AN ACOUSTIC ANALYSIS OF GERMINATION IN ESKIMO AND FRENCH: A SPECTROGRAPHIC STUDY OF THE EFFECTS ON VOWELS OF SELECTED CONSONANT AND VOWEL FEATURES IN LABRADOR ESKIMO AND ST. PIERRE FRENCH

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AN ACOUSTIC ANALYSIS OF GEMINATION IN ESKIMO AND FRENCH: A Spectrographic Study of the Effects on Vowels of Selected Consonant and Vowel Features in Labrador Eskimo and St. Pierre French.

A Thesis

Presented to

The Department of Linguistics

Memorial University of Newfoundland

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

André Lafargue

July 1974

ABSTRACT

The aim of this thesis is to investigate the extent to which surface phonetic contrasts are actually present in the acoustic stage of the speech chain, and to define the acoustic nature of such contrasts. This is mainly a spectrographic study of the three "extreme" vowels, (/i/, /a/ and /u/) to determine some of the acoustic effects on vowels of vowel and consonant gemination in two unrelated languages, Eskimo (Labrador Inuttut) and French (St. Pierre et Miquelon dialect). The phonological status of vowel and consonant gemination in French is quite different from their status in Eskimo. In French these processes occur across word boundaries, whereas in Eskimo they are word internal.

Minimal pairs in sequences of the types CVC, CVVC, CVCC, and CVVCC were recorded by two informants (one of each sex) for each dialect. The various displays available from a modified Kay Sonagraph provided the relevant data on vowel quantity and quality.

The main conclusions concerning vowel quantity are as follows:

(a) The vowels in the above four types of sequences are not always different in absolute duration but they always contrast in relative duration (i.e., as fractions of the duration of the total sequence).

(b) The gemination of a following consonant is found to have a more reducing effect on the duration of a preceding vowel in Eskimo (a language which has gemination within word boundaries) than in French (a language which has gemination across word boundaries).

(c) Gemination of a following consonant is found to have a greater effect on the duration of a preceding single vowel than on a preceding double vowel.

The concepts of co-articulation effects and language-specific neutral tongue positions provided bases for tentative explanations for some of variations in duration.

Measurements of formant frequencies and intensities suggested the following generalizations about vowel quality:

(a) Whereas all three single vowels in Eskimo are more mid-central than their corresponding double correlates, this is not true for the French high-back vowel.

(b) The effect on its quality of the doubling of a vowel is greater than the effect of the gemination of the following consonant.

(c) Formant intensities provide more consistent cues than do formant frequencies for the single/double vowel distinction.

The final conclusion of this research is that vowel doubling has a greater effect on both vowel quantity and

quality in both languages than has the gemination of the following consonant.

ACKNOWLEDGEMENTS

I would like to express my feelings of gratitude and appreciation to the many people who have provided assistance and much appreciated advice during the preparation of this thesis. I am very thankful to my informants: Miss Rose Pamack, Miss Marie Christine Briand, Mr. Sam Metcalfe and Mr. Marcel Reux for their time and patience in their digging for and recording of the minimal pairs, to "Ted" Dawe for his continuous interest in keeping the T-Kay Sonograph in Al condition and making the necessary modifications, to Memorial University of Newfoundland for its financial support in the form of a Fellowship, to Larry Smith for his advice, to the typists at Technical Typing for a fine and fast job.

I would like to make special mention of the great moral support I received from my parents and Daphne.

And last, but not least, a very special "Thanks" to my thesis supervisor Dr. Harold Paddock whose assistence, guidance and continuous attention stimulated my research "spirit" and contributed to the production of this paper. A French proverb illustrates my thoughts: "On récolte ce qu'on a semé"; he planted the seed, I hope the crop is good.

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1 SOME THEORETICAL BACKGROUND

1.1 Introductory Comments

The aim of this chapter is to provide some theoretical background for a spectrographic study of vowels in Eskimo and French. It attempts to deal with such concepts as phonemes and their distinctive features, and how these are manifested at the various stages of the speech chain (particularly the acoustic stage). It also tries to distinguish "deep" from "surface" phonology.

1.2 Structural Phonology

Originally the phoneme was defined in psychologistic terms. J. Beaudouin de Courtenay and his school defined the phoneme as the "psychological equivalent of the speech sound". (de Courtenay, 1895:152). The main argument against this definition was presented by Trubetzkoy of the Cercle Linguistique de Prague in his book Principles of Phonology (Grundzüge der Phonologie). Trubetzkoy (1939:37-38), in discussing de Courtenay's views, says that:

> Several speech sounds can correspond to the same phoneme, each such sound having its own psychic equivalent, namely acoustic and motor image corresponding to it. . . . This definition is based on the assumption that the speech sound itself is a concrete positive given entity. . . . The speech sound can only be defined in terms of its relation to the phoneme. But if in the definition of

> the phoneme one proceeds from the speech sound, one is caught in a vicious circle.

Trubetskoy himself (1939:35-36) defined phonemes as follows:

> Phonological units that, from the standpoint of a given language can not be analysed into smaller successive units. . . . The phonemes are then the distinctive marks of the configurations of words. . . . One can say that each word can be completely analysed into phonemes, that it consists of phonemes in the same way as a tune composed in major scale, although each tune will contain something that makes it a specific musical configuration. . . . One can say that the phoneme is the sum of the phonologically relevant properties of a sound.

With Trubetzkoy and Jakobson, both of the Prague School, started a new tendency toward purely linguistic abstractions (such as the phoneme) which could be defined without reference to other sciences, for example, psychology.

In America, Twadell (1935) reviewed a number of attempted definitions of the phoneme and suggested a highly abstract of his own. Two of the definitions reviewed by Twadell (1935:65) were the ones given by Jones and Bloomfield who both consider the phoneme as a physical reality but who seem to have opposed views of that reality.

> It appears that Jones's task in determining a phoneme is in a way the converse of Bloomfield's. Whereas Bloomfield has to determine some common characteristics (acoustic) fraction which makes all members of the group. Jones has to determine the hiatus of organo-genetic similarity which sets of all members of the group as distinguished from the members of all groups.

Not only does Twadell criticize those who look at the phoneme as a physical reality but he also criticizes those who consider the phoneme as a mental or psychological reality.

He disagrees with the idea of the phoneme as a mental reality because, as a definition, it does not meet the requirement of methodological feasibility within the framework of linguistic study for it is inaccessible to scientific method. Twadell (1935:57) in discussing the principles which invalidate the 'mental' definition of a phoneme, raises two objections:

> 1) We have no right to guess about the linguistic workings of an inaccessible 'mind'.
>
> 2) We can secure no advantage from such guesses.
>
> The linguistic process of the mind as such are quite simply unobservable.

In saying this, Twadell (1935:57) disagrees with Sapir (1933) who gives in his articles "The Psychological Reality of Phonemes", arguments for justifying the 'ascription of reality to mental sounds and sound patterns". Twadell (1935:58) claims that in all his examples "Sapir is obligated to present negative evidence of the real mental existence of the phoneme, that is, the constant failure of his subjects to record differently sounds which are objectively different". Twadell (1935:50) also states that many people give definitions of the phoneme as both "a mental and physical reality". He says that, for example, (1935:59) Jesperson at the Copenhagen Conference defined a phoneme as

> a family of sounds which form an objective point of view may be regarded as distinct but which are felt naturally by the speakers of a certain language as being identical, because they are not used to keep words apart.

According to Twadell (1935:67), "all attempts to

associate the term phoneme with either a mental or a physical reality appear open to serious if not unanswerable objections." He therefore proposes (1935:67) a new interpretation of the phoneme as a "fictitious unit". According to him (1935:67) there are two advantages of such a definition:

1) We could use the phoneme as a terminological convenience just as well as present,
2) We should not have to use as legal currency in out study the promissory notes of the laboratory, which are liable to a heavy discount.

After listing definitions proposed by others, Twadell (1935:74) illustrates his own interpretation of the phoneme with this example:

> The micro-phoneme which is correlated to pill belongs with the micro-phoneme which is correlated to nap. . . . The P- phoneme is therefore the sum of all those phonological differentiae which correspond to a bilabial, voiceless, stop. Thus we can combine the stops of pill, nap, tapper. . . . When we speak of a phoneme we are using an abstraction as a terminological differentiation among the elements of language. . . . A phoneme does not occur, it exists.

