may function as vowel sequences or as vowel glides. The sequences detected in this situation include the following: [ʌɪ], [ʌʊ], [ɪʌ], [ii], [uu], [ʌɪʌ], and [ɪʌɪ]. Figure 10 displays oscillograms with intensity and pitch readings of words containing these sequences. Of the two-vocoid sequences, [ɪʌ] must be interpreted as a two-vowel cluster. Should [ɪ] be interpreted as consonantal [y] it would transgress the Diari CV pattern of one and only one consonant as onset of a word initial syllable. [ʌ] is never consonantal so unless the structure of the phonetic syllable is ignored[11] the only possibility is to interpret [ɪʌ] occurring in the syllable nucleus as a two vowel cluster.

The other two-vocoid sequences are also vocalic. [ʌʊ] as it occurs in [n̪ʌʊ] *he*, begins with [ʌ], which is non-suspect, but in any case it occurs following an initial consonant which would make it vocalic. The other vocoid, [ʊ] is under the powerful invariant constraint of Diari which causes all words to end in a vowel. [ʊ] being word final, must be vocalic. [ʌɪ] as in [pʌḍʌɪ] *to hold* is interpreted as vocalic for the same reasons. [ʌ] is not suspect and [ɪ] is word final.

Though it has been established that all of the vocoids in the two sequences are vocalic, that does not mean that they are necessarily vowel sequences, for they could be interpreted as the glides [ʌʲ] and [ʌʷ]. They will, in fact be interpreted as single complex segments, from evidence to be found in the analysis of the two three-vocoid sequences.

The two three-vocoid sequences [ʌɪʌ] and [ɪʌɪ] both contain within them the combination [ʌɪ], e.g. [ŋʌɪʌnʌ] *we* (inclusive), [tɪʌɪ] *hits*, but the interpretation possibilities are different because of the difference in the sequential arrangement of the segments.

The CV (consonant-vowel) word pattern of Diari allows two possible interpretations for [ɪʌɪ], but three for [ʌɪʌ]. [ɪʌɪ] can be interpreted as consisting of the diphthong [ɪʌ] followed by a vowel [ɪ], or as consisting of the vowel [ɪ] followed by the glide [ʌɪ]. [ʌɪʌ] can be interpreted as consisting of the glide [ʌɪ] followed by [ʌ], or as consisting of the vowel [ʌ] followed by the diphthong [ɪʌ]. It can also be interpreted as containing three simple segments; [ʌ], followed by [y], followed by [ʌ].

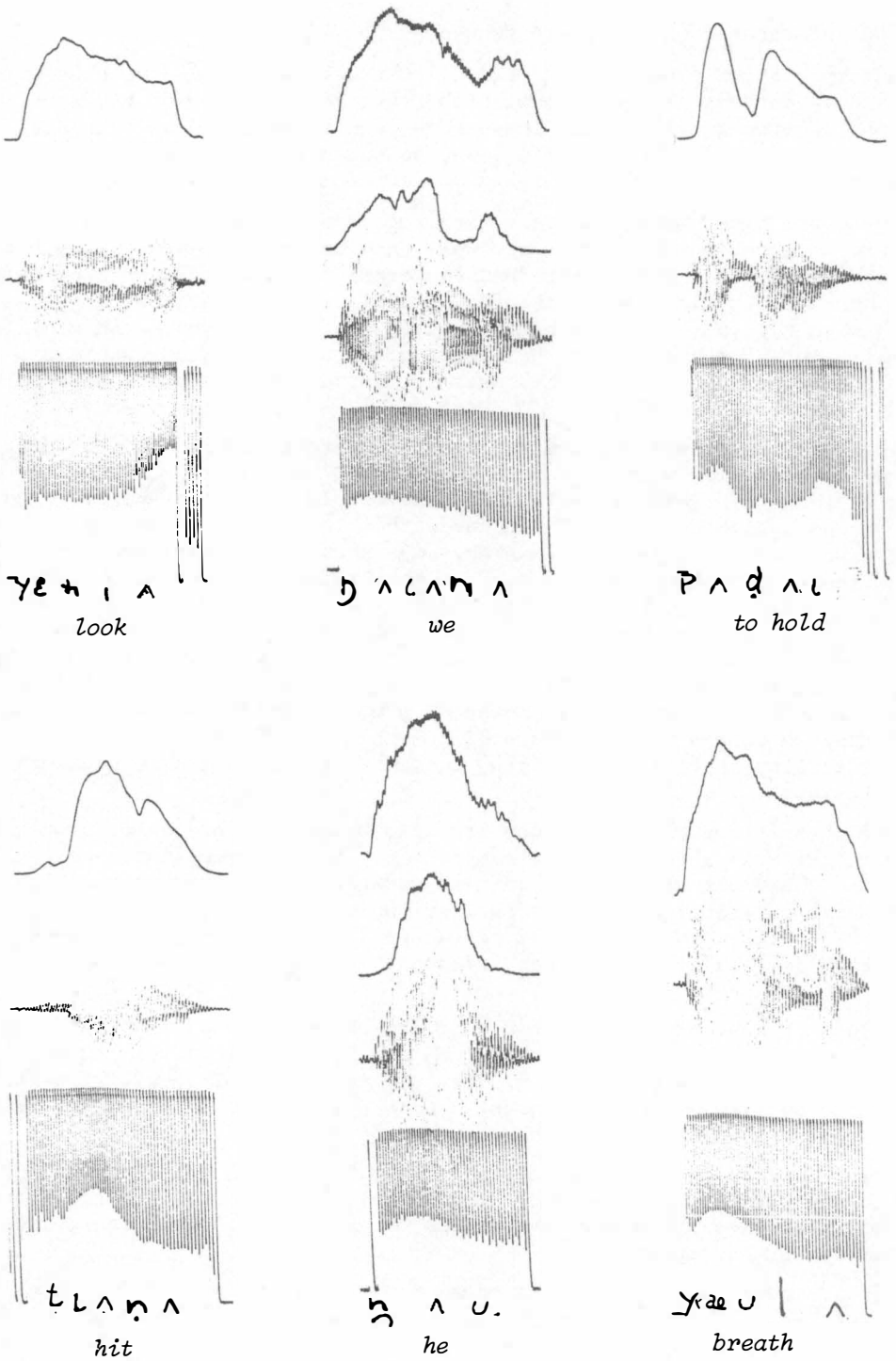


Figure 10

Diari vocoid sequences.

The last interpretation is rejected for the same reasons given for the two vocoid nuclei.

1) All three vocoids are contained within the one nucleus preventing the medial [ɹ] from being interpreted as a consonantal [y].

2) An initial consonant prevents an immediately following [ɹ] from being interpreted as consonantal [y].

3) A final [ɹ] must be vocalic.[12]

With the exclusion of [y] as one of the possible segment interpretations in the three-vocoid nucleus sequence, there are still two possibilities, either [ʌɹ] or [ɹʌ] could be interpreted as the complex segment.

In order to find a satisfactory solution it is necessary to look beyond the word distribution, and examine the intensity pattern of the vocoid sequences and the duration of the steadystates and transitions of the vocoids. Unfortunately, the acoustic evidence is meagre, as the words recorded for acoustic analysis were taken from a list which was basically of two syllables, usually with a single vowel in the stressed syllable. A few other words were included for possible minor comparisons and among these were three which contained three vocoids in the stressed syllable. Although meagre, the evidence from the analysis of the three words substantiates auditory impressions, and it is worthwhile to include it here as an illustration of the processes involved in differentiating a simple vocoid from a complex glide.

The three words under examination were each uttered by the same speaker three times. They were recorded on a Nagra III tape recorder and subsequently sonagrams were produced on a Kay Sonagraph at the Speech and Language Research Centre at Macquarie University. Figures 11 and 12 display these sonagrams. The table below gives a measurements in centi-seconds for the nine utterances. Four measurements are given for each word.

1. The duration from the beginning of the onset transition to the steady-state position of the first [ʌ].

2. The duration from [ʌ] steady-state to the steady-state of [ɹ].

3. The duration from [ɹ] steady-state to the steady-state of the second [ʌ].

4. The duration from the second [ʌ] steady-state to the end of the coda transition.

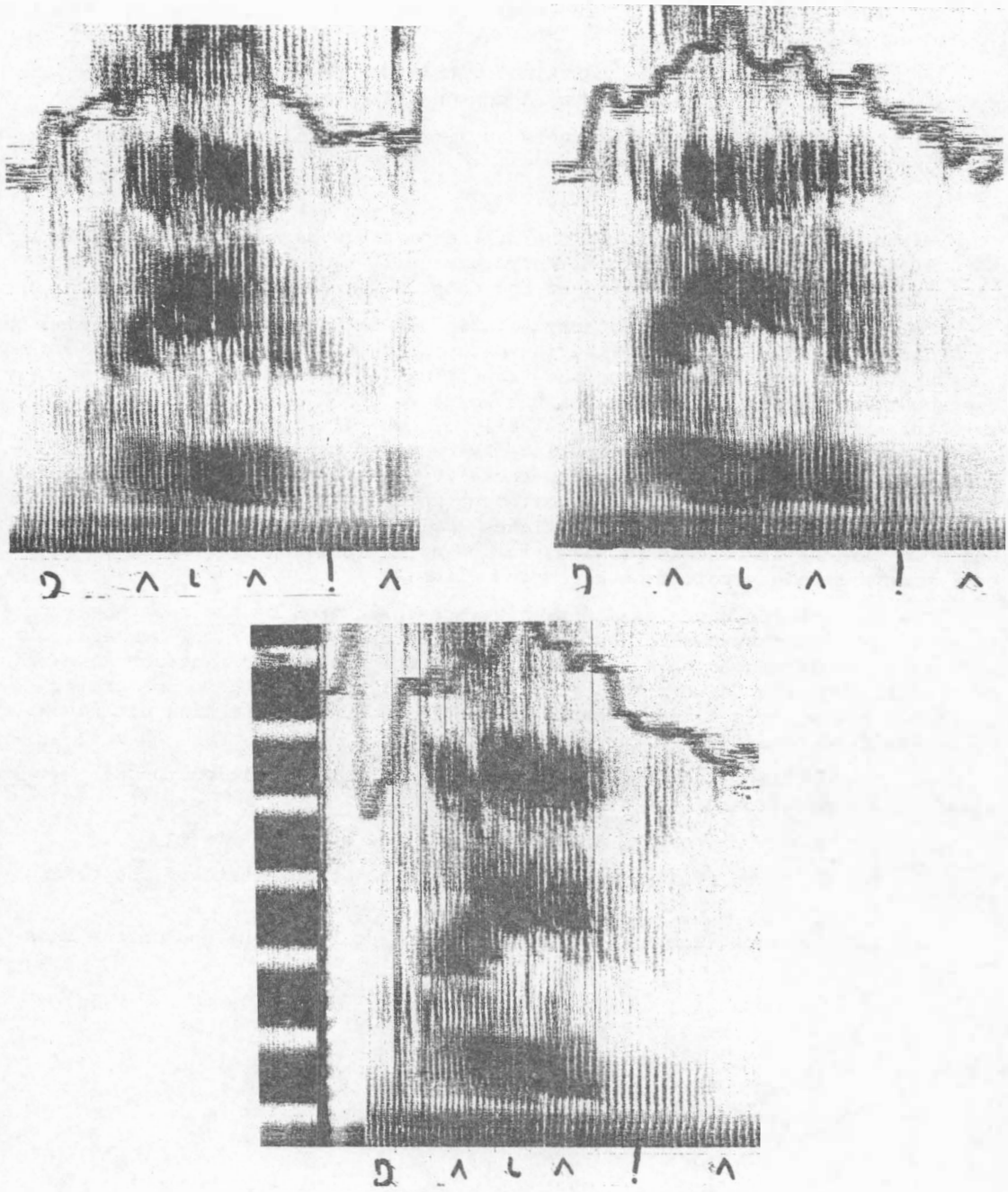


Figure 11

Sonagrams of [ŋʌɪʌ!ʌ] *sounds*, indicating the structure of the first three formants. The third sonagram contains a calibrated energy burst marking off each 500Hz.

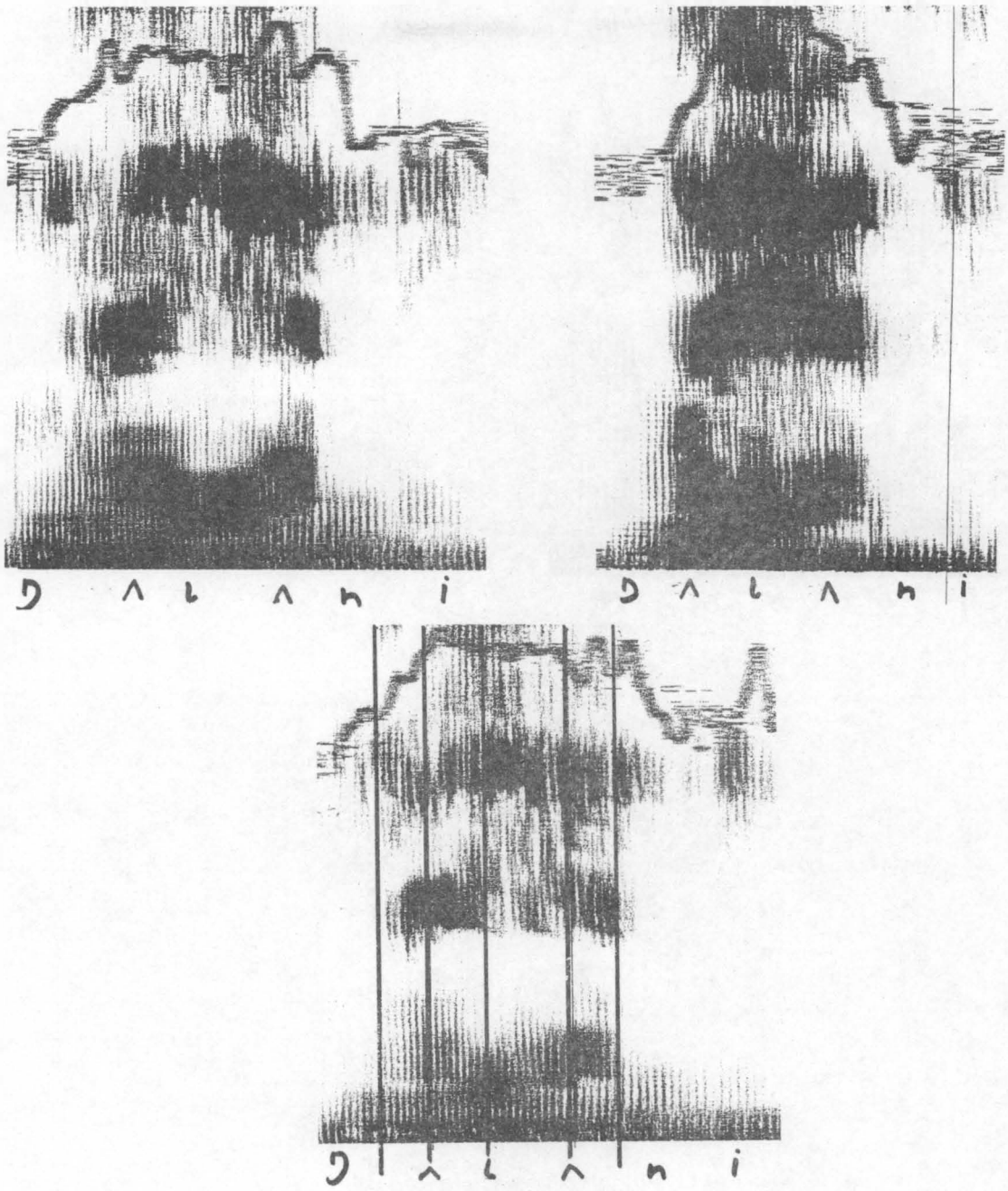


Figure 12

Sonagrams of [ŋʌɪʌni]* *we* (exclusive). The third sonagram has vertical lines added to indicate the commencement of vocoid transition, and the centres for [ʌ] target, [ɪ] target, and second [ʌ] target, and finally, the end of final vocoid transition.

*The second low vowel is often heard as [æ] under the influence of the preceding [ɪ]. The reasons for this are discussed in section 4.

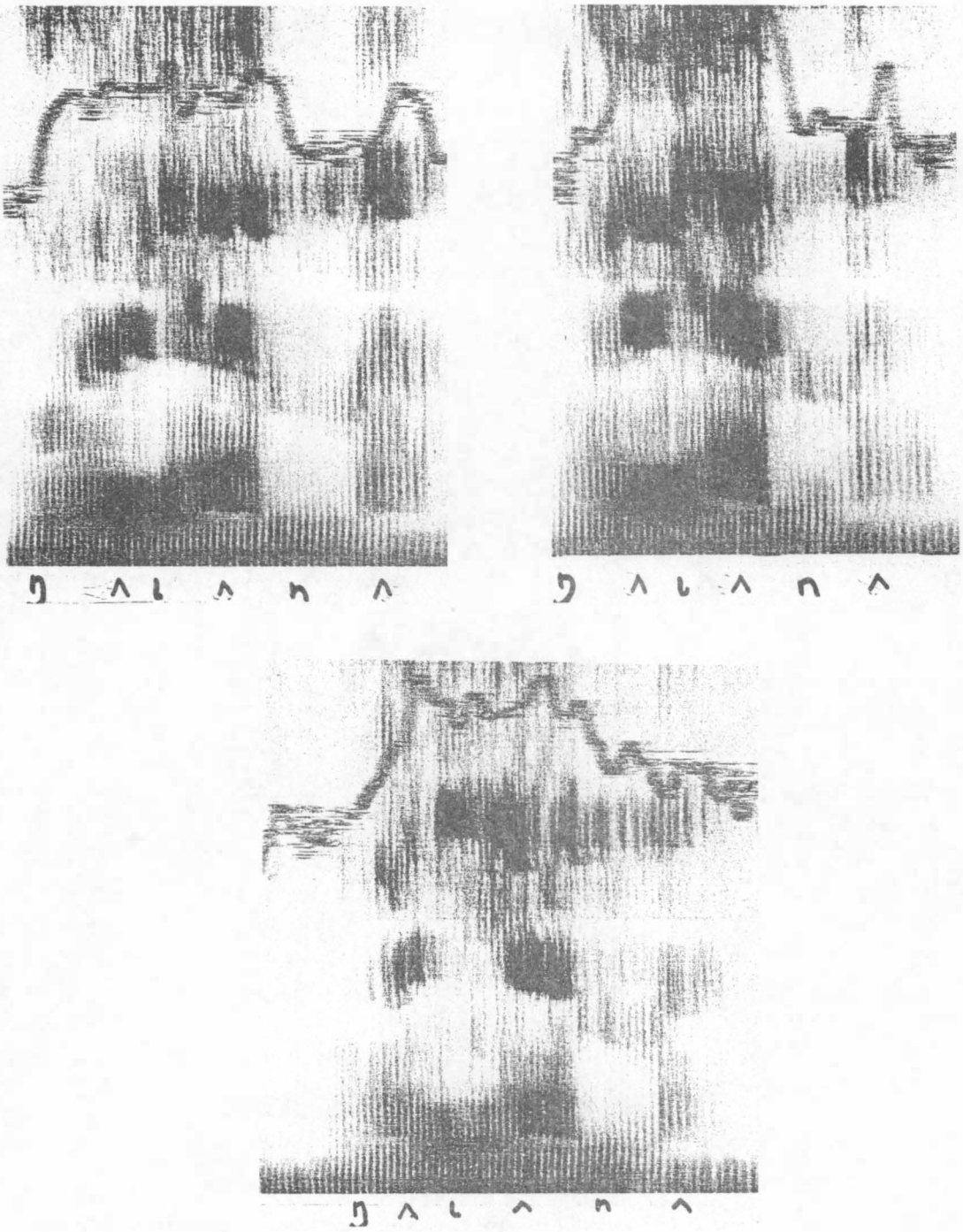


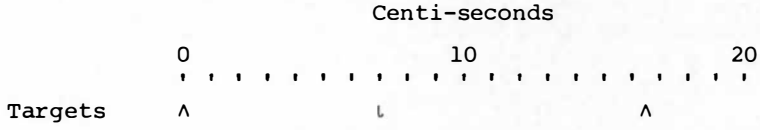
Figure 12 (cont)

Sonagrams of [ŋʌɪʌnʌ] *we* (inclusive)

Table 2: Duration in centi-seconds of measurements connected with three-vocoid sequences

	Word	Beginning of transition to centre of first [ʌ] target	Centre of [ʌ] target to centre of [ɪ] target	Centre of [ɪ] target to centre of second [ʌ] target	Centre of [ʌ] target to end of transition
1	ŋʌ ɪʌni	9.9	9.9	9.9	5.7
2	ŋʌ ɪʌni	6.8	6.3	10.7	6.0
3	ŋʌ ɪʌni	6.3	7.4	10.5	6.3
1	ŋʌ ɪʌnʌ	3.3	5.7	9.1	5.3
2	ŋʌ ɪʌnʌ	9.3	5.3	10.7	4.5
3	ŋʌ ɪʌnʌ	6.3	5.7	7.7	3.0
1	ŋʌ ɪʌlʌ	5.3	7.7	8.0	3.0
2	ŋʌ ɪʌlʌ	4.5	8.0	11.0	10.7
3	ŋʌ ɪʌlʌ	6.0	7.7	8.7	7.7

The significant measurements in this table are those indicating the time which elapses between the target of the first [ʌ] and [ɪ], and between [ɪ] and the target of the 2nd [ʌ]. In terms of duration, [ɪ] is shown to be consistently more closely related to 1st ʌ than 2nd ʌ, there being a time elapsed mean of 7.1 centi-seconds between 1st ʌ and ɪ but of 9.6 centi-seconds between ɪ and 2nd ʌ. Diagrammatically the difference in time relationship is easily seen.



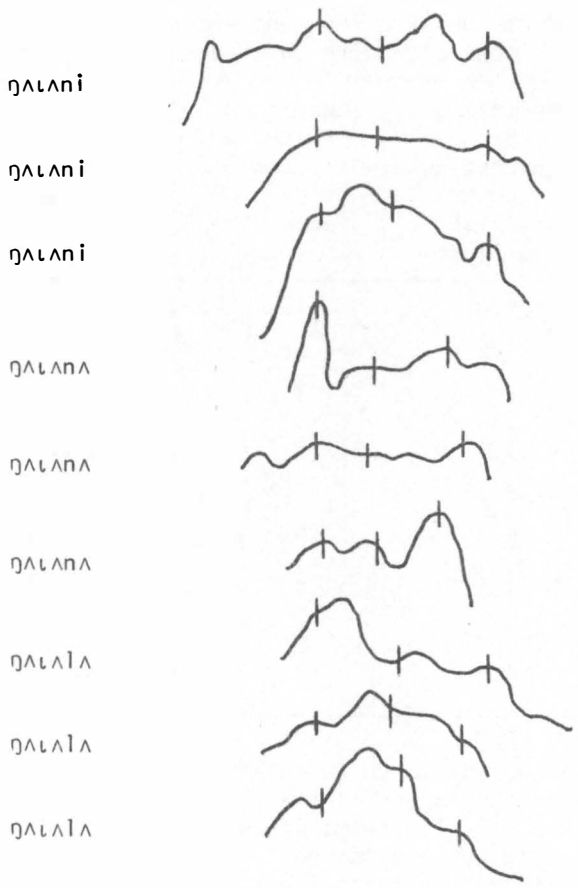


Figure 13

Amplitude displays of three sets of Diari words with intersecting lines where the vocoid target centres are reached in the formant displays.

As well as the relationship based upon duration differences another significant relationship between 1st ʌ and ɪ can be observed on the acoustical displays. Figure 13 reveals that characteristically 1st ʌ and ɪ are associated with the same intensity peak, usually approximating the target of 1st ʌ.[13] The 2nd ʌ on the other hand is disassociated from that peak by a minor trough, and instead is associated with a peak of its own.

Thus it can be seen that 1st ʌ and ɪ are associated through time and intensity pattern. These two facts together with the auditory impression gained on hearing the words, give good grounds for interpreting 1st ʌ and ɪ as the glide [ʌɪ], and the 2nd ʌ as a juxtaposed vowel [ʌ]. Also, based on these findings the sequence ɪʌɪ is interpreted as the vowel [ɪ] followed by the glide [ʌɪ].

The sequence [ʌʊ] has been recorded occupying the same nucleus with other vocoids but unfortunately these recordings were made of fast speech during text narration and it is uncertain whether or not syllable boundaries would have

occurred if the words were spoken in isolation. However, as has previously been mentioned ʌʊ does occur sharing the syllable nucleus (Figure 10), which means the sequence in those situations is vocalic without any consonantal interruption. Therefore the sequence should be interpreted as a vowel cluster or as a vowel glide. In this study it is taken to be a vowel glide based on the fact that ʌʊ is analogous with ʌɪ, ʌ having a velar off-glide on the one hand and a palatal off-glide on the other.

The remaining vocoid sequences to be examined are [ii] and [uu]. Each of these has only been detected as occurring once, [ii] in [nii] *brother*, and [uu] in [kuu] *don't know*. The important point that needs to be noticed here is that geminate vocoid clusters only occur in monosyllabic words. Another important fact that needs to be added to this is that non-lengthened [i] and [u] do not occur in mono-syllabic words but the complex vowels [ʌɪ] and [ʌʊ], do, e.g. [n̪ʌʊ] *he* (nom.) and [n̪ʌɪ] *see*. Thus it is concluded that mono-syllabic word final monophthongs are lengthened, with the result that the vocoid sequences [uu] and [ii] are interpreted as [u:] and [i:].

2.7 Interpretation of sequences containing both contoids and vocoids

Sequences involving contoids and vocoids are of two types in Diari. The first type consists of a contoid with a high front vocalic release, which can be interpreted as one of the palatal consonants [ʂ], [ɲ] and [ʎ], or as a consonant followed by the high front vowel [i]. Figures 14-16 indicate with sonagrams the three complex sequences in contrast with similar words which do not have the vocalic release. Apart from [pɪʂi] it can be noticed that in each pair of sonagrams the transitions of the second formants to and from the contoid loci are more angled for the palatal contoid than they are for the others. This explains the physical basis for the two interpretations of these segments. An examination of [pɪʂi] *tree bark* shows there is no appreciable variation of the transition as it leaves the contoid locus, and moves towards the vowel target.[14] In other words, the locus of the second formant for Diari palatal contoids approximates that for the vocoid [ɪ].

The interpretation of these contoid, vocoid sequences is relatively straightforward. As [ʂ] and [ɲ] occur word initially and consonant clusters are not permitted word initially, they cannot be considered to be the sequence [ty] and [ny]. Laterals do not occur word initially, but [ʎ] does occur medially preceding [ʂ], and as Diari does not have medial clusters of three, the sequence [ʎʂ] cannot be interpreted as [lyty]. Figures 17-18 display sonagrams with these three segments in positions which would not allow them to be interpreted as CC.

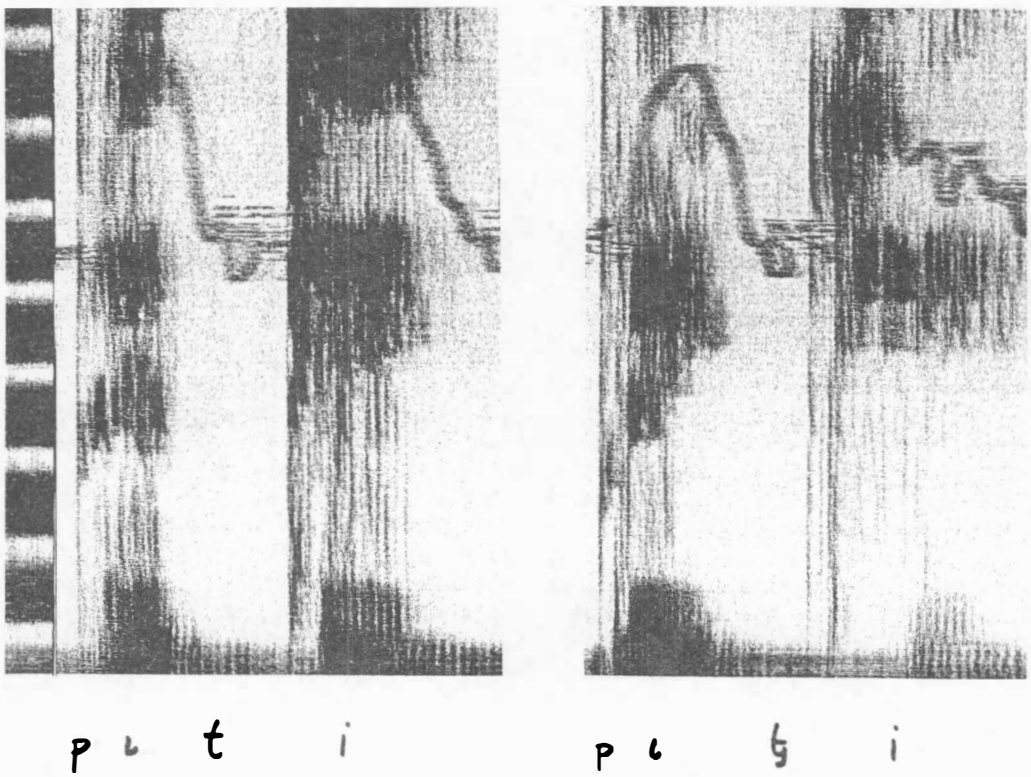


Figure 14

Sonagrams of [pɪti] *buttocks* and [pɪʈi] *tree bark*, illustrating the contrast between [t] and [ʈ].

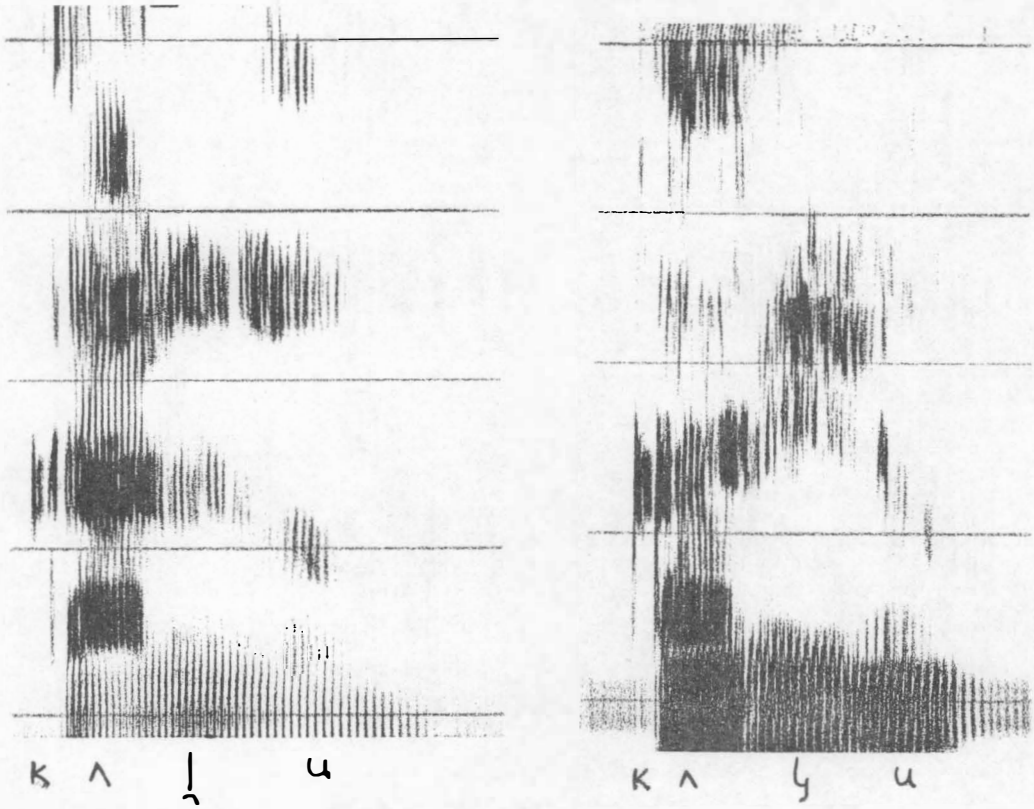


Figure 15

Sonagrams of [kal̪u] *liver* and [kaɻu] *acacia type* illustrating the contrast between [l̪] and [ɻ].

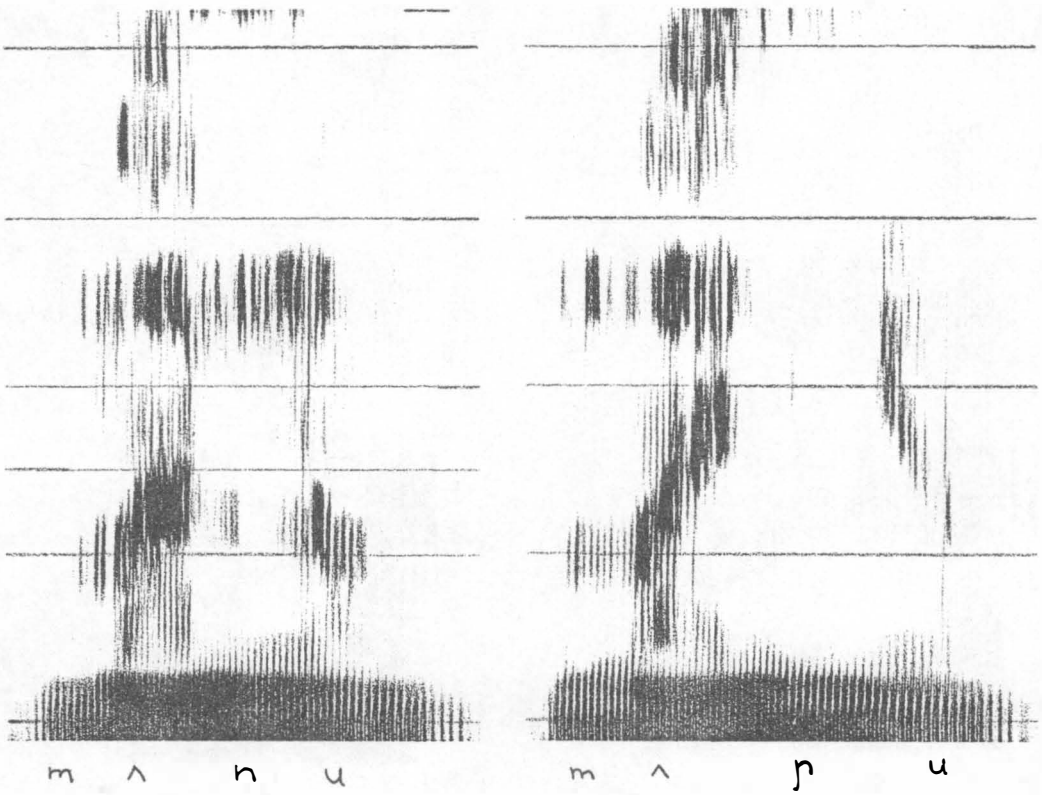


Figure 16

Sonagrams of [manu] *soul* and [maɲu] *sprightly* illustrating the contrast between [n] and [ɲ].

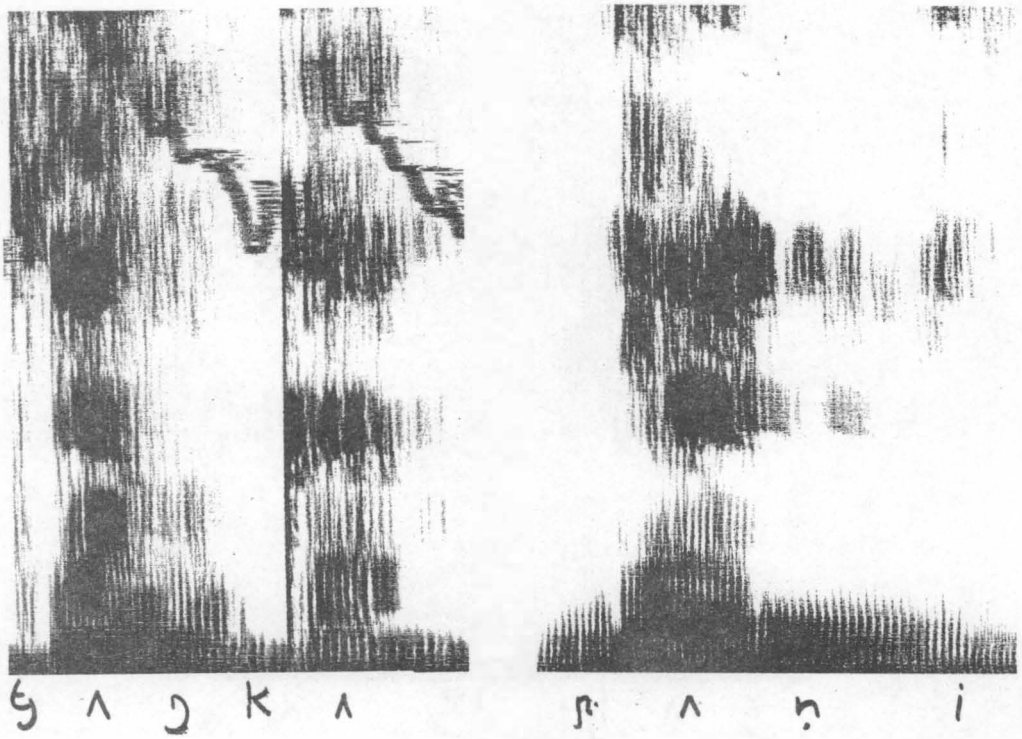


Figure 17

Sonagrams of [ʂʌŋkʌ] *soft* and [ɲʌn̥i] *blunt* with [ʂ] and [ɲ] in positions which determine they must be single complex segments.

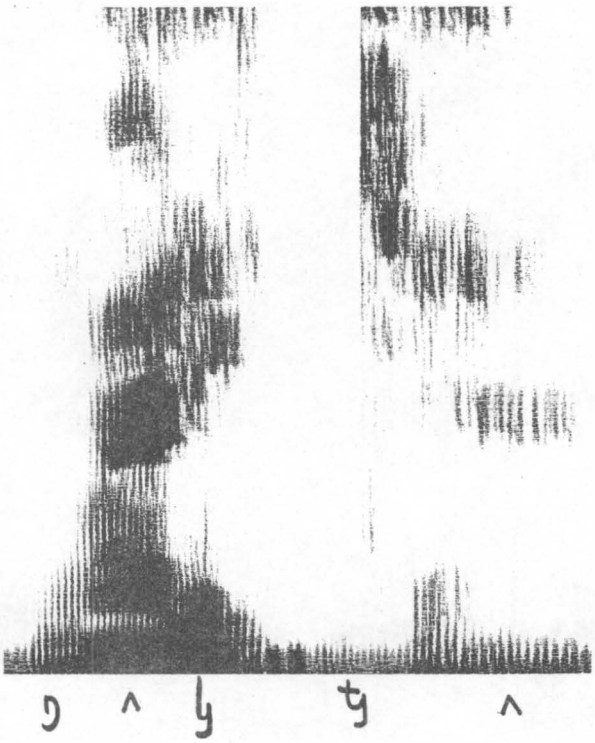


Figure 18

A sonagram of [ŋʌʃʧʌ] *saliva* with [ʃ] and [ʧ] in positions which determine they must be single complex segments.

That the segments are not interpreted as a consonant followed by /i/ is explained by the fact that [ʂ] and [ʃ] occur word medially before /i/ and geminate clusters (apart from mono-syllabic CV words as mentioned previously) do not occur in Diari. In the data gathered for this study no words were discovered with [ɳ] preceding [i] but because of the analogous structure of [ɳ] with the other two palatals it is assumed it will function similarly to the other two and thus not be interpreted as an alveolar followed by a high vowel.[15]

Since the contoid-vocoid sequences cannot be interpreted as a sequence of consonants or of a consonant followed by a vowel, it is concluded they are single complex palatal segments [ʂ], [ɲ] and [ʃ]. Figures 19-20 illustrate the differences of formant structure between words containing a palatal followed by [i] and words containing an alveolar in the same environment. Again it can be noticed how the second formant vowel transitions are considerably higher under the influence of the palatals.

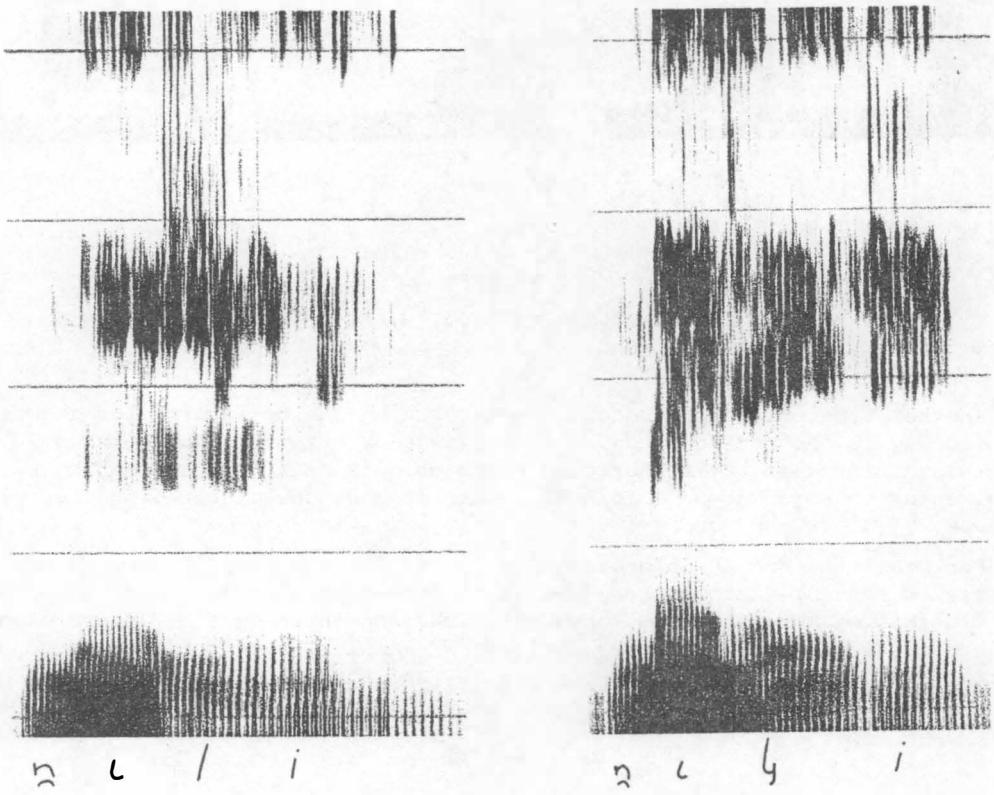


Figure 19

Sonagrams of [n̪ɪli] *needle* and [n̪ɪʃi] *egg white* illustrating the influence [l] and [ʃ] have upon vowel transitions.

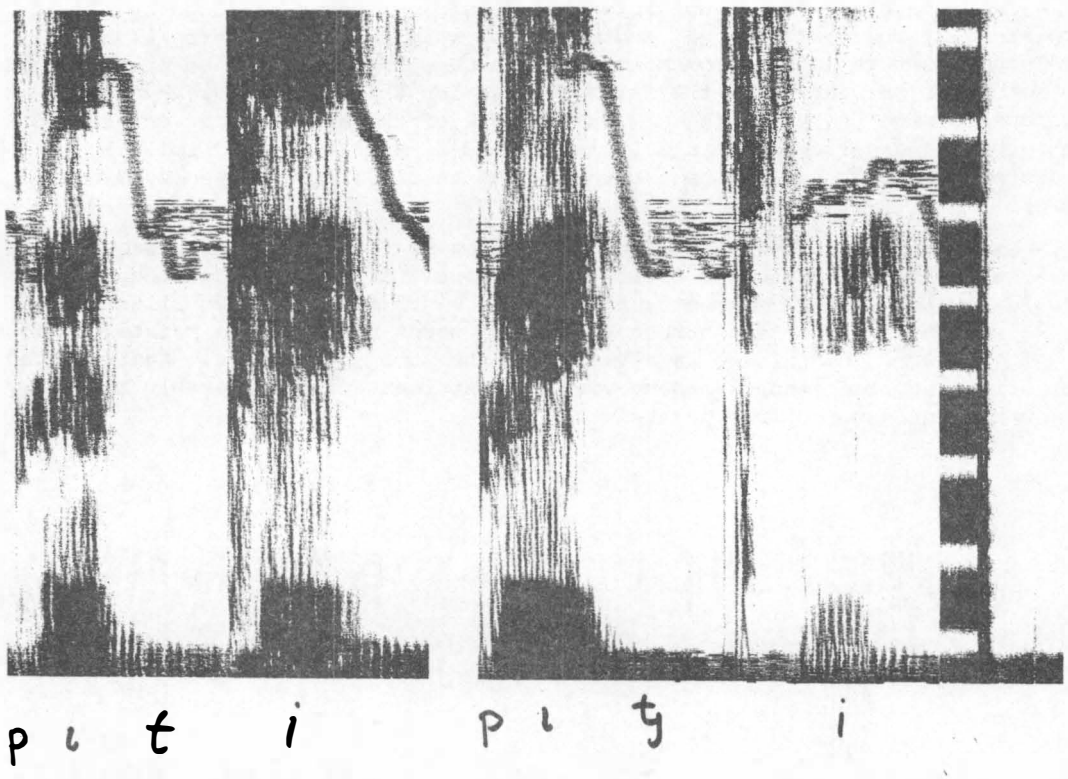
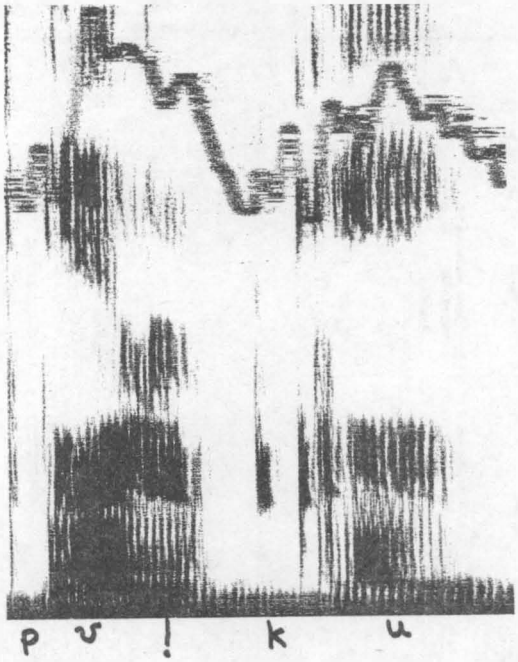


Figure 20

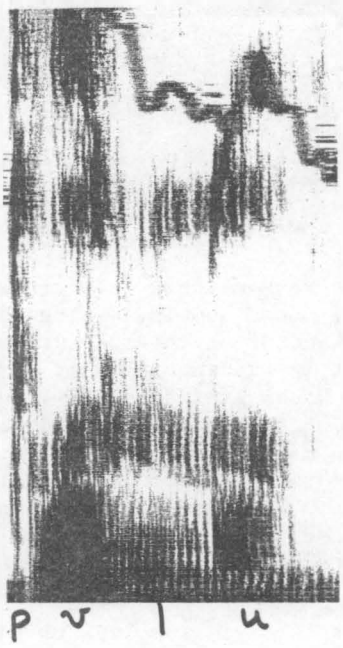
Sonagrams of [pɪti] *buttocks* and [pɪʈi] *tree bark* illustrating the influence [t] and [ʈ] have upon vowel transitions.

Another type of contoid/vocoid sequence which can be interpreted in more than one way is the retroflexed vocoid followed by a retroflexed contoid. This can be interpreted as the retroflexed resonant consonant [r] followed by one of the alveolar consonants, or it can be interpreted as one of the single complex segments, [t̪], [d̪], [n̪] or [l̪].

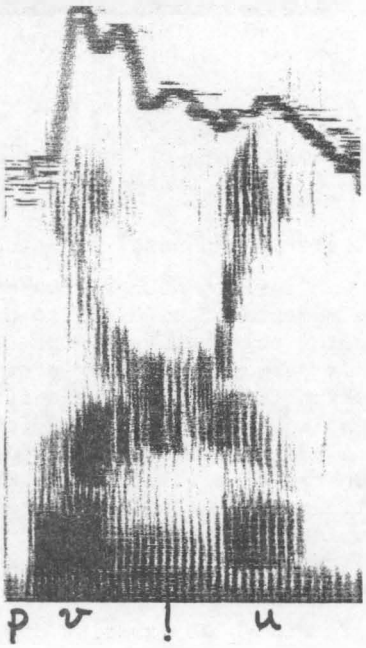
For Diari the second interpretation is the correct one, for the reason that retroflexed sequences occur preceding other consonants, and as Diari does not have clusters of more than two consonants, the sequences must be interpreted as single complex segments. Figures 21-22 show examples of retroflexed consonants occurring in clusters with other consonants, and these are contrasted with other words. [l̪] is also contrasted with [l], the third formant being considerably lowered for [l̪].



half satisfied



unable



satiated

Figure 21

Sonagrams of words containing laterals in order to illustrate [l̥] occurring in a consonant cluster, and contrasting it with [l̥] and [l] between vowels.