This kind of definition did not appeal strongly to all other linguists for various reasons. Such extreme abstractness did not appeal to structuralists like Martinet, for example, who held a functional view of the phoneme. Martinet outlined his views in his book La Description Phonologique (1956). For Martinet (1956:11)

> Tous ces instruments de communication que sont les langues dans le sens où les entend le linguiste, comportent deux types distincts d'unités: 1) des unités douées d'une signification et d'une forme phonique, 2) des unités distinctives qui ont une forme phonique mais pas de signification en elles-mêmes.

Martinet talks about two "articulations du langage humain". One point must be made here concerning Martinet's terms. He does not mean "articulation" in the English physiological sense of the word, but rather the two distinctive levels of sequential units. The diagram below illustrates his point:

e.g., MAL

Première articulation : meaningful units (= Morphemes)

MAL being the meaningful unit which translates into such meaningful English units as badly, or ill.

---

e.g., /M/+/A/+/L/

Deuxième articulation: meaningless units (= Phonemes)

/M/, /A/ and /L/ being the distinctive units (= Phonemes) which serve to keep French morphemes phonologically separate but which in themselves are meaningless.

MAL belongs to the "first articulation" because it has a meaning but MAL is analysed into three distinctive sequential units, /M/, /A/ and /L/ which have a spoken form but are meaningless in themselves.

Martinet's views are summarized below (1956:13, 39-40)

> En français, les seules unités distinctives sont les phonèmes, c'est à dire les segments résultant de la seconde articulation. . . . On nomme trait distinctif ou pertinent tout trait phonique qui permet, à lui seul, de distinguer un signe, un mot ou un énoncé d'un autre signe, mot ou énoncé: en français, la nasalité qui permet de distinguer mouche de bouche ou banc de bas est un trait pertinent. . . . Un trait pertinent peut, à l'examen phonétique, se révéler complexe: four se distingue de pour du fait de l'articulation labiodentale et fricative de /f/ s'opposant à l'articulation bilabiale et occlusive de /p/. Mais, comme en français la bilabiale est toujours

> fricative, les deux caractères non dissociables, labiodental et fricatif, forment un trait pertinent unique.

Therefore for Martinet (1956:40): "un phonème est un ensemble de traits pertinents qui se réalisent simultanement". Or, as he defines it in English in his Phonology as Functional Phonetics (1949:3): "Phonemes reveal themselves as combinations of several relevant features".

In America, the famous structuralists Bloomfield and Sapir also recognized that the phoneme could be decomposed into significant elements, but it was Jakobson who lived to develop Trubetzkoy's phonologically relative properties into a fully developed theory of distinctive features. Jakobson's features were characterized by a high degree of abstractness which emphasized a strong division between phonetics and phonology. Vacheck (1966:19) noted that this separation provoked a "hostile reaction . . . in some phonetic quarters".

To various English-speaking linguists and phoneticians, with their empirical bias, extreme abstractness did not adequately reflect phonetic realities. In the proceedings of the International Congress of Phonetic Sciences at Amsterdam (1932), England's Daniel Jones defines the phoneme as "a family of sounds in a given language which are such that no one of them ever occur in the same surroundings as any other in words". Palmer in his Principles of Romanization defines the phoneme as

> a group of sounds, consisting of an important sound of the language (i.e., the most frequently used

> members of that group) together with others which take its place in particular sound groups . . . (cited by Yuen-Ren Chao, 1934:38).

In America, other English speaking linguists also tried to stay close to the phonetic ground. Joos (1948), for example, tried to attack "the acoustico-auditory trends in the Prague School" (Paddock, 1970:27). Hockett in 1955 in his Manual of Phonology also attacked the audio-perceptual bases of Jakobson's features (see Paddock, 1970:38-44) Hockett (1955:173) retains articulatory definitions of features "as a relatively simple-minded sort of decomposition based firmly on articulation".

1.3 The Speech Chain

Twadell's article did not start a major controversy over the reality of the phoneme. Most linguists and phoneticians agreed, tacitly or otherwise, that the phoneme possesses reality, that it is as real as any other linguistic unit such as the morpheme, lexeme, sememe, or sentence. Its reality may be regarded as equivalent to that of theoretical units in other sciences, for example, of atoms and molecules in physics and chemistry.

The major controversy which did develop, centered around the question of how best to investigate or observe the nature of that reality. Here the concept of the speech chain provides us with a useful analytical tool (see Fry, 1956, or Denes and Pinson, 1963).

One might assume that the best correlates for the phoneme (or for its distinctive features) are to be found in the linguistic knowledge stored in the brain of the speaker hearer. But the development of the relevant sciences does not enable us to investigate such knowledge very directly despite experiments of the type carried out by Penfield (see Penfield and Roberts, 1959).

However, attention is naturally focused on the stages of the speech chain which are closest to that knowledge: the perceptual (or auditory) stage which forms a supposed direct input to the linguistic stage, and the neutral commands (articulatory) stage which forms a supposed direct output from the linguistic stage. This has led to two main theories of speech perception, that is, the auditory and the motor theories.

Jakobson, Fant, and Halle in their Preliminaries to Speech Analysis (1952:12-13) declared strongly in favour of the auditory theory:

> Each of the consecutive stages, from articulation to perception, may be predicted from the preceding stage. Since with each subsequent stage the selectivity increases, this predictability is irreversible and some variables of any antecedent stage are irrelevant for the subsequent stage. The exact measurement of the vocal tract permits the calculation of the sound wave, but the same acoustical phenomena may be obtained by altogether different means. Similarly, any given attribute of the auditory sensation may be the result of different physical variables so that there is no one-to-one relation between the dimensions of the acoustical stimulus and the auditory attribute. The former cannot be predicted from the latter, but the totality of the dimensions of the stimulus renders

> the attribute predictable. . . .
>
> To sum up, the specifications of the phoneme oppositions may be made in respect to any stage of the speech event from articulation to perception and decoding, on the sole condition that the variables of any antecedent stage be selected and correlated in terms of the subsequent stage, given the evident fact that we speak to be heard in order to be understood.

They defend their inclusion of acoustic (i.e. spectrographic) data because the acoustic stage forms the input to the auditory stage, therefore brings one a step closer to perception than does the articulatory stage.

However, some experimentalists have noted that articulatory facts sometimes correspond more closely to perceptual realities than do the acoustic parameters. As early as 1957, Alvin M. Liberman made the following statement:

> The occasional complexity of the relation between articulation and the resulting sound wave is, for the most part a nuisance, but it does provide us with a rare opportunity to ask this interesting question: When articulation and sound wave go their separate ways, which way does the perception go? The answer so far is clear. The perception always goes with articulation. (Liberman 1957:149).

The reader is referred to the second half of Philip Lieberman's Speech Acoustics and Perception (1972) for a more detailed exposition of this motor theory.

We may note that in their Sound Pattern of English (1968), Chomsky and Halle provide only articulatory correlates for their revised features, and that they abandon such very abstract Jakobsonian features as Compact/Diffuse in favor of a greater number of new features whose phonetic correlates are easier to define.

1.4 Generative Phonology

All the above controversy can be called "family quarrels" within the broad linguistic school called structuralism. When Chomsky applied his generative methods to phonology, the whole question of empirical reality had to be reformulated. Chomsky's ordered rules often weakened the link between observable phonetic reality and underlying phonological entities. These rules also obviated much of the criticism which had been levelled at the abstractness of Jakobson's distinctive features, and at the principle of strict binarity of features, by removing them to a deeper phonological level where no direct observation was possible.

If one accepts his model of speech perception one must say that the experimental phonetician observes only certain features of (surface) phonetic contrasts. Chomsky and Halle warn us that phonetic details which we associate with various phonemes can be perceived by the hearer who 'expects' them even when they are not actually present in the acoustic signal. For example, when discussing the stress contours of English they state that (1968:25)

> There is no evidence from experimental phonetics to suggest that these contours are actually present as physical properties of utterances in anything like the detail with which they are perceived.