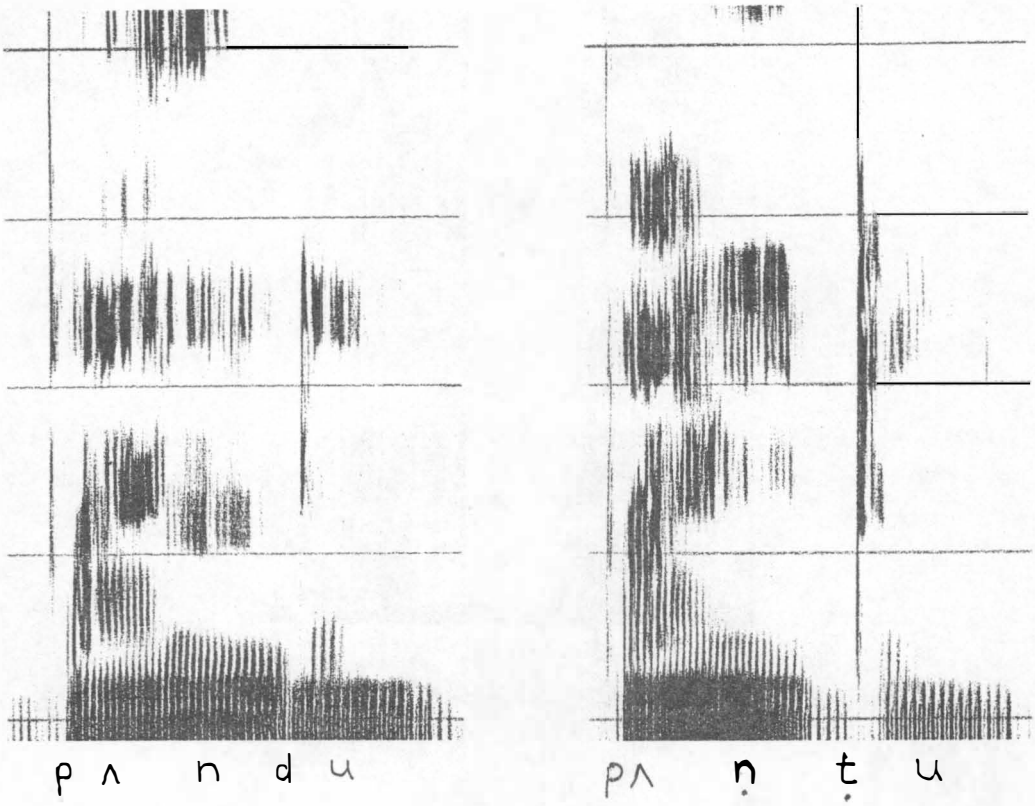


Figure 22

Sonagrams of [pʌndu] *lake* and [pʌṇṭu] *blunt* illustrating [ṇ] occurring in a consonantal cluster and differentiating it from [n].

2.8 Lateral and nasal pre-stopping

In Diari, together with other languages of the region there is a tendency for a momentary occlusion to occur preceding laterals and nasals.[16] The occlusion only occurs before dentals and alveolars and often the obstruction of the air passage is incomplete. Sometimes it is not in evidence at all. If the occlusion is complete there is a definite 'd'-like sound preceding the lateral or nasal. Pre-stopping only occurs between vowels. If it occurs following an initial (i.e. primary stressed) vowel the occlusion may be complete. Otherwise the obstruction will only be partial.[17] Also, as noted by Austin,[18] an intervocalic nasal following a word initial nasal will not be preceded by a complete occlusion. In this situation the velum is not raised after the completion of the first nasal so it is not possible for a complete occlusion to occur preceding the second nasal.

In Figure 23 examples are given of words where there is complete or partial pre-stopping. The first example, /puḻa/ [pu^{d}lʌ] *they two*, is particularly interesting. There is an almost complete occlusion of 3.7 centi-secs, followed by a duration of 4.2 centi-secs of friction, followed by a moment of air turbulence (seen as a long striation preceding from 1000-4000 Hz) followed by 5.8 centi-secs of 'lateral' sound. The other words in the figure exhibit various degrees of obstruction preceding the lateral or nasal.

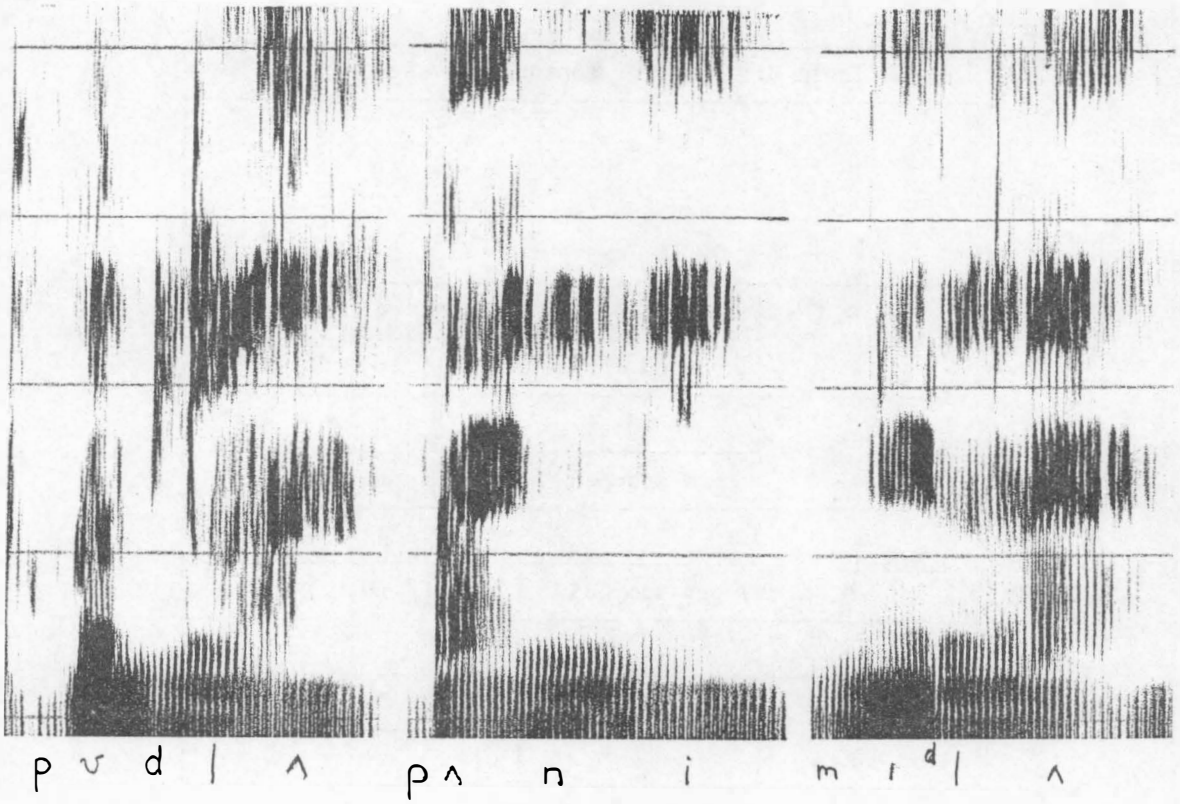


Figure 23

Spectrograms of [pʊ$\underset{\frown}{\text{d}}$lʌ] *they two*, [mɪlʌ] *thigh bone*, and [pʌni] *none*, showing differing degrees of air-flow obstruction preceding lateral or nasal consonants.

2.9 Summary of phonetic segments

The segmentation procedures used have resulted in the formulation of twenty-seven consonants and five vowels. If the consonants are indicated by normal articulatory methods, they can be presented by Table 3.

Table 3: Chart of consonantal segments

		bilabial	interdental	alveolar	retroflexed	alveopalatal	velar
Stops	voiceless	p	t̪	t	ʈ	ʧ	k
	voiced			d	ɖ		
Nasals		m	n̪	n	ɳ	ɲ	ŋ
	pre-stopped		d͡n̪	dn			
Laterals			l̪	l	ɭ	ʎ	
	pre-stopped		d͡l̪	dl			
Flap			ɾ̪				
Trill			r̪				
Semi-vowel		w			ɾ	y	

The Diari vowels are not so easily described, for as will be shown later the sum of their instances correspond to a two dimensional continuum of sound change rather than a series of discrete entities. If however, the vowels are noted according to auditory impressions gained during field recording, the following Figure can be devised.

	front	central	back
high	ɪ i		u ʊ
mid	ɛ	ə	
low	æ	ʌ	ɒ

Figure 24

Diari vowel plots based upon auditory impressions

The vowels shown on the above chart are illustrated on the next four pages in the form of sonagrams.

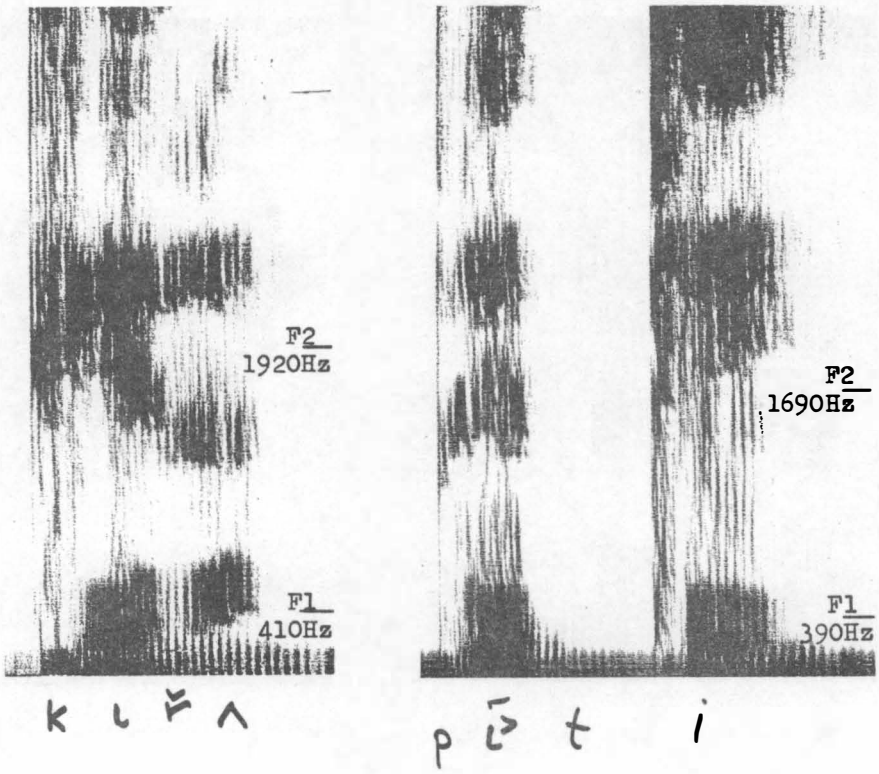


Figure 25

Sonagrams of [kɪɻʌ] *boomerang* and [pɻti] *buttocks* illustrating F1 x F2 formant structures for [ɪ] and [ɻ]. Horizontal lines with Herz readings indicate measurements of F1 and F2 at target.

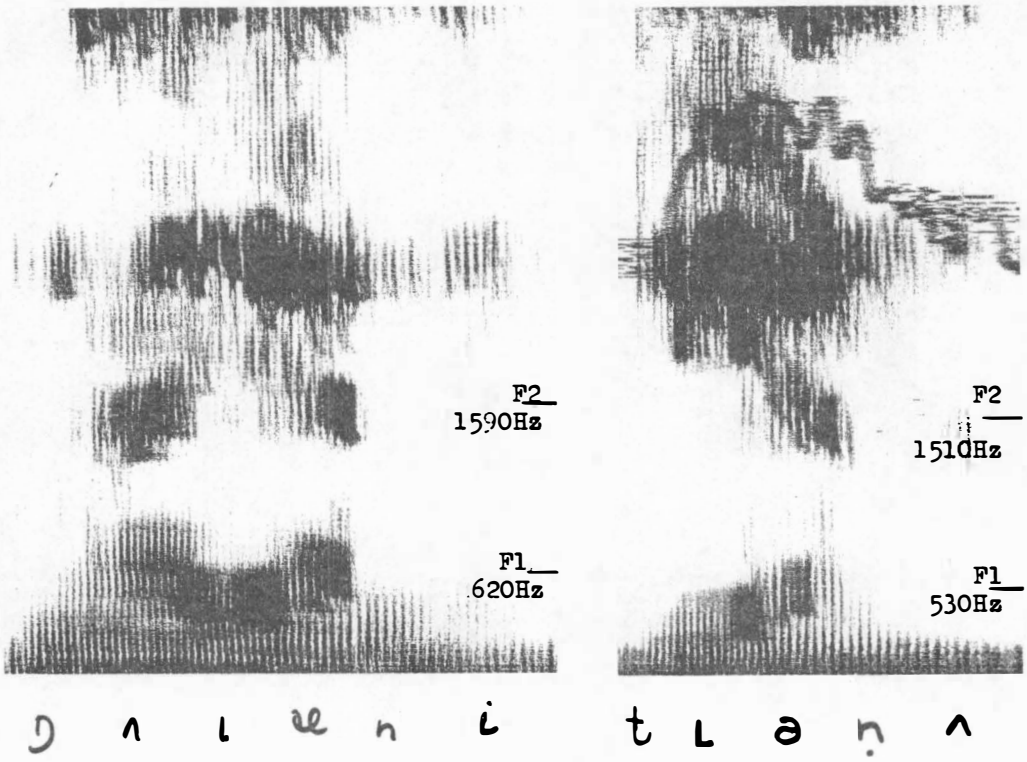


Figure 26

Sonagrams of [ŋʌɪæni] *we* and [tɪən̩ʌ] *boomeranged* illustrating F1 x F2 formant structures for [æ] and [ə]. Horizontal lines with Herz readings indicate measurements of F1 and F2 at target.

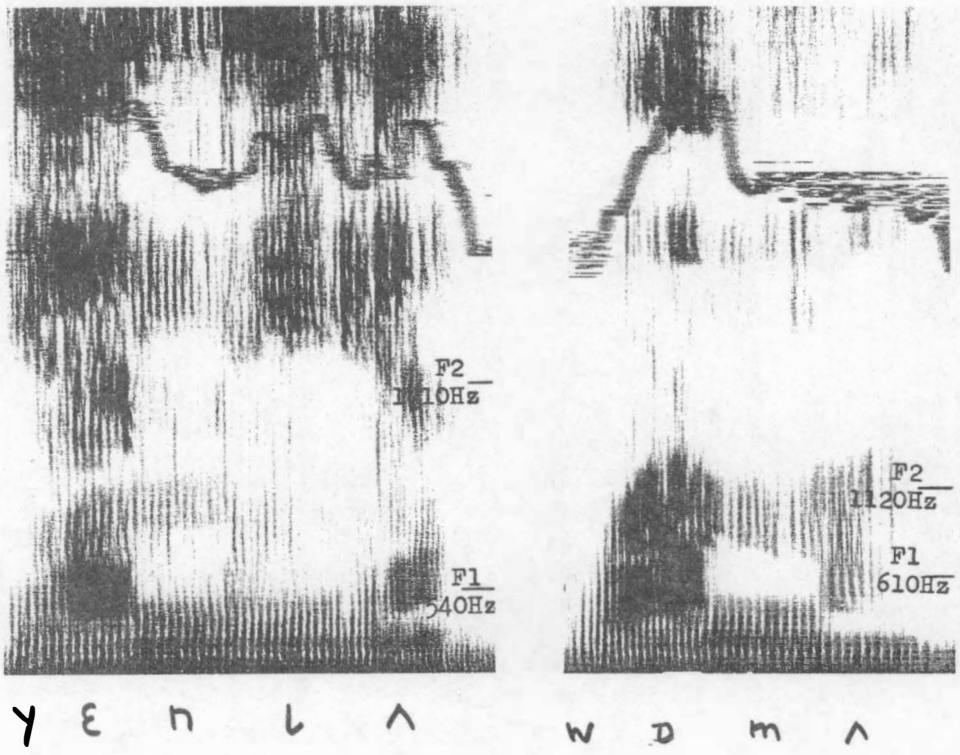


Figure 27

Sonagrams of [yɛnɩʌ] *like this* and [wɒmʌ] *carpet snake*, illustrating F1 x F2 formant structures for [ɛ] and [ɒ]. Horizontal lines with Herz readings indicate measurements of F1 and F2 at target.

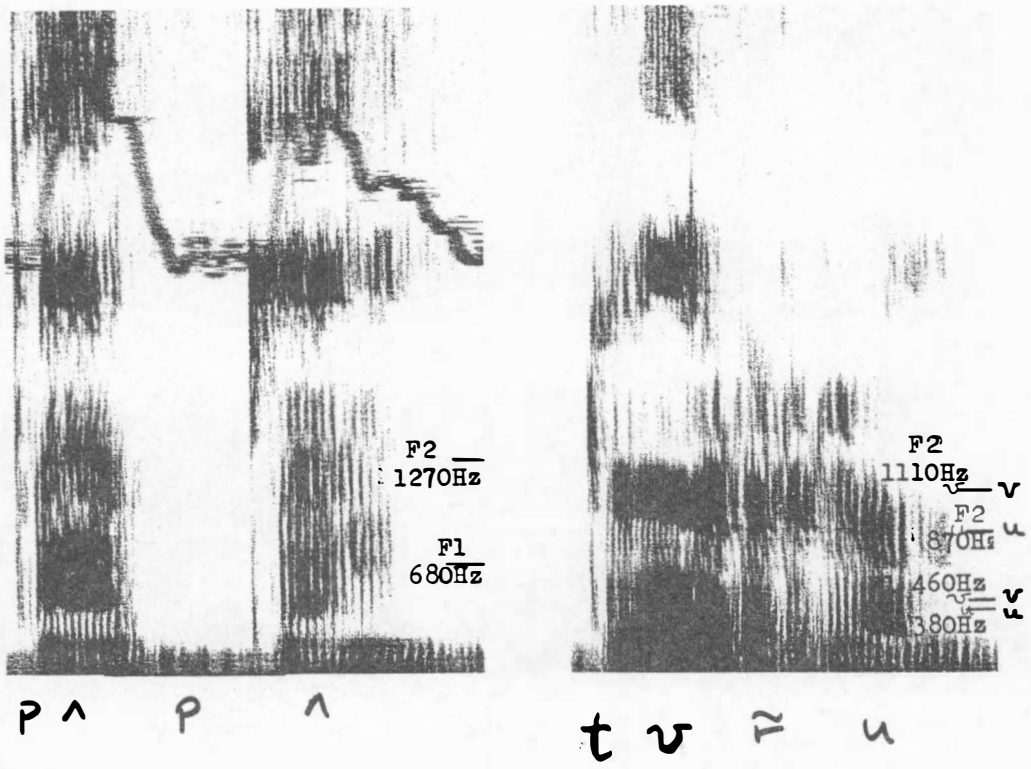


Figure 28

Sonagrams of [pʌpʌ] *father's sister* and [tʊr̆u] *hard ground*, illustrating F1 x F2 formant structures for [ʌ], [ʊ] and [u]. Horizontal lines with Herz readings indicate measurements of F1 and F2 at target.

The vowels indicated on the preceding sonagrams can be plotted on an acoustic vowel graph, and as can be seen in Figure 29 these plots are in agreement with the auditory impressions. However, as will be explained later, it would be very easy to find other words where the vowel targets vary considerably from those given.

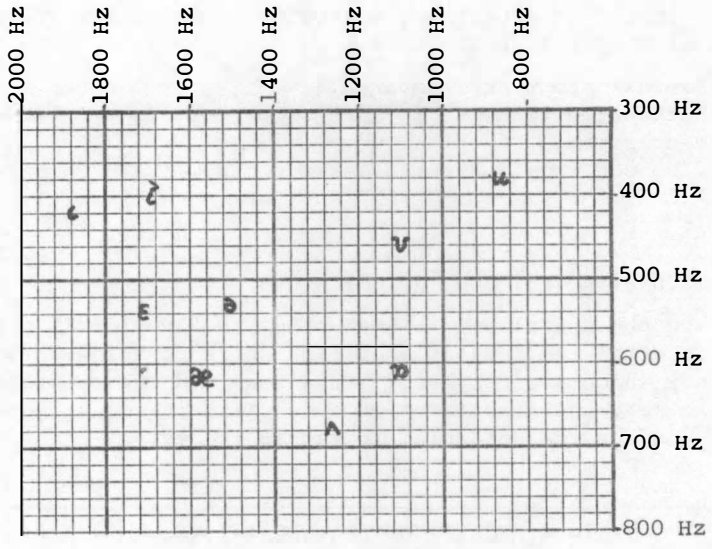


Figure 29

Vowel targets indicated in Figures 25-28 plotted on an acoustic vowel graph.

3. THE CONSONANT PHONEMES

The phonemes of Diari have been established on the basis of contrast. If the substitution in a word of one phonetic segment for another signals a change in meaning it is concluded the two segments belong to different phonemes. If it is not possible to find such minimal pairs, but nevertheless there is no evidence for uniting the segments as allophones, they can be shown to be contrastive in sub-minimal sets. Phonetic segments which are auditorily or articulatorily distinct but not contrastive, are united as allophones of the same phoneme. Uniting segments may fluctuate within a word, or their occurrence may depend upon the phonetic environment.

Consonants have been classified according to articulatory field methods. This means a phonetic symbol is used to represent a segment which has been identified by the observation of the informant's articulatory processes, together with the auditory impression gained by the investigator at that time.

Though it has been stated that phonetic symbols have been used to represent the articulatory sounds, there are some exceptions. Digraphs are used, instead

of the Pike[19] or I.P.A. symbol, for interdentals, alveo-palatals, and the alveolar trill. The digraphs representing alveo-palatals are those usually adopted by linguists when recording Australian Aboriginal languages. Those representing inter-dentals are also occasionally used. The digraph [rr] is used to represent the alveolar trill because of the unusual situation which exists in Diari where three 'r' type sounds are contrastive. The laterally released affricate [d͡l] is represented as [dlh] to keep it analogous with the other inter-dentals. The modified chart of consonants in Table 4 indicates the symbols that will now be used to describe the Diari consonants.

In order to arrive at a decision on the phonemic status of the segments four major sets of comparisons are made.

1. Apical and laminal stops are compared.
2. Nasals, with the exception of [m], are compared.
3. Laterals are compared.
4. Flap, trill, voiced stop and retroflexed semivowel are compared.

3.1 The comparison of apical and laminal stops

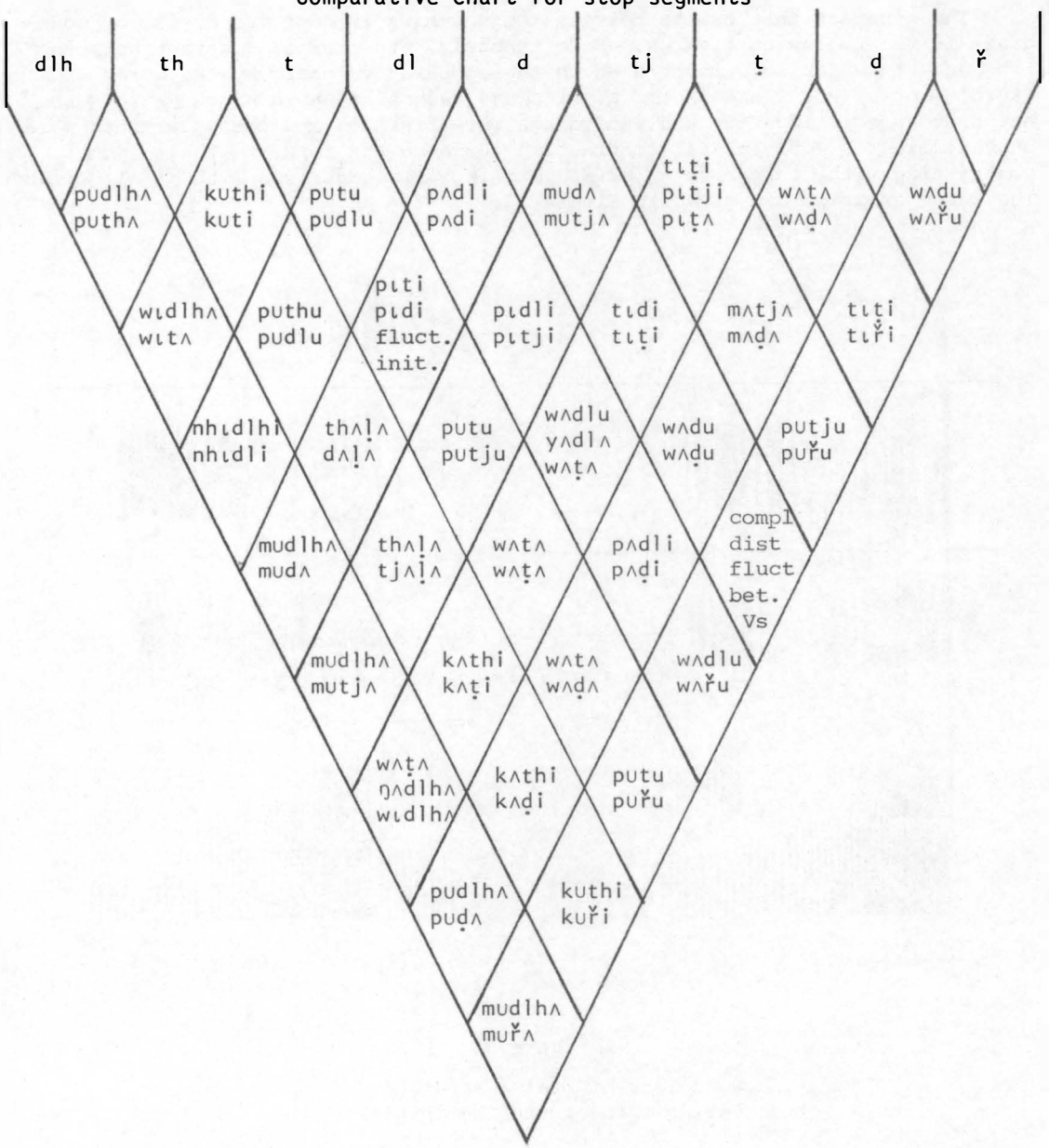
Included with the apical and laminal stops is alveolar flap, which, as will be shown, is often realised as a stop of short duration. In all there are eight segments which are compared. This required twenty-eight comparisons, though within the set, the likelihood of some pairs of sounds being united as allophones, [tj] and [ḍ] for example, is rather remote.

Table 4: Chart of consonantal segments with a modified set of symbols

		bilabial	interdental	alveolar	retroflexed	alveopalatal	velar
Stops	voiceless	p	th	t	ṭ	tj	k
	voiced			d	ḍ		
Nasals		m	nh	n	ṇ	nj	ŋ
	pre-stopped		dnh	dn			
Laterals			lh	l	ḷ	lj	
	pre-stopped		dlh	dl			
Flap				ɾ̆			
Trill				rr			
Semi-vowel		w			r	y	

The chart below indicates the result of the comparisons. If a pair of words are in minimal contrast, the words which indicate this contrast have been written in the comparative box for the two segments. If analogous contrast only has been found, then a three word set has been put in the box. When segments do not contrast, the reasons for uniting them has been indicated, whether this be fluctuation or complementary distribution.

Comparative chart for stop segments[20]



The chart shows that all segments contrast with each other unless the comparison is with [d]. [d] contrasts unambiguously with all segments except [t] and [ř]. It contrasts with [t] between vowels but fluctuates with it word initially.[21] [d] is complementary in its distribution with [ř] in all positions except between vowels when it fluctuates with it. Due to the partial overlap of the two phonemes, the /t/ phoneme is sometimes realised as [d] word initially when the voicing for the following vowel intrudes into the /t/ occlusion, and the occlusion for the /ř/ phoneme between vowels is sometimes prolonged so that it is realised as [d]. The fluctuation with [t] is shown in Figure 30, and the variation of occlusion time between vowels is shown in Figure 31.

The contrast that exists between the segments is depicted by use of sonagrams in the following figures. Unfortunately, the minimal contrast between [th] and [t] which is demonstrated on the comparative chart by the words [kʊthi] *out of sight* and [kʊti] *black swan*, cannot be shown since [kʊthi] was not discovered till after the recordings were finished and the informants were unavailable. A word-initial contrast is shown in the form of [thʌ!ʌ] *name* contrasting with [tʌ!ʌ]/[dʌ!ʌ] *skin*. [thʌ!ʌ] also contrasts with [tjʌ!ʌ] *piece*. The three examples are given in Figure 32.

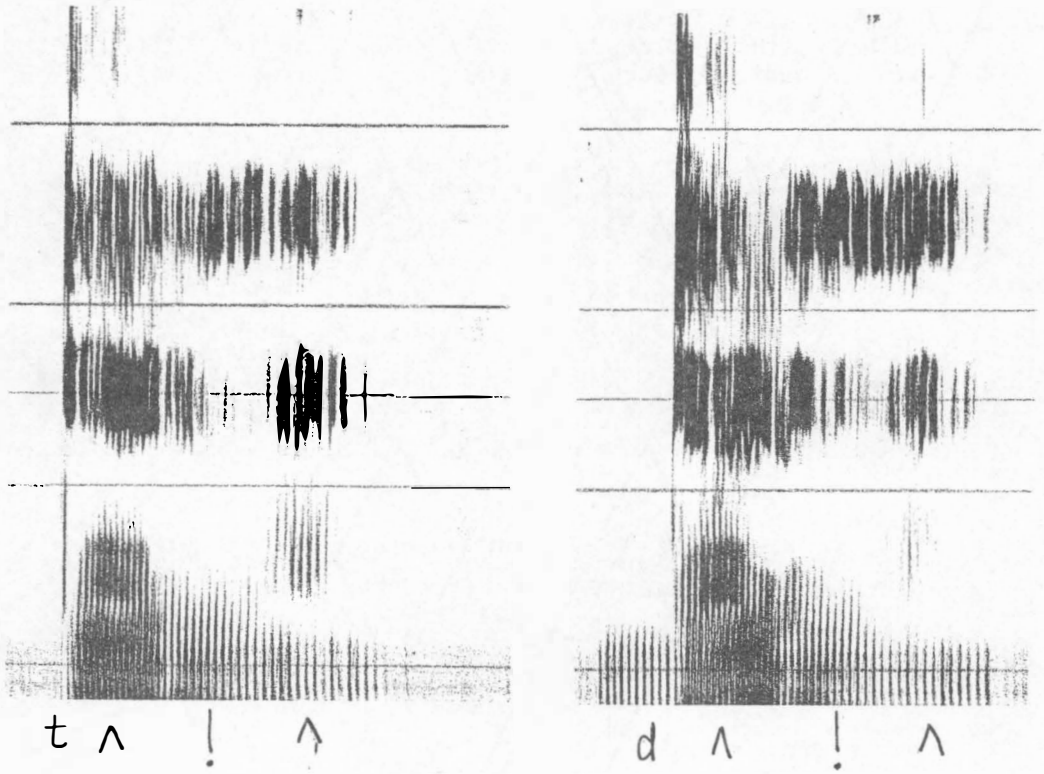


Figure 30

Sonagrams of /ta!a/ *skin* showing [d] fluctuating with [t] in the initial phoneme.

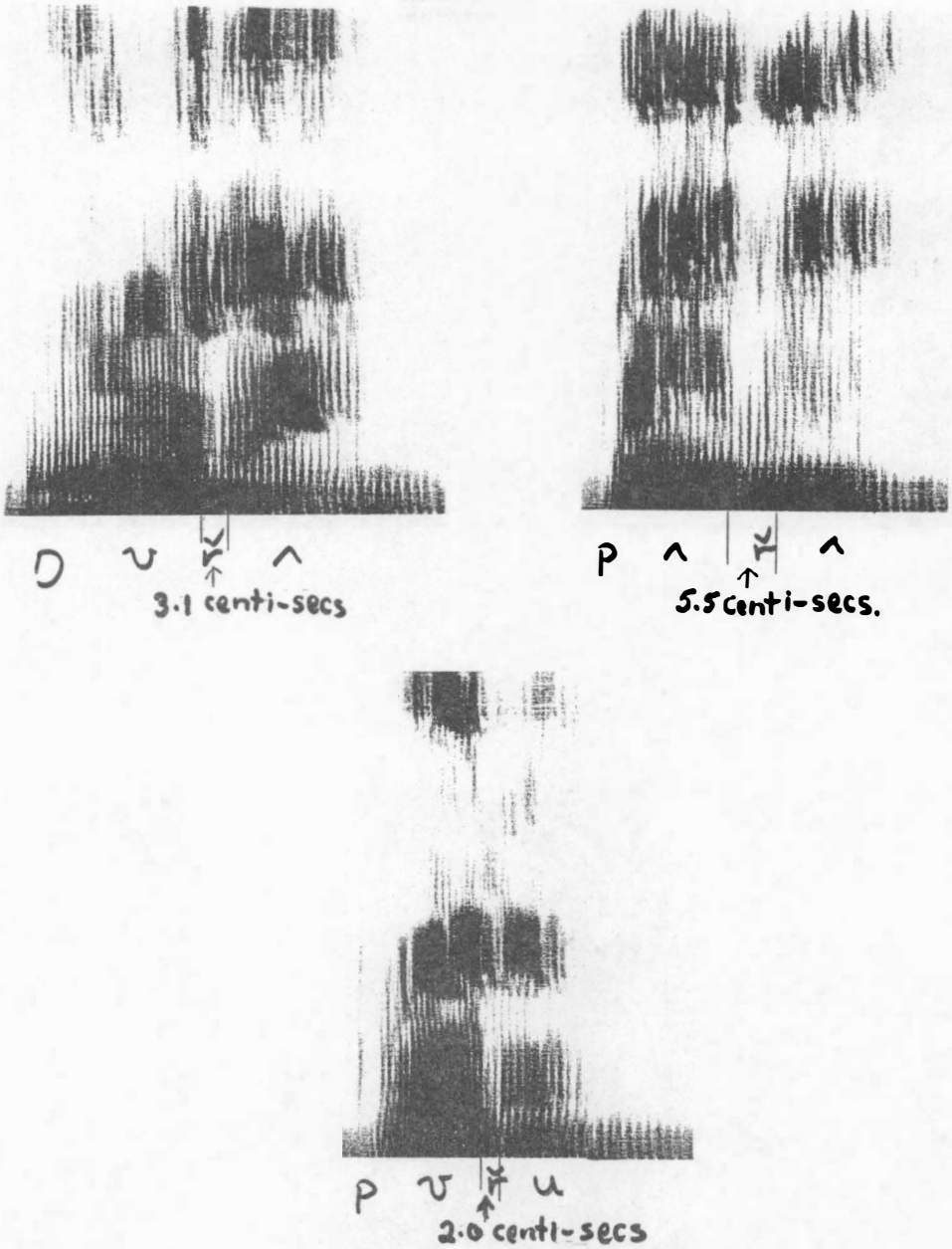


Figure 31

Sonagrams of [ŋuřʌ] *camp site*, [pʌřʌ] *hair* and [puřu] *dew*, illustrating differences in length of duration for the segment [ř].

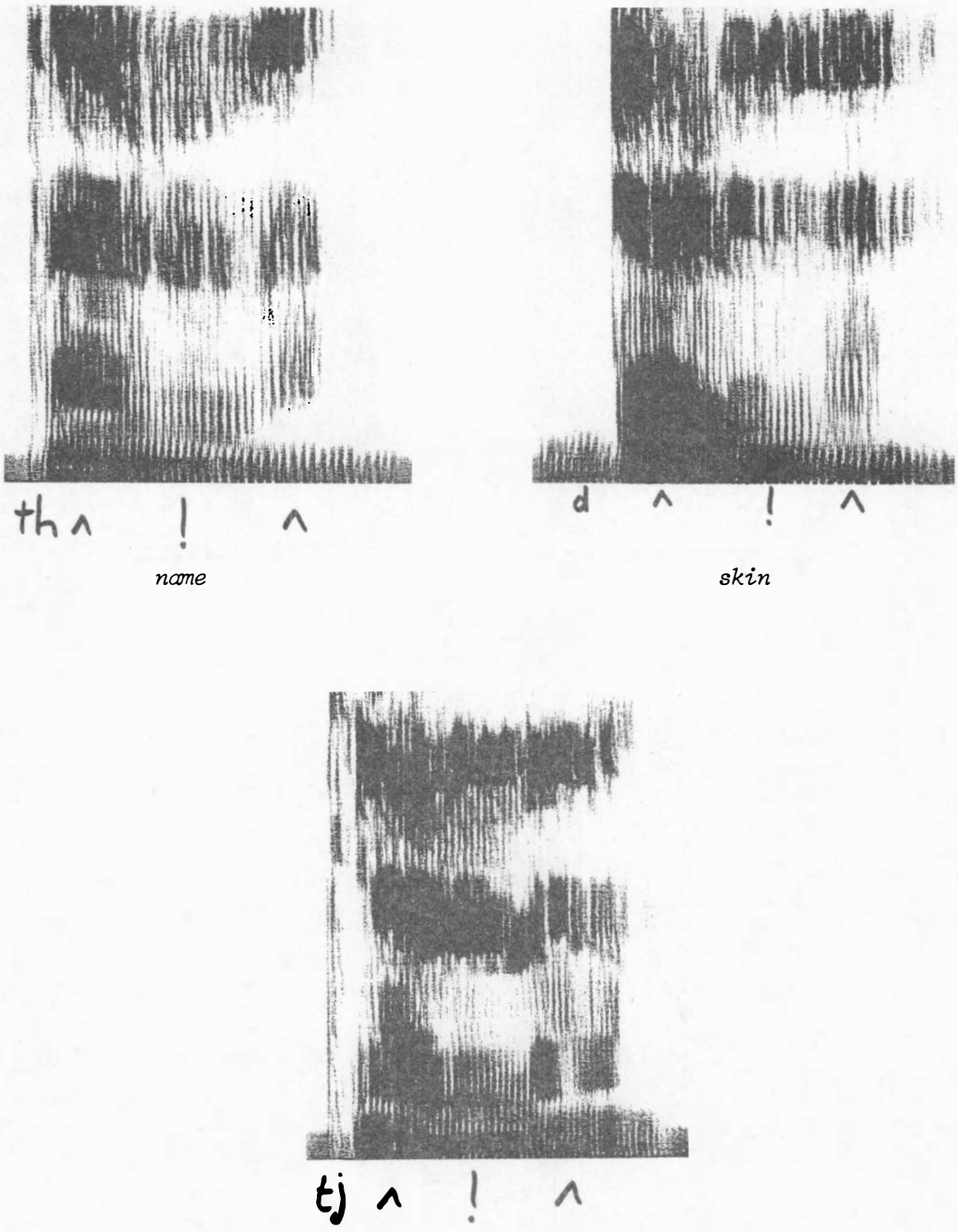


Figure 32

Sonagrams showing the contrast between [th], [t/d], and [tj].

The contrasts between [t], [ṭ], and [ḍ] are evidenced by the words [wʌtʌ] *not*, [wʌṭʌ] *tree butt* and [wʌḍʌ] *head piece*, in Figure 33.

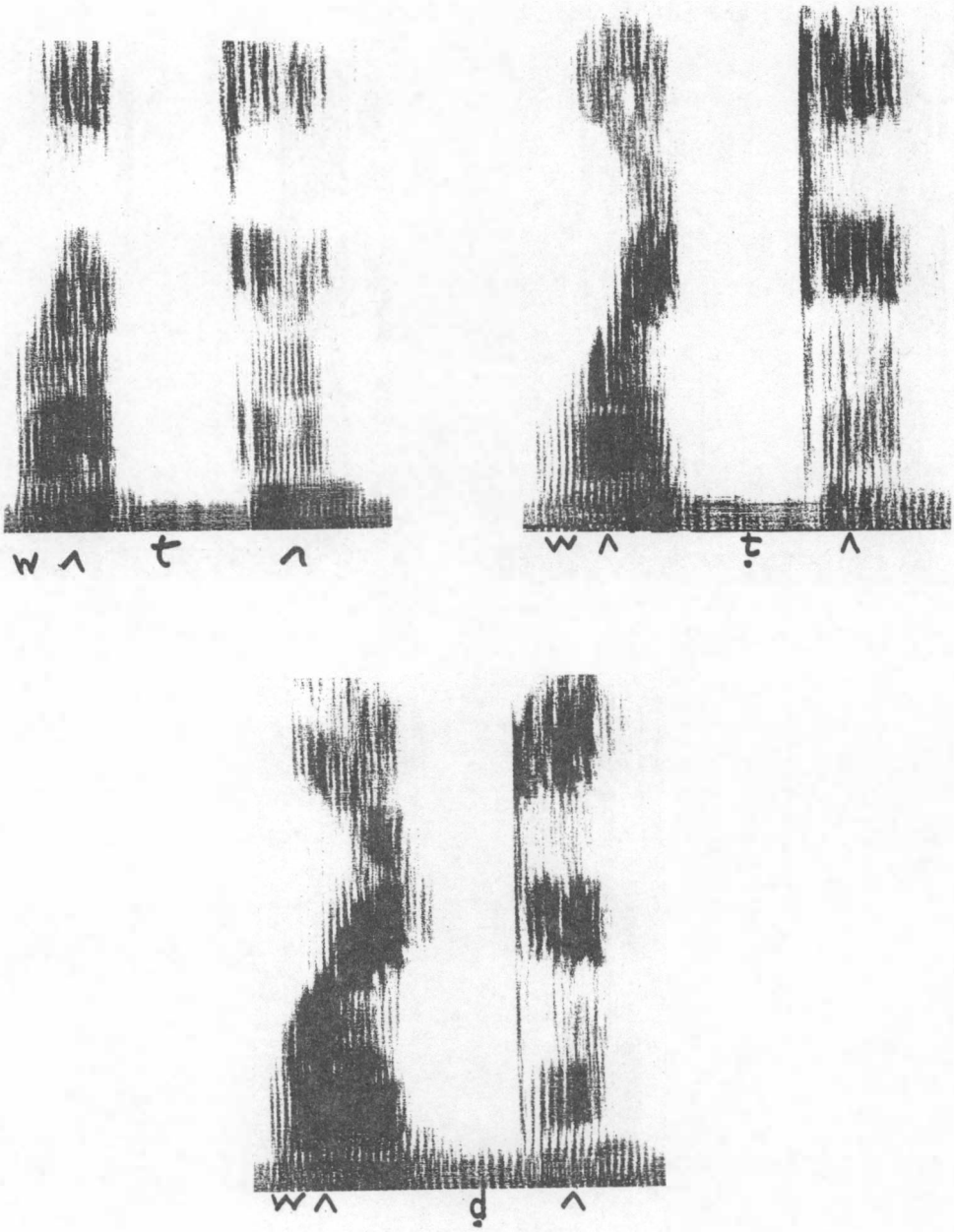


Figure 33

Sonagrams illustrating the contrast between [t], [ṭ] and [ḍ].

Figure 34 demonstrates the contrast between [th] [ṭ], and [ḍ], with sonagrams of [kʌthi] *clothing*, [kʌṭi] *raw* and [kʌḍi] *wife's brother*. Similarly, Figure 35 demonstrates the contrast between [tj], [t] and [d/ř], Figure 36 the contrast between [th], [dlh] and [ḍ], and Figure 37 the contrast between [dlh], [tj], and [d/ř]. Figures 38-41 illustrate the contrasts between [tj] and [ḍ], [ṭ] and [d/ř], [ḍ] and [d/ř], and [t] and [dlh].

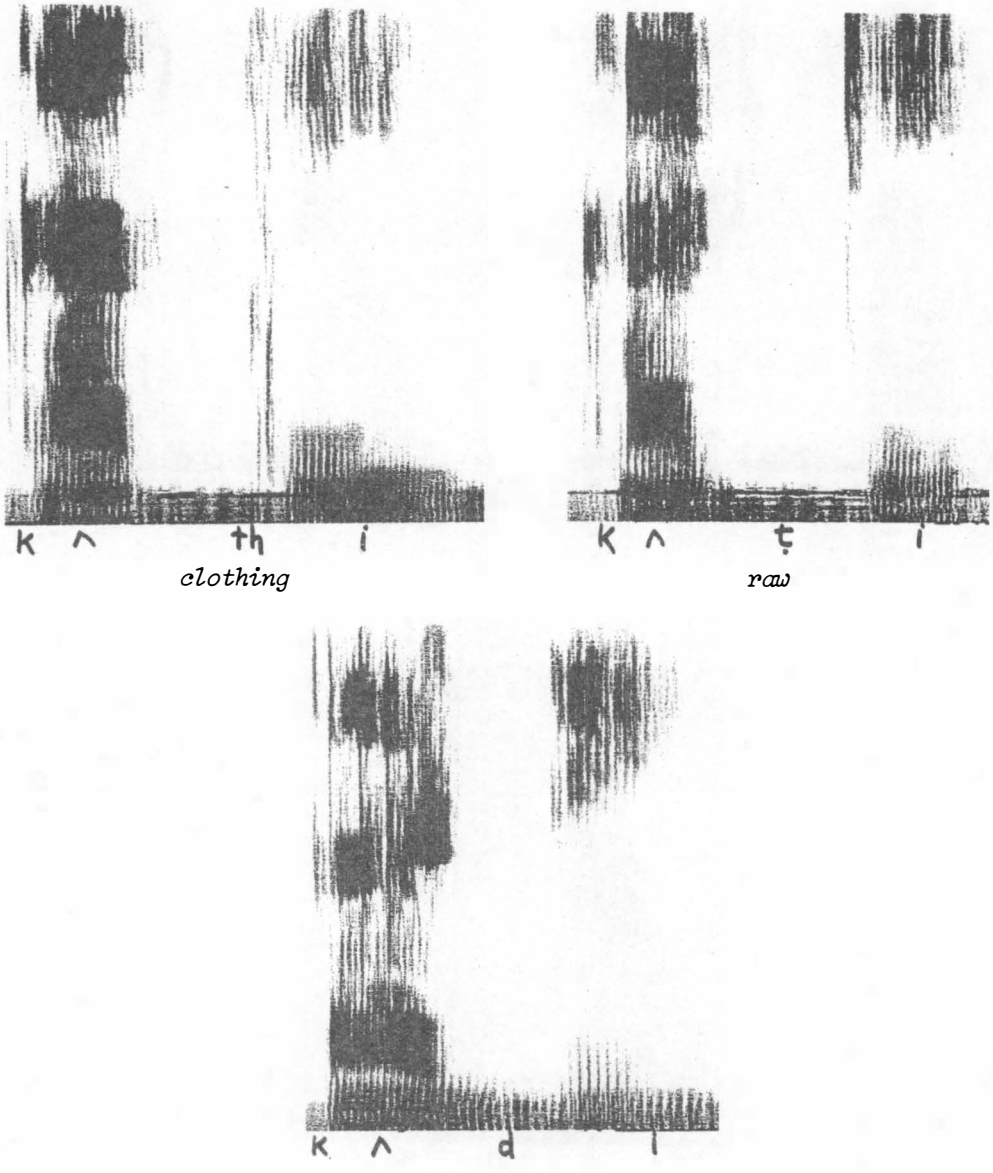
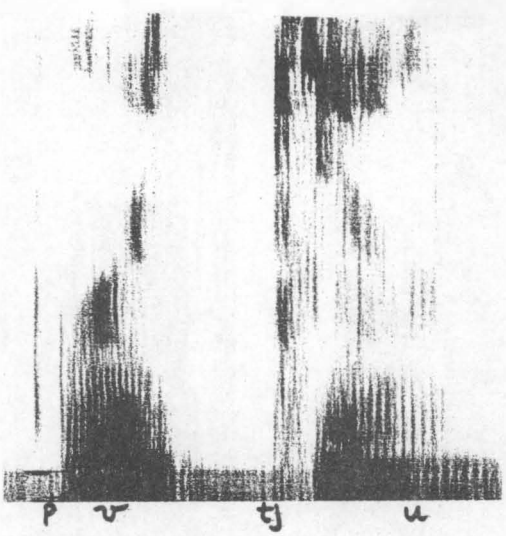
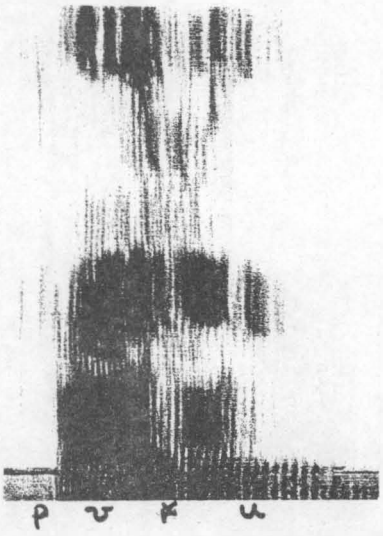


Figure 34

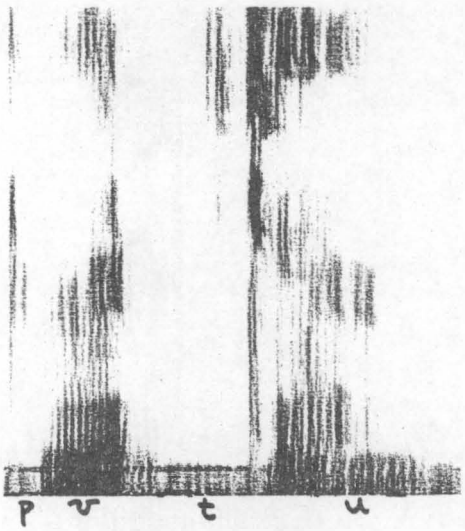
Sonagrams indicating the contrast between [th], [ṭ] and [ḍ].



blind



dew



possessions

Figure 35

Sonagrams depicting the contrast between [t], [tj], and [ř/d].

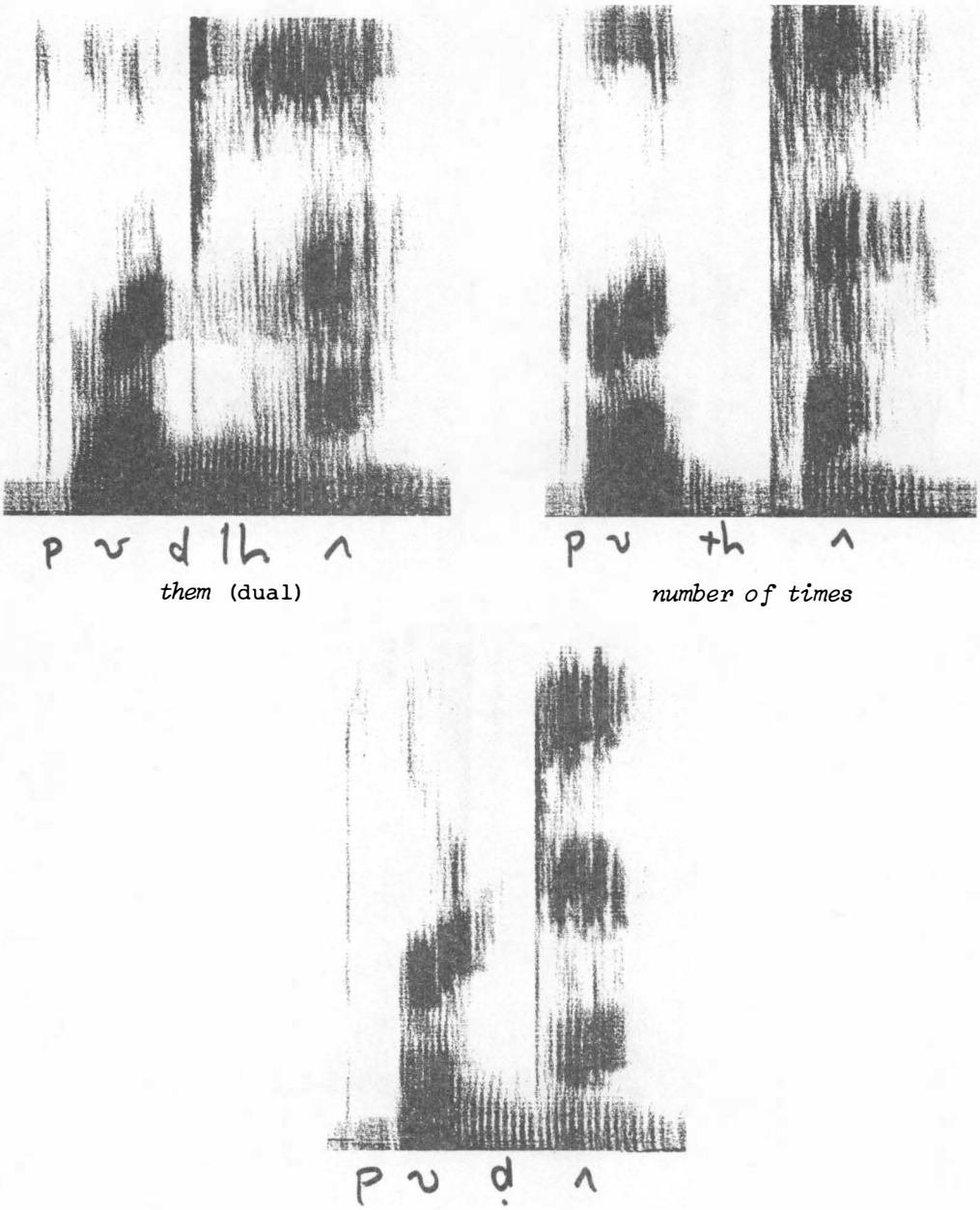


Figure 36

Sonagrams depicting the contrast between [th] [dlh], and [ḍ].

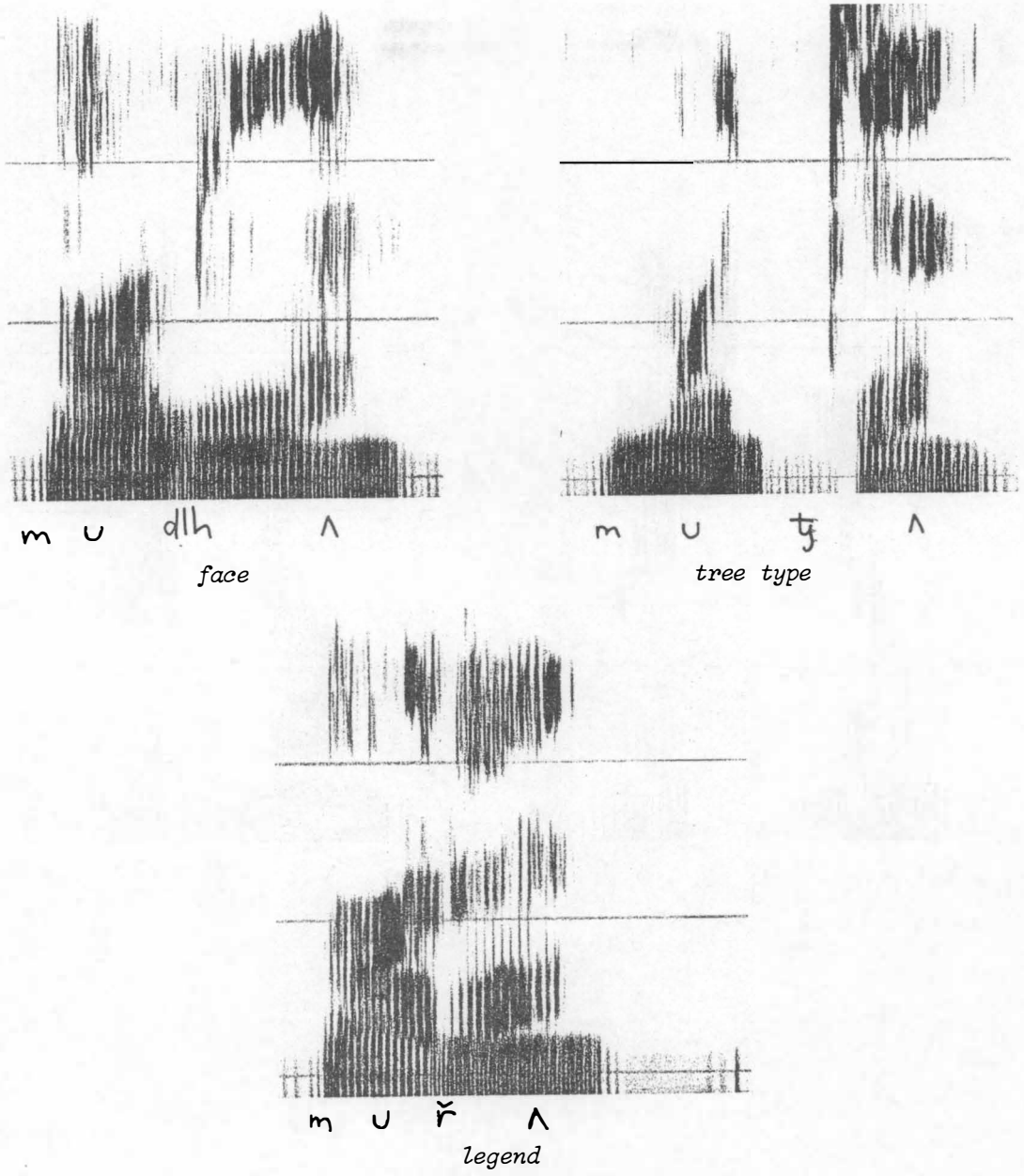
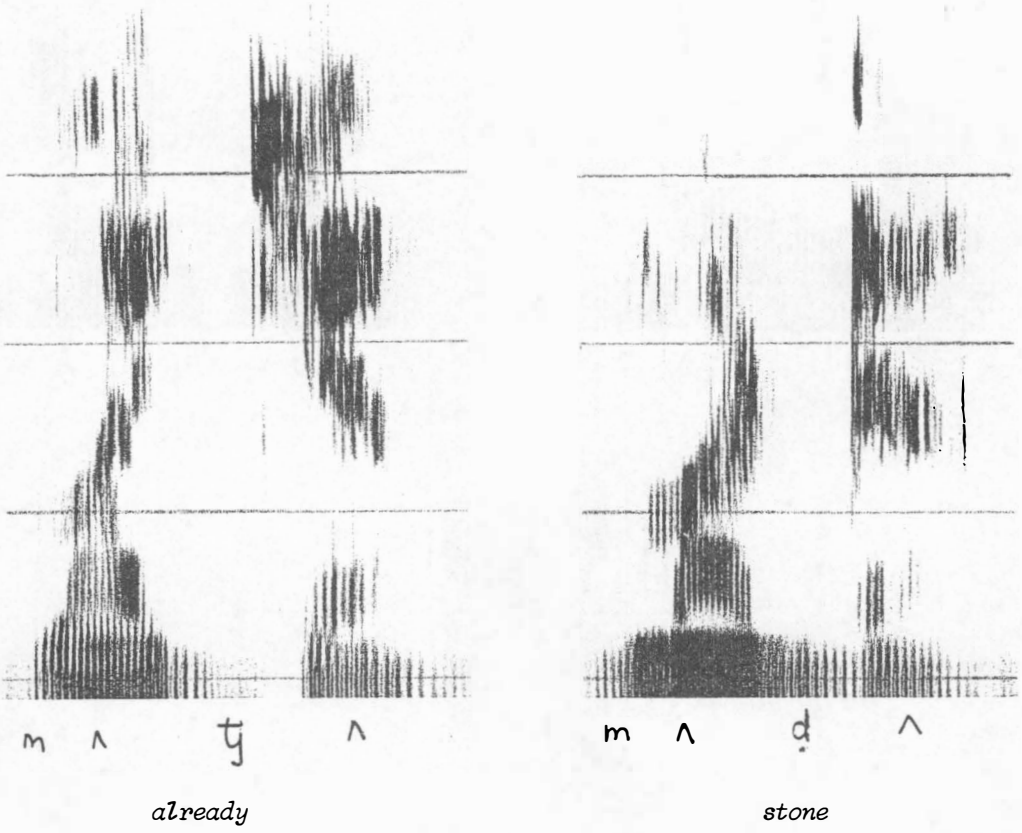


Figure 37

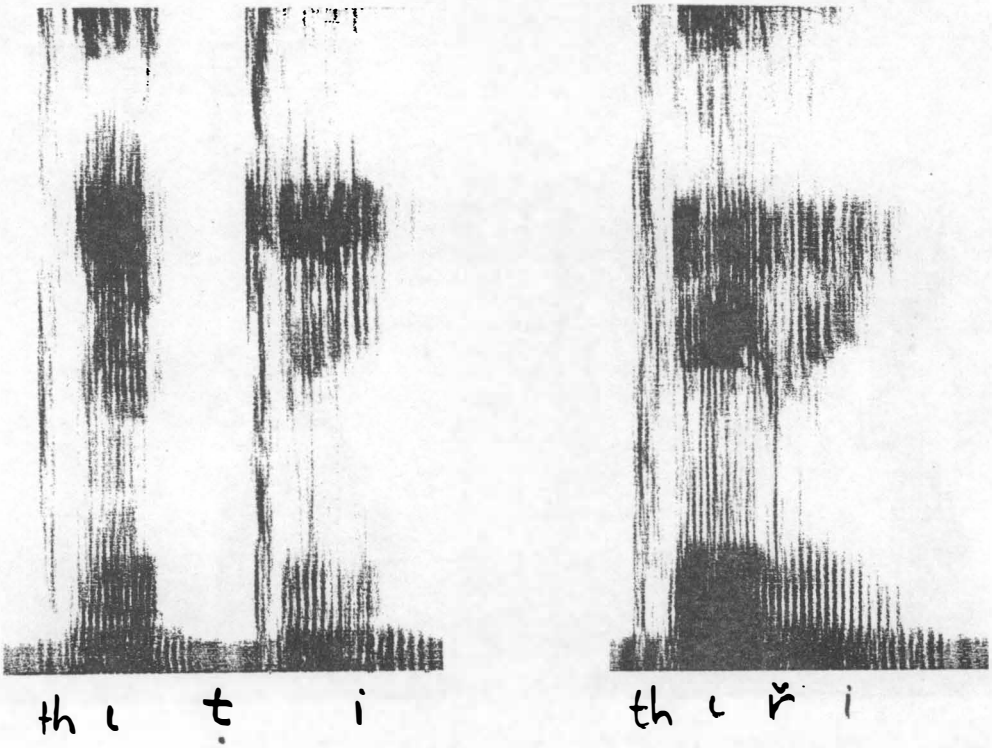
Sonagrams depicting the contrast between [dlh], [tj] and [ř/d].



already *stone*

Figure 38

Sonagrams depicting the contrast between [tj] and [ḍ].



tea *malcontent*

Figure 39

Sonagrams depicting the contrast between [ṭ] and [ř/d].

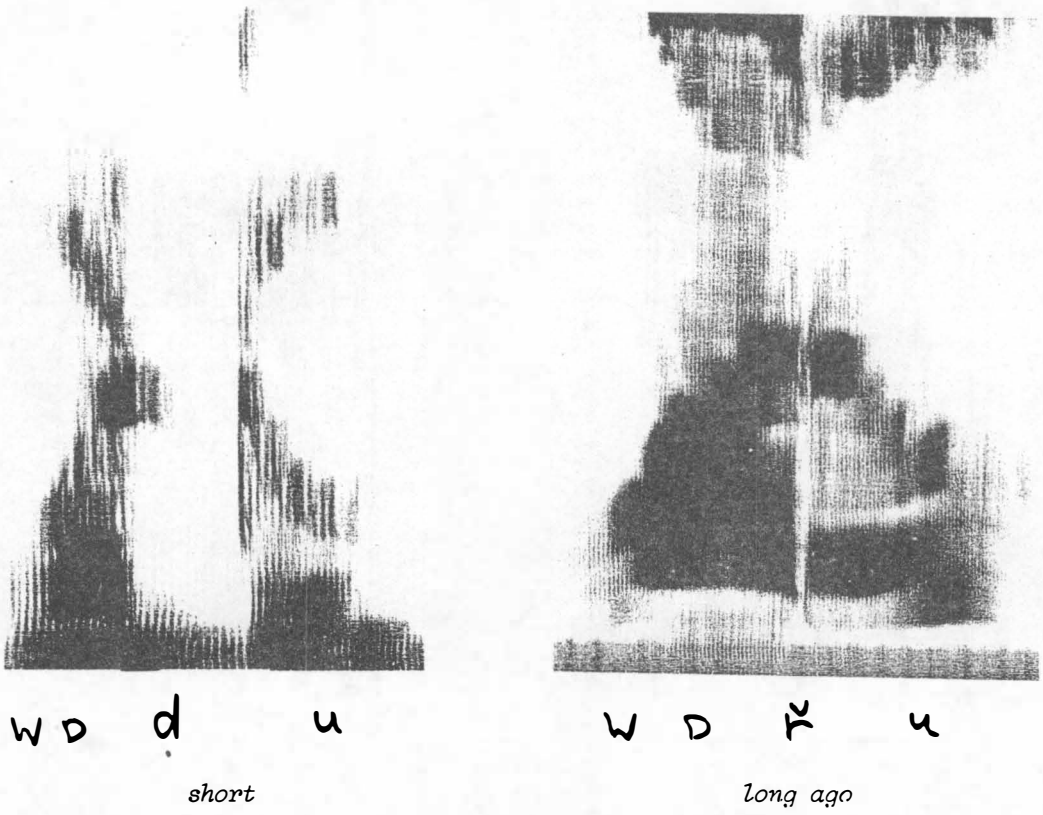


Figure 40

Sonagrams depicting the contrast between [ḍ] and [ɾ̆/d].

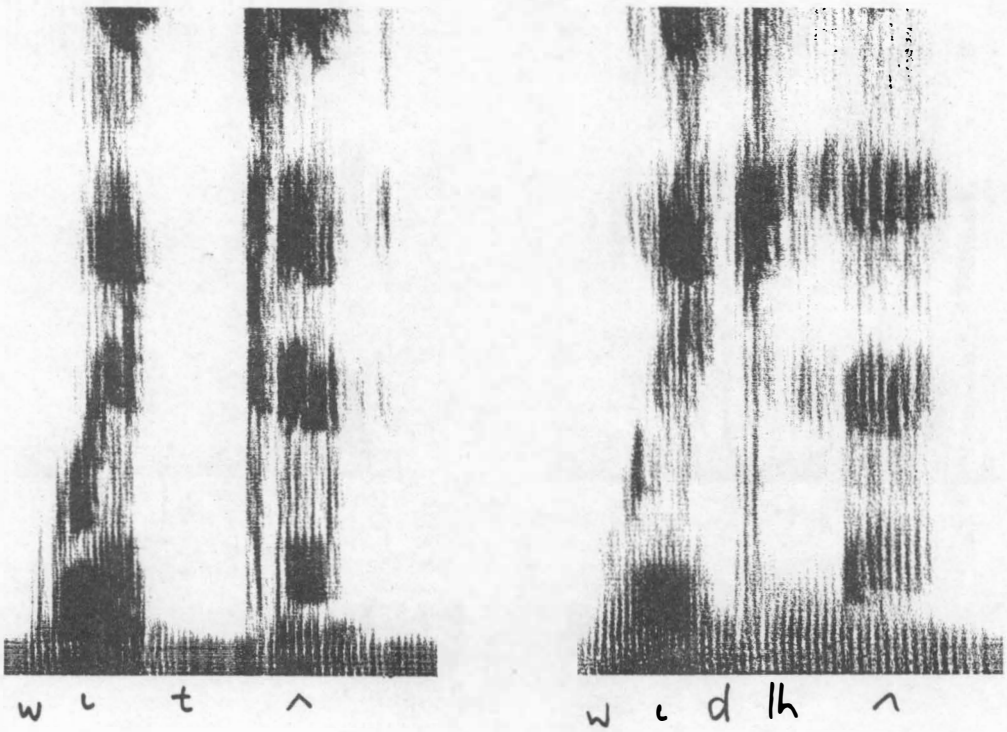


Figure 41

Sonagrams depicting the contrast between [dlh] and [t].

As no words were found which show the contrast between [tj] and [t̪], or for [dlh] and [t̪], in identical environments, the contrast is depicted by use of subminimal sets. Figures 42 and 43 display such sets.

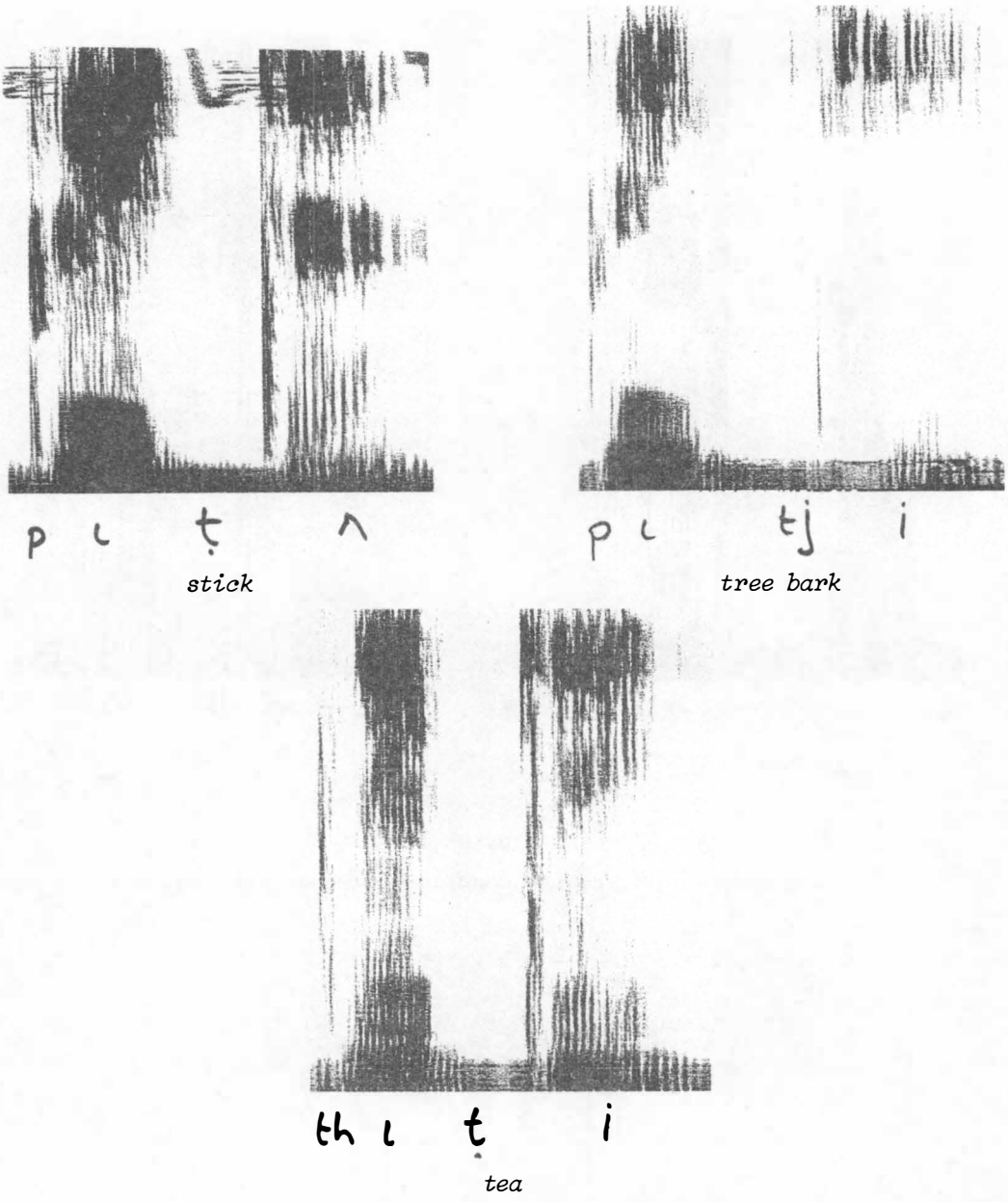


Figure 42

Sonagrams depicting the sub-minimal contrast between [tj] and [t̪].

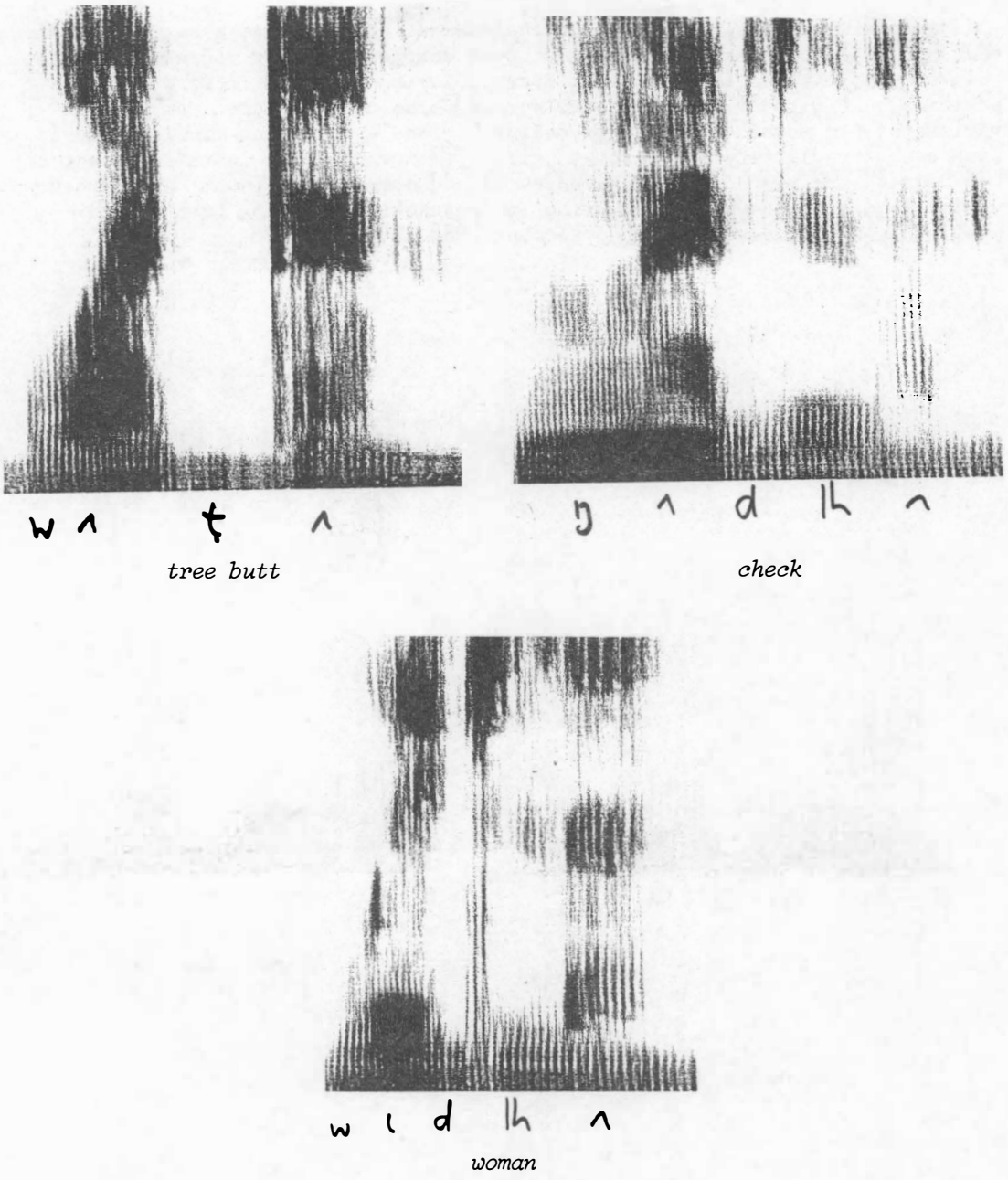
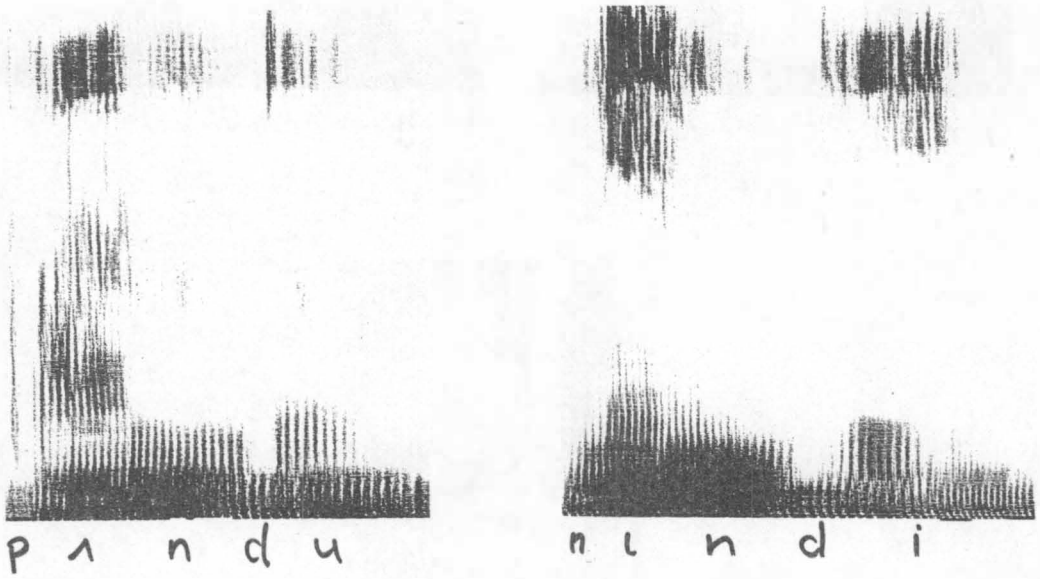


Figure 43

Sonagrams depicting the subminimal contrast between [dlh] and [ʈ].

3.2 The phonetic segment [d]

Further comment is required on the segment [d]. It has already been shown that [d] is involved in forming prestopped complex phonetic segments [^{d}n] and [^{d}l] and is involved in allophonic free variation with [t] in word initial position, and with [ř] between vowels. [d] also occurs apart from free variation. In sequence with a preceding [n] and a following vowel [d] is in complementary distribution with [t], i.e. [t] never occurs in this context but [d] does.[22] Figure 44 gives instances of [d] occurring between [n] and a vowel, whilst Figure 45 shows [d] occurring in conjunction with [n] to form the previously mentioned pre-stopped segment [^{d}n].



lake *animal hide*

Figure 44

Sonagrams of words which contain [d] following [n].

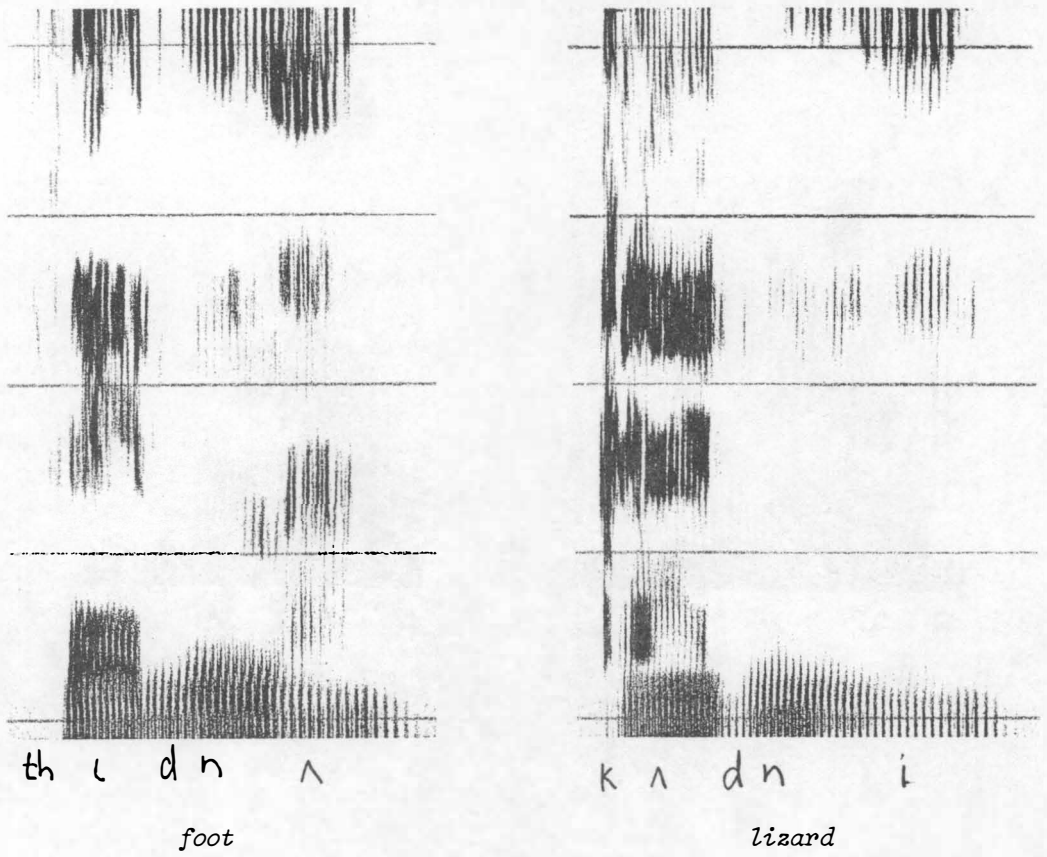


Figure 45

Sonagrams of words containing [d] preceding [n].

3.3 [ř/d] contrasted with [r] and [rr]

Before concluding the analysis if apico/laminal stops three more comparisons need to be made. [ř/d], [rr] and [r] have yet to be compared. In Diari the comparison is straightforward as there is a three-way contrast between the segments. This is demonstrated in Figure 46 with sonagrams of [puru] *end*, [puřu] *dew* and [purru] *exclamation of surprise*.

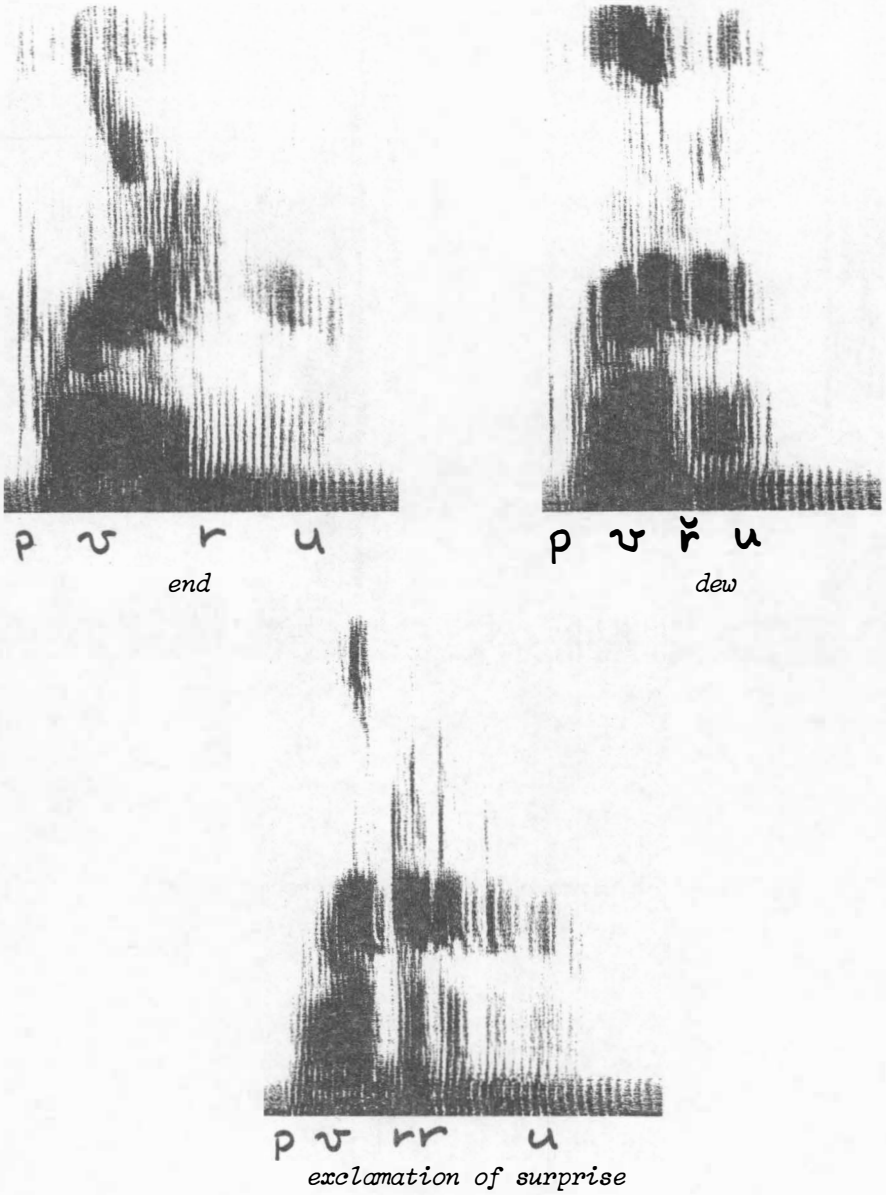


Figure 46

Sonagrams of words indicating the contrast between [r], [ř] and [rr].

3.4 Conclusion for stops, alveolar trill and retroflexed semi-vowel

From the preceding comparisons certain phonemic conclusions can be made. Of the eleven Diari stop consonants, two, [p] and [k] did not require comparisons, and [d] proved to be allophonic with [t] and [ř]. The remainder, with the exception of [dlh] and [dl], were found to be contrastive with each other. The two pre-stopped laterals have yet to be compared with other laterals. At this stage, then, the constituency of eight stop phonemes has been determined and two are held over for further comparison. Also, the two other segments compared in this section, [r] and [rr] do not require further comparison and they too may be added to the phoneme list.

Of the phonemes so far compared, one needs further comment. This is the phoneme represented by the retroflexed voiced stop [ḍ]. [ḍ] differs from the other stop phonemes in two significant ways. The most obvious of these is the voicing component. It is the only stop phoneme that is voiced between vowels. For the others voicing may partially intrude into the occlusion, but not very far, and certainly not to half-way. With [ḍ] however, the segment is voiced throughout its entire duration.

The other significant difference is concerned with duration. As can be seen in Table 5 the length of [ḍ] is only half that of other similar stops.

Table 5: Comparison of duration times for [t], [ṭ] and [ḍ] in words used in the sonagram experiment*

[t]		[ṭ]		[ḍ]			
Word	Duration in centi-secs.	Word	Duration in centi-secs.	Word	Duration in centi-secs.	Word	Duration in centi-secs.
wʌtʌ	16.1	tɪṭi	15.2	pʊḍʌ	3.8	kʌḍi	11.7
pɪti	17.7	kʌṭʌ	15.3	mʌḍu	10.0	pɪdʌ	5.2
pɪtʌ	15.6	wʊṭʌ	14.7	ŋʌḍu	12.1	mʌḍi	4.2
wɪtʌ	13.2	kʌṭi	18.8	kʊḍu	7.1	pʌḍi	6.3
kʌtʌ	16.8	pʌṭi	16.9	wʌḍu	6.4	mʌḍi	13.5
kʊti	17.2	wʌṭʌ	14.7	tʌḍi	8.9	kʊḍu	9.0
wʊti	17.7			tʊḍʌ	9.7	mʌḍʌ	11.0
				pɪḍʌ	7.3	mʌḍu	8.6
				pʌḍʌɪ	7.7	ŋʌḍu	7.0
				pʊḍʌ	4.3	kʌḍi	11.5
				wʊḍʌ	9.6	kʊḍʌ	4.1
				pʌḍi	4.5		
[t] mean - 16.3 centi-secs.		[ṭ] mean - 15.9 centi-secs.		[ḍ] mean - 8.0 centi-secs.			

*See p.260 ff. for a description of the word list used in the experiment. Also for the English meanings of the words.

Phonetically, it is still not a flap, for as Table 6 shows, it is about two and a half times longer than /ɽ̆/. Nevertheless, the evidence suggests that [ɖ̆] has more in common with /ɽ̆/ than it does with the stop phonemes. They are both relatively short in duration, and they are both voiced throughout their length. Should, then, [ɖ̆] be interpreted as the phoneme /ɽ̆/ rather than /ɖ̆/?

Other evidence for considering [ɖ̆] as a flap instead of a stop is found in the distributional pattern of phonemes. A phoneme /ɖ̆/ does not fit the pattern at all. There are six other stop phonemes, all distinguished by their place of articulation. [ɖ̆] is different, for it is differentiated from the other stops by its manner of articulation. However, if [ɖ̆] is considered to be /ɽ̆/ it will help fill out an already existing pattern. It will be one of a set of retroflexed consonants which contrast with their alveolar counterparts.

Table 6: Duration times for /ɽ̆/ in words used in sonagram experiment

Words containing /ɽ̆/	Duration of /ɽ̆/ in centi-secs.
yʌɽ̆u	3.9
mɪɽ̆i	5.5
kʊɽ̆i	1.3
t̪ɪɽ̆i	2.5
pʊɽ̆u	2.0
n̪ʌɽ̆i	4.3
kʌɽ̆ʌri	2.3
yʌɽ̆ʌ	3.8
tʌɽ̆ʌ	2.9
ŋʊɽ̆ʌ	2.0
n̪ʌɽ̆i	3.0
kʊɽ̆ʌ	2.9
kɪɽ̆ʌ	3.0
kʊ̆ɽ̆i	2.9
kɪɽ̆ʌ	4.9

Mean average duration — 3.2 centi-seconds.

It is concluded therefore that for phonetic and phonemic reasons [ɖ̆] functions in Diari as a retroflexed flap and should be symbolised as /ɽ̆/.

3.5 'd'-like sounds

As 'd'-like sounds have been involved in a number of the discussions to date but will not be seen in the identifying symbols of any of the phonemes a brief summary will be given outlining the situation in which 'd's may be 'heard' by non-Diari speakers.

The phoneme /t/ will be heard as 'd' by English speakers when it occurs at the beginning of words. In this position it may, or may not be, voiced, just as is the case for English /d/ (see p.210). This phoneme will also be heard as 'd' when it follows /n/, for just as is the case for English /d/, Diari /t/ is voiced in this position (p.224).

The phoneme /ř/ will be heard as 'd' when it occurs between vowels if the duration of the occlusion is extended beyond 4.0 centi-secs (p.210 and 228).

The phoneme /r̰/ will be heard as 'rd' as the duration of the occlusion during the production of this phoneme is usually above the perceptive threshold for English stop phonemes (p.227).

The nasal phonemes /nh/ and /n/ and the lateral phonemes /lh/ and /l/ occurring between vowels will often be heard as having a 'short' d preceding them due to the pre-stopping of these phonemes, a feature that has been developed as a regional characteristic (p.200).

The phoneme /ř/ when following /l/ or /n/ is often heard as a sequence of d followed by a trilled r. This is apparently due to the fact that in English the duration of the occlusion of /d/ following /l/ and /n/ is greatly reduced, giving it similar characteristics to the first ooclusion of [r̃] (see note p.318).

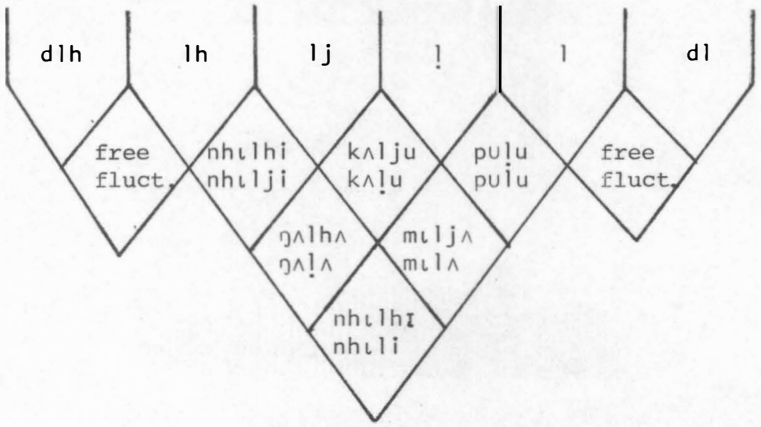
The ten phonemes so far determined are symbolised as:

/p/, /th/, /t/, /tj/, /ṭ/, /k/, /ř/, /rr/, /r/ and /r̰/.

3.6 Laterals

There are six lateral segments in Diari. The two pre-stopped laterals [dlh] and [dl] only occur in free fluctuation with their non-prestopped variants [lh] and [l] and so do not need to be compared with the other segments.

A comparative chart of the laterals is as follows;



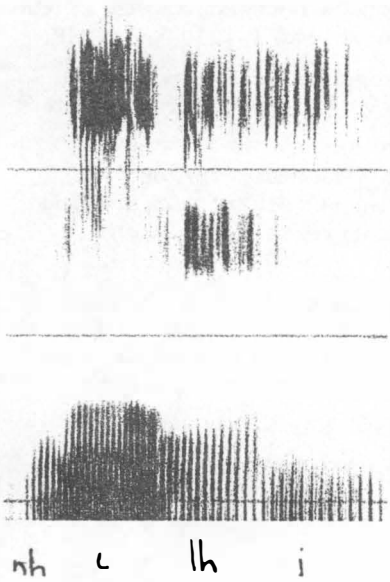
Comparative chart for laterals

Apart from the fluctuation of the pre-stopped laterals with [lh] and [l] all the segments contrast with each other. Minimal contrast occurs with them all, but between [lh] and [l] the contrast involves loan words, [nhɩli] *needle* with [nhɩlhi] *rat*, and [mili] *one who works* with [mɩlhi] *mail*.

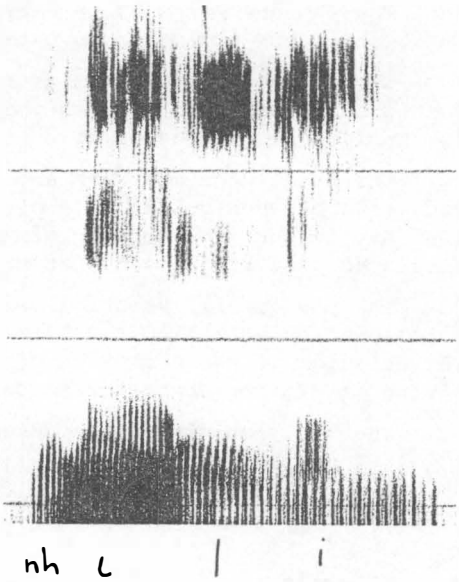
The following figures depict the contrasts, but in order to avoid loan words Figure 52 uses a subminimal set. Figure 23 illustrates the fluctuation between [lh] and [dlh].