Chomsky and Halle (1968:24) summarize their own theory of perception as follows:

> We might suppose, on the basis of what has been suggested so far, that a correct description of

> perceptual processes would be something like this: the hearer makes use of certain cues and certain expectations to determine the syntactic structure and semantic content of an utterance. Given a hypothesis as to its syntactic structure--in particular its surface structure--he uses the phonological principles that he controls to determine the phonetic shape. The hypothesis will then be accepted if it is not too radically at variance with the acoustic material, where the range of permitted discrepancy may vary widely with conditions and many individual factors. Given acceptance of such a hypothesis, what the hearer 'hears' is what is internally generated by the rules. That is, he will 'hear' the phonetic shape determined by the postulated syntactic structure and the internalized rules.

One of the aims of this thesis is to investigate the extent to which certain surface phonetic contrasts are actually present in the acoustic stage and to define the acoustic nature of such contrasts. This thesis is mainly a spectrographic study of vowels to determine some of the acoustic effects of vowel and consonant gemination.[1]

1.5 Some Phonological Notes on Eskimo and French

It was decided to examine two unrelated languages: Eskimo and French. It seems to me very interesting to use French since I am myself a native speaker of this language and since two informants from my own dialect were available and willing to help me. The dialect observed is the dialect

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[1] To avoid possible confusion hereunder, vowel gemination will be referred to as doubling, consonant gemination will be called gemination.

of St. Pierre, capital of the archipelago of St. Pierre et Miquelon, last French possession in North America and situated at about twelve miles off the South coast of Newfoundland (see Rannie, 1963). The St. Pierre dialect has strongly resisted influences from the English which "surrounds" it; except for a few borrowed English words (see Park, 1972), it remains very close to the so-called "Standard French" because of constant contact with France through education, administration, radio, television, etc.

The other language which is used in this study is Eskimo, particularly the type called Labrador Inuttut as represented by the dialects of Nain and Hebron. Two informants were at hand in the Linguistics Department to help me in my research.[1]

The phonological status of (consonant) gemination and (vowel) doubling in French is quite different from their status in Eskimo. In French these processes occur mainly across word boundaries, whereas in Eskimo they are word internal.

Example:	French	Eskimo	
	Pie ici	Piisi	(Peas)
	un cap pas beau	Nukappiak	(Child)

Each language has been studied by linguists of

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[1]The reader is referred to Section 2.2 for more details about the informants.

different schools, but I am not aware of any generative description of Eskimo phonology which approaches the broad scope of Shane's French Phonology and Morphology (1968). Generative phonology is a relatively new development and attempt at comprehensive generative phonologies have usually been concerned with better known languages such as Russian, English and French.

As a matter of fact I am aware of only one generative transformational approach to the Eskimo language. This study is now being carried out in the Department of Linguistics at Memorial University of Newfoundland by L. R. Smith, but his results have not yet been made public.

In structuralist approaches to the study of the Eskimo language, the issue of "vowel length" is a problem which still remains unsolved. Different linguists have considered this issue and the next few pages glance at a few considerations of this vowel length problem in both languages.

L. R. Smith (1974) a linguist at Memorial University, doing research on Labrador Inuttut, considers three vowel phonemes /i/, /a/, and /u/ and says that in surface output "the longest vowel or consonant cluster is a sequence of two. The three vowels can be doubled or paired", to yield a total of three short and nine long syllable nuclei as follows:

Short	i	a	u

Long	ii	ai	ui
	ia	aa	ua
	iu	au	uu

Smith (1974) also states that: "although a morphophonemic distinction between long and double vowels is likely to be desirable, there is no surface contrast".

Smith also notices a "difference in quality between long and short vowels, due to an additional time required to reach the articulatory target", and gives the following phonetic descriptions of steady vowels in Eskimo:

/i/ =	[i, lax]	/ii/ =	[i:, tense]
/u/ =	[u, lax]	/uu/ =	[u:, tense]
/a/ =	[a, lax]	/aa/ =	[a:, tense]

This gives the perceptual impression of a tense/lax distinction between long or double vowels and short or single vowels. This phonetic difference is especially noticeable for an English speaking linguist who has a tense/lax distinction in his own native language[1].

In his article "West Greenlandic Eskimo and the representation of Vowel Length", Charles Pyle (1971:115) of

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[1]Advanced/retracted tongue root has been recently proposed by Lindeau et al (1972)--as the articulatory correlate of this traditional distinction.

the University of Illinois considers the two methods

> of representing long vowels which have been used more or less indiscriminately in phonological descriptions. In some cases long vowels have been represented in a single segment marked for length and in other cases they have been represented as a sequence of identical short vowels.

Pyle (1971:143) raises the problems caused by different underlying sources for these vowels and comes to the conclusion that:

> there are no vowels which are longer than two mora on the surface, although there are several types of cases where one would expect to find three mora long vowels. . . . A sequence of three identical vowels must therefore be shortened to only two. . . . The question of how to represent vowel length is apparently very complex.

Gregg's A Student's Manual of French Pronunciation (1963) may be regarded as a typical structural (surface) analysis of French. He recognizes a maximum of sixteen surface vowel phonemes in so-called standard French which he subdivides as follows (1963:32):

A) The normal oral vowels
   Front: [i] [e] [ɛ] [a] moving from close to open
   Back: [ɑ] [ɔ] [o] [u] moving from open to close
B) The abnormal oral vowels
   [y] [ø] [œ] [ə]
C) The nasalized vowels
   [ɛ̃] [ɑ̃] [ɔ̃] [œ̃]

Gregg (p. 38) regards all the French vowels "as basically short in quantity" but recognizes lengthened allophones in certain phonetic contexts. One of these contexts, before voiced fricatives (p. 39), will be

investigated in this thesis (see section 3.6 below). My two French informants have no front/back contrast in the fully open vowels. This lack of an a/ɑ distinction supports Gregg's statement (p. 34) that "with the majority of the younger generation, however, this opposition is not observed". Both my informants were in their late teens. In fact, this neutralization is general in the St. Pierre dialect of French. However, the degree of frontness/backness of the single open vowel phoneme is an idiolectal feature in St. Pierre. My male informant consistently uses more retracted allophones of this phoneme, whereas the female informant has more fronted allophones.

In discussing French consonants Gregg also mentions (p. 61) the fact that:

> the double consonant may be pronounced double in a great many learned words especially those borrowed from or through Latin, e.g., inné [in-ne] illégal [il-le-gal].

As a native speaker of French (St. Pierre dialect) I can say that this distinction is not applicable to the dialect studied in this thesis, and that the only case where consonant gemination occurs in this dialect is across word boundaries.

The linguist who first provided a major generative analysis of French is Sandford A. Schane who published his French Phonology and Morphology in 1968. Schane stated in his Introduction the aim of his analysis:

> Within a phonological and morphological description of French we want to be able to account for the

phonological alternations that take place in morphologically related forms.

Schane (1968:64) proposes a seven-vowel system for underlying representations.

> Each of the seven vowels may be tense or lax, which is equivalent to recognizing a total of fourteen distinctive vowel segments. The feature 'tense' is not simply an arbitrary marker for distinguishing two types of vowels. We have chosen this particular feature--and not some other one--since, ultimately, at the phonetic level we will have to state whether the vowels are tense or lax. In most instances, the underlying specification of tenseness corresponds to that of the derived vowel: underlying atonic lax vowels become lax schwa if they are not deleted; tonic or pretonic tense vowels remain tense.

Schane's underlying tense vowels are capitalized:

I, E, Ɛ, A, Ɔ, O, U.

His underlying lax vowels are represented by the lower case letters:

i, e, ɛ, a, ɔ, o, u,

in contrast to the surface vowel system, as in orthoepic French, of

/i e ɛ a ɑ o u y ø œ ə ɛ̃ ɑ̃ ɔ̃ œ̃/.[1]

For Schane (1968:54) the underlying vowels are "basically short in length".

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[1] Parallel diagonal lines / /, are used by Schane to represent a broad phonetic transcription, which is equivalent to the phonetic transcription established for orthoepic French, also the sign # between segments denotes a word boundary. Schane's sign convention will be used in this thesis also sometimes the sign [ ], will represent the phonetic representation as referred to the I.P.A. system.

If one considers the corpus used for French (see Appendix II) in this experiment, in the light of Schane's tense/lax distinction, one may question the reliability of the data by asking (a) if the vowels used in the study are tense or lax and (b) if that distinction could possibly affect the results.