The comparison of the laterals has enabled four more phonemes to be added to the list. These are:

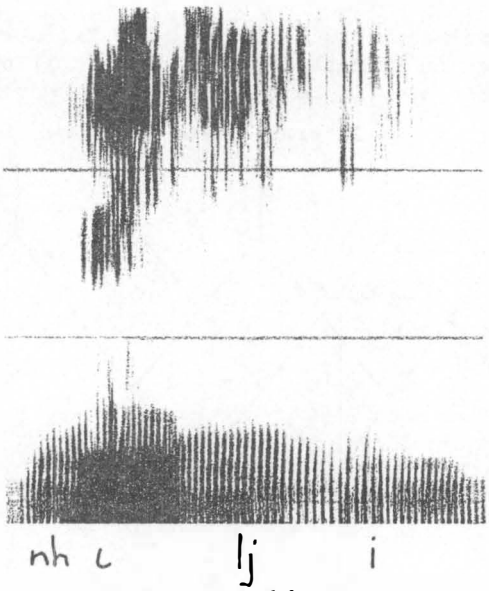
/lh/, /l/, /lj/, and /l/.



mouse



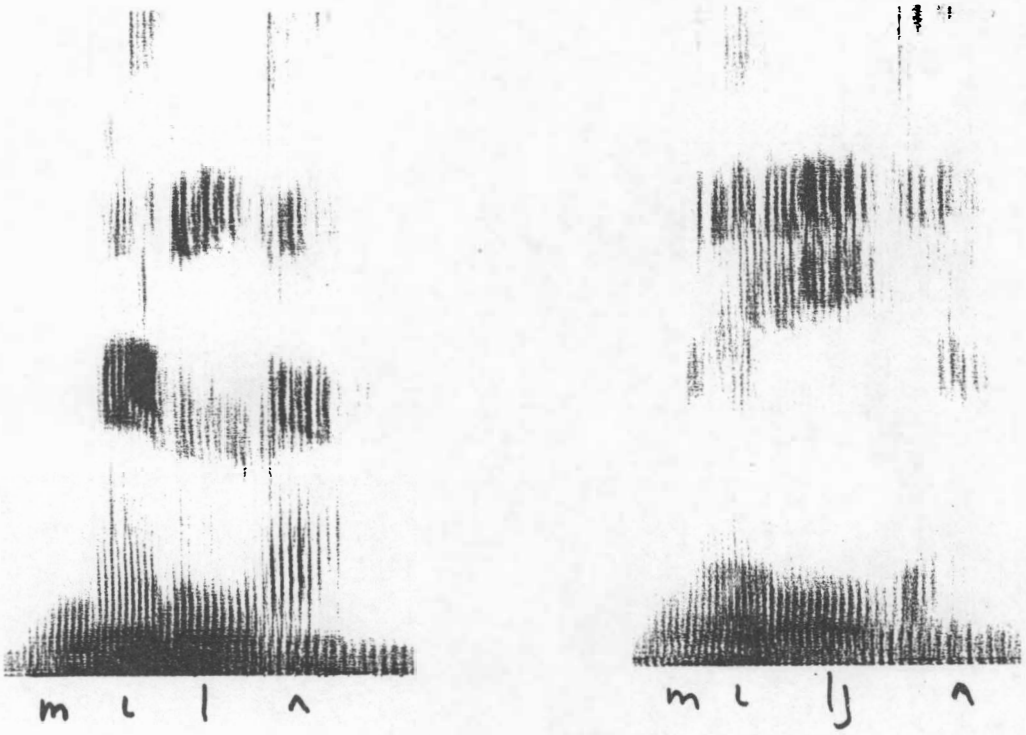
needle



egg white

Figure 47

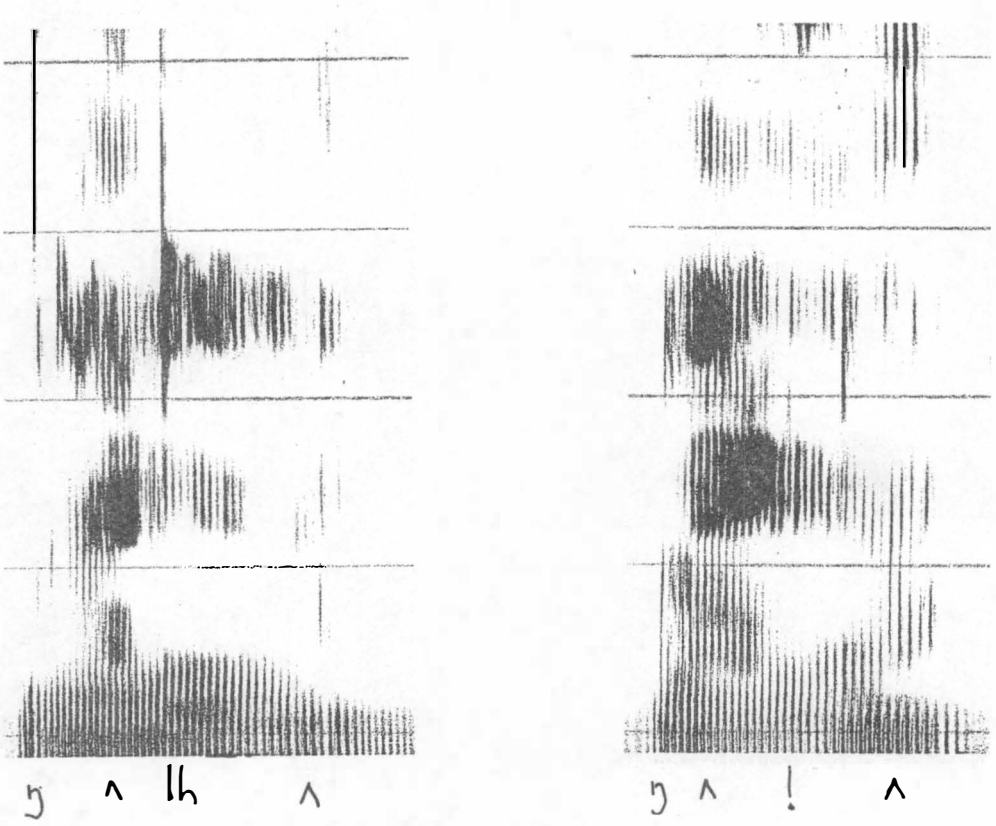
Sonagrams indicating the contrast between [lh], [l], and [lj].



bone hook *fasting*

Figure 48

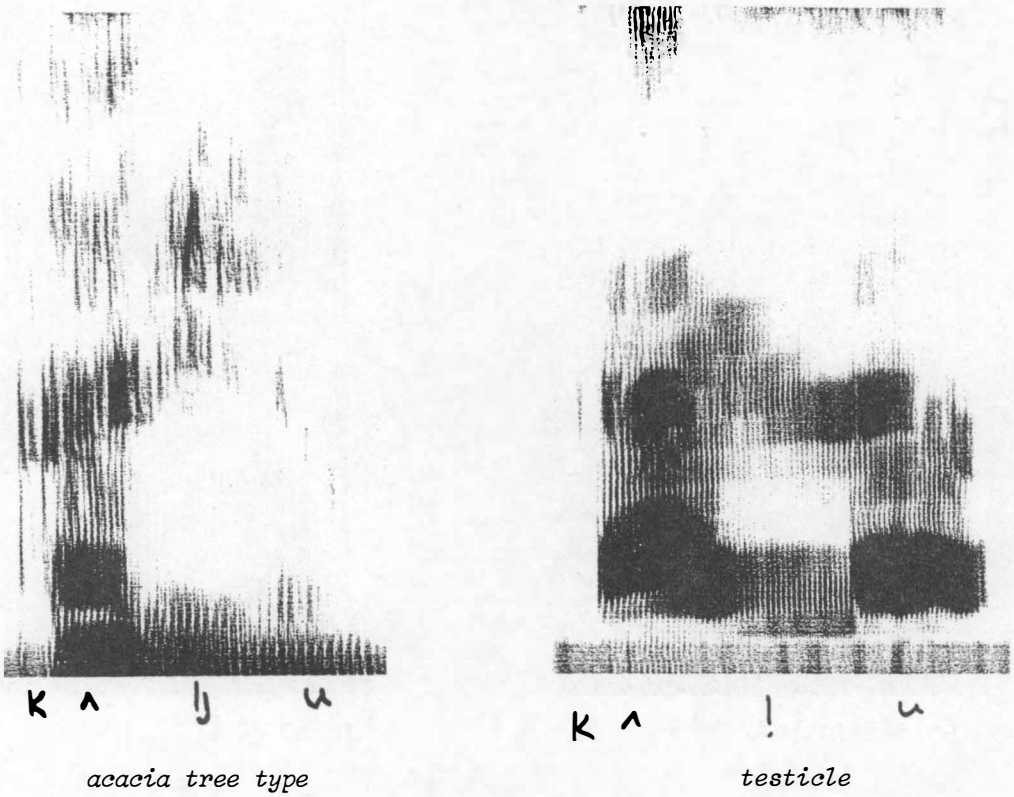
Sonagrams indicating the contrast between [l] and [lj].



cheek *but*

Figure 49

Sonagrams depicting the contrast between [lh] and [ǃ].



acacia tree type *testicle*

Figure 50

Sonagrams depicting the contrast between [lj] and [l!].

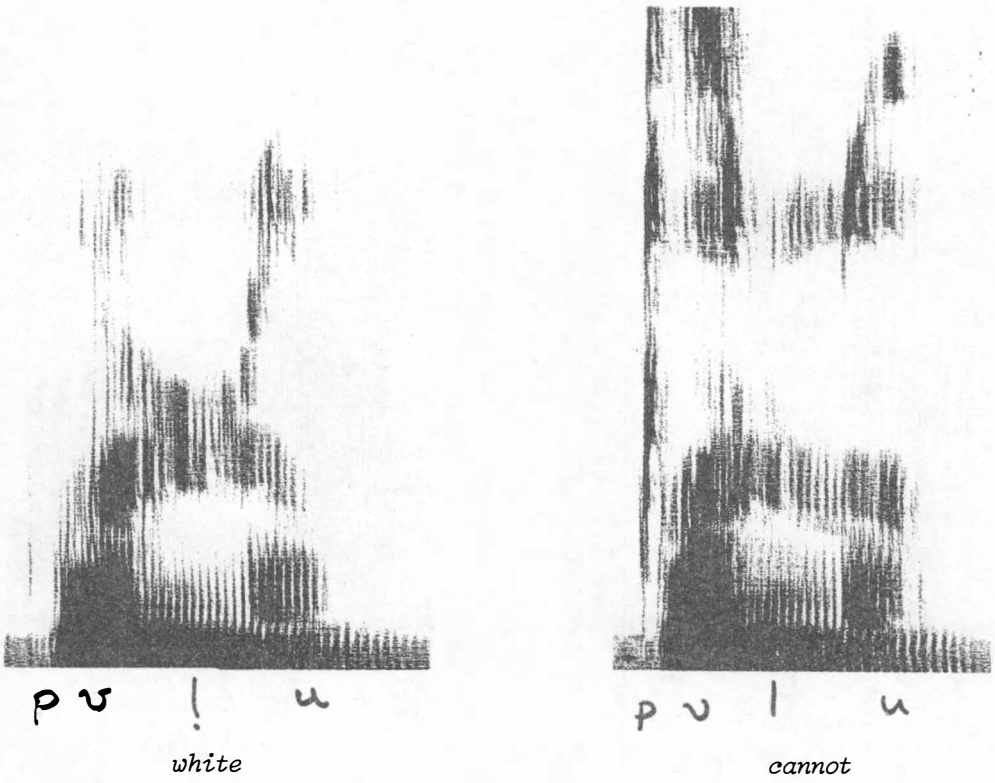


Figure 51

Sonagrams depicting the contrast between [l] and [ǃ].

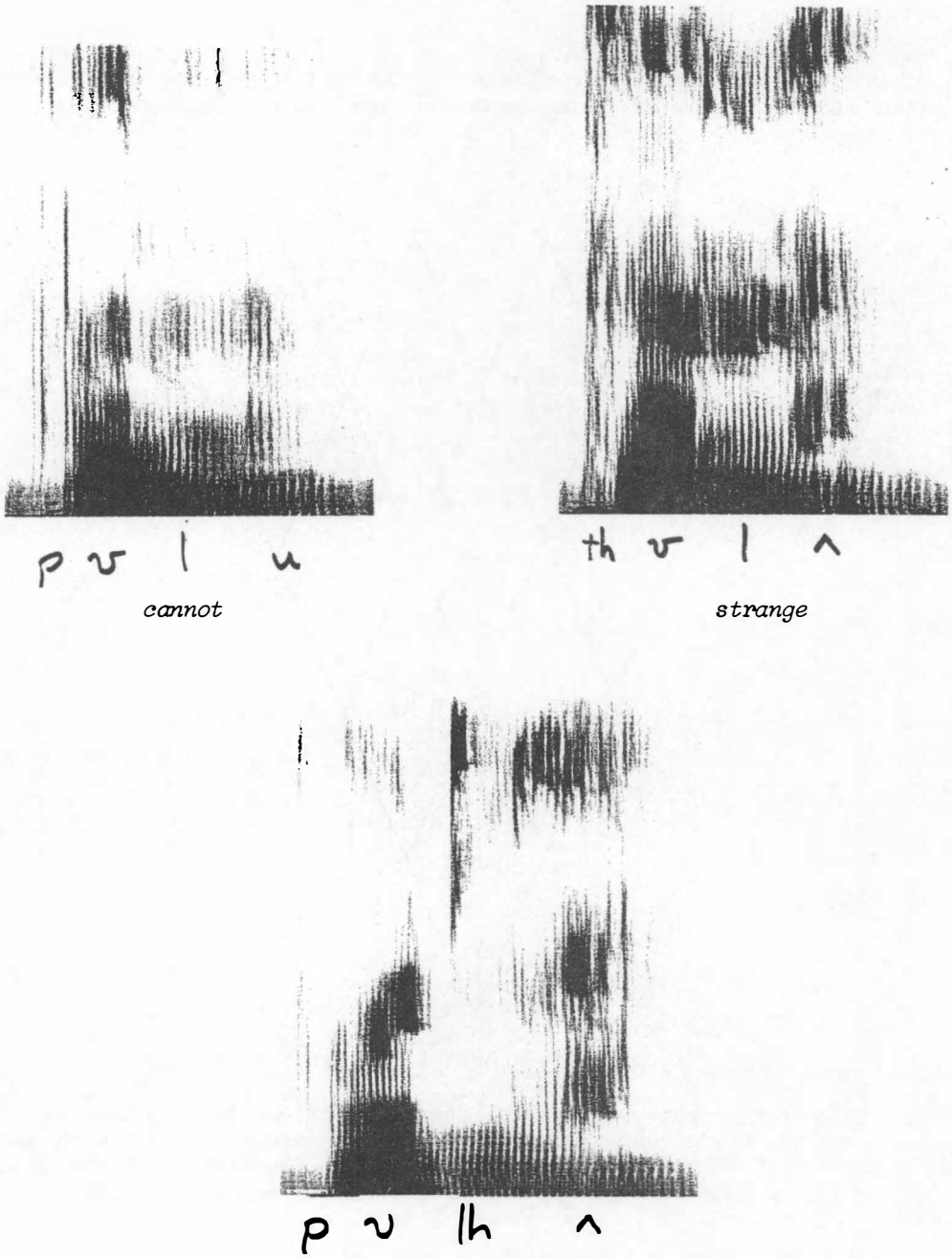
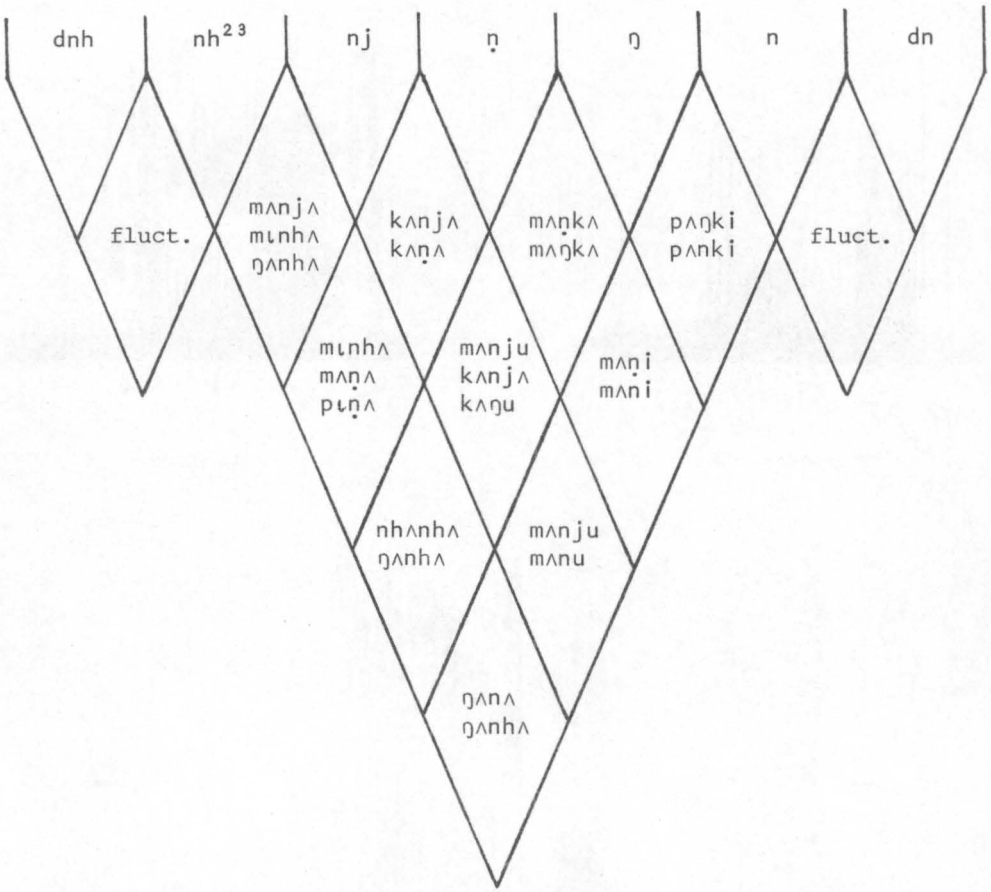


Figure 52

Sonagrams depicting the contrast between [l] and [lh] by means of a subminimal set.

3.7 Nasals

There are eight nasal segments in Diari, [m], [nhj], [dnh], [n], [dn], [nj], [ɳ], and [ŋ]. [m] is usually not considered suspect of joining with the other nasals but all the rest need to be compared. The chart below shows the results of these comparisons.



Comparative chart for nasals

Apart from the pre-stopped nasals [dnh] and [dn] which fluctuate with the non-prestopped varieties [nh] and [n] all of the segments contrast with each other. However, it should be noted that phoneme alternation exists between [nh] and [nj] in word initial position. For example, /njuɖu/ *body hair* alternates with /nhuɖu/, and /njilpa/ *egg white* alternates with /nhilpa/.[24]

Figures 53-58 depict the contrasts between the phonemes. The minimal contrast between [n] and [ɳ] cannot be shown as [mani] *getting*, was not discovered till after the word lists were recorded. A subminimal set will be given instead.

The completed comparison of nasals results in a further six phonemes added to the list, /m/, /nh/, /n/, /nj/, /ɳ/ and /ŋ/.

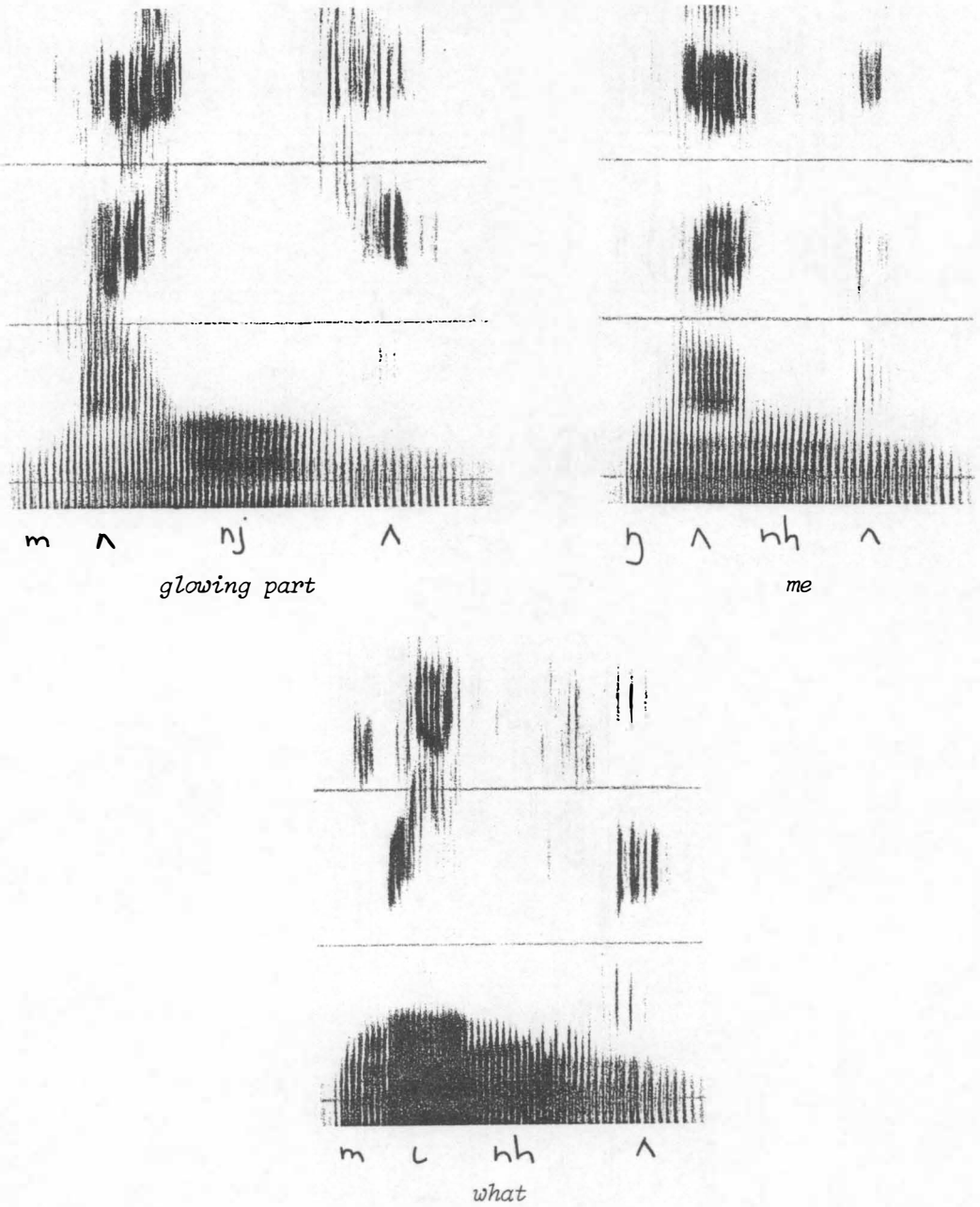


Figure 53

Spectrograms depicting the contrast between [nh] and [nj].

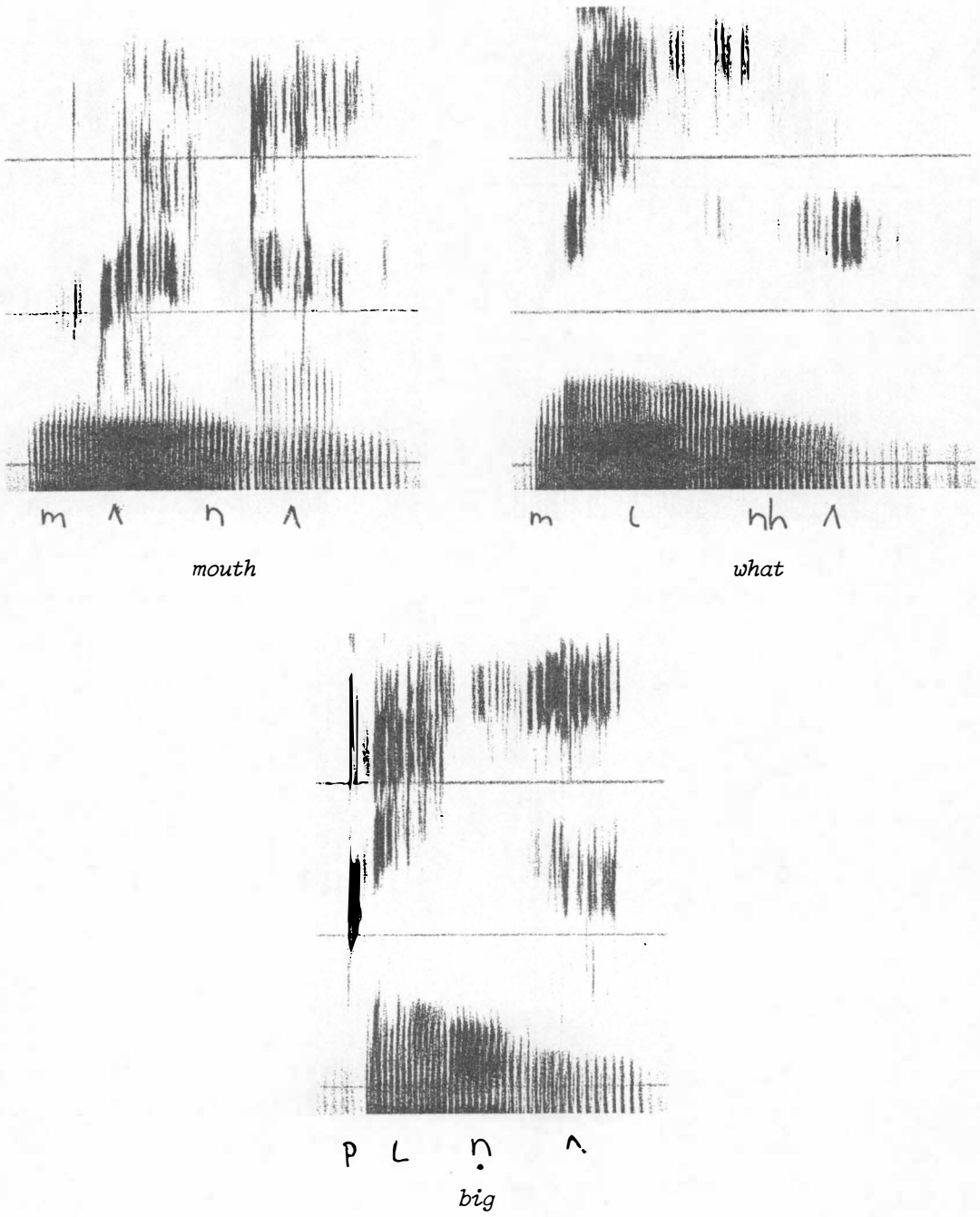
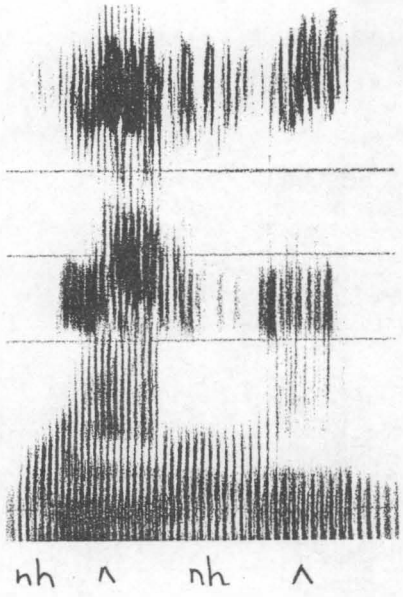
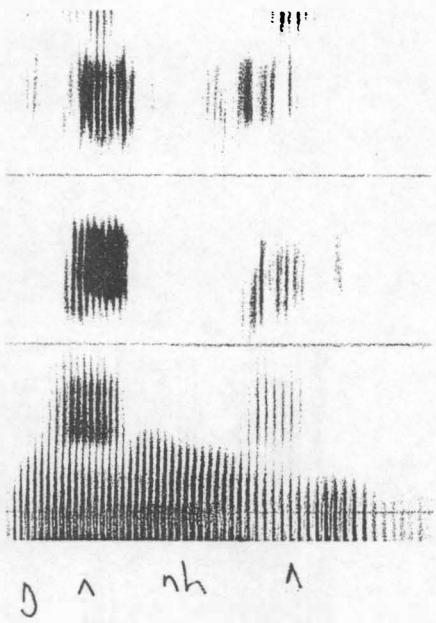


Figure 54

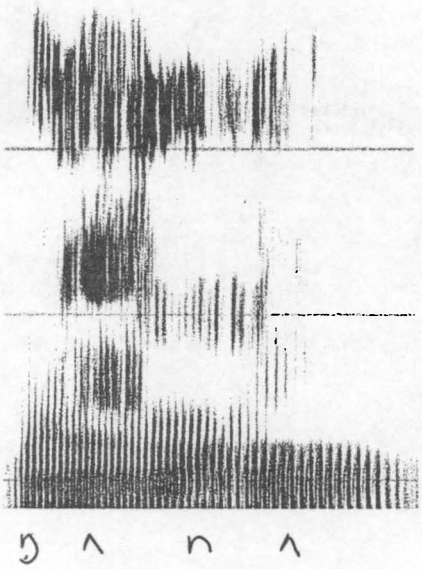
Spectrograms depicting the contrast between [nh] and [n̥].



her (object)



me



interest marker

Figure 55

Spectrograms depicting the contrast between [nh] with [ŋ] and [n].

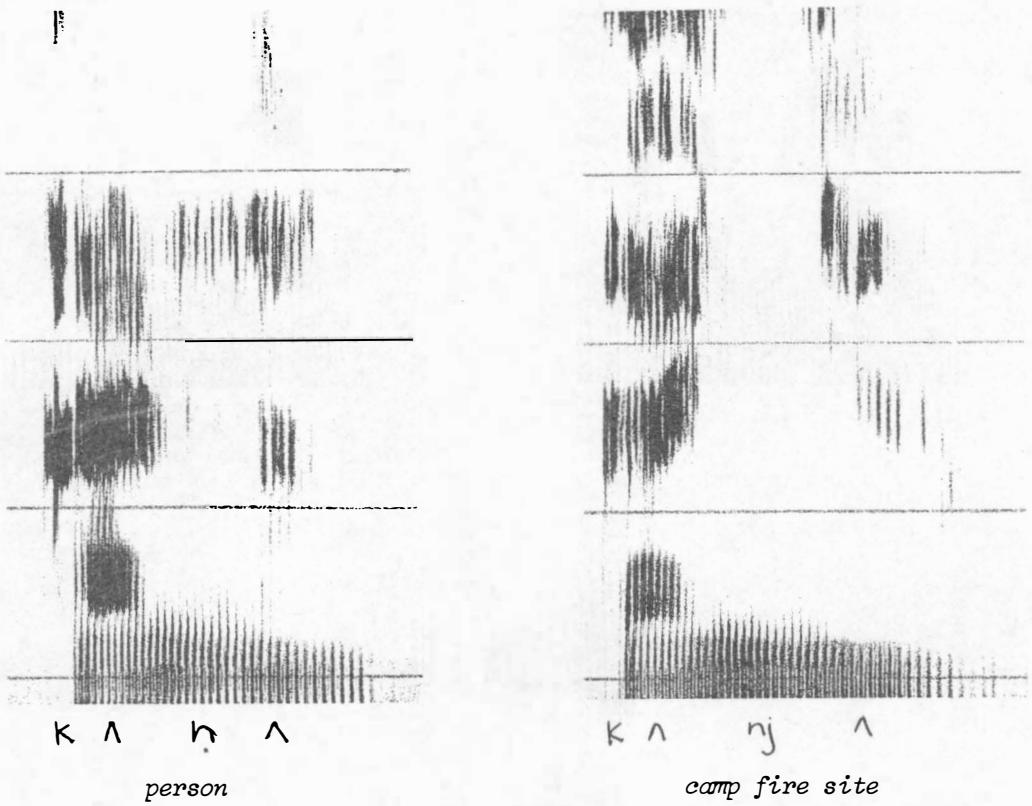
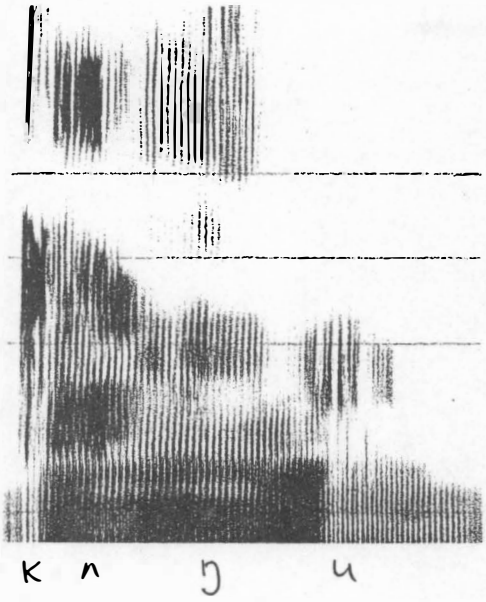
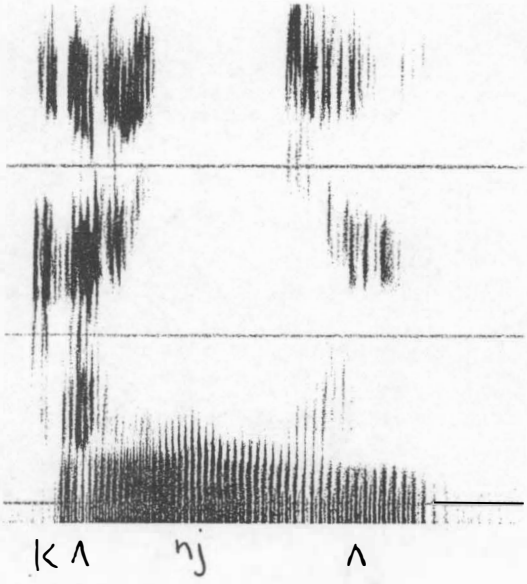


Figure 56

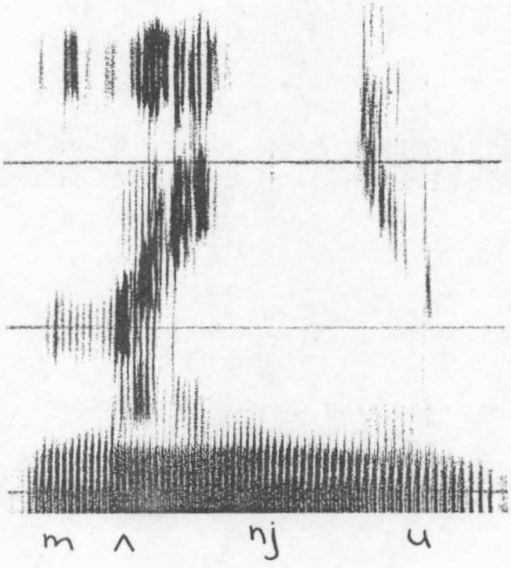
Sonagrams depicting the contrast between [ɳ] and [nj].



sweat



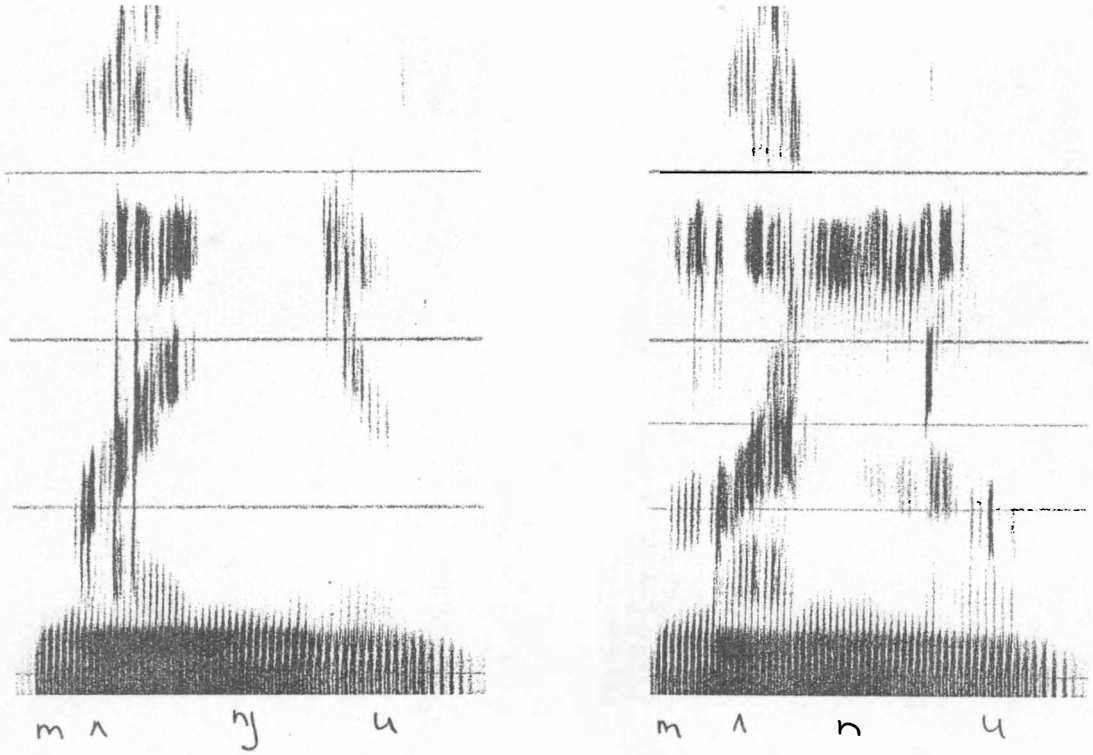
fireplace site



healthy

Figure 57

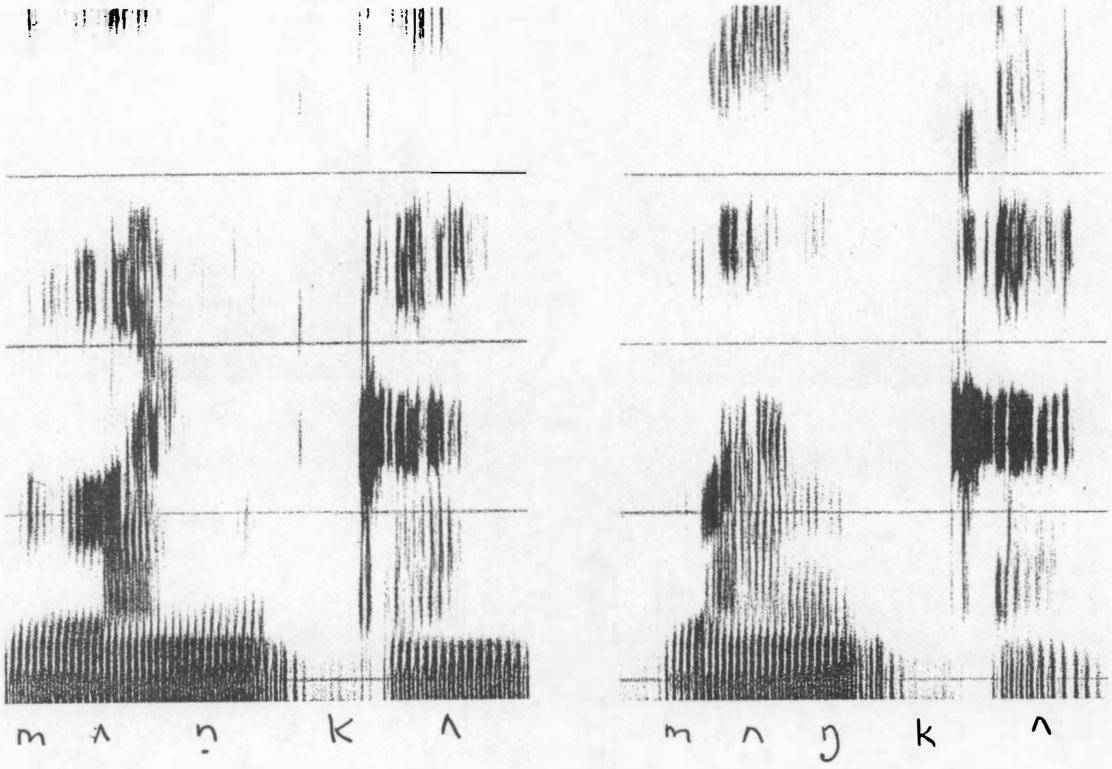
Spectrograms depicting the contrast between [nj] and [ŋ].



healthy *soul*

Figure 58

Spectrograms depicting the contrast between [nj] and [n].



persistent *wrong direction*

Figure 59

Sonagrams depicting the contrast between [n̥] and [ŋ].

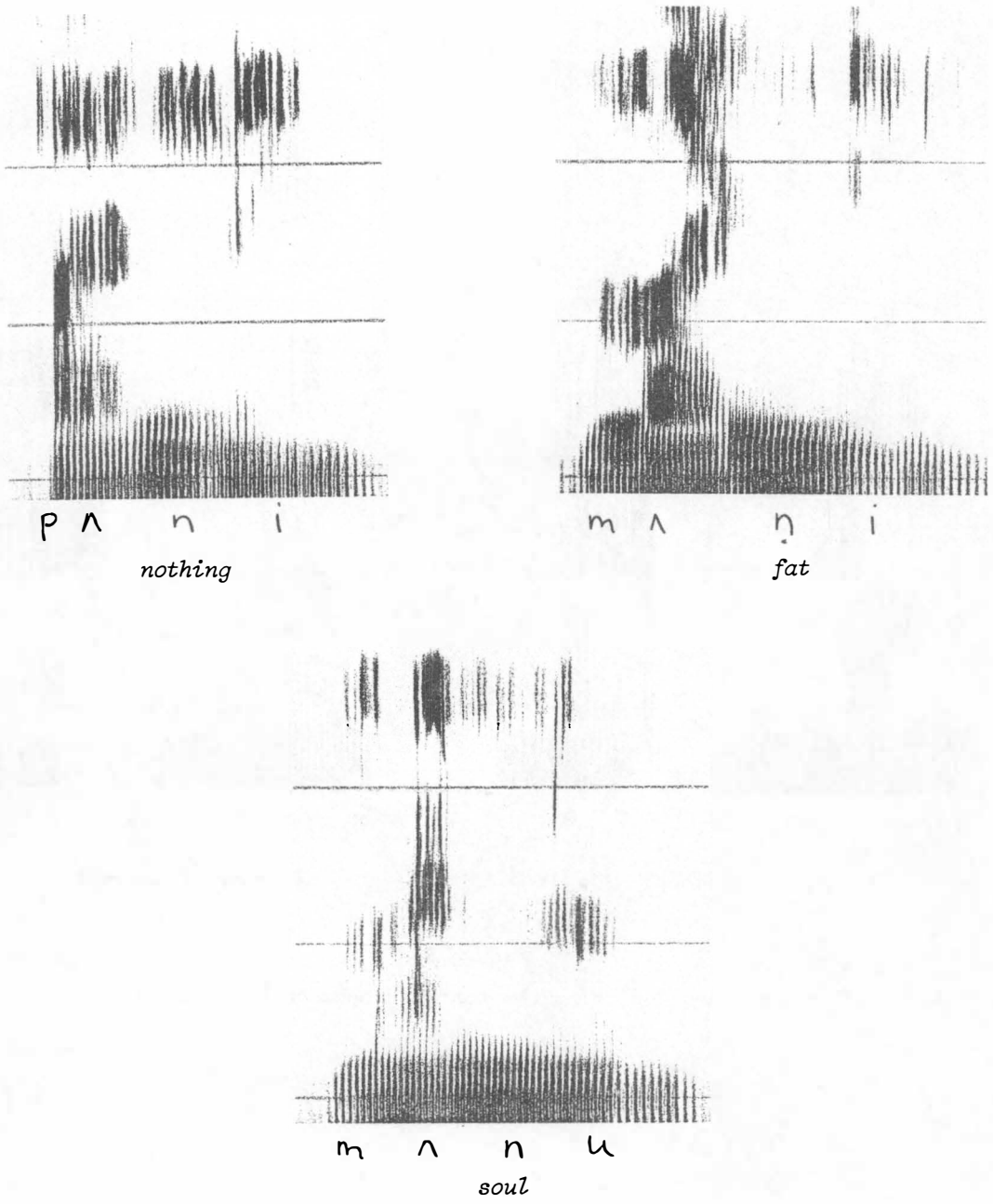
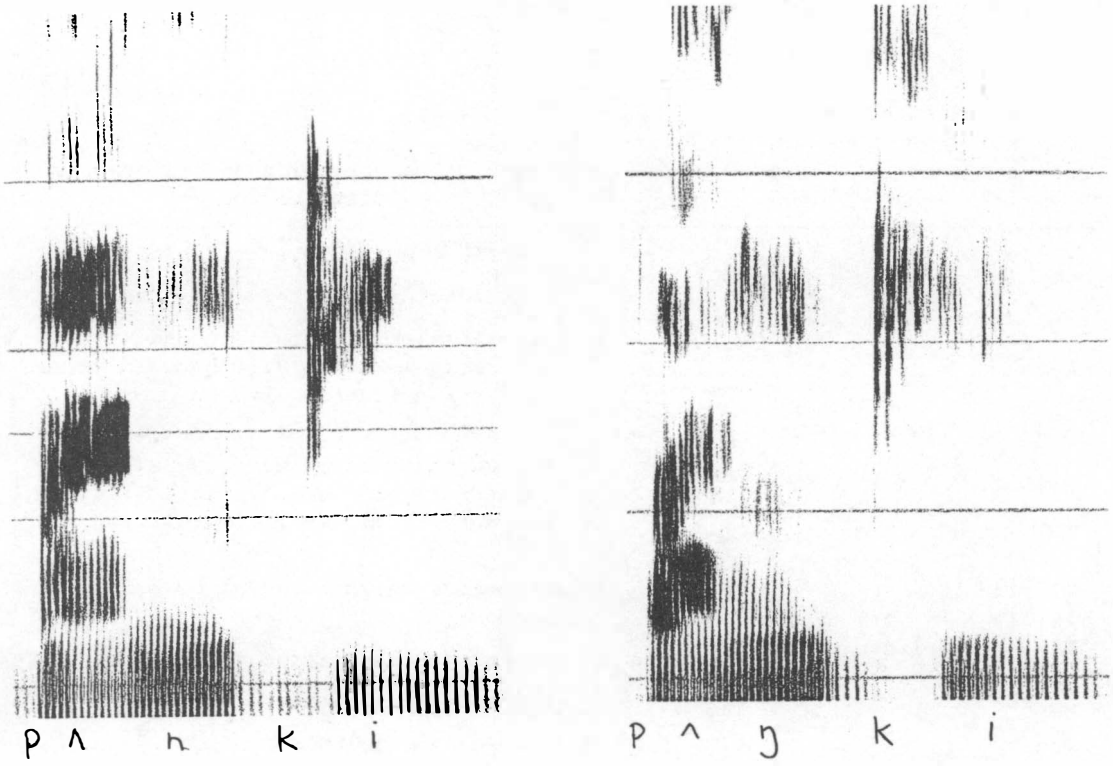


Figure 6C

Sonagrams depicting the contrast between [n] and [ɳ] using a subminimal word set.



happy *side*

Figure 61

Sonagrams depicting the contrast between [n] and [ŋ].

3.8 Semi-vowels

The three Diari semi-vowels are not sufficiently alike for them to be suspect of being submembers of the same phonemes. Therefore /w/ and /y/ can be added to the list without further discussion. [r] has already been compared with those sounds with which it is sometimes in submembership. With the addition of these phonemes, the list of Diari consonants is increased to twenty-two.

3.9 Inventory of consonants

Phoneme symbol	Phonetic symbol	Technical description and allophonic distribution
/p/	[p]	Voiceless unaspirated bilabial stop.
/th/	[th]	Voiceless unaspirated inter-dental stop.
/t/	[t]	Voiceless unaspirated alveolar stop, occurring word medially between vowels and in fluctuation with [d] word initially.
	[d]	Voiced unaspirated alveolar stop occurring word medially following [n], and word initially in fluctuation with [t].
/tj/	[tj]	Voiceless unaspirated alveo-palatal stop.
/ṭ/	[ṭ]	Voiceless unaspirated retroflexed stop.
/k/	[k]	Voiceless unaspirated velar stop.
/m/	[m]	Voiced bilabial nasal.
/nh/	[dnh]	Pre-stopped interdental nasal occurring in fluctuation with [nh] as coda of non-nasal stressed syllable. It only occurs intervocalically.
	[nh]	Voiced interdental nasal occurring in all positions.
/n/	[dn]	Pre-stopped voiced alveolar nasal occurring in fluctuation with [n] as coda of non-nasal stressed syllable. It only occurs intervocalically.
	[n]	Voiced alveolar nasal occurring in all positions.
/nj/	[nj]	Voiced alveo-palatal nasal.
/ṇ/	[ṇ]	Voiced retroflexed nasal.
/ŋ/	[ŋ]	Voiced velar nasal.

/lh/	[dlh]	Pre-stopped voiced interdental lateral occurring in fluctuation with [lh] intervocalically as coda of stressed syllable.
	[lh]	Voiced interdental lateral occurring in all positions.
/l/	[dl]	Pre-stopped voiced alveolar lateral occurring in fluctuation with [l] intervocalically as coda of stressed syllable.
	[l]	Voiced alveolar lateral occurring in all positions.
/lj/	[lj]	Voiced alveo-palatal lateral.
/ḷ/	[ḷ]	Voiced retroflexed lateral.
/ř/	[d]	Voiced alveolar stop occurring intervocalically in fluctuation with [ř].
	[ř]	Voiced alveolar flap occurring in all positions.
/ṛ̌/	[ḍ]	Voiced retroflexed stop.
/rr/	[rr]	Voiced alveolar trill.
/w/	[w]	Voiced labio-velar semivowel.
/y/	[y]	Voiced palatal semi-vowel.
/r/	[r]	Voiced retroflexed semi-vowel.

4. THE VOWEL PHONEMES

In the study of Diari consonants the use of articulatory methods proved sufficient for describing most of the phonetic segments needing phonemic analysis. In the study of the vowels it will be seen that these same methods are not adequate. However, they can be used to establish the fact that there are three simple vowel phonemes and two vowel glides. All but the complex entity [ʌʊ] show minimal contrast with each other in word final position (see Figures 62-65) where spectrograms depict words showing the contrast between [ɪ], [ʌ], [ʊ] and [ʌɪ]. [ʌʊ] has been recorded minimally contrasting with [ʌɪ] in word final position (see Figure 66) but not with its two phonetically similar non-gliding vowels [ʌ] and [ʊ]. For the contrast with these, attention needs to be turned to word medial vowels where minimal pairs between [ʌʊ] and [ʌ] (Figure 67), and between [ʌʊ] and [ʊ] (Figure 68) occur. The following comparative chart indicates by means of minimal pairs or analogous sets, the contrasts between those vowels which occur word finally.