Such a distinctive feature for French vowels is novel and controversial. D. C. Walker in a recent paper presented at the meetings of the Canadian Linguistics Association in May, 1974, in Toronto, criticizes Schane's findings and produces a new rule for stress. This new rule regularizes the cases of French Phonology and Morphology which require the special laxing rule.

> They no longer necessitate, that is, a boundary or abstract tense/lax underlying distinction in order to be stressed on the proper syllable. Pretonic syllables that acted like tonic ones in that they contained fronted or diphthongized vowels will be represented with the surface segments in underlying forms and will no longer require ad hoc extensions to the phonology either. (Walker, 1974:17-18).

Since this tense/lax distinction and the rules which utilize it are so controversial, I decided not to take them into account in the empirical part of this thesis. My spectrographic measurements will deal only with selected surface contrasts in French without regard to the "rules" which may have generated such surface contrasts.

1.6 The Focus of this Thesis

This thesis will be observing the acoustic stage of the Speech Chain. It is the stage which yields the most easily quantifiable parameters. We will be dealing with the manifestation of language on which a physical sound wave travels from the mouth of the speaker to the ear of the listener. Because of modern developments in electrical engineering, the acoustic stage of the speech chain is more easily accessible to us than any other stage. It is also more reliable in the sense that observations at any other stage are likely to have a greater effect on the human subject and so bias the experimenter's results. Added to these facts is the universal presence of sound in human language which "is obviously a process where by one person transmits his thoughts by means of an acoustic signal" (Liberman, 1972:31).

It is possible to observe and measure several different acoustic parameters on a Sona-Graph Sound Analyser (sound-spectrograph).[1]

In order to carry out a useful investigation of the acoustic parameters one important fact must be kept in mind

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[1]For more information concerning the sound spectrograph the reader is referred to Koenig, W., H. K. Dunn, and L. Y. Lacy, (1946) or Denes and Pinson, (1969:119) and section 2.3 of this thesis for a description of the modification made on the spectrograph used for these experiments.

concerning the different stages of the speech chain.

> It is generally recognized that there is no one-to-one correlation between the phemomena at the various stages of the speech event. Not all movement of the speech organs have an acoustic effect, not all features of the sound wave are perceived. The same acoustic effect may be due to different acoustic stimuli. A change in two different elements at one stage may combine to produce a change in one element at the subsequent stage etc. . . . (Fischer-Jørgensen, 1958:134).

D. B. Fry in his article "Perception and Recognition in Speech" (1956:171) suggests that "there are four (dimensions) which appear to be basic in auditory perception--quality, pitch, loudness and length". According to Paddock (1970:45) "it would be very convenient if these four dimensions on the psychological side could be shown to have a one-to-one correspondence with four physical dimensions", but Fry (1956: 171) indicates that this has not been shown:

> Although each of the four psychological dimensions has its principle counterpart in the physical world--pitch: frequency; loudness: intensity; length: duration; and quality: frequency complex--each one may also be influenced by changes in any of the physical dimensions. Thus loudness is also dependent on frequency, quality and intensity and so on, and hence there is inevitably a very complex relationship between the stimulus and the four-dimentional pattern to which it gives rise.

Observations made on the acoustic stage of the speech chain may sometimes be correlated with some manifestations at the auditory stage. Therefore it will be sometimes useful to refer to the above perceptual parameters. Attempts will also be made to relate my acoustic observations to possible articulatory sources. We may in this way throw a little light on

some of the connections between three stages of the speech chain in Eskimo and French.

CHAPTER 2--INTRODUCTION TO ANALYSIS

2.1 Selection of a Corpus

2.2 Choice of Informants

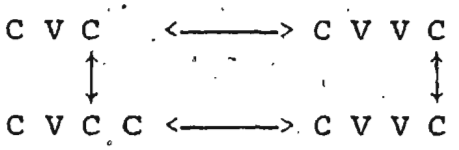
2.3 Apparatus

2.4 Recording and Processing Methods

2 INTRODUCTION TO ANALYSIS

2.1 Selection of a Corpus

Word lists were established to yield minimal pairs in which different variables would appear in two different places in sequences. The basic minimal pairs sought were as follows.



where one varies two different factors, that is, vowel length going from left to right and consonant gemination going from top to bottom in the above diagram.

Each of the "extreme" vowels /i/ & /a/ & /u/ was used and consonants were varied so that the influence of different environments on the vowels could be investigated. In Eskimo the task of finding such minimal pairs was relatively easy since it is a language which has vowel length or vowel gemination as a phonemic distinction, which some linguists might be tempted to call a tense/lax distinction.
Example: /Pinik/ "insole" Vs /Piinik/ "negativeness".
Eskimo has also consonant gemination as a phonemic distinction.
Example: /Panik/ "daughter" Vs /Pannik/ "dry tree".
This was not the case for French, and utterances with word boundaries had to be found in order to obtain such contexts.

The sentences or utterances chosen for French were colloquial or even slangy so that the informants might be encouraged to pronounce them more easily and naturally and the required gemination occurs more often in such speech. A list of the minimal pairs used for both languages is given in Appendix II.

2.2 Choice of Informants

It was decided to use two informants for each language, and since it was possible to find informants of both sexes the experiments were conducted with one male and one female informant for both Eskimo and French. For Eskimo the informants were Mr. Sam Melcalfe, who is presently working closely with the Linguistics Department of Memorial University by helping in research projects and teaching the conversation class of Labrador Inuttut, and Miss Rose Pamak, a future graduate student in Linguistics at the same university.

Mr. Sam Melcalfe was born in 1939, in Hebron, Labrador, and he has spent most of his life in Labrador. His mother is Eskimo and his father is part English, part Eskimo. The language spoken at home was Eskimo. At the age of eight, Sam moved to an orphanage, where he started learning English. He has been speaking both languages very fluently since about age ten. He has held a variety of jobs in different parts of Labrador and has often served as an interpreter.

Miss Rose Pamak was born in 1947 in Nain, Labrador. She has spent most of her life in Labrador. She started learning the English language when she was six years old. Both her parents are bilingual but the language spoken at home is Eskimo. Her dialect is the one spoken around Nain. Her father learnt English before he learnt Eskimo as he was an orphan adopted by an English settler family. Her mother speaks also the Indian Language Naskapi and Rose understands it but does not speak it fluently. She is studying French at this university and speaks French with a slight English accent.

For French the informants were Mr. Marcel Reux, presently a third year student at Memorial and Miss Marie Christine Briand, a first year student.

Mr. Marcel Reux was born in 1954 in St. Pierre where he spent most of his life. He came to Newfoundland in September, 1973, after obtaining his "Baccalauréat de l'Enseignement Secondaire" série A in May 1973 from the Lycée de St. Pierre. He speaks English fluently as well as Spanish, and he is presently studying German. His mother is Principal of "L'Ecole Publique Primaire de Jeunes Filles" in St. Pierre. His father is Chief Harbour Pilot of St. Pierre. Both of his parents were born on the island and speak standart St. Pierrais, also both of them speak a correct English, but the common language used in their home is French.

Miss Christine Briand was born in 1957 in St. Pierre where she obtained her B.E.P.C. (Junior matriculation) in 1973. She came to St. John's in September, 1973, and audited some classes at Holy Heart of Mary High School in order to improve her English. Her father owns a bookstore in St. Pierre and both her parents were born on the Island and speak standart St. Pierrais.

2.3 Apparatus

The recordings were made in an anechoic room, using an Ampex AG 600 tape recorder with optimal frequency response of 50 Hz. to 7.5KHz. at a recording speed of 3 3/4 i.p.s., and low noise Scotch recording tape. The microphone used was a Uni-dyne with a flat frequency response of 50Hz. to 10KHz.

The tapes were played back on a Wollensak tape recorder model 1520 at a speed of 3 3/4 i.p.s. This tape recorder was connected to a T-Kay Sonograph 6061B equipped with a scale magnifier and Amplitude display unit, type 6076C. The Sonograph was modified according to the plans graciously provided by Dr. Peter Ladefoged (1972:78). ". . . a switch and resistors were added which enable the base line to be raised about 1 3/4", i.e., to a point about half way up the paper. Using this switch it is possible to make two spectrograms, one above the other". Thus an expanded scale display could be obtained on the bottom part of the

sheet for measurements between OHz. and 2KHz., and a "compressed" scale display could be obtained on the top part of the sheet for measurements between OHz. and 6KHz. The settings of the machine were as follows:

(a) For normal spectrograms:

- Mark level setting .8
- AGC level setting 1
- Hs switch "on"
- Frequency switch on "Lin".
- Wide band filter "on".