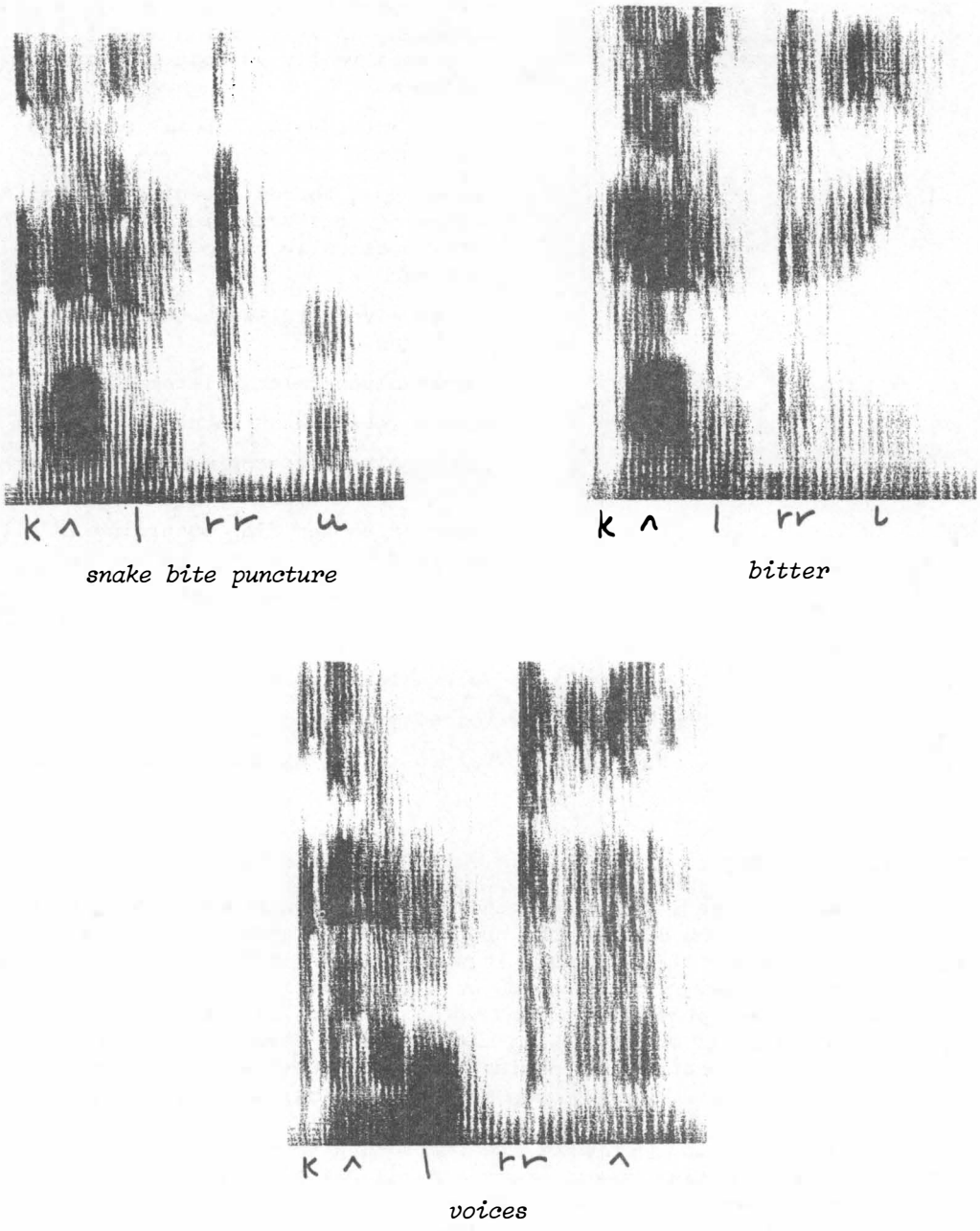
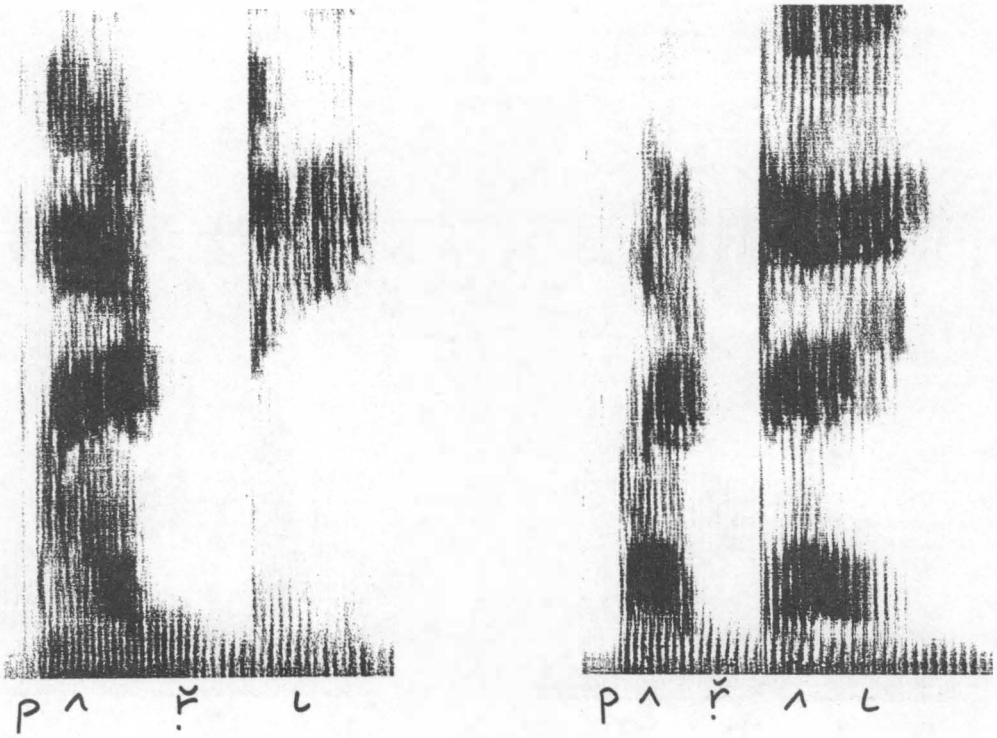


Figure 62

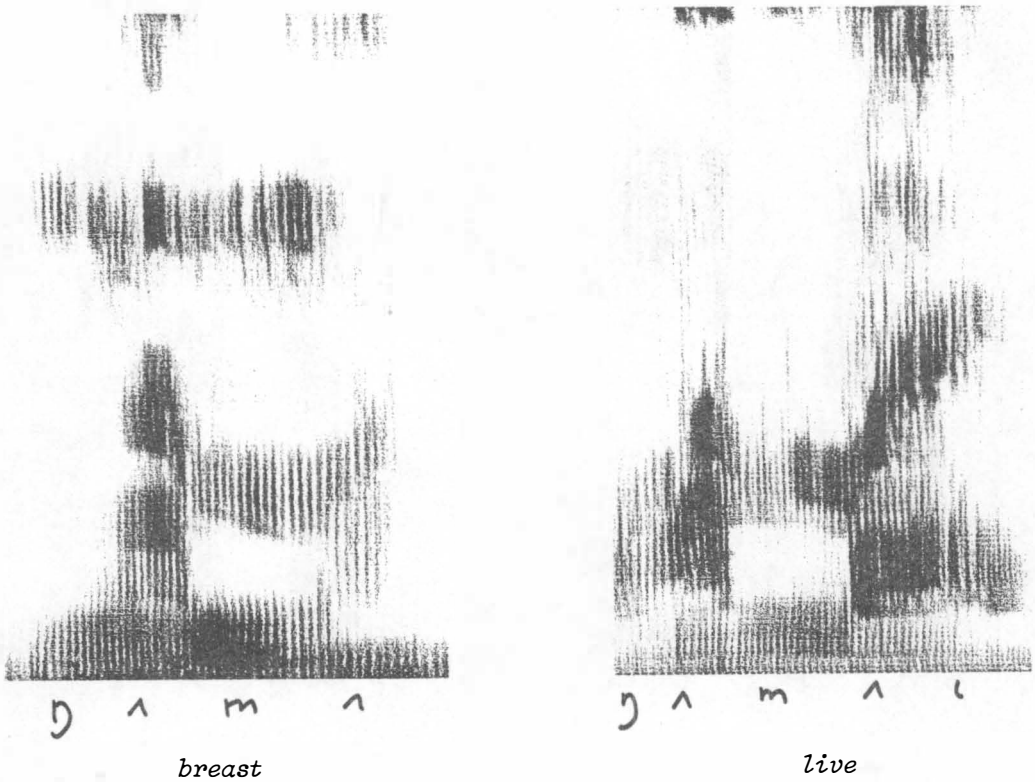
Sonagrams depicting the contrast between [ɹ], [ʌ], and [u].



grub *hold*

Figure 63

Sonagrams depicting the contrast between [ɹ] and [ʌɹ].



breast *live*

Figure 64

Sonagrams depicting the contrast between [ʌ] and [ʌɪ].

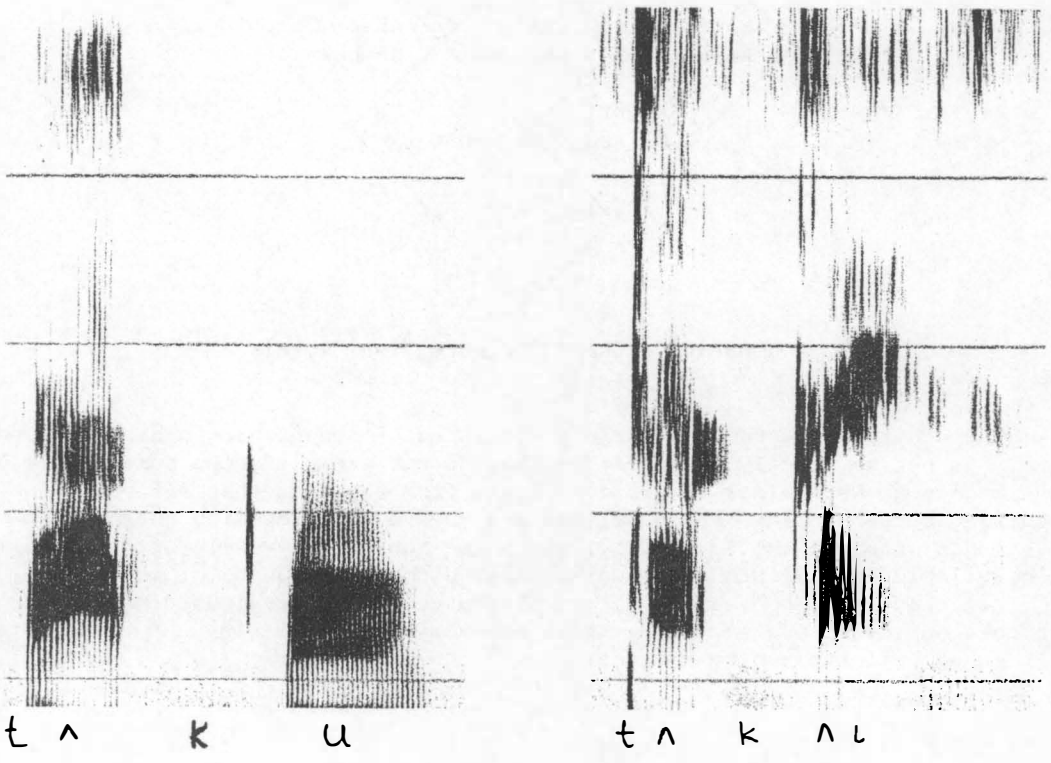
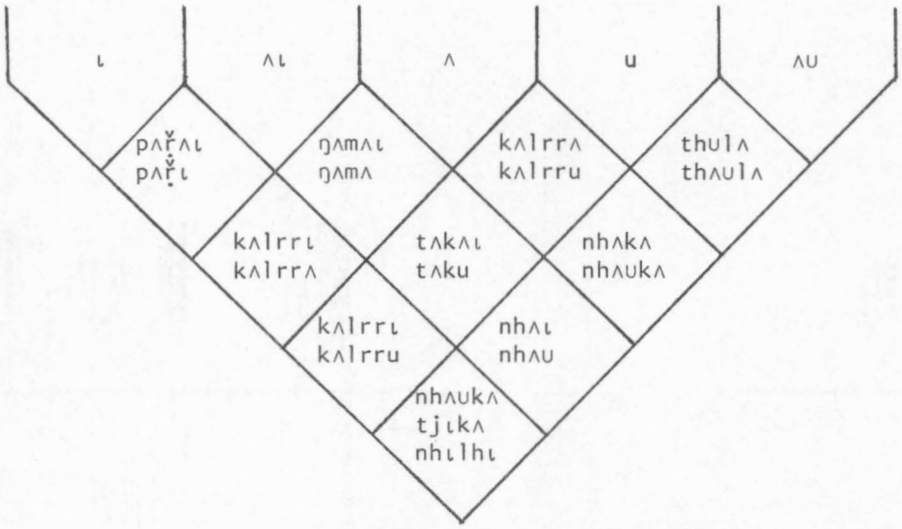


Figure 65

Sonagrams depicting the contrast between [u] and [ʌɹ].



Comparative chart for word final vowels[25]

The contrast between the various varieties of non-gliding medial stressed vowels is not so readily depicted, as they do not exemplify the same degree of consistency as word final vowels do. Apart from the fact that all vowels occurring between nasals are nasalised and the vowels preceding retroflexed consonants obtain a rhotic quality, the three non-glided vowels of the final open syllable expand into nine auditorially different sounds, [ɪ], [ɚ], [ɛ], [æ], [ə], [ʌ], [ɒ], [ʊ], and [u], and of these, if the previously mentioned contrasting vowels are excluded, there are very few contrasts. [ɒ] contrasts with [ʊ] as illustrated by the set:

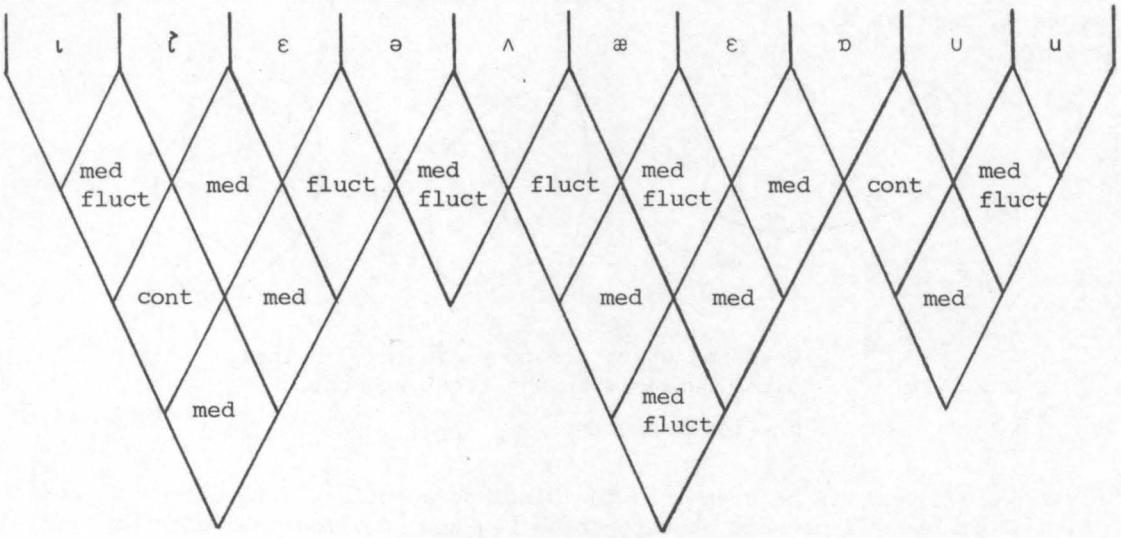
[wɒlrrʌ] *hot*
[wʊlrru] *narrow*
[wɒlu] *indistinguishable,*

and [ɪ] contrasts with [ɛ], as is shown by:

[yɛnku] *father's father*
[yɪnkʌ] *string.*

As for the rest, they are either mutually exclusive in their distribution, or they fluctuate, or they do both.

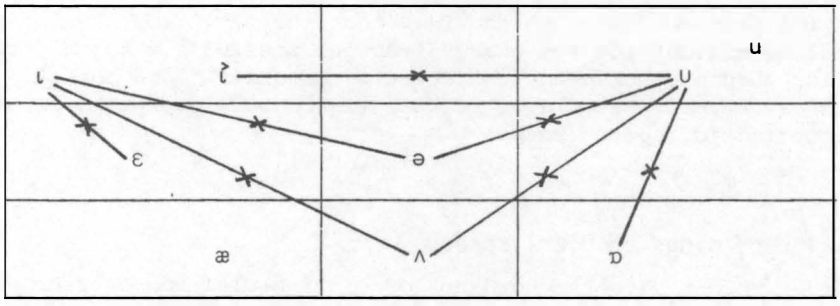
A chart for comparing the relevant medial segments, based upon auditory impressions looks like the following:



med - mutually exclusive distribution
fluct - fluctuation
cont - contrast

Comparative chart for phonetically similar medial vowels

Actually, the contrasts between [ɪ] and [ɛ], and [ɒ] and [ʊ], together with the contrasts already established, are sufficient to enable phoneme groupings to be made. In a three vowel system[26] it is to be expected that allophonic variation will be considerable, as there is little need for control over environmental influences or idiosyncratic fancies. A look at the vowel quadrilateral with lines of contrast drawn upon it makes it readily apparent how the segments are likely to group into phonemes. Perhaps it is possible to claim that there is some ambiguity regarding the relationship of [ɪ̈], [ɛ] and [ə], as the three of them are mutually exclusive in their distribution.

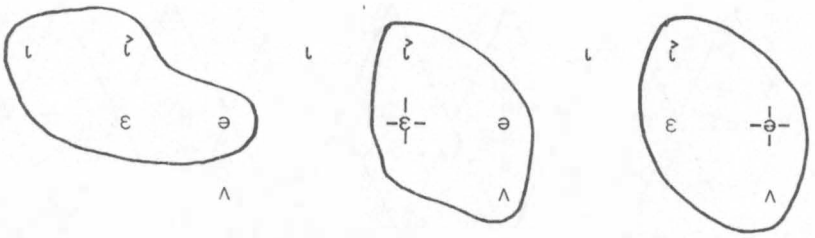


→← = contrast between segments

Figure 66

Diari vowel quadrilateral including lines of contrast where applicable.

However, [ɛ] and [ə] are also in complementary distribution with [ʌ], whereas [ɪ̈] is in contrast with that segment. Also, [ɪ̈] is in complementary distribution with [ɪ], a segment with which both [ɛ] and [ə] contrast. Diagramatically, the situation appears as,



= Segments which are complementary in their distribution with the focal segment.

= The focal segment

From this it can be seen that the simplest solution is to unite [ɪ̈] with [ɪ] to form the /i/ phoneme, and to unite [ɛ] and [ə], together with [æ] and [ɒ], to form the /a/ phoneme. This leaves [ʊ] and [u]. These unite in the /u/ phoneme.

The above conclusions resolve the apparent discrepancy between the number of phonemes occurring word medially and those occurring word finally. It now transpires that the same three non-gliding phonemes occur in the medial positions, as those that occur in word final position, though at times they undergo a fair amount of phonetic variation when they occur word medially.

4.1 An acoustic analysis of vowels

From the foregoing it is apparent that Diari vowels undergo considerable variation when they occur word medially. In fact, the variation is such that articulatory methods do not do justice to the degree or to the subtlety of the vowel changes. From one instance to another the variation may be so slight that it is impossible to discriminate between the segments, and at times the vowel quality in a word does not adequately equate with any of the phonetic symbols. The problem is due to the fact that the variation is along a two dimensional continuum with the change from one possibility to the next being much smaller than the human ear can detect. In order to combat this deficiency judgements can be made based upon the use of acoustic equipment which gives visual recordings of speech sound.

4.2 Visual recordings of Diari speech

In order to get visual recordings of Diari medial vowels from which accurate measurements could be taken, a list of two-syllable words was prepared.[27] The list contained a total of 430 entries,[28] and of these 355 were of different forms.[29] The list was familiarised by Alec Edwards, and then each

word was spoken by him deliberately and distinctly, three times. These utterances were recorded on magnetic tape using a Nagra III tape recorder, and an AKG D.24 microphone. A shorter list of approximately 190 words[30] was extracted from the longer list, and with the help of Edwards the four other known male speakers of Diari were recorded.[31] One of the recordings was rejected because of the insistence of the speaker to sing the words rather than speak them.

The recordings were taken to the Speech and Language Research Centre at Macquarie University, and using the Kay Sonagraph 6061A Spectrum analyser, spectrograms were made of each utterance. At this stage a second informant's recordings were discarded because the fundamental pitch of his vocal tract was too high for accurate measurements of his voice to be readily made.[32]

Of the three-word sonagrams produced the second word was chosen for measurement. Each word was spoken three times by the informants in order to establish a constant intonation pattern. This had the effect of creating a series type intonation, with each set spoken in a similar deliberate rhythmic manner. The second word was chosen for measuring for three reasons. In case the intonation pattern affected vowel quality, it was considered wise to be consistent in the choice of which of the three words should be measured. The third word was unsuitable, for frequently it became indistinct, due to utterance final intensity decay. The first word was usually suitable but occasionally there was some hesitancy during its pronunciation, particularly when the speaker was looking for assurance that he was saying the correct word. The second word was free of both these influences and was therefore chosen for measurement.

Herz measurements were taken of the frequencies of the first and second formants of the target area of the stressed vowel. The target area was determined by the characteristics of the first three formants, particularly of F2 (formant two). The determining characteristics consisted of a significant change of direction of the formant, a steady-state position of the formant, and a significant burst of energy in a formant. The first two factors were taken as the more important, but occasionally, in the absence of other criteria, the latter had to be relied upon. Figures 67-69 illustrate how these determining variables appear on sonagrams.

When the target area had been determined for each stressed vowel, the central frequency of the first and second formants was noted. In order to facilitate the measuring of the formants, a square wave energy burst with harmonics at regular 500 Hz intervals was incorporated into the sonagraph. After each three word utterance was recorded onto the magnetic cylinder of the sonagraph, the square wave energy burst was also recorded, which meant that a 500 Hz scale was calibrated onto each sonagram.

A calibrated rectangular piece of clear perspex was used in conjunction with the electronic scale. The calibrations on the perspex were made to agree with a fixed setting of the sonagraph, which filtered frequencies from 100 Hz to 3900 Hz. The sheet of perspex was cut to the identical height of a sonagram but a quarter of an inch shorter in length. It was then calibrated with a line scored along the length of the perspex to represent each 100 Hz. See Figure 70.

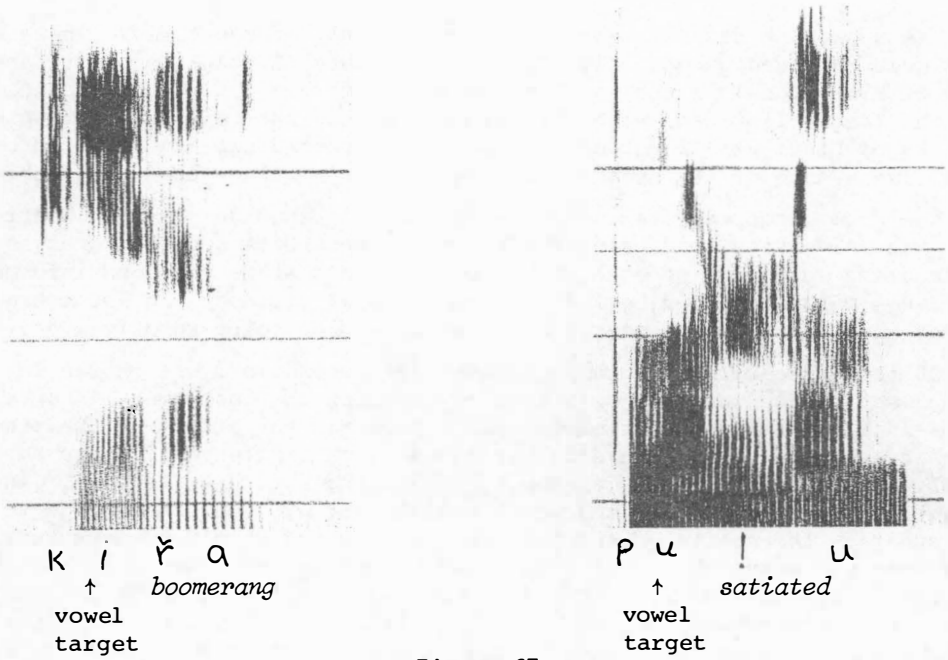


Figure 67

Sonagrams with vowel target indicated by a steady-state position of the formants followed by a change of direction.

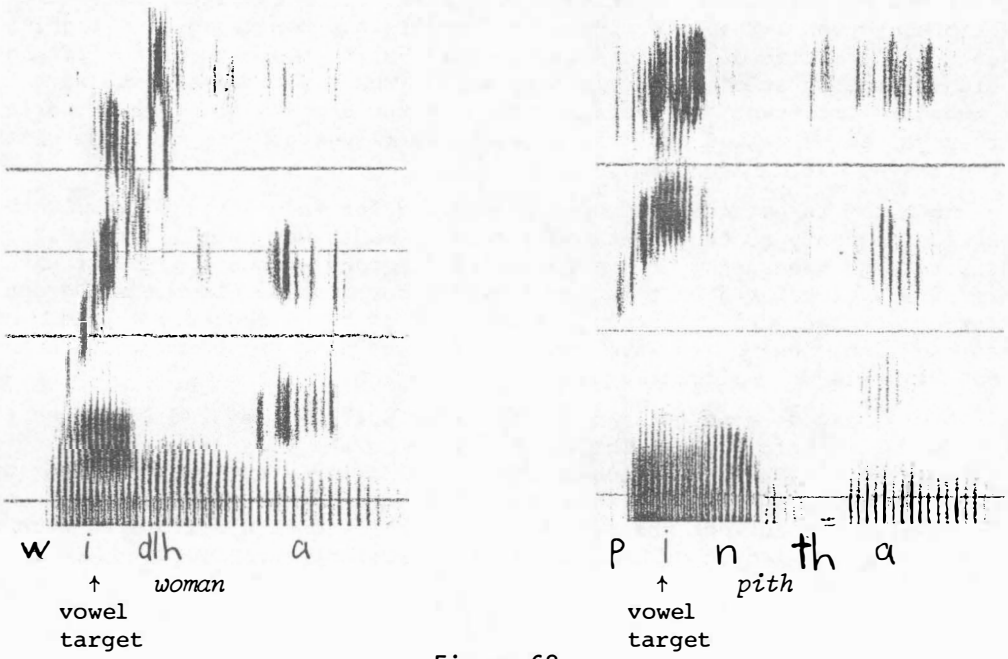


Figure 68

Sonagrams with vowel targets indicated by a change in formant direction before and after the steady-state position.

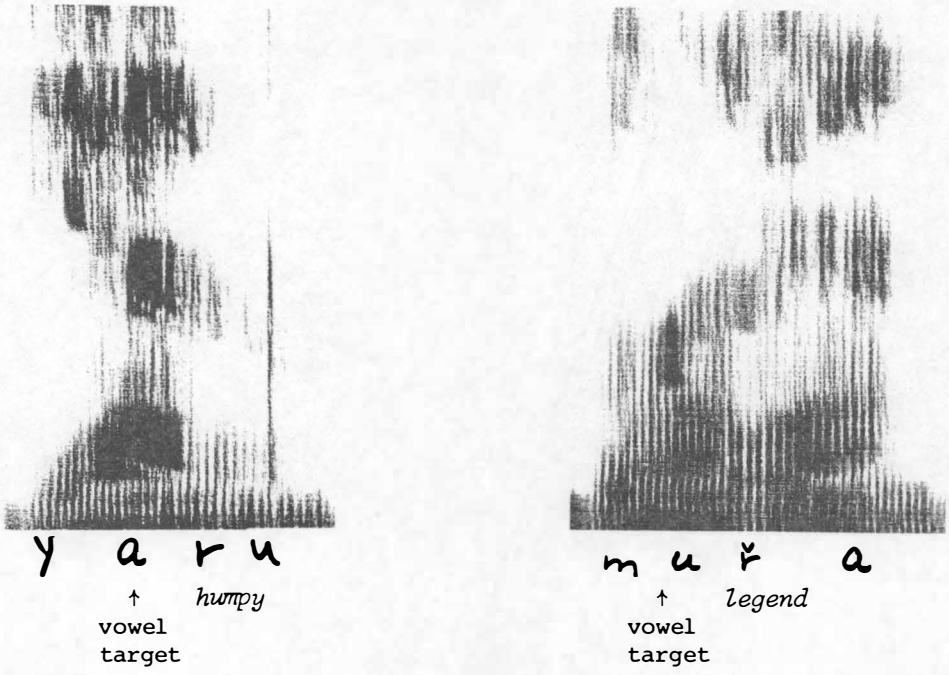


Figure 69

Sonagrams with vowel targets indicated by a burst of energy of the second formant during the steady-state position.

A stand was also made. This consisted of a squared length of pineboard, a little larger than a sonagram,[33] and a squared length of quarter-inch perspex screwed at right angles to one of its long edges.

The measurements were taken from a sonagram by placing it upon the stand with the calibrated perspex sheet placed over it. It was then possible to accurately read the frequency of the formants at any point along the sonagram. Figure 71 illustrates the use of this equipment.

In order to adjust any tendency of the sonagram to wander from its setting, a frequency metre was attached to the sonagraph. When the top setting shifted by 10 Hz the sonagraph was readjusted to the original setting.

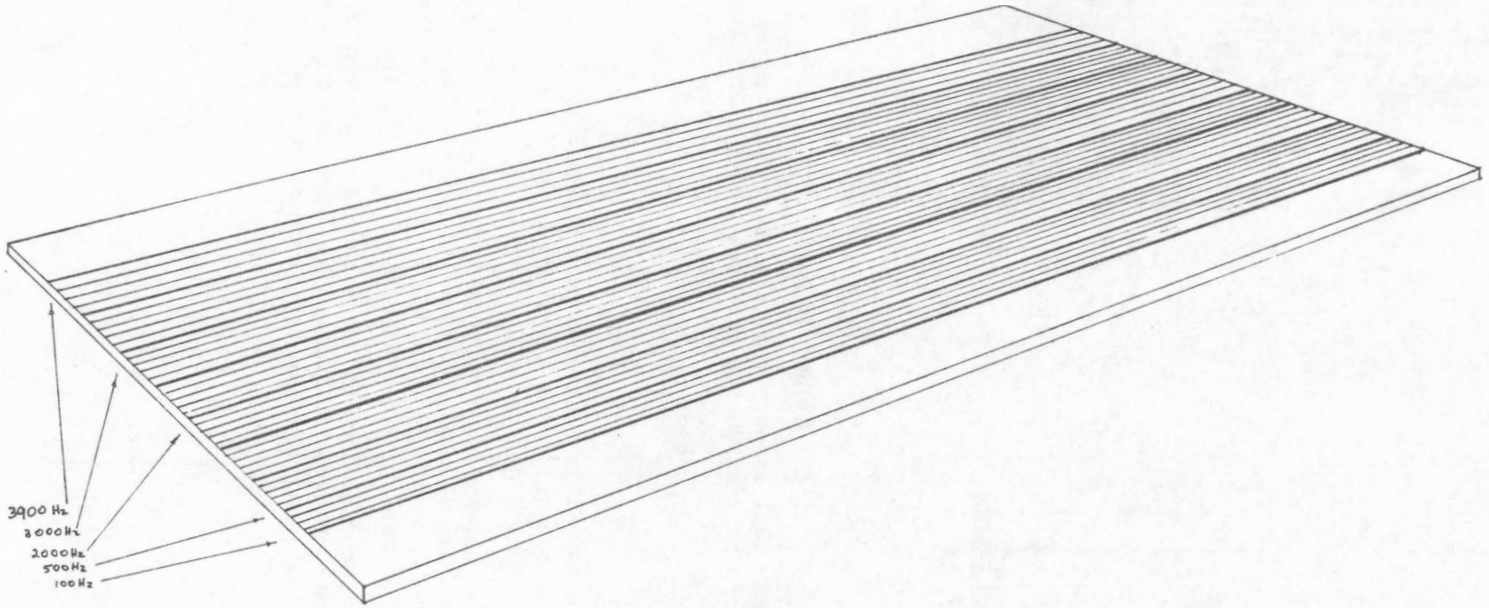


Figure 70

Illustration of perspex calibrated scale
used for measuring sonagram frequencies.

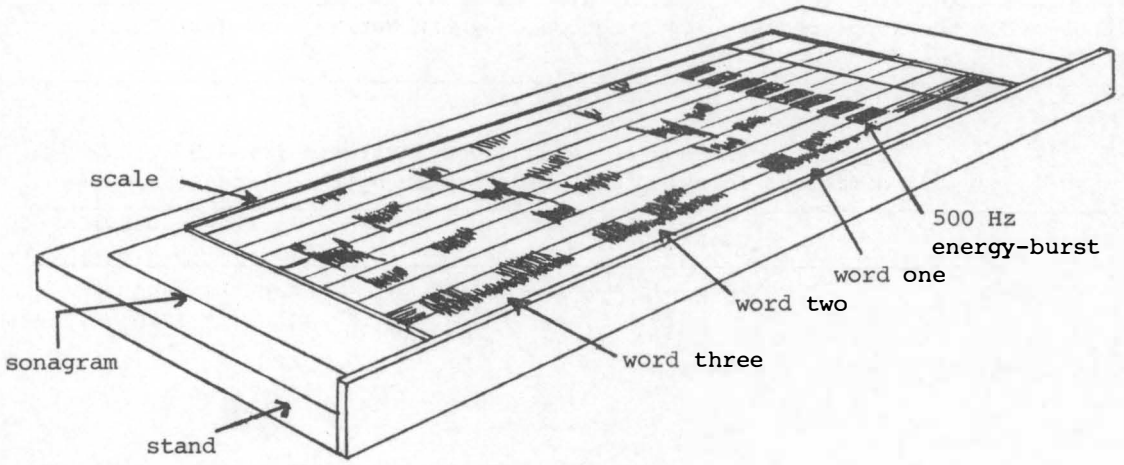


Figure 71

An illustration of sonagram and perspex scale placed on their measuring stand.

Note: The illustrated scale is calibrated for each 500 Hz whereas the actual scale is calibrated at each 100 Hz. (See Figure 70)

4.3 The analysis of the sonagrams

The measurements of the first two formants of each of the 429 words are presented in Table 7. The table lists each word in phonemic script, gives its nearest English equivalent, and then states the estimated central frequency of the first two formants during the target for the initial stressed vowel. Three columns of figures are presented. The first and major column represents the readings taken from the sonagrams of Alec Edwards, and the next two columns are those from the supplementary lists recorded by Ern Murray, and Jack Carrot.

Table 7[34]

F1 and F2 readings of initial vowel targets for 429 (355 different forms) Diari words spoken by three speakers.

No.	Word	Meaning		F1, F2 Frequencies A.E.	E.M.	J.C.
1	papa	*mother's brother*	F1	640	600	660
			F2	1260	1340	1240
2	paṭipaṭi	*silly*		620		
				1450		
3	paka	*tobacco*		790		
				1290		
4	paku	*purposeless*		580	590	570
				1200	1270	1240
5	pani	*none*		620	850	680
				1360	1360	1360
6	pantu	*lake*		750		
				1180		
7	panki	*happy*		640		
				1490		
8	panrra	*cooked*		730		
				1370		
9	panjtja	*knee*		660		
				1470		
10	paṇi	*to smell*			650	670
					1400	1310
11	paṇtu	*blunt*		650		
				1420		
12	paṇtu	*blunt*		700		
				1300		
13	paŋa	*caterpillar*		680		860
				1130		1370
14	paŋki	*side*		590		
				1420		
15	paŋki	*side*		630		
				1430		

No.	Word	Meaning		A.E.	E.M.	J.C.
16	palhthu	*path, track*	F1	750		
			F2	1250		
17	pali	*to die*		690		
				1240		
18	palu	(no meaning)*			630	
					1310	
19	palku	*body*		800		
				1200		
20	palrru	*salt bush*		600		
				1250		
21	paljtji	*at the hip*		640	610	600
				1300	1330	1370
22	paḷa	*sexual arousal*		770		
				1140		
23	paḷu	*naked*		760		660
				1180		1270
24	paḷpa	*some*		650		
				1200		
25	pařa	*hair*		690		
				1400		
26	paṛai	*to hold*		600	620	560
				1430	1250	1410
27	paṛi	*grub*		570	580	660
				1420	1360	1200
28	paṛi	*grub*		720		
				1450		
29	parru	*fish type (bony bream)*		730	620	720
				1490	1300	1240
30	pawa	*seed type*		650	600	720
				1130	1230	1240
31	pawa	*seed type*		660		
				1150		
32	paya	*bird*		610	610	680
				1500	1240	1310
33	pari	*heavily loaded*		620		
				1270		
34	paru	*flashing light, glittering*		540	600	610
				1370	1270	1170

*Given by Ern Murray instead of paḷu. It was not noticed at the time so there was no way for checking it for meaning.

No.	Word	Meaning		A.E.	E.M.	J.C.
35	paru	*flashing light, glittering*	F1 F2	700 1280		
36	pita	*ochre pit*		400 1910	420 1860	
37	pita	*ochre pit*		390 1880		
38	piti	*buttocks*		390 1830		
39	pitji	*tree bark*		400 1930	400 1870	460 1810
40	piṭa	*wood*				410 1570
41	pintha	*pith*		500 1700		
42	pinthi	*report, rumour*		390 1910		
43	piṇa	*large*		410 1840	410 1750	440 1780
44	pinrri	*grasshopper*		400 1590		
45	pinja	*warrior band*		390 1920	370 1680	470 1840
46	pinja	*warrior band*		420 2040		
47	pili	*bag*		400 1750	460 1680	430 1790
48	pilki	*different*		410 1600		
49	pilrra	*possum*		370 1580		
50	piljtjarru	*scattered*		410 1750		
51	piṟarru	*drought*		500 1610		390 1860
52	piṟa	*navel*		410 1810		
53	piṟa	*navel*		420 1500		
54	pirra	*bowl*		400 1500		
55	pirri	*chisel*		390 1530	420 1750	520 1540

No.	Word	Meaning		A.E.	E.M.	J.C.
56	pira	*moon*	F1	400	430	470
			F2	1630	1870	1760
57	piri	*cleared area, open place*		400	400	
				1650	1760	
58	putha	*shallow*		490	450	450
				1010	1270	1090
59	putha	*number of times*		500		
				1090		
60	putha	*ashes*		390	400	490
				1070	1180	1170
61	puthu	*personal effects*		390		
				1080		
62	putju	*blind*		470	480	470
				1010	1020	1120
63	puka	*bread*		510	440	460
				910	890	1060
64	punka	*flax*		490		
				1000		
65	punŋa	*lungs*		480		
				1110		
66	puŋa	*house*		400	420	480
				900	950	960
67	pulha	*them* (dual)		400		
				920		
68	pulha	*them*		420	420	500
				1110	960	1010
69	pulu	*unable*		470	500	
				930	1040	
70	pulu	*unable*		430		
				860		
71	puḷu	*white, satiated*		450		420
				980		980
72	puḷpa	*a cleared area*		410		
				1150		
73	puḷku	*half-satisfied*		420		
				900		
74	puřu	*dew*		460	450	440
				1080	930	1090
75	puřka	*mind, conscience*		520		
				970		
76	puřku	*small tree type*		430	460	440
				1000	1200	1080

No.	Word	Meaning		A.E.	E.M.	J.C.
77	puṙa	*unripe, bud*	F1	370	370	450
			F2	970	1020	1030
78	puṙa	*unripe, bud*		490		
				1000		
79	purru	*exclamation of surprise*		480	400	440
				1010	1020	1030
80	puru	*end*		420	450	440
				1050	1020	1040
81	thathi	*centre*		610	580	740
				1490	1370	1310
82	thaka	*clay*		590		
				1410		
83	thampaṇa	*to creep up*		610		
				1470		
84	thana	*them*		670	580	830
				1500	1340	1310
85	thanrra	*fruit*		670		
				1370		
86	thanju	*bush type*		600	660	600
				1400	1340	1340
87	thaŋka	*milk*		530		
				1440		
88	thalhtha	*crack, split*		600		
				1400		
89	thalpa	*ear*		650		
				1420		
90	thalpa	*ear*		670		
				1490		
91	thalku	*straight*		650		
				1260		
92	thaḷa	*name*		620	620	670
				1320	1410	1380
93	thaḷi	*tongue*		600	580	710
				1520	1380	1290
94	thaḷi	*tongue*		650	590	800
				1370	1400	1340
95	thaṙa	*thigh*		630		
				1320		
96	thaṙa	*thigh*		660		
				1380		
97	thaṙi	*thirsty*		570	590	650
				1500	1520	1290

No.	Word	Meaning		A.E.	E.M.	J.C.
98	tharaṇa	*ascending*	F1	570		
			F2	1300		
99	tharu	*wife's father*		570	570	840
				1380	1300	1340
100	thipi	*healthy, spritely*		430	410	500
				1800	1790	1550
101	thiṭi	*tea*		500		500
				1700		1860
102	thiti*	?			450	
					1910	
103	thinka	*night*		490		
				1810		
104	thiljtja	*sinew*		410		
				1810		
105	thiři	*threatening, angry for fighting*		480	440	530
				1800	1880	1770
106	thina	*foot*		400		
				1750		
107	thirri	*fight*			420	
					1800	
108	thiwi	*flower*			410	510
					1980	1790
109	thupu	*smoke*		500	400	460
				1010	1150	1250
110	thuku	*back*		500	440	540
				1110	1250	1080
111	thuna	*gypsum*		500	420	510
				970	1350	1350
112	thuŋka	*rotten*		500		
				1090		
113	thula	*foreign, exotic, strange*		490	390	460
				1090	980	1240
114	thula	*foreign, exotic, strange*		500		
				1050		
115	thula	*foreign, exotic, strange*		400		
				950		
116	thuřa	*midday*		490	410	520
				1090	1200	1350

*E. Murray gave thiti for *tea* though generally regarded as being thiṭi. As the error wasn't detected till field work was completed there was no way of checking the form to see if it has some other English gloss.

No.	Word	Meaning		A.E.	E.M.	J.C.
117	thiwi	*flower*	F1	420		
			F2	1320		
118	thiwi	*flower*		490		
				1350		
119	tapa	*sore, wound*		540	700	690
				1540	1470	1250
120	tapa	*sore, wound*		590		
				1510		
121	tapi	*calm, still*		550	610	700
				1510	1480	1170
122	taku	*sandhill*		620	620	630
				1440	1490	1300
123	tanthu	*soft*		610		
				1410		
124	taḷa	*fish scales, skin*		600		
				1440		
125	taḷa	*fish scales, skin*		530		
				1480		
126	titji	*sun*			420	460
					2020	1670
127	tilka	*splinter, thorn*		420		
				1700		
128	tilka	*splinter, thorn*		420		
				1720		
129	tiřtji	*rough sand*		500	400	480
				1690	1920	1140
130	tunjtji	*mulga type*		380		
				1230		
131	tunjtji	*mulga type*		390		
				980		
132	turru	*hard ground, hump*		420	430	490
				1040	1260	1200
133	turru	*hard ground, hump*		400		
				1050		
134	tjaŋka	*soft*		650		
				1590		
135	tjaḷa	*a fragment, piece*		590	590	690
				1480	1500	1340
136	tjika	*incorrect*		410	380	450
				2060	1850	1600
137	tjilpi	*wart, knot, nipple*		390		
				1860		

No.	Word	Meaning		A.E.	E.M.	J.C.
138	tjilpi	*wart, knot, nipple*	F1	370		
			F2	1820		
139	tjutju	*reptiles, spiders, stinging insects*		400	440	510
				1310	1360	1390
140	tjuru	*intelligence, sense*		490	430	490
				1240	1190	1320
141	kapa	*waist*		580	580	700
				1330	1480	1220
142	kapi	*egg*		620		
				1480		
143	kathi	*clothing*		570		
				1500		
144	kathu	*windbreak*		590	690	700
				1390	1400	1280
145	kathu	*windbreak*		590		
				1360		
146	kata	*louse*		590	570	600
				1530	1590	1370
147	kaṭa	*noise*		580	650	770
				1410	1560	1290
148	kaṭi	*raw*		620		
				1480		
149	kaku	*elder sister*		580	570	820
				1230	1350	1290
150	kami	*father's mother*		830	650	600
				1490	1310	1230
151	kanhini	*mother's mother*		610		
				1510		
152	kanpu	*echo, thumping sound*		600		
				1440		
153	kanpu	*echo, thumping sound*		620		
				1410		
154	kanhtha	*grass type*		600		
				1510		
155	kanrri	*round sided, boomerang*		590		
				1520		
156	kanja	*fireplace*		610	550	600
				1500	1540	1380
157	kanjtji	*can*		730		
				1470		
158	kaṇa	*person*		620	620	750
				1420	1400	1410

No.	Word	Meaning		A.E.	E.M.	J.C.
159	kaŋi	*fun-lover*	F1	640		750
			F2	1390		1340
160	kaŋi	*fun-lover*		600		
				1480		
161	kaŋu	*perspiration*		580	730	690
				1330	1360	1300
162	kanku	*boy*		640		
				1430		
163	kalhu	*liver*		590	640	
				1450	1280	
164	kalhthi	*spear*		590		
				1400		
165	kalki	*creeping plant*		590		
				1420		
166	kalrra	*voices*		870		
				1430		
167	kalrri	*bitter, salty*		580		
				1420		
168	kalrru	*snake bite puncture*		580		
				1320		
169	kalju	*acacia tree*		600		
				1460		
170	kalju	*acacia tree*		830		
				1450		
171	kalju	*acacia tree*		630		
				1500		
172	kaḷa	*empty*		610		
				1400		
173	kaḷu	*testicle*				560
						1310
174	kaḷku	*rushes, reeds*		570		
				1400		
175	kařari	*today*		540		
				1480		
176	kani	*lizard*		590	650	800
				1460	1480	1300
177	kaṟi	*wife's brother, sister's husband*		580		
				1440		
178	kaṟi	*wife's brother, sister's husband*		590		
				1400		
179	kara	*perhaps, flea*		610	550	680
				1460	1420	1380

No.	Word	Meaning		A.E.	E.M.	J.C.
180	kara	*perhaps, flea*	F1	590	640	600
			F2	1510	1350	1350
181	kima	*tumour, swelling*		390	390	480
				1960	1950	1770
182	kini	*penis*		430		
				1890		
183	kinjtja kinjtja	*dispirited, fed up*		410		
				1910		
184	kilhthi	*stew*		400		
				1830		
185	kilpa	*cold*		420		
				1750		
186	kilirri*	?			430	
					2070	
187	kiḷa	*vagina*		500		
				1770		
188	kiḷa	*vagina*		440		
				1760		
189	kiřa	*boomerang*		410	400	510
				1970	1930	1930
190	kiři	*move aside*		400	430	510
				1820	2010	1860
191	kirri	*clever, very*		420	450	500
				1680	1740	1590
192	kupa	*child*		370	400	500
				790	750	970
193	kuthiṇa	*hiding*		490		
				1090		
194	kuti	*black swan*		450	410	540
				1000	1000	1100
195	kutja	*feathers*		390	410	480
				940	1260	1100
196	kutja	*feathers*		410		
				970		
197	kutji	*spirit*		380		
				1000		
198	kuku	*hollow, cup*		420	440	510
				870	970	1000

* Given by E. Murray for *clever* but then corrected to kirri. He was not able to give the English equivalent for /kilirri/.

No.	Word	Meaning		A.E.	E.M.	J.C.
199	kuku	*hollow, cup*	F1	420		
			F2	800		
200	kuku	*hollow, cup*		420		
				930		
201	kuma	*corpse*		380	420	460
				790	910	980
202	kuma	*corpse*		430		
				900		
203	kunhtha	*crustacean type*		450		
				1060		
204	kunhthi	*mosquito*		470		
				990		
205	kunki	*doctor*		460		
				940		
206	kunmi	*fog*		390		
				790		
207	kunmi	*fog*		440		
				930		
208	kuṇu	*one, another*		460	380	500
				850	910	1070
209	kuṇu			490		
				1030		
210	kuŋkakuŋkaṇa	*to limp*		400		
				890		
211	kulrru	*back*		500		
				920		
212	kuḷa	*sand grass*		400		
				870		
213	kuḷi	*odour*		440	440	490
				890	1060	1090
214	kuḷpi	*subincision*		390		
				830		
215	kuřa	*sore throat*		430	430	470
				1000	1130	1010
216	kuři	*shell*		360	410	480
				940	980	1130
217	kuři	*shell*		440	430	470
				1100	970	1240
218	kuna	*faeces*		430		
				1090		
219	kuṟa	*new moon*		420		
				960		

No.	Word	Meaning		A.E.	E.M.	J.C.
220	kuṙu	*hole*	F1	420		
			F2	950		
221	kuṙu	*hole*		410		
				950		
222	kuṙu	*hole*		380		
				720		
223	kuri	*sap, plant shoot, stealing*		420	430	500
				880	1100	1320
224	kuri	*sap, plant shoot, stealing*		420	410	490
				980	1050	1000
225	kuri	*sap, plant shoot, stealing*		400		
				1020		
226	matja	*already*		600	750	610
				1490	1500	1360
227	maku	*lower half of trunk of body*		650	910	630
				1230	1400	1170
228	maku	*lower half of trunk of body*		630		
				1250		
229	manu	*soul, mind, idea*		590	710	690
				1280	1310	1330
230	manrra	*stomach, messenger*		680		
				1340		
231	manrru	*two*		590		
				1240		
232	manja	*glowing part of fire stick*		710		
				1500		
233	manju	*tasty, spritely, healthy*		600		
				1470		
234	manju	*tasty, spritely, healthy*		730		
				1490		
235	manju	*tasty, spritely, healthy*		630		
				1300		
236	maṇa	*mouth*		570		
				1270		
237	maṇi	*fat*		560		
				1100		
238	maṇka	*doggedly*		580		
				1380		
239	maṇka	*doggedly*		650		
				1550		
240	maṇka	*doggedly*		680		
				1480		

No.	Word	Meaning		A.E.	E.M.	J.C.
241	maŋka	*wrong direction*	F1	670		
			F2	1320		
242	maŋka	*wrong direction*		610		
				1150		
243	malka	*mulga type*		770		
				1180		
244	maljka	*trace, marking*		650		
				1390		
245	maḷa	*more*		610		
				1110		
246	maṙka	*camp out*			680	560
					1300	1300
247	maṙki	*vexed, angry*		670		
				1490		
248	maṙa	*stone*		600		
				1270		
249	maṙi	*heavy*		800		
				1480		
250	maṙi	*heavy*		700		
				1400		
251	maṙu	*sweet, totem*		730		
				1320		
252	maṙu	*sweet, totem*		620		
				1250		
253	marra	*new*		610		
				1280		
254	marru	*wide, broad*		630	690	640
				1270	1240	1150
255	mara	*hand*		630	710	600
				1270	1290	1300
256	mara	*hand*		630		
				1380		
257	maru	*black*		610	710	670
				1280	1370	1200
258	mitha	*earth*		410	480	490
				1930	1920	1560
259	minha	*what*		400	430	500
				2020	1660	1500
260	minhthi	*fish net*		430		
				2010		
261	minka	*hole, cave*		330		
				1780		

No.	Word	Meaning		A.E.	E.M.	J.C.
262	minrri	*plant*	F1	380		
			F2	1710		
263	mila	*thigh bone, fish hook*		330	410	480
				1580	1300	1500
264	mila	*thigh bone, fish hook*		360		
				1500		
265	milki	*eye*		410		
				1610		
266	milja	*fasting*		380		
				1810		
267	miři	*peak, top*		440	380	520
				1980	1910	1660
268	miři	*peak, top*		390	390	500
				2020	1860	1540
269	miřtja	*noise of people*		440	440	460
				1510	1730	1570
270	miřka	*ant*		410	440	520
				1580	1730	1560
271	mutja	*cotton, bush*		440	370	480
				1060	1020	1030
272	mutja	*cotton, bush*		400		
				920		
273	mutja	*cotton, bush*		470		
				1290		
274	muka	*sleep*		430	420	520
				870	870	970
275	muku	*bone*		450		
				840		
276	munhtha	*self*		450		
				810		
277	munji	*owlet nightjar*		420	490	480
				870	1050	990
278	munjtja	*sick*		420		
				910		
279	munjtja	*sick*		530		
				1040		
280	munjtju	*fly*		470		
				870		
281	muṇa	*lap*		420	510	500
				880	1120	1040
282	mulha	*face*		430	490	520
				890	1000	1090

No.	Word	Meaning	A.E.	E.M.	J.C.
283	muḷa	*placid*	390 890	390 1010	520 1040
284	muřa	*legend, history*	430 900	480 1100	510 1030
285	muřku	*muddy*	400 1120	530 1120	480 1130
286	murru	*crust, scum*	410 1010	440 1060	550 1120
287	muya	*withered, dried out*	450 960	360 930	490 1100
288	muya	*withered, dried out*	360 1020		
289	nhaka	*there*	680 1330	590 1420	590 1400
290	nhanha	*her* (object)	600 1380	590 1470	590 1380
291	nhani	*she* (nominative)	610 1430		
292	nhanrru	*she* (ergative)	610 1400		
293	nhanrru	*she* (ergative)	710 1410		
294	nhaři	*dead*	620 1500	690 1440	770 1370
295	nhaři	*dead*	660 1500		
296	nhauwa	*he* (distant)	570 1200	710 1360	690 1280
297	nhinhtha	*shy, shame*	400 1930		
298	nhinti	*skin, hide*	410 2030		
299	nhinrri	*whole of a tree*	400 2000		
300	nhilhi	*mouse*	360 1550		
301	nhili	*needle*	380 1710	490 2030	
302	nhilpa	*louse egg*	420 1690		
303	nhilji	*egg white*	410 1980		

No.	Word	Meaning		A.E.	E.M.	J.C.
304	nhiyi	*older brother*	F1	350	440	540
			F2	1940	2010	1850
305	nhuŋku	*extinguished, damped*		440		
				860		
306	nhulu	*he* (ergative)		390	400	470
				890	940	1150
307	nhurru	*quick*		470	440	490
				890	1030	1290
308	nhuwa	*spouse*		430	350	490
				990	1170	990
309	nhura	*tail*		410	400	500
				990	1120	1180
310	njaṇi	*blunt*		550	790	
				1540	1600	
311	njilpa	*louse egg*		410		
				1790		
312	njuṟ̥u	*body hair*		400	460	520
				1070	1390	1290
313	ŋapa	*water*		640	680	
				1330	1300	
314	ŋapu	*dumb*		660		570
				1310		1160
315	ŋathu	*I* (ergative)		600	780	610
				1340	1400	1220
316	ŋaka	*bird's crop*		680	660	580
				1370	1390	1150
317	ŋama	*breast*		820	830	580
				1330	1380	1230
318	ŋami	*mob, group*		590	620	580
				1500	1410	1350
319	ŋampa	*pubic tassel, grinding stone*		630		
				1430		
320	ŋampa	*pubic tassel, grinding stone*		600		
				1470		
321	ŋampu	*children's game, almost*		590		
				1090		
322	ŋampu	*children's game, almost*		620		
				1310		
323	ŋana	*interest marker*		680	950	580
				1500	1410	1190
324	ŋanha	*me*		620		
				1460		
325	ŋanhi	*I*		710		
				1480		

No.	Word	Meaning		A.E.	E.M.	J.C.
326	ŋanthi	*animal, meat*	F1	640		
			F2	1500		
327	ŋanka	*beard*		640		
				1370		
328	ŋanka	*beard*		720		
				1390		
329	ŋanrra*	*thighs*		560		
				1480		
330	ŋanrri	*mother*		750		
				1490		
331	ŋalha	*cheek*		650	780	580
				1430	1510	1130
332	ŋali	*we* (dual exclusive)		620	780	590
				1480	1430	1360
333	ŋalki	*joint*		620		
				1470		
334	ŋalrra	*we* (dual inclusive)		570		
				1100		
335	ŋaḷki	*little finger, toe*		600		
				1300		
336	ŋalku	*desirous of food*		630		
				1280		
337	ŋaljtja	*spittle*		730		
				1450		
338	ŋaḷa	*but, surely*		730		
				1450		
339	ŋaḷpa	*lap*		680		
				1360		
340	ŋaṟ̆u	*edible seed*		620		
				1490		
341	ŋaṟ̆u	*edible seed*		810		
				1250		
342	ŋarru	*emu feathers*		620	720	570
				1310	1330	1330
343	ŋara	*heart*		670	730	600
				1480	1300	1380
344	ŋara	*heart*		670		
				1320		

*It is uncertain whether /ŋanrra/ refers to the upper thighs or the upper thighs and the lower torso.

No.	Word	Meaning		A.E.	E.M.	J.C.
345	ŋara	*heart*	F1	610		
			F2	1500		
346	ŋaru	*echo*		620	660	590
				1500	1300	1310
347	ŋaru	*echo*		660		
				1440		
348	ŋuku	*vomit*		530	480	520
				900	1040	950
349	ŋumu	*good, nice*		410	410	470
				760	900	1050
350	ŋuna	*arm*		380	430	480
				910	1120	1140
351	ŋunku*	*chewing tobacco*		500		
				1000		
352	ŋulku	*slanderer, tattler*		370		
				830		
353	ŋulji	*gum*		440	430	480
				940	960	1140
354	ŋulji	*gum*		410		
				970		
355	ŋulji	*gum*		520		
				1020		
356	ŋuřa	*camp*		420	380	520
				1070	810	1150
357	ŋurra	*endless, continuous*		420	370	450
				1060	870	1030
358	ŋurrti	*husks*		340	410	450
				890	1040	1070
359	ŋuya	*lazy, category*		480	430	470
				1080	910	1060
360	ŋuya	*lazy, category*		380		480
				1030		1100
361	wata	*not*		610	580	680
				1280	1160	1270
362	wati	*grinding stone*		540		
				1070		

*Austin records /pitjirri/ as tobacco and /ŋunku/ as a Wangkanguru loan word. I have ŋunku mentioned three times in my field notes without any comment. It was, however, the same person (Alec Edwards) who used the word.

No.	Word	Meaning		A.E.	E.M.	J.C.
363	waṭa	*tree butt*	F1 F2	550 860		
364	waka	*small, young*		590 1110	600 1240	620 1060
365	waka	*small, young*		570 1070		
366	wama	*carpet snake*		610 1040	630 1020	610 1080
367	wama	*carpet snake*		620 1020		
368	wanpa	*hill*		620 1090		
369	wanhtha	*passing by*		570 1300		
370	wanku	*snake type*		640 1160		
371	wanrra	*thick*		560 960		
372	waṇki	*sedentary*		610 1310		
373	wanka	*wilderness, unoccupied country*		580 1020		
374	walu	*undistinguishable*		650 1350	710 1270	640 1190
375	walrra	*hot*		580 1110		
376	walja	*soon*		550 1120	620 1490	620 1120
377	waljtja	*hip*		580 1190		
378	waḷi	*who, which person?* (ergative)		580 1100		
379	waŕu	*long ago*			600 1240	610 1120
380	waŕku	*cross wise*		550 1230		
381	waŕku	*cross wise*		580 1400		
382	waṛa	*corroboree head, piece*		490 970		
383	waṛu	*short*		580 1120		

No.	Word	Meaning		A.E.	E.M.	J.C.
384	warra	*half*	F1	560		
			F2	1350		
385	warru	*white*			570	650
					1290	1120
386	wari wari	*heat exhaustion*		520	680	660
				1270	1170	1200
387	waru	*inflated, extended*		550		
				1210		
388	wipa	*valley, land depression*		420	470	500
				1480	1540	1500
389	wita	*a row, series*		440	430	450
				1530	1810	1580
390	wima	*song, corroboree*		510	450	490
				1600	1360	1630
391	wima	*song, corroboree*		470		
				1700		
392	winhtha	*owl species*		480		
				1820		
393	winrri	*only*		540		
				1530		
394	wilha	*woman*		400	450	440
				1530	1580	1620
395	wilpa	*narrow hole, narrow opening*		390		
				1510		
396	wilpa	*narrow hole, narrow opening*		410		
				1470		
397	wilhthu	*flower type*		450		
				1250		
398	wilhthi	*flower type*		390		
				1460		
399	wiřpa	*pubic tassel*			470	510
					1300	1500
400	wiřka	*crack*		480	450	460
				1500	1440	1390
401	wiři	*extremities, outside ones*		410	440	460
				1540	1590	1480
402	wirra	Acacia type		460	500	490
				1480	1670	1500
403	wirra	Acacia type		430		
				1480		
404	wutju	*pole-like*		400	470	
				910	800	

No.	Word	Meaning		A.E.	E.M.	J.C.
405	wulrru	*narrow*	F1	400		
			F2	920		
406	yapa	*timid, frightened*		590		
				1510		
407	yama	*net*		580	680	610
				1560	1570	1400
408	yania	*like this*		560	690	560
				1650	1670	1510
409	yanilu	*just like this*		530		
				1750		
410	yanku	*father's father*		610		
				1540		
411	yala	*together, jointly*		540		
				1490		
412	yalpi	*edge, flower type*		520		
				1560		
413	yara	*this way*		700	600	670
				1450	1700	1320
414	yarra	*that way*		520	510	620
				1480	1710	1330
415*	yarru	?			620	
					1580	
416	yaru	*humpy*		560		580
				1490		1300
417	yawa	*grass onion*		510	590	570
				1410	1460	1310
418	yinka	*string, bush type*		400	420	430
				2160	1980	1880
419	yinka	*string, bush type*		350	380	440
				2100	1630	1930
420	yilrri	*crying* (distant)		300		
				1700		
421	yini	*you* (singular nominative)		390		
				1920		
422	yutja	*barter*		390	420	500
				1440	1590	1360
423	yuku	*twigs*		410	440	460
				870	1610	1350

*Jack Carrot gave /yarru/ for *humpy* instead of /yaru/. What /yarru/ really means is uncertain.

No.	Word	Meaning		A.E.	E.M.	J.C.
424	yunka	*annoying*	F1	360		
			F2	1130		
425	yunrru	*you* (singular ergative)		370		
				1210		
426	yuŋa	*skin water-bag*		390	440	460
				1000	1360	1350
427	yulha	*you* (dual nominative)			410	
					1430	
428	yuṙa	*lizard's hole*		360		
				1190		
429	yuri	*veins, small snake*		370	380	520
				1180	1370	1230

In order to see more clearly the significance of the variations in the frequencies recorded in Table 7, F1 can be plotted against F2 and following normal practice the frequency scales can be reversed, so that the vowel plots will approximate those arranged on articulatory diagrams.[35] This has been done in Figure 72. For convenience, the logarithmic or mel scale has not been adopted, but, following Bernard,[36] linear scales are used, with F2 frequencies being double the scale of F1. By plotting the vowels this way the arrangement is similar to that of the mel scale, yet the inconvenience of using a scale that is not linearly constant is avoided. Figure 72 shows the results of this plotting in the form of a scattergram of each of the vowels and a spectrum envelope which outlines the extent of the variation. The mean average plots for each vowel are also included. These are the results of the computations shown in Table 8.

As is to be expected the mean averages for the three vowel phonemes which are shown in Figure 72 are quite different, and the articulatory assertion that they should be classified as high-front, high-back and low-mid is substantiated by the acoustic plots.

Table 8: The sum and the mean for F1 and F2 of each vowel measured in Table 7

Vowel	No.	ΣF1	Mean F1	ΣF2	Mean F2
/i/	164	70,100	427.4 Hz	283,650	1729.6 Hz
/a/	360	229,340	637.1 Hz	486,200	1350.6 Hz
/u/	238	105,600	443.7 Hz	248,010	1042.1 Hz

It is of interest to note just how much the three phonemes vary in quality. In Figure 73 the mean values of the eleven Australian English vowels[37] are placed on a grid with the three Diari vowels.

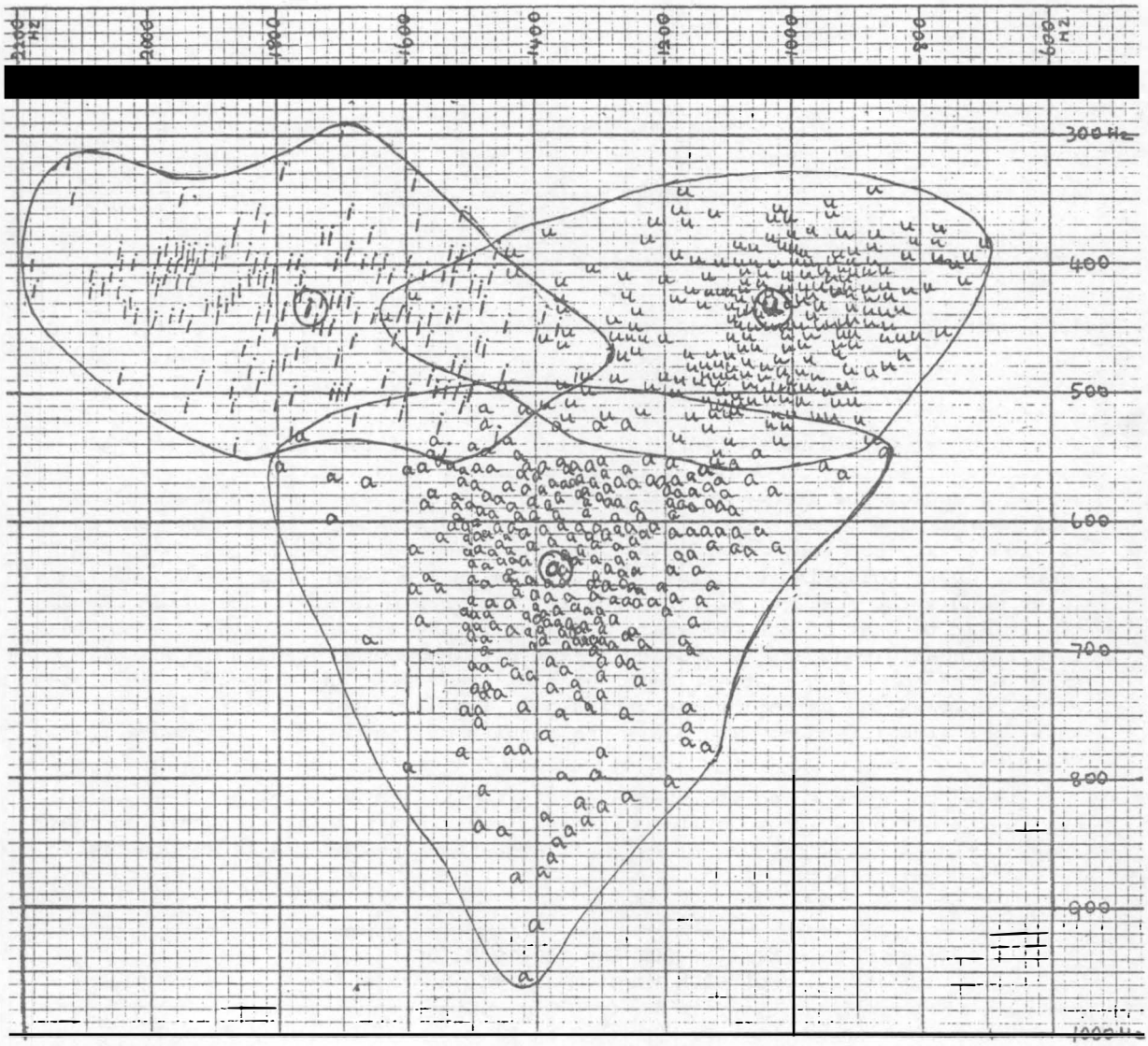


Figure 72

Scattergrams and spectrum envelopes for F1 x F2 plots of Diari vowels. The mean plot for each vowel is encircled.

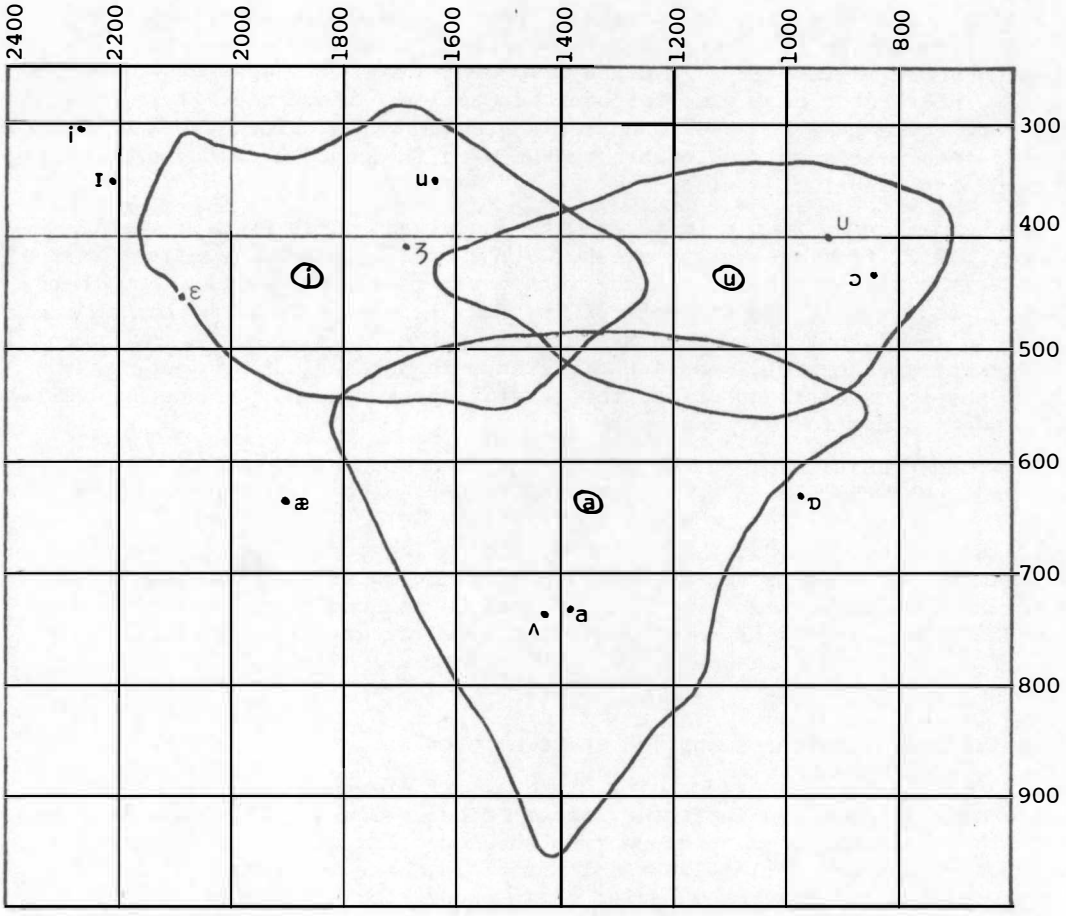


Figure 73

Means of eleven Australian English vowels on a grid with the three Diari vowels.

4.4 Vowel overlap

Another surprising fact revealed by the acoustic plots is the degree to which the vowels overlap.[38] The target of /a/ is sometimes the same as the target for /i/, and at other times it is the same as the target for /u/. Also, the target value of /i/ is sometimes the same as the target value for /u/. This suggests that the intended meanings for the signals in those areas could be misunderstood. In fact this is not so. Tape recordings of the words containing these extreme F1 x F2 plots played back to Diari speakers, are correctly interpreted each time, without hesitation. Therefore, it is concluded that there must be some conditioning factor which orientates a hearer to correctly interpret vowels which are spoken with frequencies in the overlapping section of its spectrum envelope.

One conditioning factor is to do with individual differences. Vowel envelopes differ from speaker to speaker. The vowel plots are constant in the sense that the mean of F2 for a high-front vowel is always greater than that for a high-back vowel, and the mean of its F1 will always be less than that of the low-mid vowel, but they are not constant in the sense that the envelopes for different speakers will embrace different frequencies. This means that spectrum envelopes of frequencies, for several speakers, may produce an overlap that does not occur for any one speaker.

A second conditioning factor is to do with a sound's linguistic environment. A neighbouring sound can affect the target value of a vowel. If the environment which affects one vowel has the same effect upon another vowel, the overlap may occur because of the opposing influences of two different environments. If this is so, the overlap will not occur when the vowels are said in the same environment, and it can then be deduced that the environment will effect the hearer's expectation of the vowel targets interpretation.

4.5 Individual differences applied to vowel overlap

In order to see the effect of individual differences upon vowel overlap the information contained in Table 7 needs to be reviewed. This time the computations, scattergrams, and spectrum envelopes are given for each speaker instead of giving the collective results for all three speakers. Table 9 computes the mean average frequencies of F1 and F2 for each Diari speaker, and Figures 74, 75 and 76 display these averages together with scattergrams and spectrum envelopes for each of the speakers. All this information is superimposed on the combined spectrum envelopes.

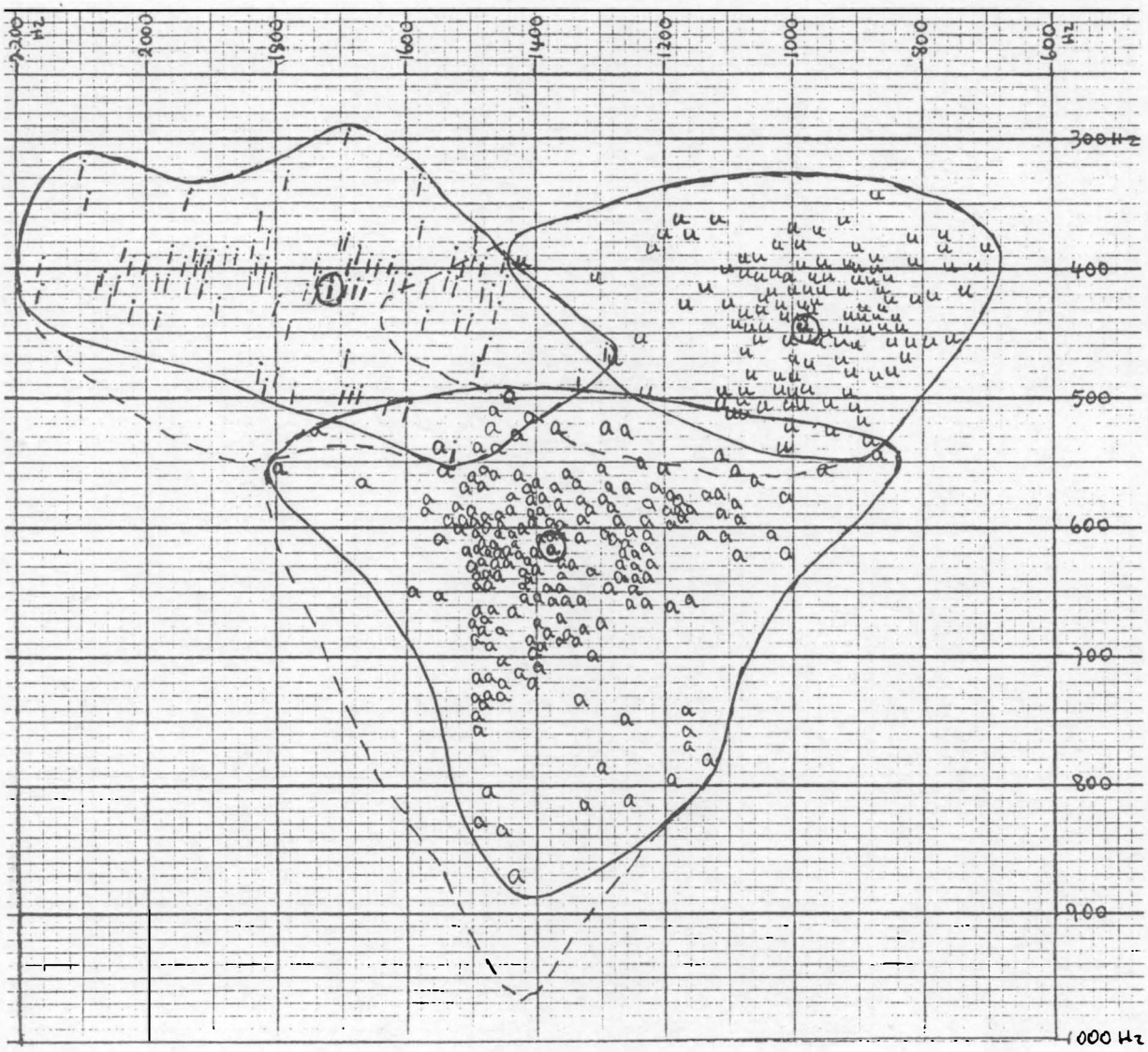


Figure 74

Spectrum envelopes for /i/, /a/, and /u/ for A. Edwards, superimposed on the combined vowels envelopes. Mean average of F1 x F2 for each of Edwards' vowel targets is encircled.

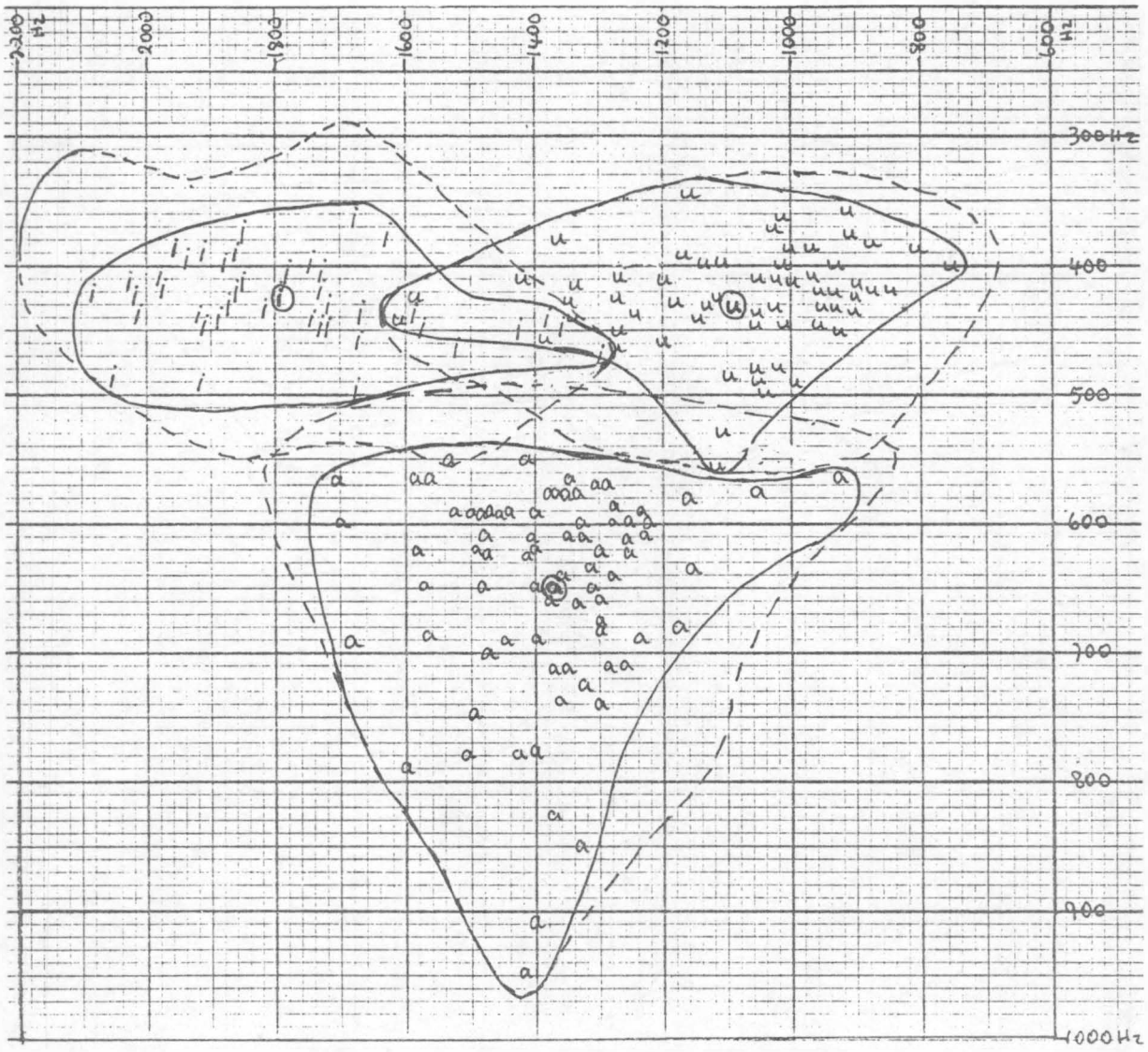


Figure 75

Spectrum envelopes of /i/, /a/, and /u/ for E. Murray, superimposed on the combined vowels envelopes. Mean average for each of Murray's vowel targets is encircled.

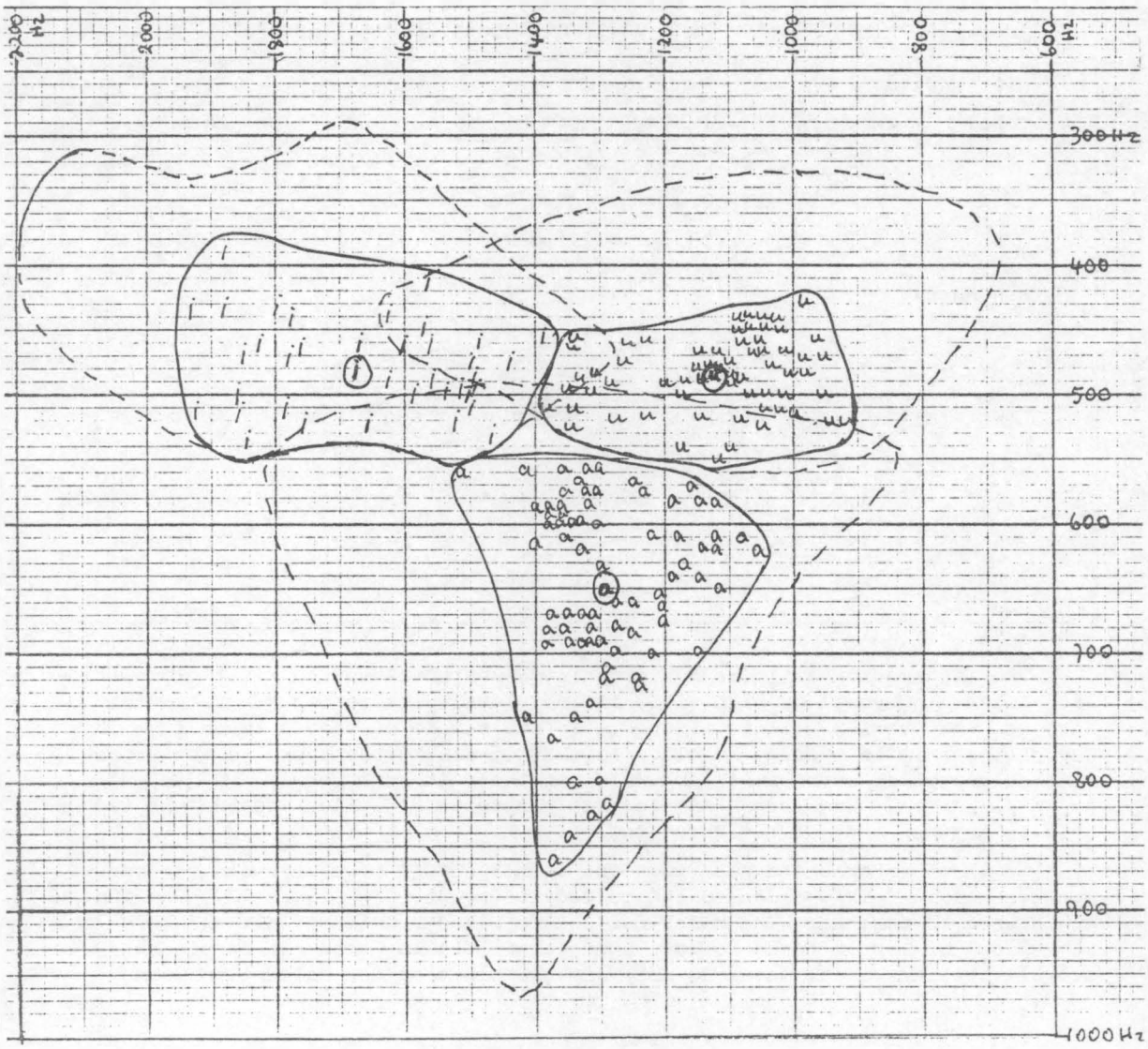


Figure 76

Spectrum envelopes of /i/, /a/, and /u/ for J. Carrot, superimposed on the combined vowels envelopes. Mean average for each of Carrot's vowel targets are encircled.

Table 9: The sum of the frequencies and the mean averages of F1 and F2 for each vowel of the three Diari speakers

Vowel	No.	ΣF1	Mean F1	ΣF2	Mean F2
Alec Edwards					
/i/	86	34,840	414.8 Hz	149,340	1736.5 Hz
/a/	211	132,070	625.9 Hz	288,130	1365.6 Hz
/u/	117	51,290	431,0 Hz	115,130	984.0 Hz
Ern Murray					
/i/	41	17,630	430.0 Hz	72,890	1777.8 Hz
/a/	74	48,400	654.1 Hz	102,610	1386.6 Hz
/u/	61	26,040	426.9 Hz	66,070	1083.0 Hz
Jack Carrot					
/i/	37	17,710	478.6 Hz	61,530	1663,0 Hz
/a/	75	48,990	653.2 Hz	96,220	1282.9 Hz
/u/	60	29,130	485.5 Hz	67,270	1121.2 Hz

The information as it is now organised substantiates the first proposition made concerning vowel overlap, i.e. if individual differences are taken into account, the overlap will be reduced. In the sample of speech taken from Jack Carrot there is no overlap at all. In that of Ern Murray there is still considerable overlap between /i/ and /u/, but there is none between /u/ and /a/, and /i/ and /a/. The larger sample that was taken from Alec Edwards has reduced overlap between each of the three vowels.

It is of interest to note that the mean averages of the vowels for each speaker remain fairly close to the collective means. In Figure 77 the means are displayed together with means for the combined results of all speakers. The speech of Carrot tends to have a higher F1 reading than the others but overall the individual means do not vary greatly from the collective means.

4.6 The influence of context on vowel overlap

The above discussion confirms that individual differences of F1 x F2 plots accounts for some of the overlap that exists between vowels, but after this is accounted for, reduced overlap still remains, so some other factor must also be involved. It was suggested previously that a vowel's environment can affect its target value and so it seems sensible to see if this could account for vowel overlap. In order to test this, the data was rearranged again to find out what influence a word initial consonant has upon the target of the following vowel. Tables 10, 11 and 12 compute the mean averages of F1 x F2 for each vowel of each speaker as it occurs following different initial consonants, Figures 78-80 show these mean average plots on vowel spectrum envelopes. Table 13 computes the combined means for all of the speakers and Figure 81 shows the plots for these means.

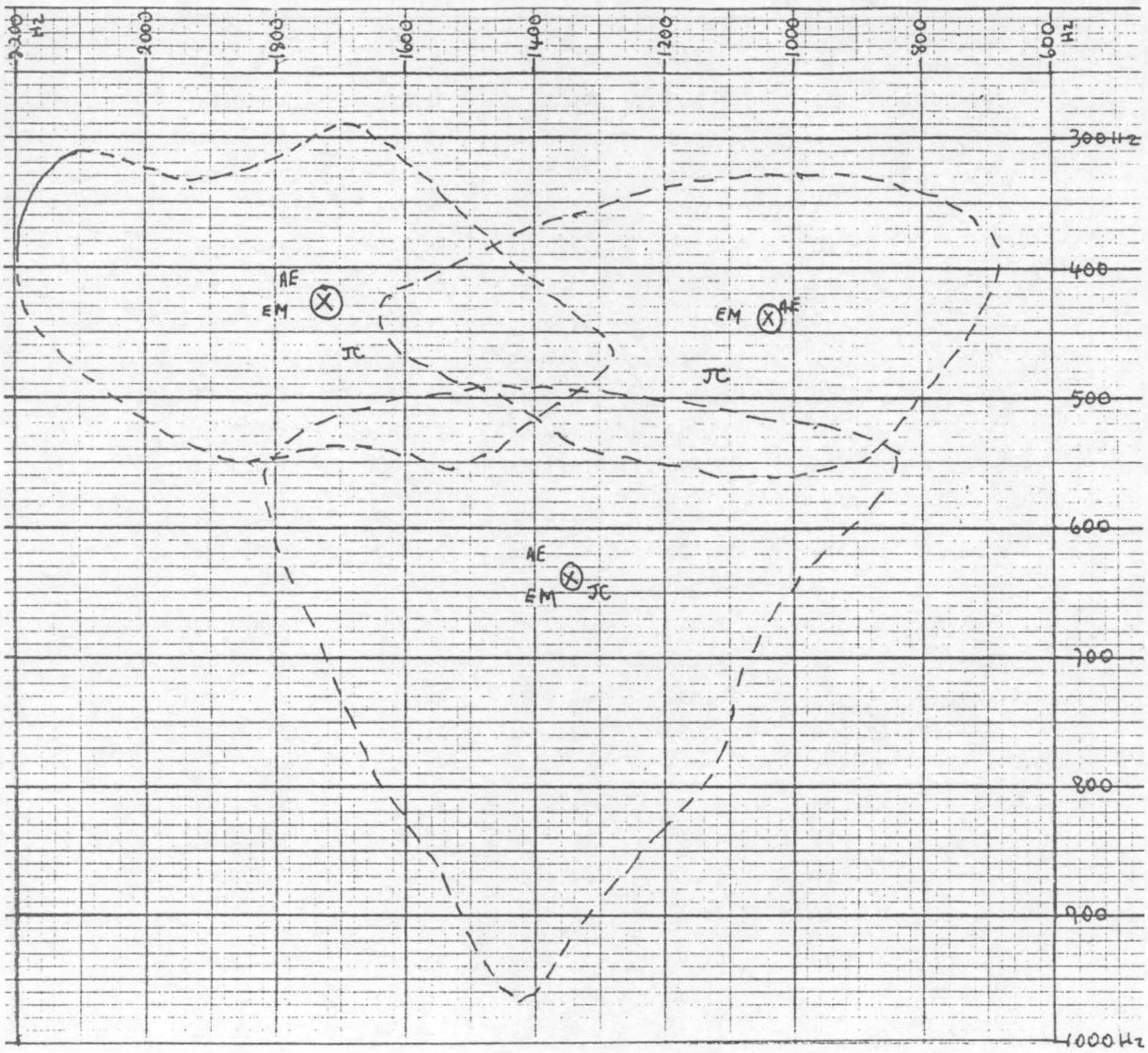


Figure 77

Mean averages of F1 x F2 for A.E., E.M., J.C., and the combined results of all three, displayed within the combined spectrum envelope. Mean of combined total written as 'x'.

Table 10: Computations of the means for F1 and F2 of Edwards' vowel targets following different consonants

Consonant/ vowel sequence	No.	ΣF1	Mean F1	ΣF2	Mean F2
/pi-/	21	8,600	409.6 Hz	36,460	1736.2 Hz
/thi-/	8	3,620	455.0 Hz	13,300	1662.5 Hz
/ti-/	3	1,340	446.7 Hz	5,110	1703.3 Hz
/tji-/	3	1,170	390.0 Hz	5,740	1913.3 Hz
/ki-/	10	4,220	422.0 Hz	18,340	1834.0 Hz
/mi-/	13	5,140	395.4 Hz	23,190	1783.8 Hz
/nhi-/	8	3,130	391,6 Hz	14,830	1853.8 Hz
/nji-/	1	410	410.0 Hz	1,790	1790.0 Hz
/wi-/	15	6,680	445.3 Hz	22,940	1529.3 Hz
/yi-/	4	1,440	360.0 Hz	7,880	1970.0 Hz
Total /i/	86	35,750	415.7 Hz	149,580	1739.3 Hz
/pa-/	33	22,030	667.6 Hz	43,620	1321,8 Hz
/tha-/	19	11,620	611,6 Hz	26,740	1407.4 Hz
/ta-/	7	4,040	577.1 Hz	10,330	1475.7 Hz
/tja-/	2	1,240	620.0 Hz	3,070	1535.0 Hz
/ka-/	39	24,130	618.7 Hz	56,010	1436.2 Hz
/ma-/	31	19,990	644.8 Hz	41,300	1332.3 Hz
/nha-/	8	5,060	632.5 Hz	11,150	1393.8 Hz
/nja-/	1	550	550.0 Hz	1,540	1540.0 Hz
/ŋa-/	35	22,850	652.9 Hz	48,770	1393.4 Hz
/wa-/	25	14,410	576.4 Hz	28,710	1148.4 Hz
/ya-/	11	6,220	564.4 Hz	16,890	1535.5 Hz
Total /a/	211	132,070	625.9 Hz	288,130	1365.6 Hz
/pu-/	23	10,290	447.4 Hz	23,110	1004.8 Hz
/thu-/	8	3,380	485.0 Hz	8,360	1045.0 Hz
/tu-/	4	1,590	397.5 Hz	4,300	1075.0 Hz
/tju-/	2	890	445.0 Hz	2,550	1275.0 Hz
/ku-/	34	14,380	422.9 Hz	31,660	931.2 Hz
/mu-/	18	7,770	431,7 Hz	17,150	952.8 Hz
/nhu-/	5	2,140	428.0 Hz	4,620	924.0 Hz
/nju-/	1	400	400.0 Hz	1,070	1070.0 Hz
/ŋu-/	13	5,600	430.8 Hz	12,460	958.5 Hz
/wu-/	2	800	400.0 Hz	1,830	915.0 Hz
/yu-/	7	2,640	377.1 Hz	8,020	1145.7 Hz
Total /u/	117	49,880	426.3 Hz	115,130	984.0 Hz

Table 11: Computations of the means for F1 and F2 of Murray's vowel targets following different consonants

Consonant/ vowel sequence	No.	ΣF1	Mean F1	ΣF2	Mean F2
/pi-/	8	3,310	413.8 Hz	14,220	1777.5 Hz
/thi-/	5	2,130	426.0 Hz	9,360	1872.0 Hz
/ti-/	2	860	430.0 Hz	3,940	1970.0 Hz
/tji-/	1	380	380.0 Hz	1,850	1850.0 Hz
/ki-/	5	2,100	420.0 Hz	9,700	1940.0 Hz
/mi-/	7	3,050	435.7 Hz	12,090	1727.1 Hz
/nhi-/	2	930	465.0 Hz	4,040	2020.0 Hz
/wi-/	8	3,660	457.5 Hz	12,290	1536.3 Hz
/yi-/	2	800	400.0 Hz	3,610	1805.0 Hz
Total /i/	40	17,220	430.5 Hz	71,100	1777.5 Hz
/pa-/	12	7,560	630.0 Hz	15,660	1305.0 Hz
/tha-/	8	4,770	596.25 Hz	11,060	1382.5 Hz
/ta-/	3	1,930	643.3 Hz	4,440	1480.0 Hz
/tja-/	1	590	590.0 Hz	1,500	1500.0 Hz
/ka-/	13	8,090	622.3 Hz	18,520	1424.6 Hz
/ma-/	7	5,160	737.1 Hz	9,410	1344.3 Hz
/nha-/	4	2,580	645.0 Hz	5,690	1422.5 Hz
/nja-/	1	790	790.0 Hz	1,600	1600.0 Hz
/ŋa-/	11	8,190	744.6 Hz	15,160	1378.2 Hz
/wa-/	8	4,990	623.8 Hz	9,880	1235.0 Hz
/ya-/	6	3,750	625.0 Hz	9,690	1615.0 Hz
Total /a/	74	48,400	654.1 Hz	102,610	1386.6 Hz
/pu-/	12	5,240	436.7 Hz	12,500	1041.7 Hz
/thu-/	5	2,060	412.0 Hz	5,930	1186.0 Hz
/tu-/	1	430	430.0 Hz	1,260	1260.0 Hz
/tju-/	2	870	435.0 Hz	2,550	1275.0 Hz
/ku-/	12	5010	417.5 Hz	12,090	1007.5 Hz
/mu-/	10	4480	448.0 Hz	10,280	2038.0 Hz
/nhu-/	4	1590	397.5 Hz	4,260	1065.0 Hz
/nju-/	1	460	460.0 Hz	1,390	1390.0 Hz
/ŋu-/	8	3340	417.5 Hz	7,650	956.3 Hz
/wu-/	1	470	470.0 Hz	800	800.0 Hz
/yu-/	5	2090	418.0 Hz	7,360	1472.0 Hz
Total /u/	61	26,040	426.9 Hz	66,070	1083.0 Hz

Table 12: Computations of the means for F1 and F2 of Carrot's vowel targets following different consonants

Consonant/ vowel sequence	No.	ΣF2	Mean F1	ΣF2	Mean F2
/pi-/	8	3,590	448.8 Hz	13,950	1743.8 Hz
/thi-/	4	2,040	510.0 Hz	6,970	1742.5 Hz
/ti-/	2	940	470.0 Hz	3,110	1555.0 Hz
/tji-/	1	460	460.0 Hz	1,600	1600.0 Hz
/ki-/	4	2,000	500.0 Hz	7,150	1787.5 Hz
/mi-/	7	3,470	495.7 Hz	10,890	1555.1 Hz
/nhi-/	1	540	540.0 Hz	1,850	1850.0 Hz
/wi-/	8	3,800	475.0 Hz	12,200	1525.0 Hz
/yi-/	2	870	435.0 Hz	3,810	1905.0 Hz
Total /i/	37	17,710	478.6 Hz	61,530	1663.0 Hz
/pa-/	13	8,650	665.4 Hz	16,730	1286.9 Hz
/tha-/	8	5,840	730.0 Hz	10,600	1325.0 Hz
/ta-/	3	2,020	673.3 Hz	3,720	1240.0 Hz
/tja-/	1	690	690.0 Hz	1,340	1340.0 Hz
/ka-/	14	9,620	687.1 Hz	18,450	1317.9 Hz
/ma-/	7	4,400	628.6 Hz	8,810	1258.6 Hz
/nha-/	4	2,640	660.0 Hz	5,430	1357.5 Hz
/ŋa-/	11	6,430	584.6 Hz	13,810	1255.5 Hz
/wa-/	8	5,090	636.3 Hz	9,160	1145.0 Hz
/ya-/	6	3,610	601.7 Hz	8,170	1361.7 Hz
Total /a/	75	48,990	653.2 Hz	96,220	1282.9 Hz
/pu-/	12	5,480	456.7 Hz	12,660	1055.0 Hz
/thu-/	5	2,490	498.0 Hz	6,270	1254.0 Hz
/tu-/	1	490	490.0 Hz	1,200	1200.0 Hz
/tju-/	2	1,000	500.0 Hz	2,710	1355.0 Hz
/ku-/	12	5,890	490.8 Hz	13,010	1084.2 Hz
/mu-/	10	5,050	505.0 Hz	10.540	1054.0 Hz
/nhu-/	4	1,950	487.5 Hz	4,610	1152.5 Hz
/nju-/	1	520	520.0 Hz	1,290	1290.0 Hz
/ŋu-/	9	4,320	480.0 Hz	9,690	1076.7 Hz
/yu-/	4	1,940	485.0 Hz	5,290	1322.5 Hz
Total /u/	60	29,130	485.5 Hz	67,270	1121.2 Hz

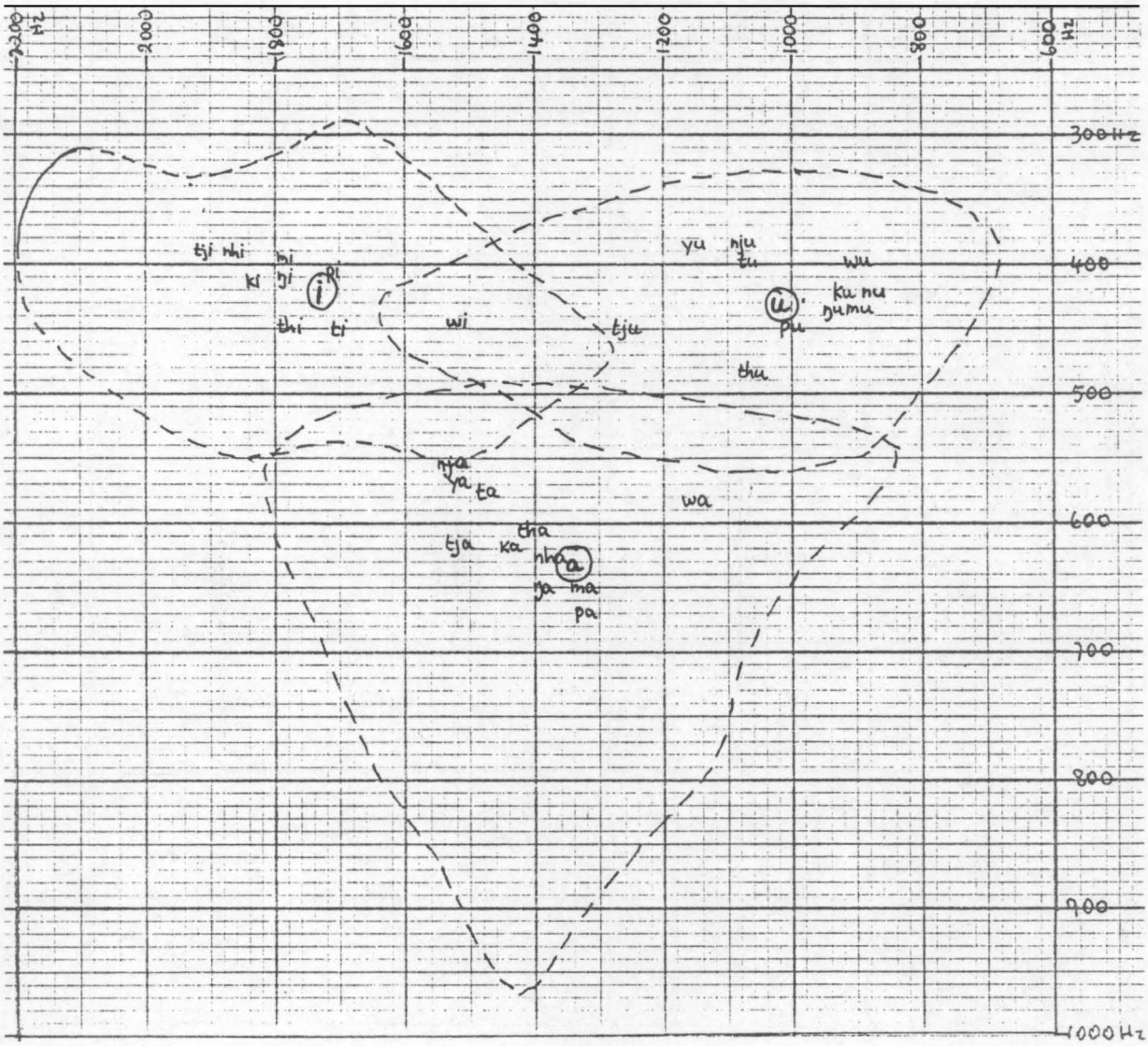


Figure 78

F1 x F2 mean plots for vowels of A. Edwards in context with different initial consonants. Means are indicated within the combined speakers spectrum envelopes, and the overall mean is indicated with a circle.