(b) For sections:

- Mark level setting 4.5
- AGC level 1.
- Hs switch "on".
- Narrow band filter "on".

Expanded scale sections were made using the scale magnifier and setting the upper limit at 4KHz..

2.4 Recording and Processing Methods

Each word or sentences, (Cf. Appendix II), was presented in writing at random to each informant, who was asked to pronounce them at a natural conversational speed, at a distance of approximately 15 inches from the microphone. The informants were asked to repeat each item three times. The recordings of each informant were all made using the same apparatus. The recording of the utterances were then

processed on a sound spectrograph modified as described above in section 2.3, and spectrograms were made using two different scales (i.e., OHz. to 2KHz. and OHz. to 6KHz.). Examples of such displays are given in Appendix III.

Sections were made of the sequences of the type t (V) V (t) t in each language. First "normal sections" were made using a normal (three-dimensional) display between OHz. and 4KHz. on the lower half of the sheet; then an ordinary section was made on the upper half of the sheet.

The same sections were reproduced on another sheet using the scale magnifier, so that a display of the section from OHz. to 4KHz. was obtained on the full width of the paper. This enabled us to obtain more accurate readings of frequency. Example of sections are given in Appendix IV.

3 QUANTITY MEASUREMENTS

3 QUANTITY MEASUREMENTS

3.1 Methods of Measurements

It was decided to work with the computed ratios of the duration of the vowels to the duration of the CV(V)C(C) sequences to which they belong, rather than to work with absolute durations of vowels. This was done in an attempt to compensate for the lack of control of the rate of speech for each informant. Even though each informant was asked to keep a steady conversational speed, it was impossible to control accurately the rate of his speech. The results of work in experimental phonetics also support the idea that the whole spectrum of a sequence plays an important part in perception (see, for example Fischer-Jørgensen, 1958:136-137). One assumes therefore that the changes in tempo affect the durations of all the segments and a study of absolute vowel duration would be less revealing than the type of ratio mentioned above.

The readings of time were made from each spectrographic display produced as described in section 2.4. Those readings were made using a transparent "template" on which each division equalled one centisecond (= 10 milliseconds) Duration measurements of sequences and vowels were interpolated to the nearest centisecond.

The sequence measurements were made as follows:

- For voiceless stop sequences, for example pVp, the measurements were taken from the burst of the initial stop to the burst of the second stop. The aspiration following the last stop was not included in the measured duration.

- For nasal and fricative sequences, for example, pVn and pVs, the measurements were taken from the burst of the initial voiceless stop to the end of the nasal or fricative consonant. A vowel always followed the nasal or fricative in all the sequences in such a way that the limit between the consonant and the vowel was clearly visible. See Appendix III for examples of spectrographic displays of nasal and fricative sequences. (Compare Peterson and Lehiste, 1960.)

The vowel duration measurements were made as follows: It was arbitrarily decided that the duration of a vowel would be measured from the limit existing between the aspiration of the initial voiceless stop and the following vowel, to the moment in time where the intensity of the vowel fell most rapidly towards the intensity of the following consonant (Compare Peterson and Lehiste, 1960.)

The results of duration measurements were tabulated as showed in Tables 1 to 18 in Appendix I. The reader is referred to the introduction to Appendix I for a more detailed description of the tables.

3.2 Influence of Place of Articulation of Preceding Consonant on Duration of Following Vowel

In order to find out whether or not the place of articulation of a preceding consonant has any influence on the ratio of vowel duration to sequence duration, it was decided to deal with vowels having the same final environments while varying the preceding consonants from /p/ to /t/ to /k/ in initial position.

We investigated the following pairs and attempted to make generalizations from the resulting data:

$$\left.\begin{matrix} p \\ t \\ k \end{matrix}\right\} V\ (V)t\ (t). \qquad \left.\begin{matrix} p \\ t \\ k \end{matrix}\right\} V\ (V)n\ (n);$$

The detailed results are as shown in Tables A to D.

3.2.1 In Eskimo

In examining Table A we can see that for each informant the values of the averaged ratios remain fairly constant in every case when we vary the preceding consonants.

The biggest difference in ratios is for the high front vowel /i/ with my male informant where the ratios vary from .650 for piit to .527 for tiit which is a difference of .123 .

A tentative explanation can be given for this difference that is the articulation of a sequence like piit necessitates the use of at least two different articulators

(i.e., the lips for /p/ and the tongue for /ii/) while the production of a sequence like tiit necessitates the use of closely related articulators (i.e., movement of the tongue from /t/ to /ii/ positions). It appears that the vowel to sequence ratio is bigger when two different articulators are used to pronounce the sequence, than when a rather small movement of the tongue itself is involved.

In examining Table B we find that no big or consistent difference can be noticed when sequences contain final nasals and in general vowels do not seem to be influenced by the place of articulation of the preceding consonant.

The greatest difference found within the same CV(V)C(C) type of sequence is the .135 difference between pun (.398) and kun (.263). Here again the coarticulation theory as described by Sven Öhman, (1966 & 1967) may explain the observed facts. The basic articulation for the /u/ vowel in Eskimo is velar (the labial movement is secondary and perhaps optional) and this velar vowel gesture is very like that required for /k/

3.2.2 In French

A look at French (Table C) reveals little or no influence of the place of articulation of the preceding consonant on the duration of a following vowel. Although the differences which occurs between the ratios are in general bigger than for Eskimo, the only big difference

which exists between these ratios is for the sequence tuut, where for the male informant we get an exceptionally high ratio of .750 as compared with .529 and .530 for puut and kuut respectively.

Two tentative explanations can be given here.

(1) Perhaps the informant for some reason pronounced the tuut sequence in a tempo which altered the ratio of vowel to sequence.

(2) Again we might attribute the difference to coarticulation effects (see Öhman 1966 & 1967). Note that the labial consonant /p/ and the velar consonant /k/ have a shorter labio-velar vowel /uu/ following them than does the apical consonant /t/. Also no big difference was observed in the ratios where final nasals were used.

We can reasonably conclude that in Eskimo, as in French, the place of Articulation of a Preceding Consonant does not significantly influence the values of the ratio of the duration of the vowel V to the duration of the whole CVC sequence in which it occurs. This agrees with the results of Fant (1969) and those of Peterson and Lehiste (1960). Apparent exceptions to this generalization are perhaps due to coarticulation effects. However, there does not seem to be any overall trend towards shorter vowels in the case of homorganic articulation versus longer vowels in the case of heterorganic articulation.

TABLE A

FINAL /t/ SEQUENCES IN ESKIMO

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
pVt	.384	.327	.310	.261	.311	.313
tVt	.357	.427	.225	.288	.232	.378
kVt	.287	.268	.257	.233	.348	.344*
pVVt	.673	.576	.650	.517	.676	.521
tVVt	.668	.627	.527	.557	.645	.483
kVVt	.673	.547	.581	.512	.640	.501
pVtt	.138	.203	.101	.129	.133	.133
tVtt	.144	.231	.113	.126	.136	.201
kVtt	.190	.193	.111	.112	.105	.121
pVVtt	.351**	.400	.209	.313	.285	.368
tVVtt	.363	.419	.283	.284	.285	.352
kVVtt	.292	.365	.295	.328	.285	.361

*Value for kuk. **Value for Paapp.