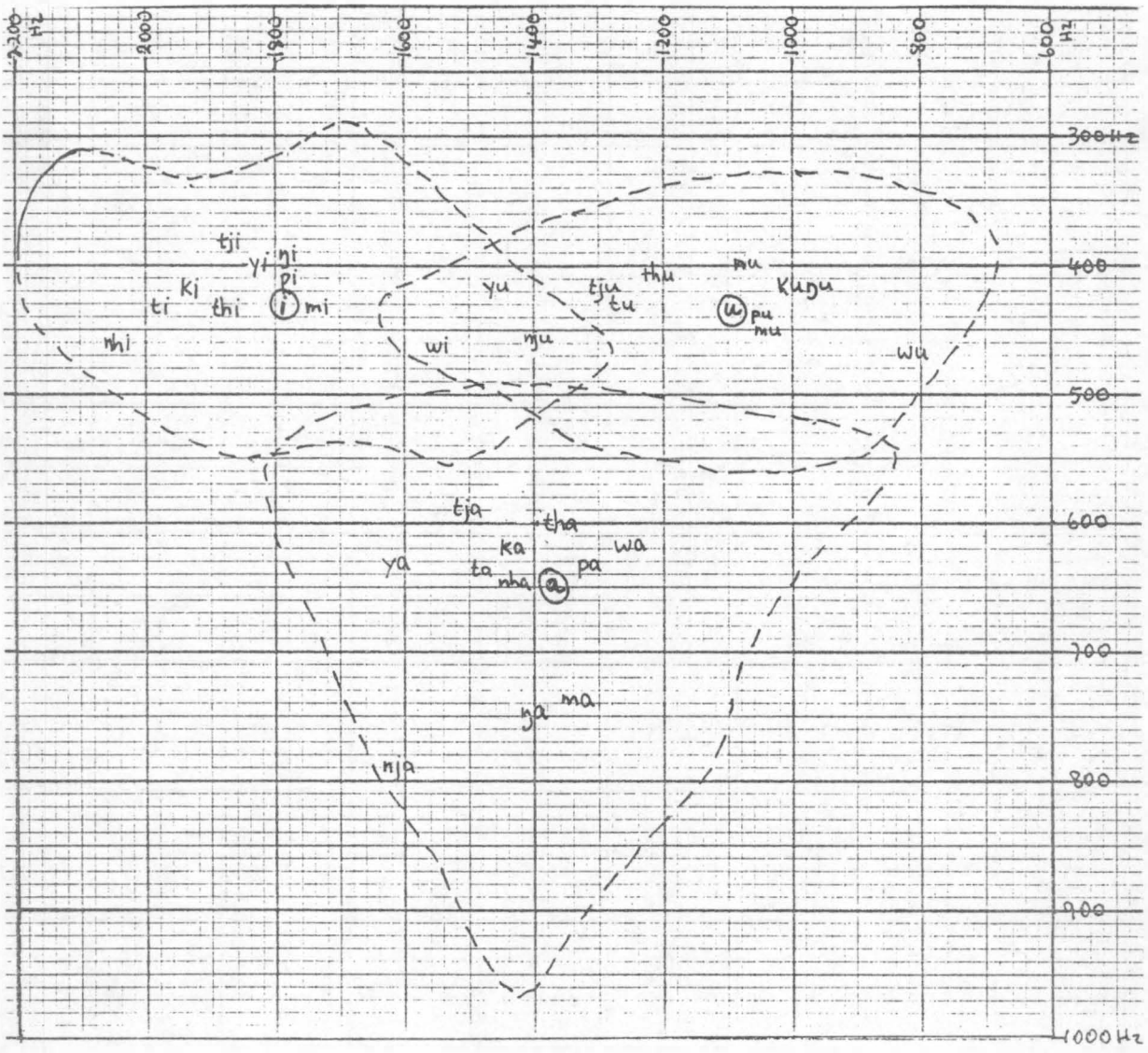


Figure 79

Fl x F2 mean plots for vowels of E. Murray in context with different initial consonants. Means are indicated within the combined speaker's spectrum envelopes, and the overall mean is indicated with a circle.

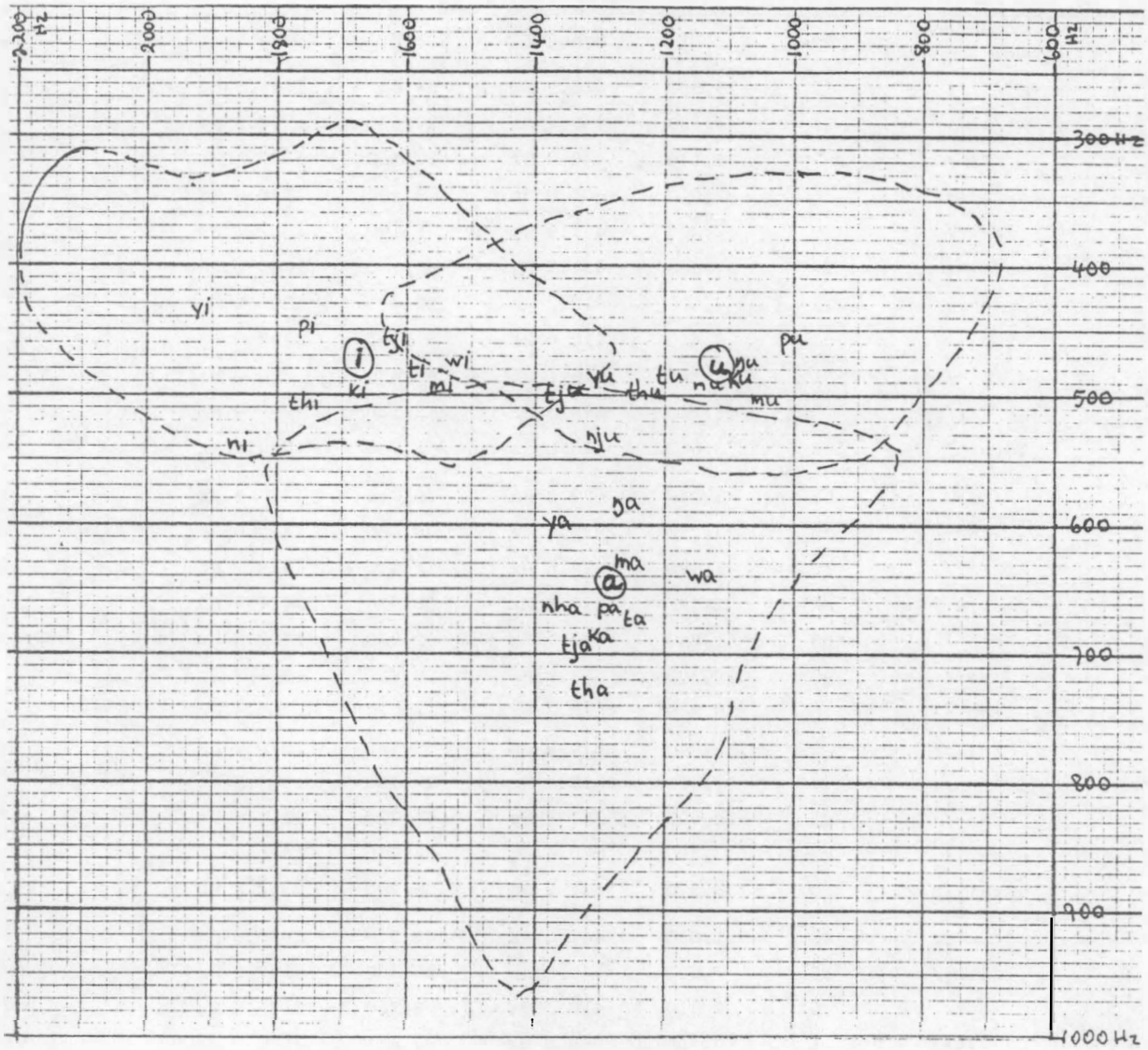


Figure 80

Fl x F2 mean plots for vowels of J. Carrot in context with different initial consonants. Means are indicated within the combined speaker's spectrum envelopes and the overall mean is indicated with a circle.

Table 13: Computations of the means of F1 and F2 for the contextual vowels of the totals for the three speakers

Consonant/ vowel sequence	No.	ΣF1	Mean F1	ΣF2	Mean F2
/pi-/	37	15,500	418.9 Hz	64,630	1746.8 Hz
/thi-/	17	7,790	458.2 Hz	29,630	1742.9 Hz
/ti-/	7	3,140	448.6 Hz	12,160	1737.1 Hz
/tji-/	5	2,010	402.0 Hz	9,190	1838.0 Hz
/ki-/	19	8,320	437.9 Hz	35,190	1852.1 Hz
/mi-/	27	11,660	432.2 Hz	46,170	1705.9 Hz
/nhi-/	11	4,600	418.2 Hz	20,720	1883.6 Hz
/nji-/	1	410	410.0 Hz	1790	1790.0 Hz
/wi-/	31	14,140	456.1 Hz	47.430	1530.0 Hz
/yi-/	8	3,110	388.7 Hz	15,120	1890.0 Hz
Total /i/	163	70,680	433.6 Hz	282,030	1730.2 Hz
/pa-/	58	38,240	659.3 Hz	76,010	1310.5 Hz
/tha-/	35	22,230	635.1 Hz	48,400	1382.6 Hz
/ta-/	13	7,990	614.6 Hz	18,490	1422.3 Hz
/tja-/	4	2,520	630.0 Hz	5,910	1477.5 Hz
/ka-/	66	41,840	633.9 Hz	92,980	1408.8 Hz
/ma-/	45	29,390	653.1 Hz	59,260	1316.9 Hz
/nha-/	16	10,250	640.6 Hz	21,770	1360.6 Hz
/nja-/	2	1,340	670.0 Hz	3,140	1570.0 Hz
/ŋa-/	57	37,470	657.4 Hz	77,750	1363.9 Hz
/wa-/	41	24,490	597.3 Hz	47,750	1164.6 Hz
/ya-/	23	13,580	590.4 Hz	34.750	1510.9 Hz
Total /a/	360	229,340	637.1 Hz	486,200	1350.6 Hz
/pu-/	47	21,010	447.0 Hz	48,270	1027.0 Hz
/thu-/	18	7,930	440.6 Hz	20,560	1142.2 Hz
/tu-/	6	2,510	418.3 Hz	6,760	1126.7 Hz
/tju-/	6	2,760	460.0 Hz	7,810	1301.7 Hz
/ku-/	58	25,280	435.9 Hz	56,760	978.6 Hz
/mu-/	38	17,350	456.6 Hz	37,970	999.2 Hz
/nhu-/	13	5,680	436.9 Hz	13,490	1037.7 Hz
/nju-/	3	1,380	460.0 Hz	3,750	1250.0 Hz
/ u-/	30	13,260	442.0 Hz	20,800	993.3 Hz
/wu-/	3	1,270	423.3 Hz	2,630	876.7 Hz
/yu-/	16	6,670	416.9 Hz	20,670	1291.9 Hz
Total /u/	238	105,100	441.6 Hz	248,470	1044.0 Hz

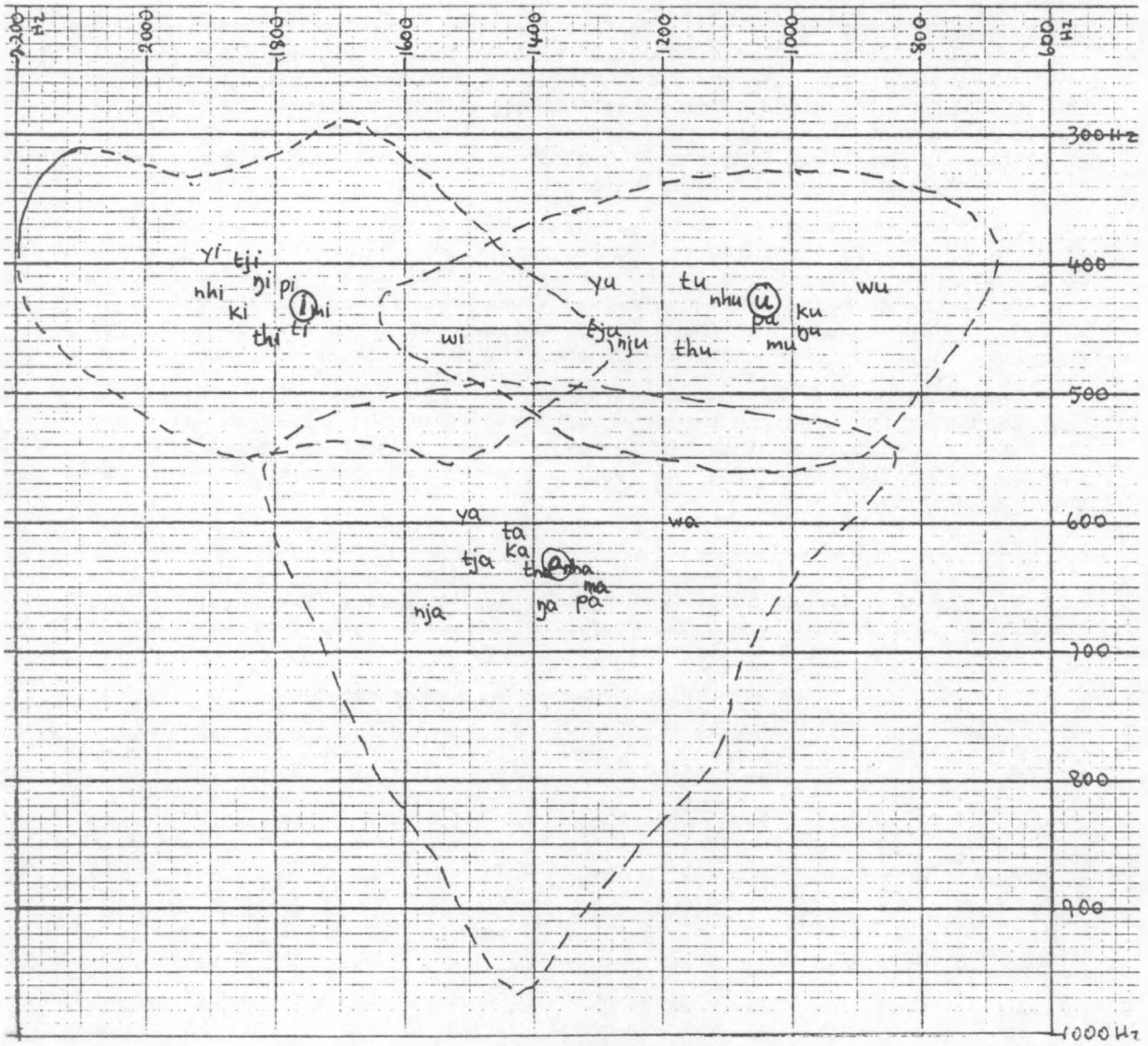


Figure 81

Vowel plots of F1 x F2 for the combined contextual means. The means calculated regardless to context are included, and indicated with a circle.

The rearrangement of the data in order to include preceding environment in the assessment of the target vowel produced some interesting results. It becomes obvious that the target is influenced by a preceding consonant. Though some of the samples are not very large, the fact that the target value is assessed under two sets of conditions[39] permits positive assertions to be made when the results are substantially the same under the different conditions. Simply looking at the vowel plots is enough to show that alveo-palatals consistently influence the vowel so that it has higher F2 frequencies than the mean, and /w/ affects it so that is has lower frequencies, but in order to make the evidence measurable, a simple ranking device has been instituted.

The ranking has been done by giving a value to each of the contextual vowels from one to twelve, according to the frequency count of F1 and F2. The ranking of F1 gives the value of one to the contextual vowel with the lowest frequency count, two to the next lowest contextual vowel, and so one, till they are all ranked. F2 is ranked in the opposite direction, the vowel with the highest frequency count is given the value of one, the next highest two, and so on.

The first set of ranking scales indicates the relative degree of influence each consonant has upon the target vowel for each of the speakers. It also indicates the direction of the influence. The second set indicates the same ranking system, but this time the results include the combined influence of the three speakers.

Table 14: Contextual vowels for each speaker ranked according to the mean frequency of F1. Rank 1 has the lowest frequency.

						/i/						
	Rank order of contextual vowels											
	1	2	3	4	5	6	7	8	9	10	11	12
A. Edwards	tji	nhi	mi	pi		/i/*	ki	wi	ti	thi		
E. Murray	tji	yi		pi	ki	thi	ti /i/		mi	wi	nhi	
J. Carrot	yi	pi	tji	ti	wi	/i/	mi	ki	thi	nhi		
						/a/						
A. Edwards	nja	ya	wa	ta	tha	ka	tja	/a/	nha	ma	ŋa	pa
E. Murray	tja	tha	ka	wa	ya	pa	ta	nha	/a/	ma	ŋa	nja
J. Carrot	ŋa	ya	ma	wa	/a/	nha	pa	ta	ka	tja	tha	
						/u/						
A. Edwards	yu	tu	nju wu		ku	nhu	ŋu	/u/	mu	tju	pu	thu
E. Murray	nhu	thu	ŋu ku		yu	/u/	tu	tju	pu	mu	nju	wu
J. Carrot	pu	ŋu	yu	/u/	nhu	tu	ku	thu	tju	mu	nju	

*Vowel in phonemic brackets represents the mean average for the vowel without regard to context.

Table 15: Contextual vowels for each speaker ranked according to the mean frequency of F2. Rank 1 has the highest frequency.

	/i/											
	Rank order of contextual vowels											
	1	2	3	4	5	6	7	8	9	10	11	12
A. Edwards	yi	tji	nhi	ki	mi thi			/i/	pi	ti	wi	
E. Murray	nhi	ti	ki	thi	tji	yi		pi	/i/	mi	wi	
J. Carrot	yi	nhi	thi pi		ki	/i/	tji	ti	mi	wi		
	/a/											
A. Edwards	nja ya		tja	ta	ka	tha	nha ŋa		/a/	ma	pa	wa
E. Murray	nja ya		tja	ta	ka nha		ŋa	/a/	tha	ma	pa	wa
J. Carrot	ya	nha	tja	tha	ka	pa	/a/	ŋa ma		ta	wa	
	/u/											
A. Edwards	tju	yu	nju tu		thu	pu	/u/	ŋu	mu	ku	nhu	wu
E. Murray	yu	nju	tju	tu	thu	/u/	nhu	pu mu		ku	ŋu	wu
J. Carrot	tju	yu	nju	thu	tu	nhu	/u/	ku	ŋu	mu	pu	

Ranking the contextual vowels to minimise any idiosyncratic factors of the speakers, is done by adding the rank scores of each speaker for the same contextual vowel, and dividing by the number of speakers.

Table 16

Scales, based on computations of individual vowel rankings, measuring degree of influence of preceding consonant on F1 of target vowel, and the direction of that influence.

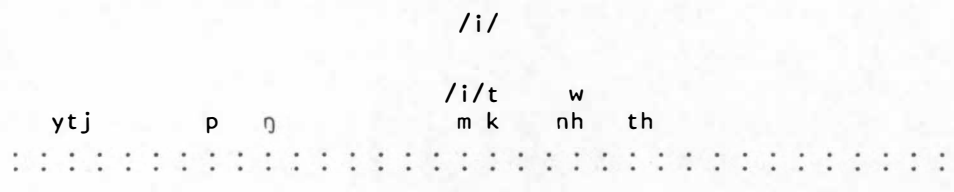
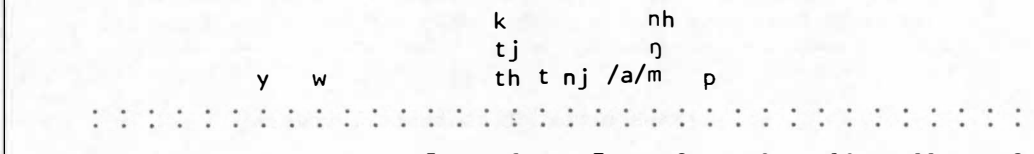


Table 16 (cont.)

/a/



/u/

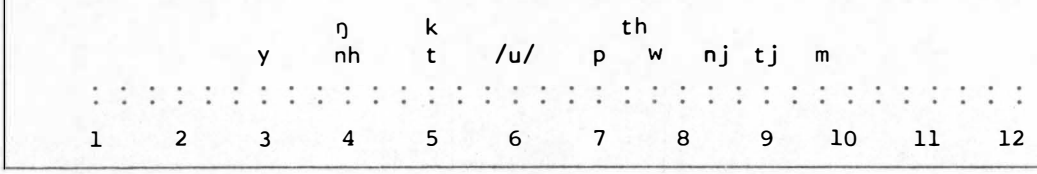
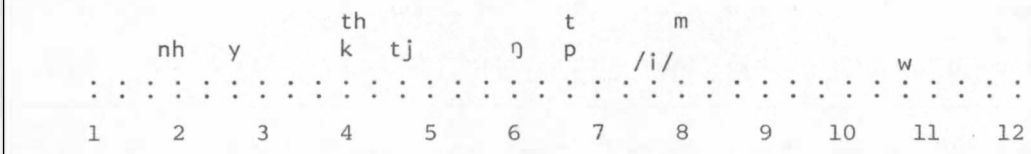


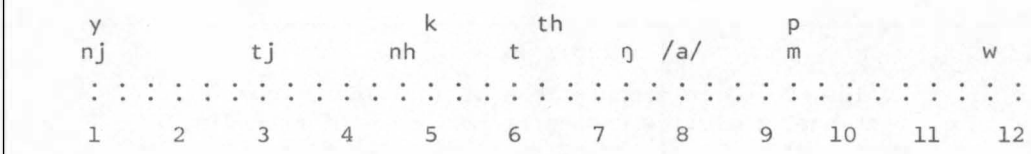
Table 17

Scales, based on computations of individual vowel rankings, measuring degree of influence of preceding consonant on F2 of target vowel, and the direction of that influence.

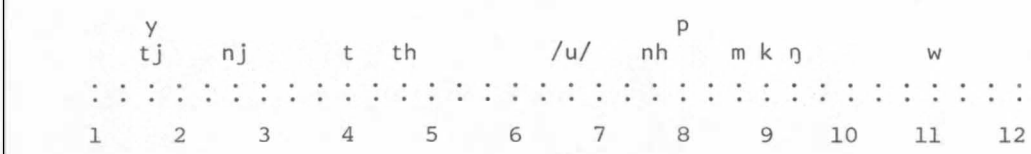
/i/



/a/



/u/



Conclusions based on the results of the ranking orders and the ranking scales agree with the visual impressions given when observing Figures 72-81, i.e. some consonants affect the target value of a following vowel. Particularly noticeable is the fact that alveo-palatals and /w/ strongly influence the target value of F2 of the vowel. Alveo-palatals raise the Herz value and /w/ lowers it. Alveo-palatals have less influence on /i/, presumably because this phoneme already has a high Herz value for F2, but the ranking of the vowels influenced by these consonants are considerably higher than the ranking of the means for the vowels when their context is ignored.

The ranking scale for /a/ reveals that /y/ and /w/ also have a strong influence upon its first formant. The rest of the consonants have little effect upon the formant but the two semivowels consistently lower its Herz value.

The influence alveo-palatals and /w/ have upon the vowel target can be seen if the vowels containing them are extracted from the data. Figure 82 shows scattergrams and envelopes of the vowels for the three speakers when they follow alveo-palatals, and Figure 83 shows them when they follow /w/. Figures 84 and 85 show the same information in the form of combined envelopes within the total spectrum envelope. Figures 86-88 consist of scattergrams for the vowels when those which occur following /w/ or an alveo-palatal are excluded, and Figure 89 shows this information in the form of individual envelopes superimposed on each other. Figure 90 shows the relationship of the combined reduced vowel envelopes to that of the complete spectrum envelope. It is to be noted that with this exclusion there is no overlap of the envelopes of the three vowels, nor is there any overlap for the vowels following /w/, or the vowels following alveo-palatals.

The conclusion that can be made from this evidence is that initial consonants, particularly /w/ and alveo-palatals, influence the target value of a following vowel and this has a conditioning effect upon the speakers and hearers of Diari so that considerable variation in the formant structures is tolerated provided that the movement is between the consonant locus and the mean for the vowel. Should the variation extend beyond the mean to any appreciable degree there would be danger of the contextual vowel phoneme being confused with another vowel phoneme in the same context. For instance, if F2 of /i/ following /y/ moves beyond the mean of /i/ by 150 Hz in the opposite direction of the locus of /y/ (c2200 Hz) the vowel will be intruding into the range of possibilities of /u/ in the context /yu.../.

4.7 The influence of the following context upon the vowel target

The fact that a preceding initial consonant influences the target value of a following vowel leads one to expect that a following consonant would have a similar effect. A detailed examination of this proposition is difficult with the limited data available. Instead of eleven consonants being associated with the vowels as is the case for word initial consonants any of the twenty-two Diari consonants may follow an initial syllable's vowel[40]. This reduces by half the number of times a vowel can be expected to occur with any one consonant. Nevertheless, there is enough information to check for any tendencies. In Figure 81 it can be seen that the mean average plots for vowels preceded by /p/ remain close to the means for the vowels when they are calculated without regard to context, yet, as Figure 91 reveals, plots for all instances of /i/ following /p/ for A. Edwards, show a great deal of variation.

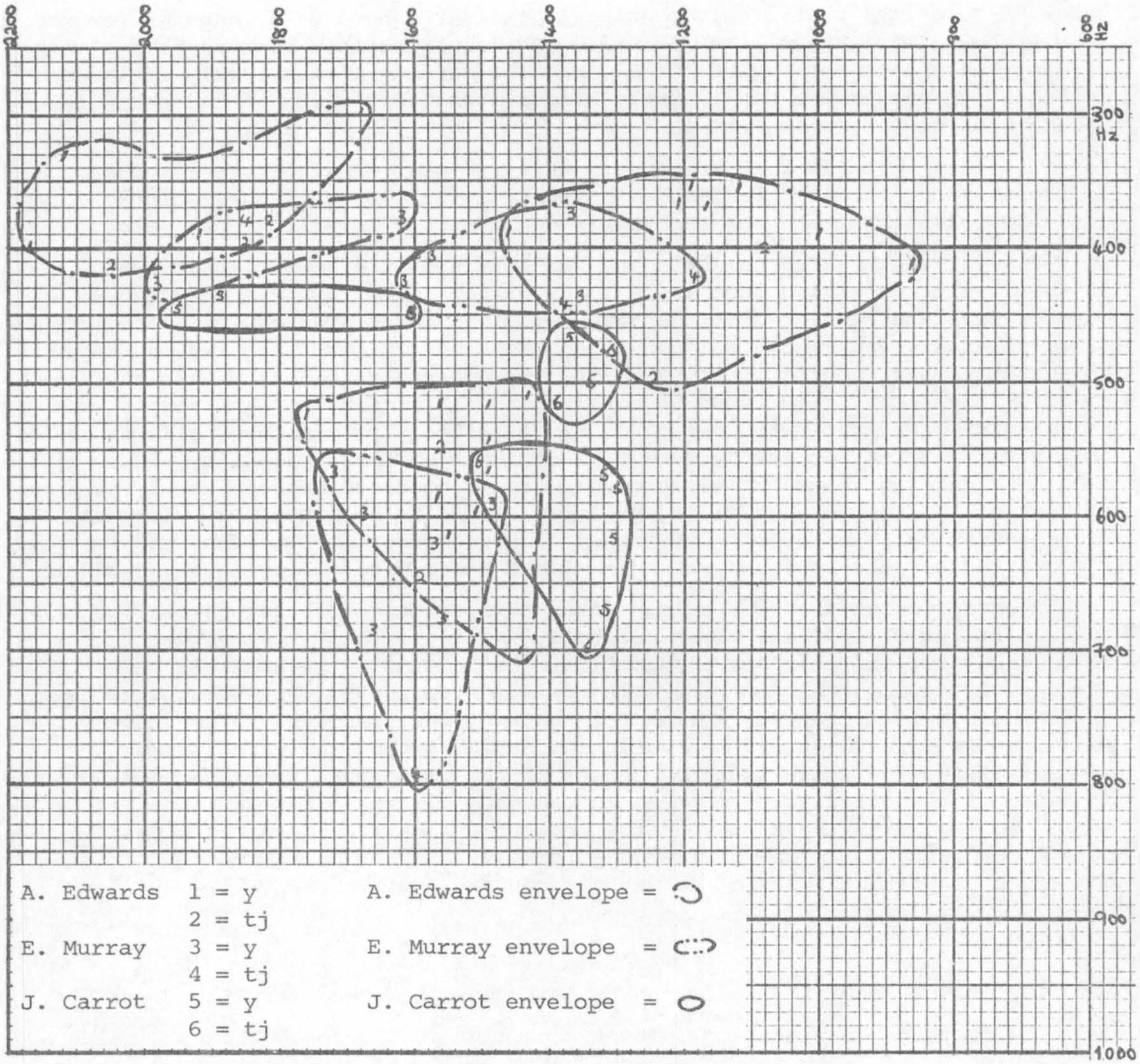


Figure 82

Scattergrams and spectrum envelopes for /i/, /a/, and /u/, in context with preceding alveo-palatals.

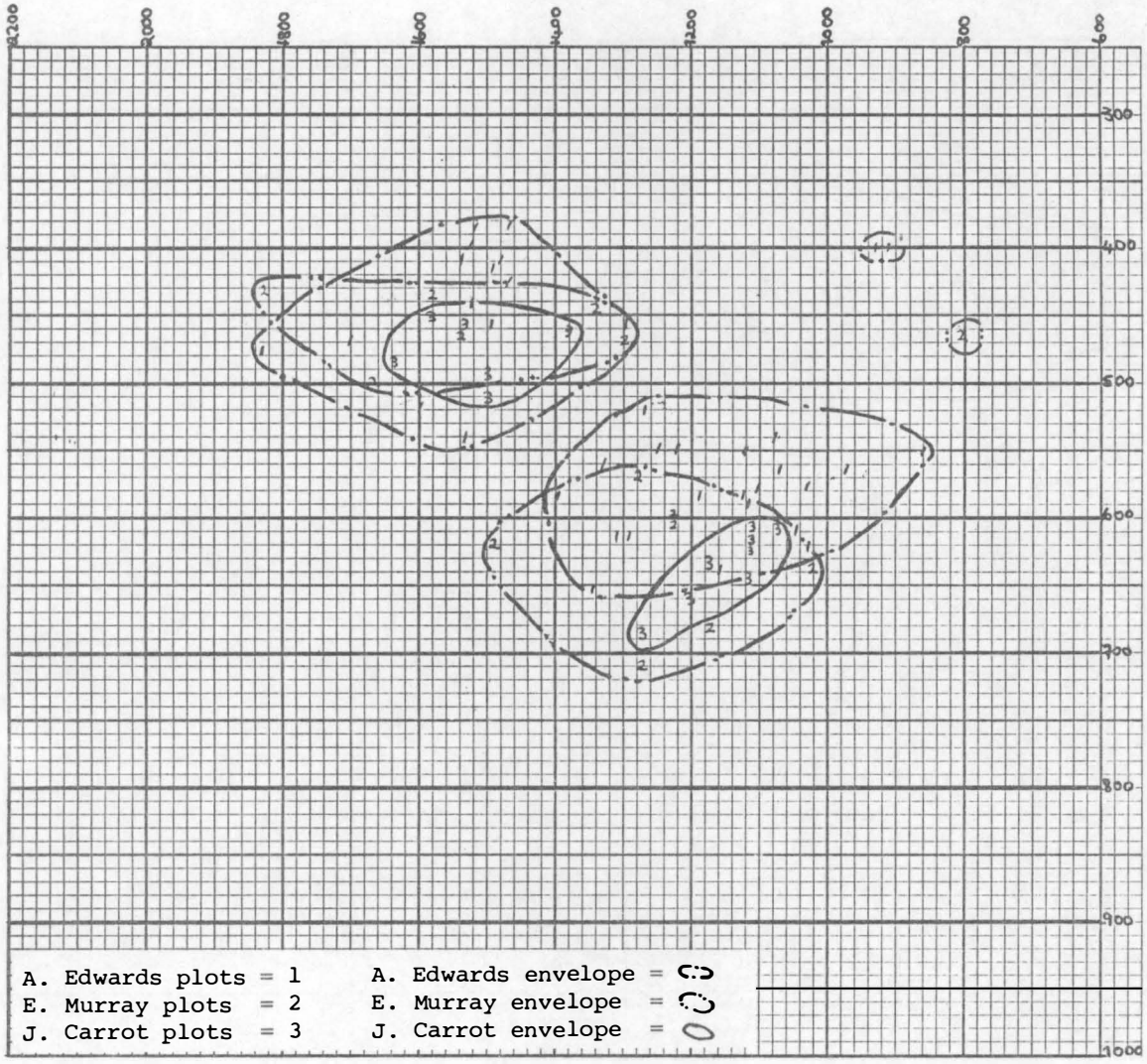


Figure 83

Scattergrams and spectrum envelopes for /i/, /a/, and /u/, in context with preceding /w/.

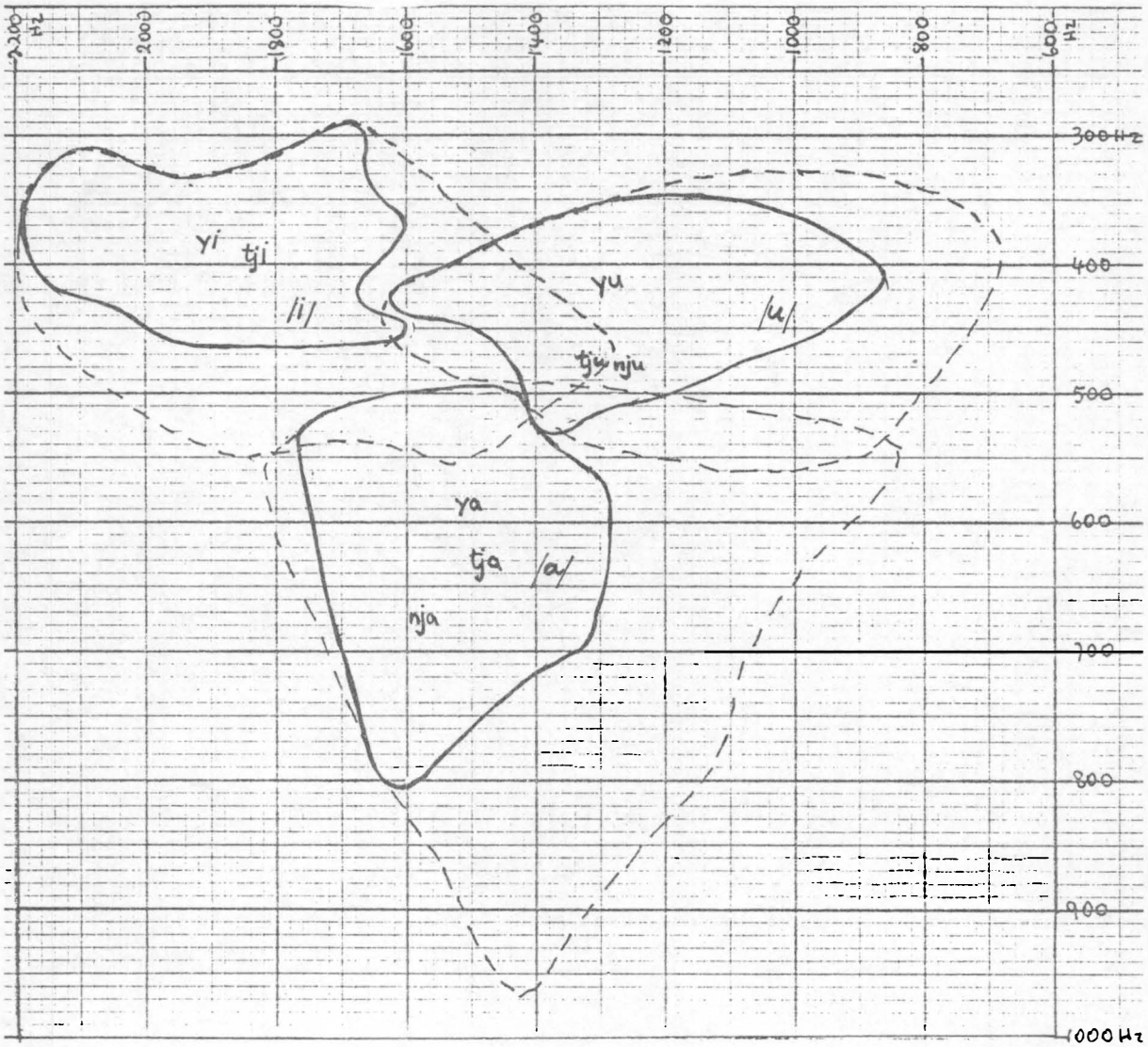


Figure 84

Spectrum envelopes, of the three speakers combined, for /i/, /a/, and /u/ in context with preceding alveo-palatals, superimposed on the non-contextual spectrum envelope. Mean average plots for contextual vowels are indicated, together with the non-context mean.

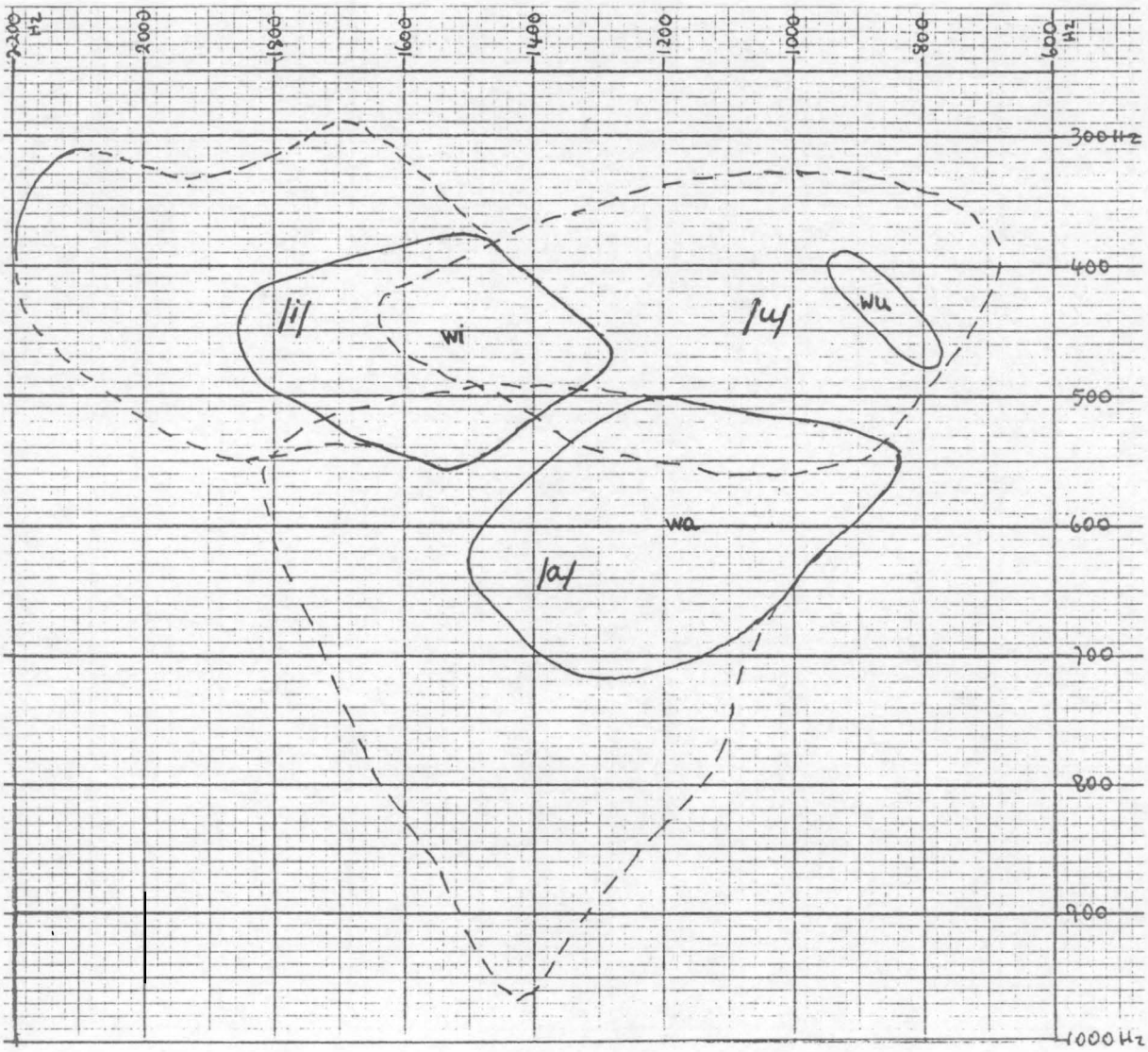


Figure 85

Spectrum envelopes, of the three speakers combined, for /i/, /a/, and /u/ in context with preceding /w/, superimposed on the non-contextual spectrum envelope. Mean average plots for contextual vowels are indicated, together with the non-context mean.

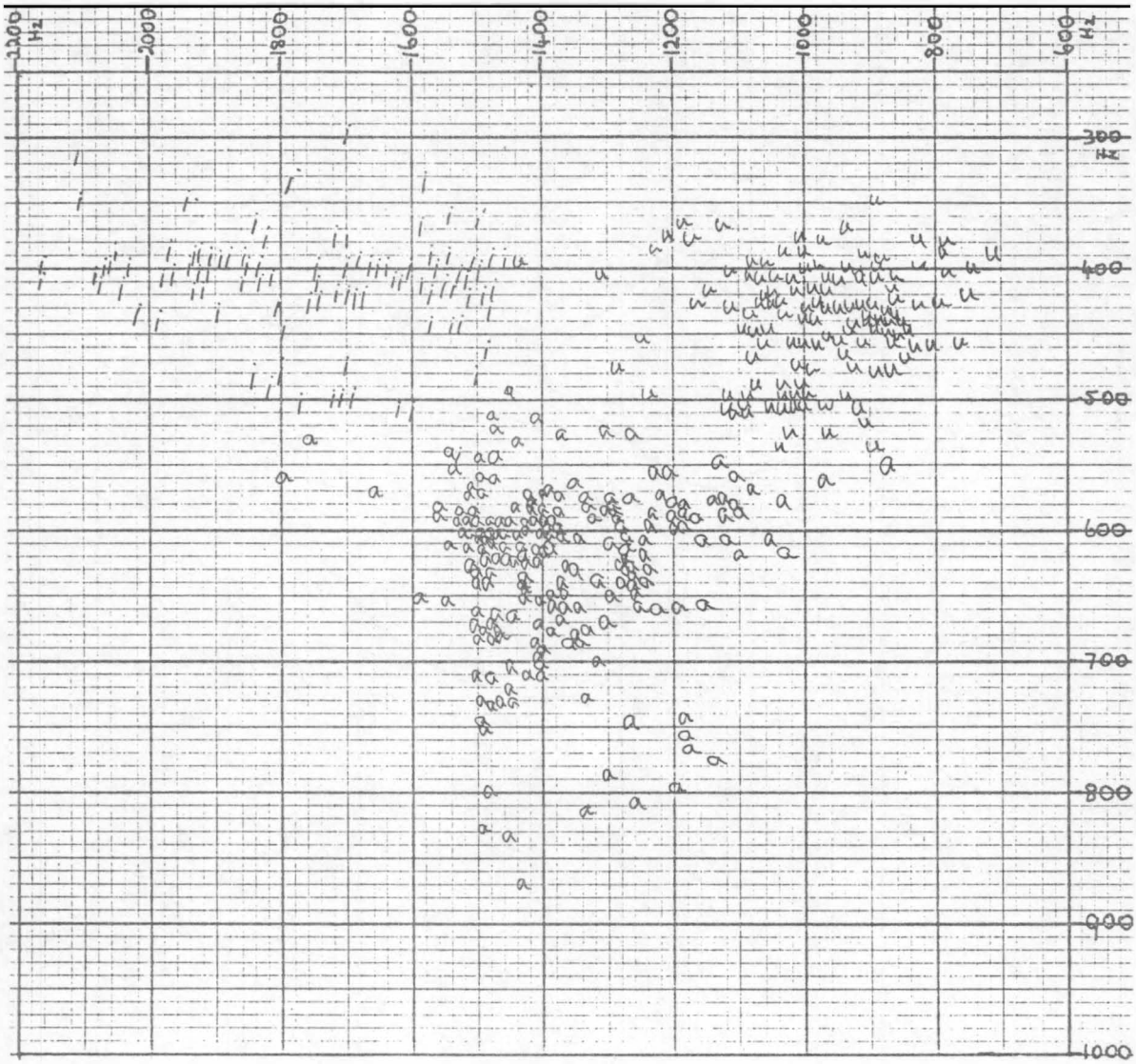


Figure 86

Reduced scattergram of vowel targets for A. Edwards. Reduction due to removal of vowels following alveo-palatals or /w/.