TABLE B

FINAL /n/ SEQUENCES IN ESKIMO

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
pVn	.468	.392	.436	.372	.533	.398
tVn	.487	.414	.343	.346	.387	.329
kVn	.457	.357	.281	.303	.300	.263
pVnn	.131	.202	.125	.181	.203	.156
tVnn	.192	.240		.187	.160	.234
kVnn	.157	.170	.115	.131	.156	.150
pVVn	.766	.671	.605	.565	.620	.544
tVVn	.730	.678	.634	.583	.682	.560
kVVn	.744	.615	.644	.527	.711	.558
pVVnn	.381	.487	.384	.424	.366	.434
tVVnn	.411	.468	.452	.407	.409	.271
kVVnn	.379	.473	.400	.343	.333	.348

TABLE C

FINAL /t/ SEQUENCES IN FRENCH

Sequences	Low V		High Front V		High back V	
	Male	Female	Male	Female	Male	Female
pVt	.515	.477	.292	.362	.310	.323
tVt	.545	.366	.205	.385	.455	.390
kVt	.500	.403	.333		.331	.341
pVtt	.366	.354	.157	.133	.238	.184
tVtt	.333	.364	.250	.242	.164	.216
kVtt	.323	.283	.185	.133	.238	.247
pVVt	.668	.666	.500	.533	.529	
tVVt		.607	.590	.468	.750	.551
kVVt		.488	.483	.408	.530	.421
pVVtt	.561	.538	.342	.296	.487	
tVVtt	.666	.562	.381	.347	.367	.406
kVVtt	.508	.403	.298		.434	.315

TABLE D

FINAL /n/ SEQUENCES IN FRENCH

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
pVn	.498	.488	.319	.278	.232	.272
tVn	.461	.408	.292	.235	.384	
kVn	.435	.333				.142
pVnn	.267	.358	.203	.190		
tVnn	.317		.134	.165	.178	.250
kVnn	.272	.289	.148	.191		.150
pVVn	.677	.636	.579	.474	.507	.499
tVVn	.641	.616	.555	.500		
kVVn	.588	.463	.547	.385		
pVVnn	.484	.566				
tVVnn	.553					
kVVnn	.510	.516				

3.3 Influence of Place of Articulation of Following Consonants on Preceding Vowels

In order to investigate the influence of the place of articulation of the following consonant on a preceding vowel it was decided to compute the averaged values of the ratios of vowels to sequence (regardless of the initial consonant) in sequences of the type

$$T\ V\ (V)\begin{cases} p\ (p) \\ t\ (t) \\ k\ (k) \end{cases}$$

for example,

$$\text{Averaged TVp ratio} = \frac{\Sigma \text{tVp ratio} + \Sigma \text{pVp ratio} + \Sigma \text{kVp ratio}}{\text{total number of ratios.}}$$

The results are given in Tables E and F for both languages.

3.3.1 In Eskimo

The only consistent difference which can be seen in this table is the difference which exists between the ratios of vowels to sequences for the sequences Tu(u)t(t) on the one hand and the sequences Tu(u)k(k) on the other.

We can see that in most cases the ratios of vowel to sequences are significantly larger for the Tu(u)t(t) sequences than for the Tu(u)k(k) sequences. This is particularly true for the cases where the vowels are doubled.

TABLE E

FINAL VOICELESS STOP SEQUENCES IN ESKIMO

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVp	.309	.336	.294	.250	.287	.293
TVt	.335	.339	.295	.269	.310	.335
TVk	.319	.373	.245	.274	.329	.296
TVpp	.156	.160	.134	.105	.110	.126
TVtt	.156	.208	.115	.127	.127	.147
TVkk	.172	.232	.139	.116	.126	.143
TVVp	.621	.543	.579	.482	.568	.486
TVVt	.671	.594	.567	.515	.655	.505
TVVk	.635	.589	.539	.541	.572	.471
TVVpp	.332	.368	.257	.274	.262	.294
TVVtt	.327	.397	.252	.321	.285	.360
TVVkk	.355	.417	.289	.311	.200	.255

TABLE F

FINAL VOICELESS STOP SEQUENCES IN FRENCH

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVp	.392	.388	.318	.343	.280	.307
TVt	.520	.415	.276	.373	.365	.351
TVk	.495	.389	.330	.336	.348	.358
TVpp	.316	.246	.167	.202	.177	.197
TVtt	.340	.333	.197	.169	.213	.215
TVkk	.356	.351	.154	.203	.172	.192
TVVp	.592	.559	.575	.458	.459	.452
TVVt	.668	.587	.524	.469	.603	.486
TVVk	.591	.600	.481	.455	.532	.568
TVVpp	.485					
TVVtt	.578	.501	.340	.321	.429	.360
TVVkk	.473	.478	.442	.572	.360	.467

Examples

Female informant Tuutt = .360 Vs. Tuukk = .255

Male informant Tuutt = .285 Vs Tuukk = .200

Female informant Tuut = .505 Tuuk = .471

Male informant Tuut = .655 Tuuk = .572

It is also noticeable that in most of the cases the values of the ratios for sequences of the type TV(V)p(p) are smaller than the ratios for sequences of the type TV(V)t(t). This difference can be explained in terms of coarticulation effects. The gestures for labial /p/ and velar /k/ involve articulatory movements already carried out for the preceding labio-velar vowel whereas apical /t/ requires completely new gestures. In the case of /k/ the required consonant gesture is already nearly completed during the vowel, for /p/ the labial rounding and/or protrusion of the vowel must be changed to labial closure, whereas for /t/ a completely new gesture must be initiated.

3.3.2 In French

The pattern which we notice in the tables for French is different than the one for Eskimo.

This time it is relevant that the ratios for the Tiitt and Tiikk sequences are quite different. The values are as follows:

Female informant Tiitt .321 Vs. Tiikk .572

Male informant Tiitt .340 Vs. Tiikk .442

A look at the other values does not reveal any particular

pattern.

3.3.3 Comparison of Eskimo and French

Such a comparison shows us that whereas in Eskimo the average discrepancy between the ratios is .045 within the same CV(V)C(C) type of sequence, (i.e., .042 Male, .047 Female), in French the average discrepancy is .074 (.081 Male, .069 Female). It can be noticed that biggest difference in ratios is observed for the following sequences:

Eskimo

Female Tuutt = .360 Vs Tuukk = .255

Male Tuutt = .285 Vs Tuukk = .200

French

Female Tiikk = .572 Vs Tiitt = .321

Male Tiikk = .442 Vs Tiitt = .340

A look at these differences in ratios tells us that, in both languages the low ratios have in common the fact that their sequences are produced using closely associated articulators whereas high ratios have in common the fact that their sequences are produced using very different articulatory movements. It seems then that in both languages the ratio of the vowel to sequence depends on the relatedness of the articulators used to produce the sequence.

A further point could be made here concerning these results. It seems then that the "neutral" positions are very different in French and Eskimo. Whereas in Eskimo

the "neutral" position occupied by the tongue at rest seems to be high back, in French it seems to be high front.[1] This would explain why the ratio time needed to pronounce "back" sequences is smaller in Eskimo than in French whereas the ratio time needed to pronounce tongue front sequences is smaller in French than it is in Eskimo.

If we compare section 3.3 and 3.4 of this thesis we can see that in general, vowel duration is influenced more by a following consonant than by the preceding consonant. This agrees with the results of Peterson & Lehiste (1960), Elert (1964), and Karlsson & Nord (1970).

3.4 Influence of Manner of Articulation of Following Consonants on Preceding Vowels

The next step taken, was to divide the raw data of Appendix I and to regroup it into different sections regardless of the place of articulation of the initial consonant.

The following types of sequences were discriminated:

sequence of the type: TV(V)T(T) - i.e., final voiceless stop sequences for both languages

" " " : TV(V)n(n) - i.e., final nasal sequences for both languages

[1] The reader is referred to Beatrice Honikman's article "Articulatory settings" (1964:78) for more details concerning this theory of "neutral positions".

sequences of the type: TV(V)s(s) - i.e., final voiceless apical fricative sequences for French only

" " " : TV(V)ŝ - i.e., final voiceless apical fricative sequences for Eskimo only

" " " : TV(V)q(q) - i.e., final voiceless dorso-velar fricative sequences for Eskimo only (/q/ = [χ])

" " " : TV(V)F(F) - i.e., averaged final voiceless fricative sequences for Eskimo only

" " " : TV(V)g(g) - i.e., final voiced velar fricative sequences for Eskimo only (/g/ = [ɣ])

" " " : TV(V)z(z) - i.e., final voiced apical fricative sequences for French only

" " " : CV(V)C(C) - i.e., general sequences for both languages

Averaged proportions of vowels to sequences were computed for each section and were tabulated in the tables G and H.