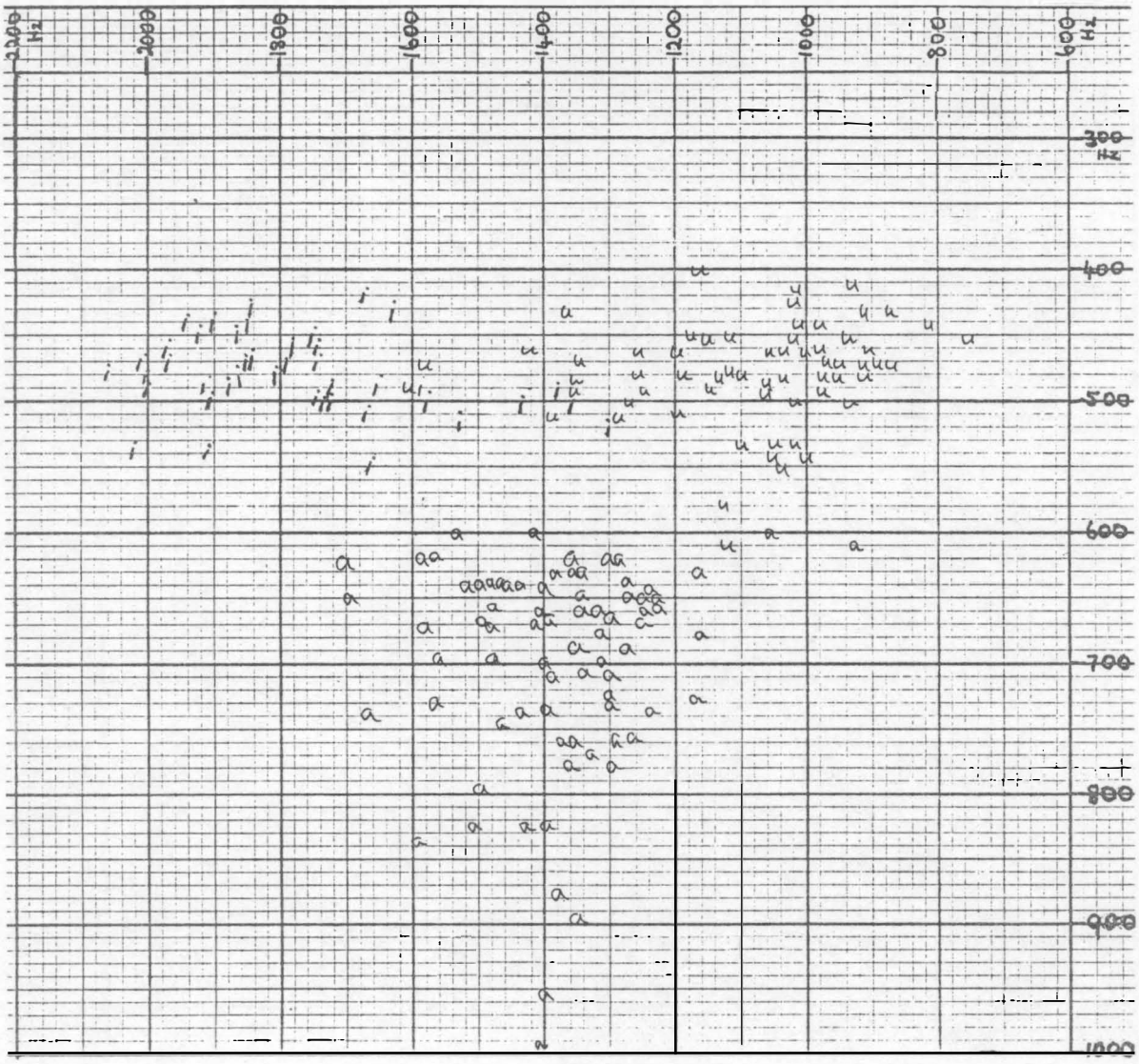


Figure 87

Reduced scattergram of vowel targets for E. Murray. Reduction due to removal of vowels following alveo-palatals or /w/.

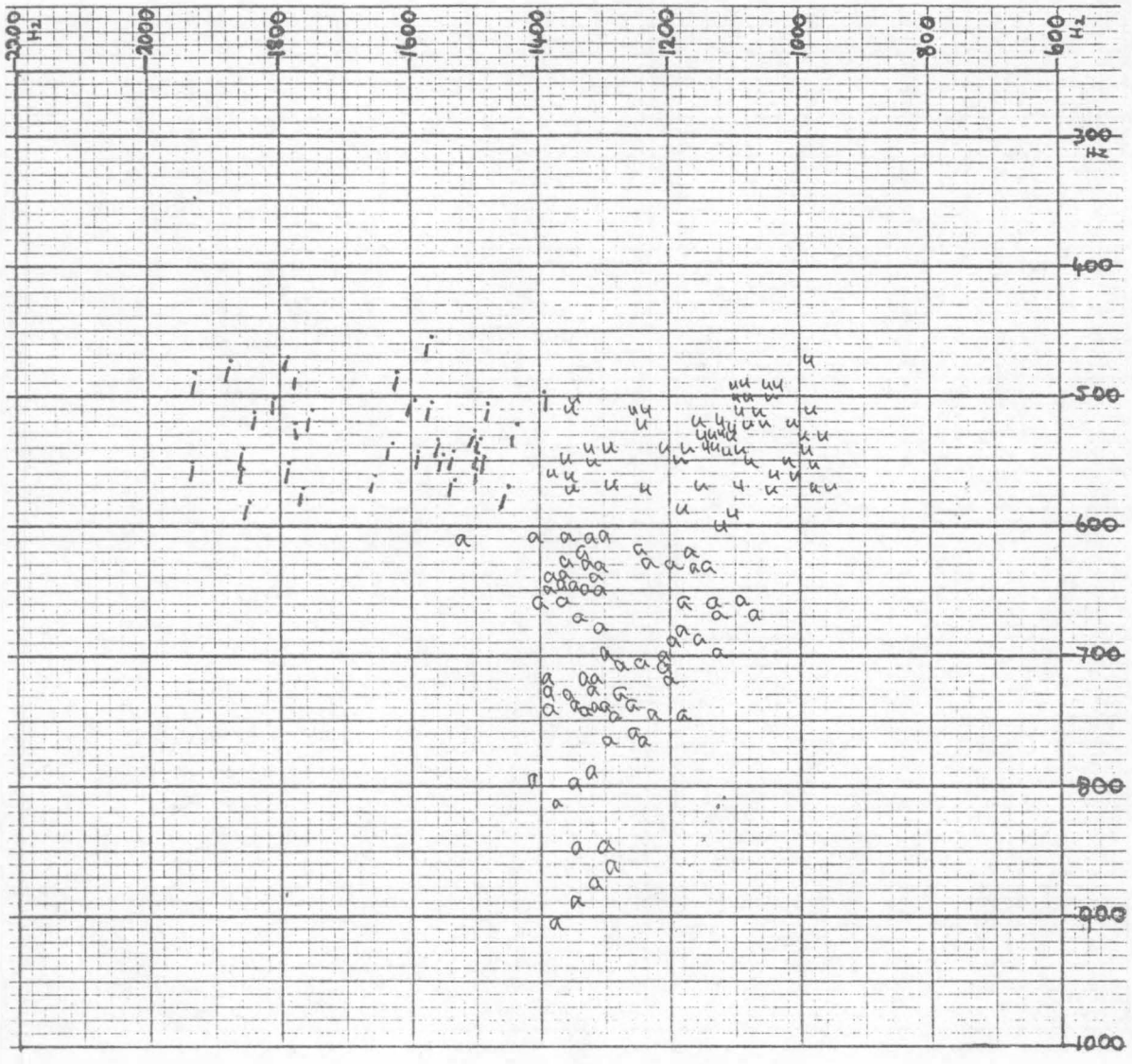


Figure 88

Reduced scattergram of vowel targets for J. Carrot. Reduction due to removal of vowels following alveo-palatals or /w/.

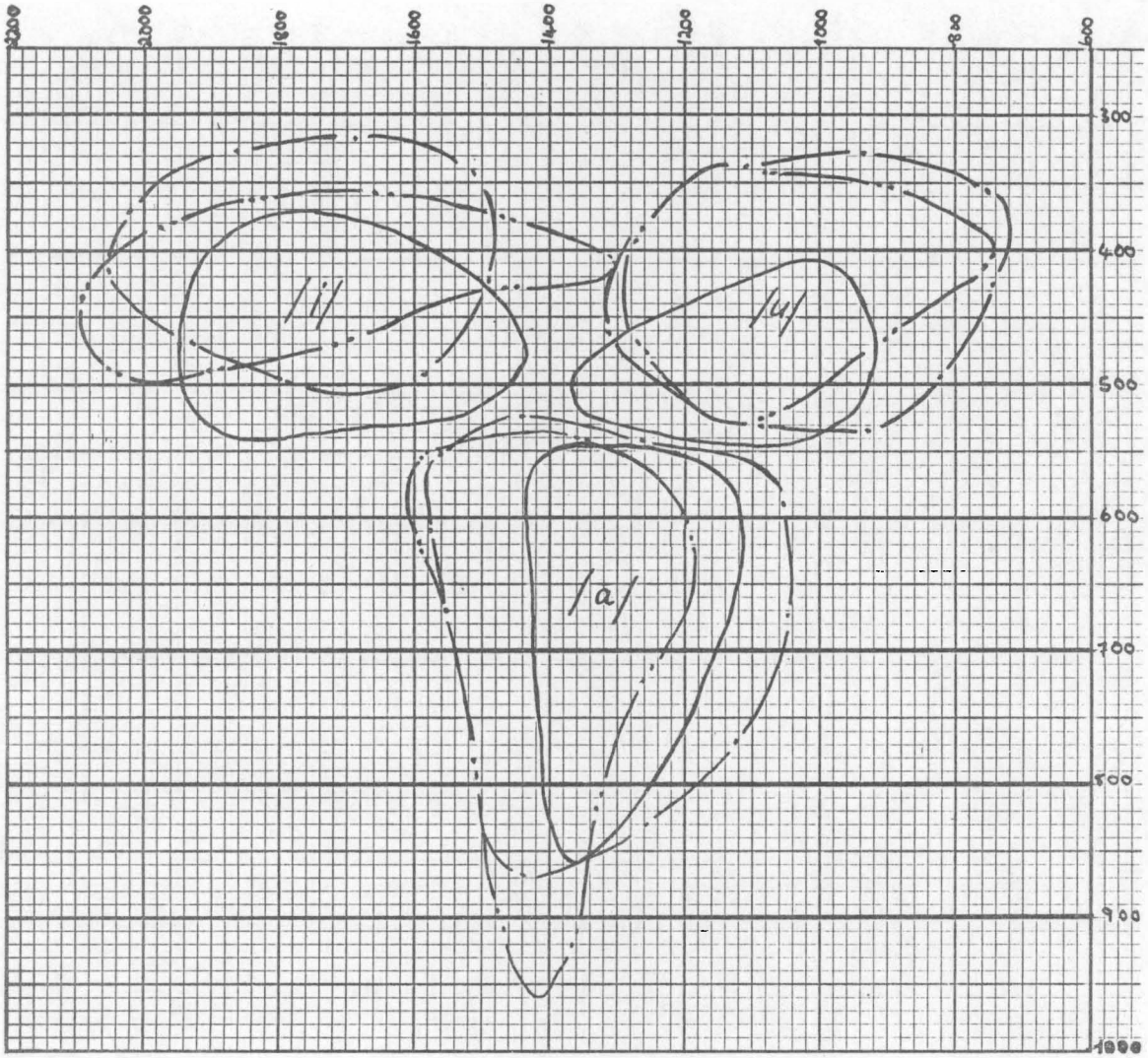


Figure 89

Spectrum envelopes for /i/, /a/, and /u/ after the removal of the vowels which are preceded by alveo-palatals or /w/.

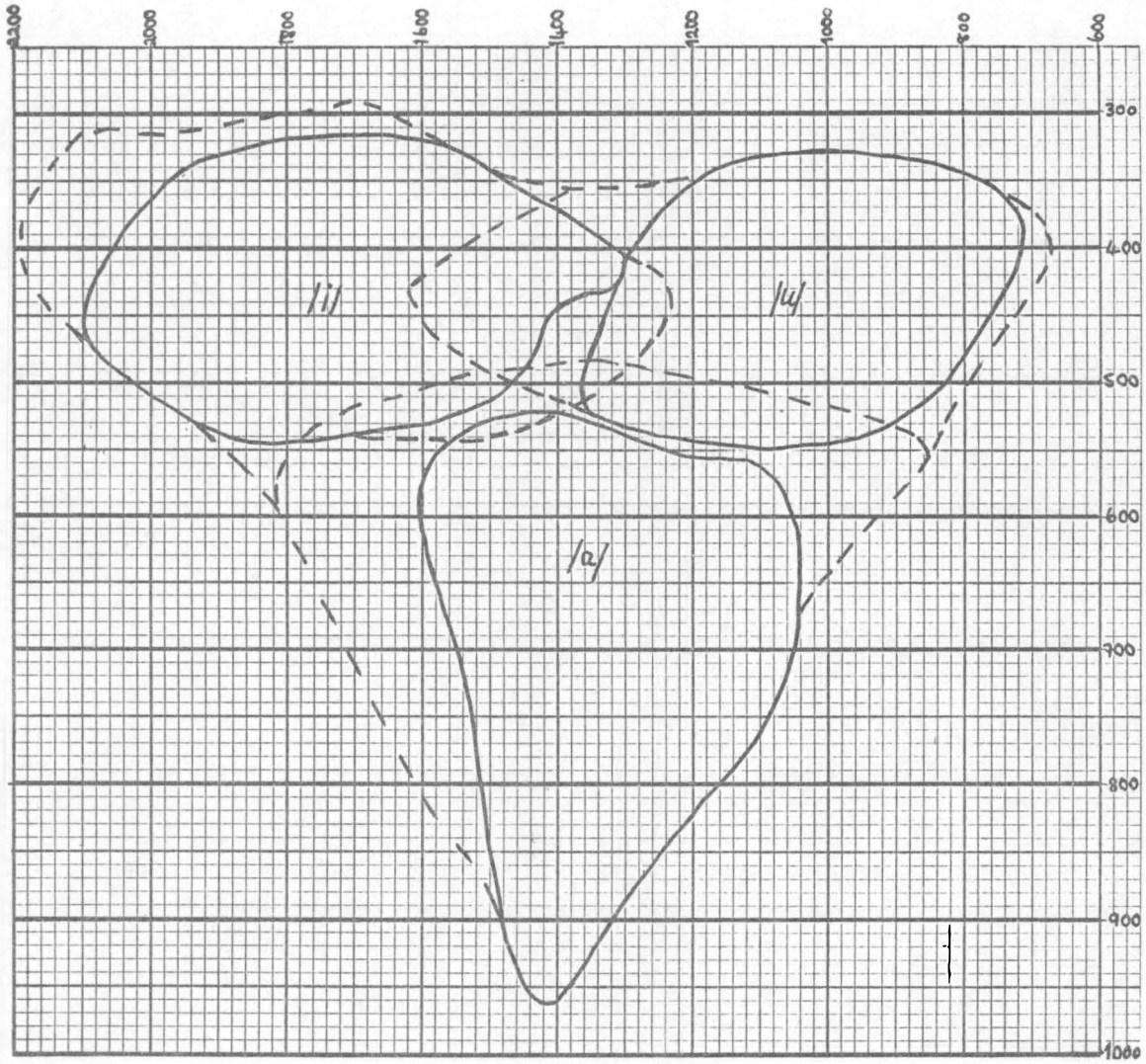


Figure 90

Reduced spectrum envelopes, of the three speakers combined, for /i/, /a/, and /u/, superimposed on unreduced ones.

The two instances of /pirr../, /pirra/ *coolamin* and /pirri/ *chisel* both occur with an F2 reading 200 Hz lower than the mean for Edwards' /i/ phoneme, whereas /pi../ preceding the alveo-palatals /nj/ and /tj/ is 200-300 Hz higher than the mean. Figures 92 and 93 indicating the plots of these combinations for Murray and Carrot, show that they also occur far from the mean. (Means for these contextual vowels are calculated in Table 19.) Earlier it was seen that initial avleo-palatals raise the frequency of F2, now it is seen that a following alveo-palatal has the same effect.

It is interesting to note that the one occurrence of /lj/ following /pi../ does not appear to influence the vowel target in the way the other alveo-palatals do. The reason for this is perhaps due to the fact that it is a lateral. In Figure 91 it can be seen that /...l/ has a tendency to lower the frequency of F2, though not as decisively as /..rr/. The plots shown in Figure 94 support this observation for it can be seen that the F2 of all speakers for /..il/ is generally lower than the mean. Thus, it seems that laterality has a moderate tendency to lower the F2 reading of the vowel target, and this tends to neutralise the effect that alveo-palatalisation has upon it. /lj/ therefore tends to be less radical than either /tj/ or /l/.

From this small amount of evidence it seems possible to expect that following consonants affect the vowel target as effectively as preceding ones do, and this results in considerable variation for the vowel target even when the initial consonant is kept constant.

Table 19

Calculations for determining mean plots of /..irr/, /..il/, and /pi$^{tj}_{nj}$../.

	/..il/	
N	-	23
ΣF1	-	9,310
Mean F1	-	404.8 Hz
ΣF2	-	38,710
Mean F2	-	1683.0 Hz

	/..irr/	
N	-	12
ΣF1	-	5,400
Mean F1	-	450.0 Hz
ΣF2	-	19,260
Mean F2	-	1605.0 Hz

	/pi$^{tj}_{nj}$../	
N	-	7
ΣF1	-	2,910
Mean F1	-	415.7 Hz
ΣF2	-	13,090
Mean F2	-	1870.0 Hz

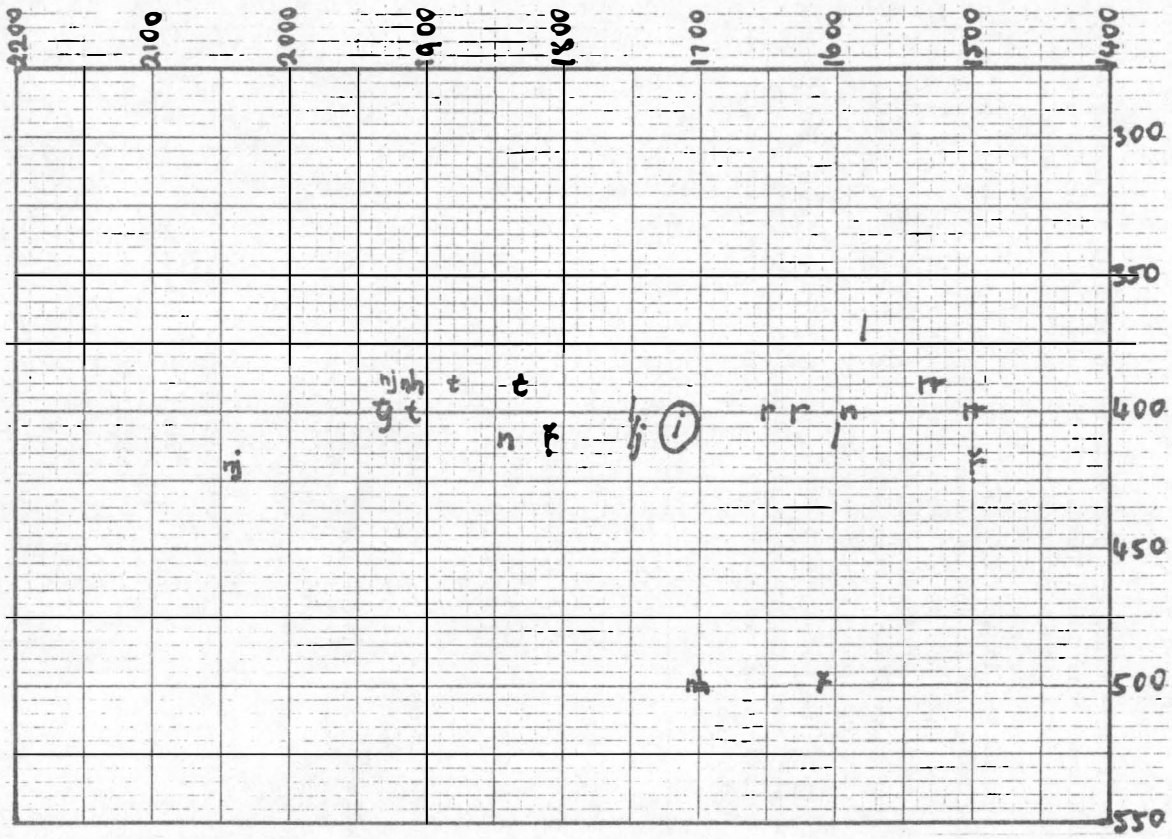


Figure 91

F1 x F2 plots of /pi../ when spoken by A. Edwards

Each vowel plot is indicated by the consonant which follows it in that particular word.

The mean for the plots in the scattergram is indicated with a circle.

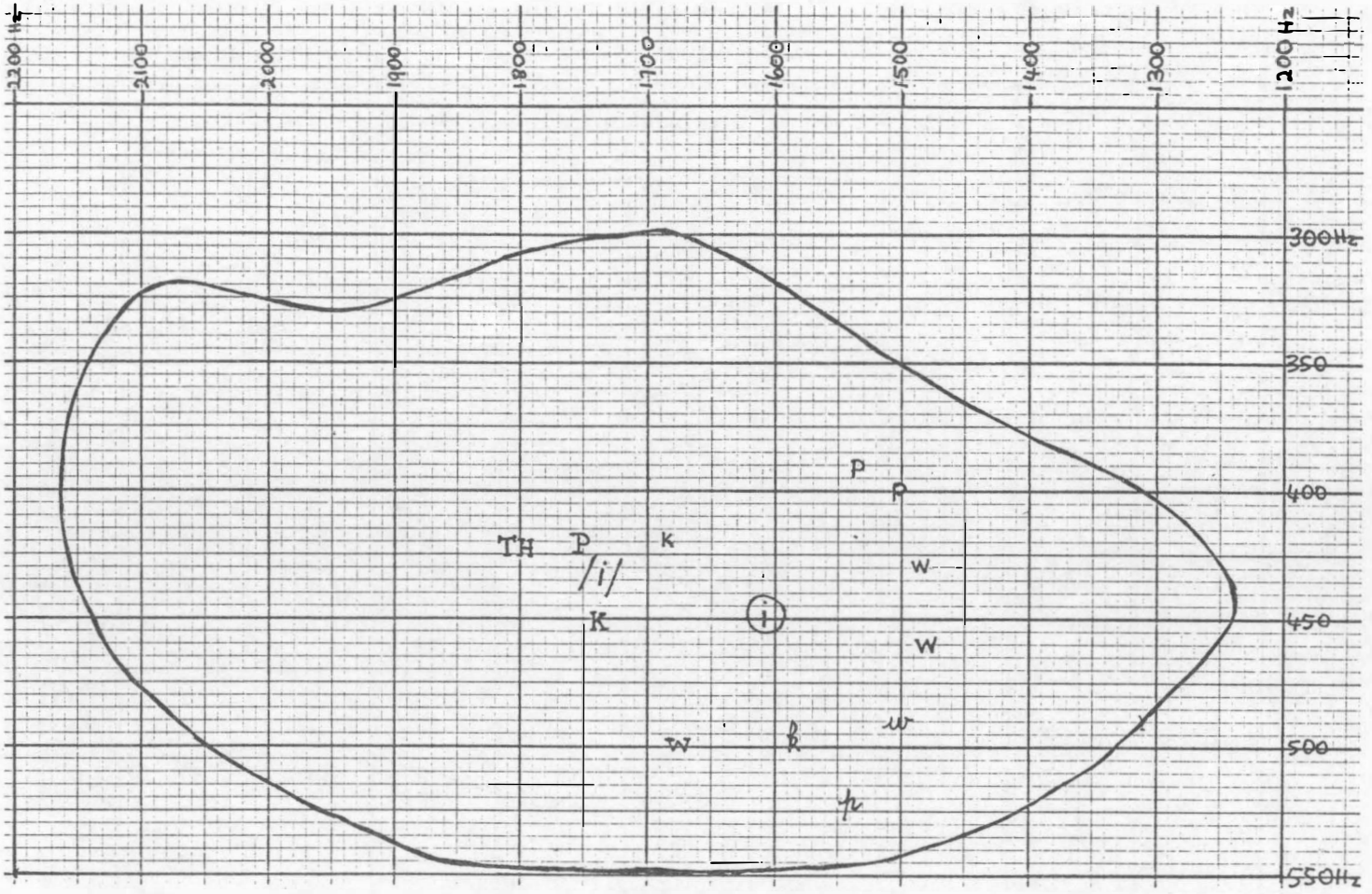


Figure 92

F1 x F2 plots of /..irr/ enclosed in the /i/ spectrum envelope.
Vowel plot indicated by its preceding consonant.
Average mean of vowel indicated by /i/, mean for /..irr/ indicated by ⓘ.
A. Edwards plots w, p. E. Murray plots w, p. J. Carrot plots w, p

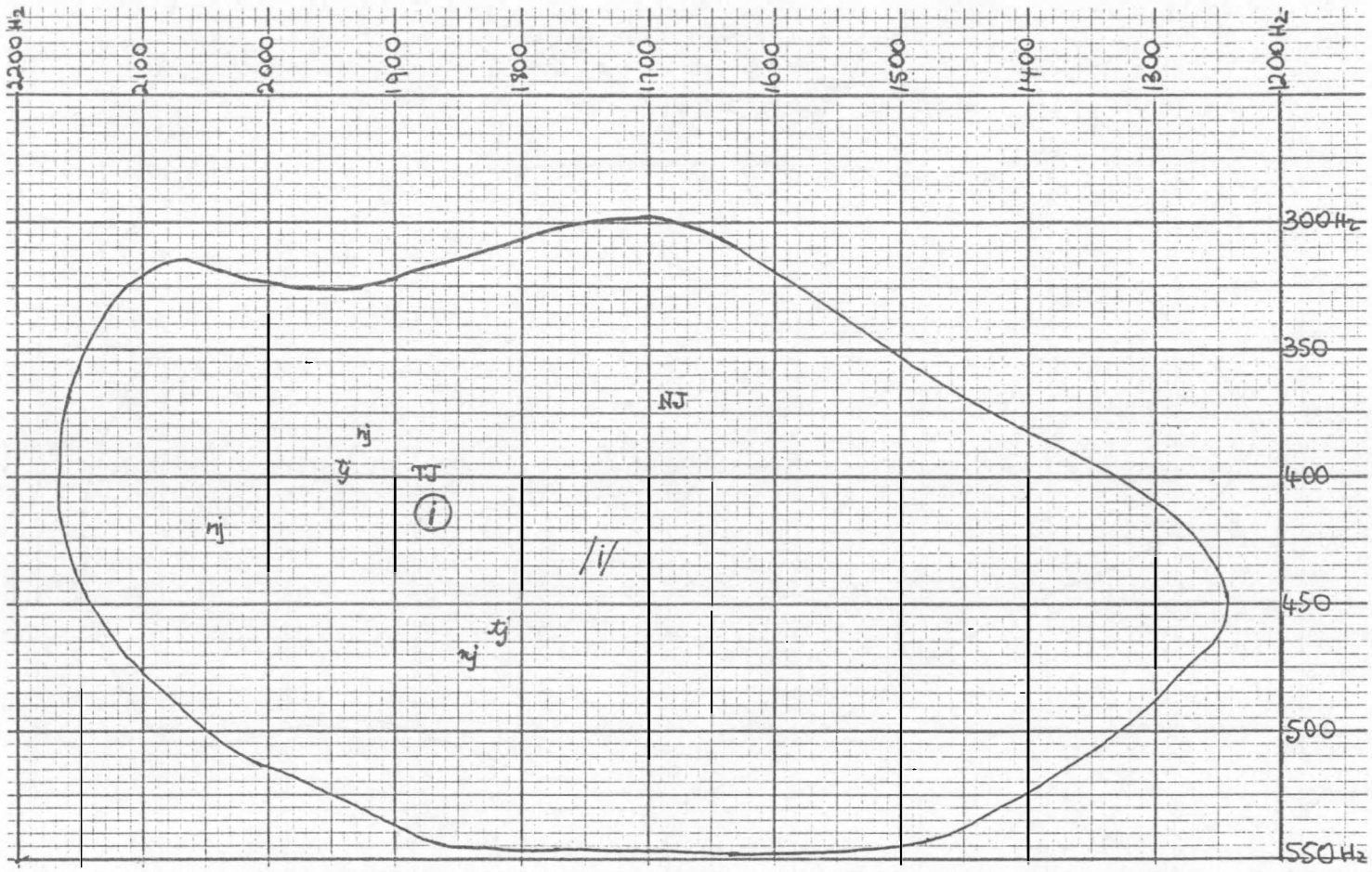


Figure 93

Fl x F2 plots of /pinj../ and /pitj../ enclosed in the /i/ spectrum envelope.
Vowel plot indicated by its preceding consonant.
Average mean for vowel indicated by /i/, and the mean of the sample is ⓘ.
A. Edwards plots **tj**, **nj**. E. Murray plots **TJ**, **NJ**. J. Carrot plots **tj**, **nj**

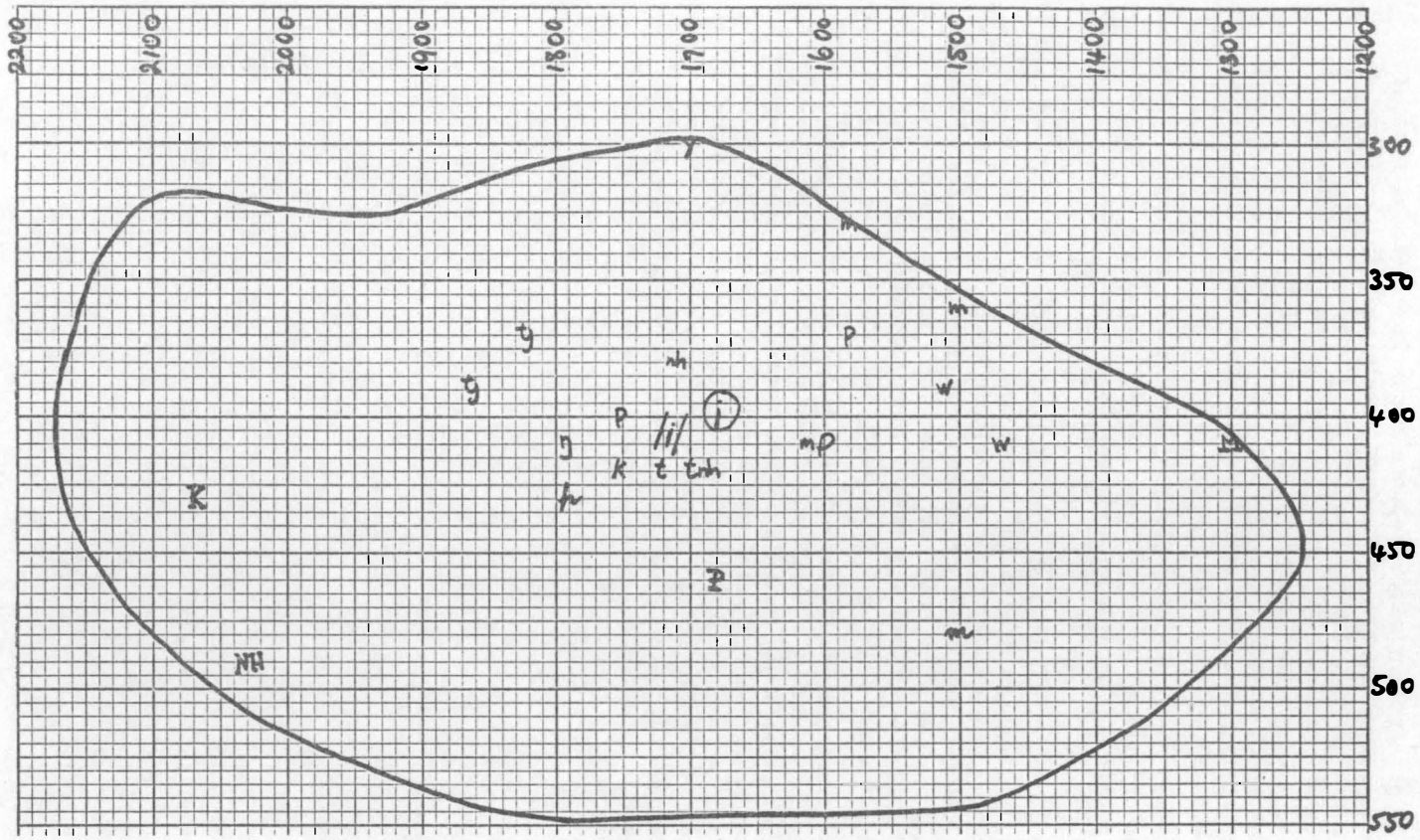


Figure 94

F1 x F2 plots of /..il/ enclosed in the /i/ spectrum envelope.
Vowel plot indicated by its preceding consonant.
Average mean for vowel indicated by /i/, and the mean for /..il/, by ⓘ.
A. Edwards plots ʧ, nh. E. Murray plots NH, K. J. Carrot plots m, r.

5. CONCLUSION

Diari, a language of eastern Lake Eyre, has shown itself to be typically Australian in its phonological system. Its five vowels contain the three basic Australian vocalics plus two diphthongs. All of the consonants with the possible exception of the variants [d̪l̪] and [dl] are widespread in their occurrence over the Australian continent, and the parallel system of stops and nasals which is a feature of Diari, is also a feature of Australian languages in general. The fact that all six stops and nasals occur in the same language is less general but typical of the region.

One feature of Diari is uncharacteristic of Australian languages. A number of languages have the three rhotics [r], [ř], and [rr] combining in different ways to produce two phonemes. In Diari the segments are each phonemes in their own right.

Another feature of Diari which is not widespread concerns the CV pattern of words. It is similar to many Australian languages in that there are strict limits to the CVC patterns which may occur and within those limits there are further constraints on which sequences of consonants may occur in a CC cluster. Its difference relates to the word final syllable. In Diari all words must end in vowels whereas in the majority of Australian languages there limitations on which consonants occur word finally but some of them will occur.

The considerable range in the degree of allophonic variation found in Diari vowels is to be expected in a three-vowel phonological system. Some of the variation is free in the sense that it is not controlled by the linguistic system but is more to do with the physiological facts of speech, but other variation is due to the system and is the result of the effect each segment has upon its neighbour. The further an adjacent consonant's loci is from the norm for a vowel's target the more likely will the phonetic realisation of that vowel be divergent from its norm, the divergence being in the direction of the consonant's loci.

NOTES

1. There are at least eight other spellings for the name of the dialect, e.g. Deerie, Dieyerie, Diyari, Diyeri, Dieyrie, Dijari, Dyeri and Dieri. See W.J. and L.F. Oates, 1970, and P.K. Austin, 1978. Diari is the name adopted in this work (also the name used by J.G. Reuther in his grammar of 1899), based on perceptual phoneme principles given in Trefry 1974. Austin (1981) spells the name 'Diyari' using a different set of principles.

2. Breen 1971, and Austin 1981.

3. George Murray, the eldest, and Ern, were Diari speakers, the youngest, a half-brother, Ben, had Arabana as his first language and was not used as a subject in my acoustic study. In the absence of his brothers he subsequently became a major informant for Austin and proved to be a fluent speaker of Diari.

4. This only included those who lived between Cooper's Creek and Port Augusta. G. Breen from Monash University has reported two other speakers in the Birdsville area. Subsequent to my study, P. Austin (1978) names four other male speakers in the Port Augusta - Maree region. Two of these speakers I met, another, Mr Alfie Harris, was pointed out to me, but not as a Diari speaker. The fourth, Mr Jimmy Russel I had no knowledge of, though, as it turns out he is a son of one of my informants. Of the two men I met, Ben Murray I have mentioned (note 3), and Mr Mick Mclean whom I met in Port Augusta would not admit to knowing sufficient Diari to act as a language consultant in that language. He was, I believe, fully conversant in Waŋkaŋuru.

   There was also a number of female speakers of Diari but unfortunately, the 400 Hz bandwidth speech spectrograph used for the analysis was not able to display the formant patterns of the relatively high Herz frequencies of women's voices.

5. The term 'breath pulse' is used instead of 'chest pulse' in order to avoid the physiological implications generated by the use of that term.

6. A.C. Gimson 1962, p.52.

7. The terms vocoid and contoid are taken from Pike (1967:372). They are used to prevent confusion between physiologically and phonologically based uses of the terms vowel and consonant. The latter two terms are only used for phonologically interpreted sounds.

8. See Pike, 1947:60ff.

9. 'O' stands for 'onset', 'N' stands for 'nucleus' and 'C' stands for 'coda'.

10. It is of interest to note that all previous writers on Diari have written the sequence [lr̃] and [nr] as [ldr] and [ndr]. In my field notes I have also recorded the sequence as a three consonant cluster. Phonetically, a flap [ɾ̆], or the initial occlusion of a trill [r̃] will differ from a [d] only by the differences in the duration of that occlusion. Other factors, such as the degree, or the place of intensity of air turbulence at the release of the occlusion may give interpretive cues for identifying the occlusion as one of several phonemic possibilities.

A spectrographic spot check on the duration of the first occlusion for [r̃] following [l] and [n] in Diari is interesting. Fourteen words repeated three times were taken from the Edwards word list. Seven words contained the medial sequence [lr̃] and seven words [nr̃]. The following table indicates, in centi-seconds, the duration of the first occlusion of [r̃] in these medial clusters.

Word	Duration in centi-secs of each repetition of words containing [lr̃]		
	1	2	3
/kalr̃a/	3.1	3.1	1.8
/walr̃a/	2.8	1.3	2.0
/wulr̃u/	2.6	1.8	1.3
/kalr̃i/	3.0	4.0	4.2
/palr̃u/	2.0	3.0	3.1
/kalr̃u/	5.0	3.0	3.4
/yilr̃i/	1.2	3.0	3.0
	Range of duration = 1.2 — 5.0		
	Mean = 2.7		

Word	Duration in centi-secs of each repetition of words containing [nr]		
	1	2	3
/wanr̃a/	1.6	2.2	2.0
/winr̃i/	1.8	1.6	1.8
/yunr̃u/	1.6	2.4	2.0
/ninr̃i/	2.5	3.0	4.0
/minr̃i/	2.0	1.5	3.1
/kanr̃i/	5.0	5.1	5.0
/panr̃a/	2.0	2.1	1.9
	Range of duration = 1.5 — 5.1		
	Mean = 2.6		

If these figures are compared with those in Tables 5 and 6 it will be seen that the duration of the first occlusion in the sequences [lr̃] and [nr̃] correlate with [ɾ̆] not with the stop phoneme. Also, as the intensity tracing (i.e. the top one) in Figure 6 reveals, there is no significant difference between the duration of the first occlusion of the trill and the subsequent ones.

From the evidence above, it can be seen that systematically it is vacuous to argue for the adoption of the more complex sequences [ldr] and [ndr]. The inclusion of these expanded clusters has led Austin (1981) to postulate a phoneme /d/ though it has no unequivocal phonetic reality.

The question could be asked why it is that 'd' is usually heard in the sequence if there is no systematic reason for its inclusion. It seems to me that the answer is concerned with interpretation cues of the /d/ phoneme in English and other similar languages containing an intervocalic sequence /nd/ or /ld/. According to Fry (1979) English stop consonants range between 7 and 14 centi-seconds. There does not seem to have been any systematic study of the consonants occurring intervocalically in association with /l/ or /n/, (M. Haggard 1972 and D. O'Shaughnessy 1974 have done studies of clusters word initially and word finally) so I did a spot check by producing 10 spectrograms of English words containing intervocalic /ld/ and /nd/ and then measured the duration of the occlusion. The occlusion ranged from 0 - 4 centi-seconds in duration (the zero reading was for 'kinder', where the nasal resonance formant extended to the point of release of the /d/). In other words, in English we do not rely on the stop occlusion for identifying a /d/ following /n/ or /l/ but make the required interpretation from the burst of energy at the release of the cluster. It is therefore not surprising that English speakers (or speakers of languages with similar clusters) will hear the Diari sequence of [nr̆] and [lr̆] as [ndr̆] and [ldr̆].

11. This, in fact, is what Austin (1981:22) does, claiming that systematic generalisations overrule other considerations. In this present study, based on the concept of the phoneme being a unit of perception rather than a morpho-phonemic unit (Trefry 1974, part A) every effort is made to correlate phonemic description with phonetic reality.

12. The interpretation for these words contrasts with other words where there is a syllabic trough within the sequence. For example, /paya/ *bird* has a phonetic sequence [ʌɪʌ] but ɪ occurs across a syllabic trough and is therefore interpreted as [y]. (See also Figure 7 where high vocoids have been interpreted as [y] and [w].)

13. One instance of ŋʌɪʌnʌ has 1st ʌ and ɪ on two minor peaks. In this particular utterance the word stress has been placed on the 2nd ʌ instead of on the 1st ʌ — ɪ complex and seems to have effected the displacement of intensity between the two phones.

14. The upward move of 600 Hz from the first vocoid to the contoid is explained in the analysis of the vowels in section 4. The /i/ phoneme varies from [ɛ] to [i], and in this instance the high front vowel is of a lower variety.

15. [ɲ] does occur preceding /i/ word initially in the word [ɲɪlpʌ] *louse egg* but as it occurs in fluctuation with [n̪ɪlpʌ] I hesitate to use it. Austin (personal communication) has recorded [ɲɪrɪ] *wrinkled*, which would support the analysis of this paper.

16. See Hercus 1972 for the first discussion of this in the Lake Eyre region. Though I have previously noted the phenomenon (Trefry 1974:246 and 277ff) I treated the nasals differently from the laterals and so failed to observe the generalisation.

17. Listening through tape recordings of eight texts, at two places I heard a 'd'-like sound preceding a non-primary stressed intervocalic lateral. On no occasion when eliciting words have I recorded a pre-stopped nasal in that position.

18. Austin 1981:18.

19. The use of the phonetic symbols of K.L. Pike is discussed in Trefry 1974, chapter 2. They are the symbols used in Pike, 1947.

20. English glosses for the words in the above chart are found in Table 7: 123ff. It needs to be remembered, however, that the representations in this chart are phonetic, whereas those found in Table 7 are phonemic.

21. Austin (1981), has written initial alveolar stops as though they were retroflexed and has then united them with medial retroflexed stops as the phoneme /ḍ/. It seems that the confusion has been caused by the manner of production of Diari alveolars. They, in common with some other Australian languages (see Sharpe 1970:125-126, Yallop 1977:22 and Trefry 1974:122) produce alveolars with a depressed tongue blade. This had the effect of reducing fricative noise at the release of the consonant and thus increasing the difference between alveolars and dentals (which have a comparatively large amount of fricative noise during the consonantal release), but at the same time, it means that the tongue's configuration is similar to that of retroflexed stops. The confusion is more likely to happen in word initial position where the rhotic quality of a preceding vowel is not available as an additional cue for retroflexion.

    It is interesting to note that Austin's analysis results in a most unusual phonemic distribution. In it the alveolar stop only occurs word medially whilst the retroflexed stop occurs both initially and medially. The analysis in this monograph follows a typical Australian pattern, i.e. if retroflexed and alveolar stops both occur in the language and if one of them does not occur in word initial position, it is the retroflexed stop which is absent in that position.

22. Austin (personal communication) reports as having recorded *lake* as [pʌntu]. This, of course contradicts my statement on the complementary distribution of [t] and [d]. I have seven instances of tape recordings for lake. In each instance the alveolar is voiced. However, if [t] does occur in fluctuation with [d] between [n] and a vowel, the phonemic conclusion will be the same, i.e. they are allophones of the same phoneme.

23. I described the phonetic difference between [nh] and [n] in 1974 (Trefry 1974) but it was Austin (1978) who was able to establish the contrast between these segments.

24. Austin (1981) records alternation between initial dental and palatal stop phonemes (though not between nasals). I have no recordings of any stop alternations.

25. Glosses for most of the words in the chart are indicated in Table 7. Those words not found in the Table have the following meanings. [ŋʌmʌɪ] *live*, [tʌkʌɪ] *impale*, [nhʌɪ] *see*, [nhʌu] *he*, [thʌuɪʌ] *duck type*, [nhʌukʌ] *he* (selected).

26. Technically, Diari has five vowels, but the fact that [ʌʊ] and [ʌɪ] are glides sets them apart from the other three in that a single vowel target is not the goal in their production.

27. A few three and four syllable words were included by error, but were left in when it was observed that there was no apparent difference in their vowel targets.

28. The list was formed by extracting 476 words from Reuther's manuscripts and then adding to them words which were discovered through consultations with A. Edwards. During these consultations words were discarded if he did not recognise them as being Diari. Some words were from Arabana or Wangkangurru, or forms from other languages. Some words Edwards considered to be errors. A few more words were added after the recording of Edwards, but the list is far from exhaustive. Material collected subsequent to this experiment contains a number of other two syllable words.

29. Identical forms were sometimes due to hom nyms or meaning variations. A few identical forms were included as checks on the accuracy of the recordings.

30. The list varied slightly from speaker to speaker, due mainly to communication problems, which was one of the reasons for originally shortening the list. There were two other inter-related reasons. Informants tended to lose concentration if the list became too long, and it would have proved difficult to get Lesley Russel or Jack Carrot to record more than once as both were stockmen in from their cattle station.

31. It was thought that one Diari speaker was living at Innaminka and another one was in the Birdsville area somewhere, but nobody was really sure. (See also note 4, p.317.)

32. It was for this reason that females were not able to be used for the experiment. This was unfortunate as there were a number of women Diari speakers available between Port Augusta and Marree.

33. A sonagram measures 12.75" x 5.7".

34. This word list is an edited version of that found in Trefry 1974. P. Austin has checked the original list and where he has disputed the form or meaning of a word the following four steps have been taken before a final choice has been made.

    1. My original field notes have been rechecked to make sure an error hasn't found its way into the script.

    2. A hand-written dictionary from English to Diari, which was compiled by Mr Jack Irrgang, the son of a lay worker at the Ettadunna Lutheran Mission station was consulted. As Jack put it, he was brought up as one of the Diaris and the only schooling he had was in the Diari school.

    3. Six texts and two conversations which were taped, transcribed and translated under the supervision of Alec Edwards have been computerised into a lexicon and were then used as a further check both for form and for meaning.

    4. The original word lists were rechecked both auditorially and visually (through use of spectrograms).

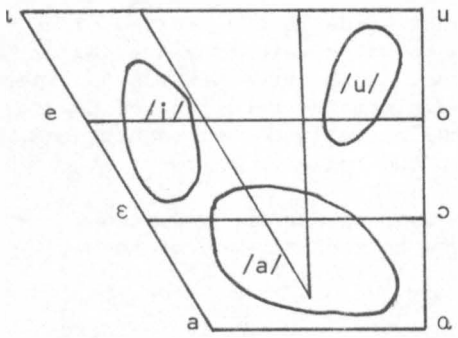
35. Delattre, Liberman, Cooper and Gerstman 1953:200.

36. J.R.L. Bernard 1970:116.

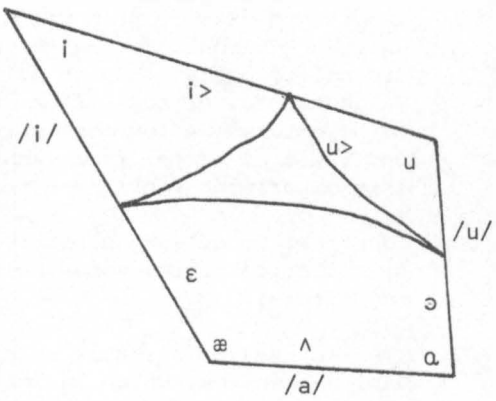
37. J.R. Bernard 1970(b):116.

38. cp. previous diagrams based on articulatory methods. In these there is no suggestion of phoneme overlap.

Trefry 1970



Austin 1981



39. For one set the speaker remains constant, and the words containing the target vowel are varied, and in the other, the word remains constant and the speakers vary.

40. There are, however, phonotactic constraints which limit the variety of consonants which occur in clusters. Sequences of more than two do not occur and only certain consonants occur in the sequences. The first consonant is limited to nasals, laterals, ř and rr, and the second consonant is limited to stops, peripheral nasals, and rr. Within this general framework the following combinations occur.

    The most limited class of consonants to occur in clusters is that of the intermittants.

    ř occurs preceding p, tj, and k, e.g. řp, řtj, řk. rr occurs preceding t, and following the continuants n and l, e.g. rrt, nrr, lrr.

    The other possible combinations can be categorised in the following way,

    1. Stops are preceded by their homorganic continuants, e.g. mp, nhth, nt, njtj, n̪t̪, ŋk, lhth, lt, ljtj, l̪t̪.
    2. Apical continuants precede extremity stops, e.g. lp, lk, np, nk, l̪p̪, l̪k̪, n̪p̪, n̪k̪.
    3. Alveolar nasal precedes peripheral nasals, e.g. nm, nŋ.
    4. Palatal lateral precedes retroflexed stop, e.g. ljk.

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