TABLE G

Averaged Proportions of Vowel to Sequence in Different Types of Sequences in Eskimo

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVT	.333	.353	.284	.265	.309	.307
TVTT	.162	.202	.123	.117	.122	.139
TVVT	.653	.581	.561	.512	.605	.485
TVVTT	.339	.396	.270	.299	.249	.304
TVn	.469	.384	.353	.345	.407	.330
TVnn	.160	.204	.120	.168	.173	.180
TVVn	.753	.661	.625	.559	.671	.554
TVVnn	.391	.473	.412	.388	.369	.351
TVs	.366	.321	.299	.220	.387	.264
TVVs	.604	.488	.590	.463	.596	.451
TVq*	.386	.284	.281	.352	.437	.405
TVqq	.171	.162	.171		.190	
TVVq			.584	.486		
TVF	.376	.302	.290	.286	.412	.334
TVFF	.171	.162	.171		.190	
TVVF	.604	.488	.587	.474	.596	.451
TVg*	.386	.455	.422	.414	.386	.418
TVVg	.171	.718	.700	.679	.596	.705
CVC	.377	.359	.327	.319	.385	.344
CVCC	.164	.189	.138	.142	.161	.159
CVVC	.663	.621	.612	.539	.617	.548
CVVCC	.365	.434	.341	.343	.309	.327

*No data was available for /p/ and /k/ initial segments so all these ratios come from /t/ initial segments.

TABLE H

Averaged Proportions of Vowel to Sequence in Different Types of Sequences in French

Sequences	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVT	.447	.403	.308	.354	.324	.337
TVTT	.342	.309	.168	.191	.181	.204
TVVT	.611	.570	.504	.457	.514	.482
TVVTT	.448	.492	.361	.434	.411	.384
TVn	.472	.424	.308	.261	.308	.175
TVnn	.286	.324	.160	.183	.178	.216
TVVn	.640	.556	.560	.453	.507	.333
TVVnn	.508	.541				
TVs	.376	.368	.301	.252	.247	.240
TVss	.323	.315	.238	.169	.163	.177
TVVs	.523	.495	.495	.382	.463	.390
TVVss	.454	.458	.384	.342	.381	
TVz*	.558		.391		.320	
TVzz	.437		.223		.201	
TVVz	.647		.500		.518	
TVVzz	.705					
CVC	.463	.398	.327	.289	.299	.250
CVCC	.347	.316	.197	.181	.180	.199
CVVC	.605	.540	.514	.430	.500	.401
CVVCC	.528	.497	.372	.388	.396	.384

*Data available for male informant only.

3.4.1 Nasals Vs. Voiceless Stops

The difference between the ratios for vowels with following nasals and the ratios for vowels with following voiceless stops were computed.

3.4.1.1 In Eskimo

The following results were obtained:

Difference of ratios	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVn - TVT	+.136	+.031	+.069	+.080	+.098	+.023
TVnn - TVTT	-.002	+.002	-.003	+.051	+.051	+.041
TVVn - TVVT	+.100	+.080	+.064	+.047	+.066	+.069
TVVnn - TVVTT	+.050	+.077	+.142	+.089	+.120	+.047

From this table the influence of nasals on the preceding vowel is quite apparent in Eskimo. The ratios for the vowels in sequences with final nasals are with only two exceptions always larger than the ratios for the vowels in sequences with final voiceless stops.

The two exceptions are for the male informant for the vowels /a/ and /i/ in front of geminated nasals, and even then the values show us that the ratios are almost equal for final nasals and final voiceless stop sequences.

Therefore one could easily conclude that following

nasals slightly lengthen the preceding vowels in Eskimo, or that vowels /a/, /i/ and /u/ (simple or double) are in general longer before nasals in Eskimo. Smith (forthcoming in IJAL) has stated that "vowels are allophonically half lengthened before nasals". Smith's statements are only "aural impressionistic and not based on spectrographic analysis".

This is a good example of a difference between acoustic duration and perceptual length. It shows us that what Smith consider perceptualy as a "half lengthened" vowel is in fact on the average only .075 (of the sequence) longer in duration.

3.4.1.2 In French

The same comparison between voiceless stops and nasal final sequences ratios were made in French and the following results were tabulated:

Difference of ratios	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVn - TVT	+.025	+.021	.000	-.093	-.016	-.162
TVnn - TVTT	-.056	+.015	-.008	-.008	-.003	-.012
TVVn - TVVT	+.029	-.014	+.152	-.004	-.007	-.049
TVVnn - TVVTT	+.060	+.049				

From the table above the influence of nasality on the preceding

vowel is not apparent in French. It seems that the ratios for the vowel /u/ to the sequences with final nasals are always smaller than the ratios for the same vowel to sequences with final voiceless stops.

The ratios for the vowel /a/ with nasals seems to be bigger than the ratios for /a/ with voiceless stop except in two instances:

1. For the male informant where the ratio for the single vowel /a/ before geminate voiceless stop was bigger than the ratio for the single vowel /a/ before geminate nasals.

2. For the female informant where the ratio for the double vowel /aa/ before single voiceless stop is bigger than the ratio for the same double vowel /aa/ before single nasal.

The ratio for the vowel /i/ to its sequence does not seem to be influenced very much by a following nasal, except for the male informant where the ratio for double vowel before single nasal is greater than that for double vowel before single stop.

3.4.1.3 Comparison of Both Languages

Comparing both languages we can see that: final nasals increases the ratio of vowel to sequence in Eskimo in every case while in French these ratios are slightly increased by nasals for the vowel /a/ only. A question may be raised here concerning the reliability of those results since the methods of duration measurements

for the final nasal segments is not strictly comparable to the method used for the voiceless stop final segments. (See section 3.1)

Since final aspiration was not counted as part of the duration of the stop-final sequences, the vowel ratios for such sequences are perhaps slightly "inflated" in relation to the vowel ratios for nasal-final sequences. This fact may affect comparisons of the effects of stops versus nasals (on preceding vowels) within the same language, but it does not affect the comparison of Eskimo and French results which clearly indicate that nasals "cause" a greater lengthening of preceding vowels in Eskimo than in French.

We may assume that this lengthening is a perceptual feature of nasalized vowels in French, but that is not a perceptual feature of oral vowels before nasals. In Eskimo, on the other hand, there is no surface contrast of oral versus nasal vowels and allophonic lengthening and nasalizations of vowels sometimes occur before nasals. This illustrates the principle that fewer phonemic distinctions permit greater allophonic variations.

3.4.2 Influence of Fricatives vs. Stops

The difference between the ratios for vowels with following voiceless fricatives and the ratios for vowels with following voiceless stops were computed.

3.4.2.1 -In Eskimo

In this language gemination of voiceless fricatives is very rare and only a small corpus was used in the investigation. The following results were obtained:

Difference of ratios	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVF - TVT	+.043	-.051	+.060	+.021	+.103	+.027
TVFF - TVTT	+.011	-.040	+.048		+.068	
TVVF - TVVT	-.049	-.093	+.026	-.038	-.009	-.034
TVVFF - TVVTT						

The results for the male informant show that apparently following voiceless fricatives increase the duration of vowels while the results are not consistent for my female informant, especially for the vowel /á/ where the ratios are consistently smaller than the ratios for the same vowel in voiceless stop environments. For the female informant, one may notice for the vowel /i/ and /u/ an increase of the ratios for TVF segments but a decrease of the ratios for TVVF segments. One might be tempted to say that in Eskimo a voiceless fricative following a single vowel lengthens this vowel, whereas a voiceless fricative following a double vowel shortens this double vowel. However, there is an insufficient quantity of data to justify any valid conclusions.

3.4.2.2 In French

For French we have the results summarized in the table below:

Difference of ratios	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVF − TVT	-.071	-.035	-.007	-.102	-.077	-.097
TVFF − TVTT	-.019	-.006	+.070	-.022	-.018	-.027
TVVF − TVVT	-.088	-.075	-.009	-.075	-.051	-.092
TVVFF − TVVTT	+.006	-.034	+.023	-.092	-.030	

In French the apparent influence of fricatives is a slight decrease in the ratio of vowel to sequence. For the vowel /u/ the voiceless fricatives decrease the ratios in every case. In the cases of single consonant following vowels we notice a decrease of the ratios for every vowel.

The cases where vowels are followed by geminate voiceless fricative consonants are not so consistent even though in general the ratios are decreased as compared to the ratios for vowels before voiceless stops. This does not agree with Delattre's statement (1965:64) that "vowels are longer before fricatives than before plosives consonants" and also with O'Connor's statement (1957:99) that

> House and Fairbanks in an experiment with spoken nonsense syllables show a significant relation between vowel duration and surrounding consonants

> as a function not only of consonant "voicing" but also of manner of articulation, since they found vowel durations to be greater when surrounded by fricatives than by stops. (House and Fairbanks 1953)

The fact that my results here are at variance with the findings of other investigators may be caused by my methods of measurements (see discussion in section 3.4.1 above) which do not make the ratios for vowels before stops strictly comparable with those for vowels before fricatives and nasals.

Comparing both languages we can see that as a rule vowels are shortened in French before voiceless fricatives while in Eskimo the results are not consistent for both informants.

3.5 Relative Length of Three Vowels in CV(V)C(C) Sequences

In Eskimo the vowel /a/ is in general longer than the vowels /i/ and /u/ as a proportion of the sequence (see table G) the only exception is for my male informant and for the vowel /u/ in the context CVC which is proportionally longer than /a/ before fricatives (voiced or voiceless). For Eskimo the general order of the vowel length seems to be /a/. /u/ and /i/ since the values of the ratios decrease in that order (see table G).

In French also the vowel /a/ is proporcionally longer than the other vowels (see table H). In this table we can see that the vowel /a/ has bigger ratios than either /i/ or

/u/. It can be observed that the vowel /a/ in both languages is as a rule longer proportionally than the vowels /i/ and /u/. This may be explained by the fact that in order to produce the vowel /a/ additional time is needed for the opening of the mouth which involves, for example, a movement of the lower jaw not needed to produce the higher vowels /i/ and /u/. This agrees with the results of Elert (1964) and Lindblom (1968).

3.6 Influence of Consonant Voicing on Preceding Vowel

3.6.1 In 'Eskimo

The influence of voicing in Eskimo was investigated by comparing voiceless fricative-fianl sequences with voiced fricative-final sequences since there are no voice contrast in Eskimo for stops. We compare the TV(V)F(F) sequences (Table G) with the TV(V)g(g) sequences (Table G). Insufficient data forced us to use the averaged values of all voiceless fricative-final sequences TV(V)F(F) instead of just the voiceless velar fricative-final sequences TV(V)q(q) which really are the voiceless equivalents of voiced-final sequences: TV(V)g(g).

To see the influence of voicing in Eskimo we computed the differences between the corresponding ratios. The results are summarized in the table below:

Effects of Voicing on Vowel Ratios

Comparison pairs	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
TVg - TVF	-.043	+.153	+.132	+.128	-.026	+.084
TVVg - TVVF	+.039	+.023	+.113	+.205	0	+.254

Since no data was available for geminate fricatives the influence of voicing on single and double vowels before single consonants only could be investigated.

It is quite obvious that in most of the cases the voicing of a consonant lengthens the preceding vowel. However one may notice the fact that in three cases. i.e., for Tag, Tug and Tuug, for the male informant it was found that the ratios of vowel to voiced fricative-final sequences were slightly smaller than or equal to the ratios of vowel to voiceless fricative-final sequences. The results for my female informant show in every case an increase of the ratio of vowel to sequence when the vowel is followed by a voiced fricative.

3.6.2 In French

To investigate the influence of voicing in French it was decided to compare also the voiceless fricative-final sequences with the voiced fricative-final ones. When the experiment was designed to do this investigation female

informant was unavailable and the experiment had to be conducted with only the male informant. The results for my male informant only are therefore displayed in the table below:

Effects of Voicing on Vowel Ratios

Comparison pairs	Low V	High front V	High back V
TVz - TVs	+ .182	+ .090	+ .073
TVzz - TVss	+ .114	- .015	+ .038
TVVz - TVVs	+ .124	+ .005	+ .055
TVVzz - TVVss	+ .251		

Except for the single case of Tiss vs. Tizz (where the vowel ratio is slightly larger before voiceless -ss), the voicing of sequence-final fricatives corresponds to an increase in vowel to sequence ratio. My results therefore support the affirmation of R. J. Gregg (1963:39) that: "all French vowels are lengthened, if they occur before final voiced fricatives, [V,z, ʒ, j, R, VR]".

A hierarchy of lengthening can be noticed in that vowel /a/ is very much lengthened, vowel /u/ is moderately lengthened in all three cases while vowel /i/ is only slightly lengthened in two cases.

3.6.3 Comparison of Effect of Voicing in Both Languages

Comparing the influence of voicing in both French and Eskimo shows that as a rule the ratio of vowel to sequence

in voiced fricative-final sequences is larger than the ratio of vowel to sequence in voiceless fricative-final sequences. Whereas the largest increase in ratio of vowel to sequence in French occurs for the sequences containing the low vowel /a/ it is found that in Eskimo the largest increase in ratio of vowel to sequence occurs for the sequences containing the high front vowel /i/.

Perhaps the different hierarchies of lengthening for the three vowels which were found in the two languages can be described in terms of the neutral position theory discussed in Section 3.3 above. Thus in French the vowel least lengthened is /i/ which is closest to the high-front (tongue) neutral position postulated for that language; whereas the vowel most lengthened is /a/ which is the most distant of the three vowels from that position. In Eskimo we note that the largest increase occurs with the only front vowel /i/ which is farthest removed from the retracted neutral position which we have postulated for that language.

3.7 Influence of Consonant Gemination on Preceding Vowel

Small summarizing tables were made so that it would be possible to observe more directly the influence of consonant gemination. The ratios

$$\frac{\text{CVCC ratio}}{\text{CVC ratio}} \quad \text{and} \quad \frac{\text{CVVCC ratio}}{\text{CVVC ratio}}$$

were obtained in different environments and tabulated (where ratio in the terms of the equation means ratio of vowel to that particular type of sequence.

3.7.1 In Eskimo

For sequences with final voiceless stops, that is: TV(V)T(T) sequences.

	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{TVTT ratios}}{\text{TVT ratios}}$	.48	.57	.43	.44	.39	.45
$\frac{\text{TVVTT ratios}}{\text{TVVT ratios}}$	.52	.68	.48	.58	.41	.62

All those ratios are smaller than one. Therefore consonant gemination following a single or double vowel in final voiceless stop sequences in Eskimo reduces the ratio of vowel to sequence.

For sequences with final nasal consonants.

	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{TVnn ratios}}{\text{TVn ratios}}$	.34	.53	.34	.48	.42	.54
$\frac{\text{TVVnn ratios}}{\text{TVVn ratios}}$	.52	.71	.66	.69	.55	.63

Here again it can be seen that all the ratios are smaller than one. Therefore nasal consonant gemination following a simple or double vowel in Eskimo reduces the ratio of vowel to sequence.

For sequences of all types.

	Low V		High Front V		High Back V	
	Male	Female	Male	Female	Male	Female
CVCC ratio / CVC ratio	.43	.52	.42	.44	.42	.46
CVVCC ratio / CVVC ratio	.55	.70	.55	.63	.50	.60

This table reveals the fact that vowels are shortened by following geminate consonants in the sense that the proportion of vowel to sequence is reduced considerably, that is, from .42 to .70 of its value before single consonants. It is also apparent that the effect of gemination on preceding single vowels is proportionally greater than on preceding double vowels.

3.7.2 In French

For sequences with final stops the following table was made:

	Low V		High Front V		High Back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{TVTT ratio}}{\text{TVT ratio}}$	.76	.76	.54	.54	.56	.60
$\frac{\text{TVVTT ratio}}{\text{TVVT ratio}}$	.73	.86	.72	.95	.80	.79

All those ratios are smaller than one. Therefore consonant gemination following a single or double vowel in final voiceless stop sequences in French shortens the ratio of vowel to sequence.

For sequences with final nasal:

	Low V		High Front V		High Back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{TVnn ratio}}{\text{TVn ratio}}$	.60	.76	.52	.70	.58	1.2
$\frac{\text{TVVnn ratio}}{\text{TVVn ratio}}$	.79	.97				

This table also reveals the fact that most of the ratios are smaller than one. Therefore in general nasal consonant gemination in French following a single vowel shortens the ratio of vowel to sequence. The only instance where the gemination of the nasal /n/ does not shorten the ration of the vowel to the sequence is for the female informant and for the sequence TUnn. Here the value 1.2 obtained on the table appears to show that gemination has a tendency to lengthen

the vowel.

This anomalous value comes from the fact that the items used to calculate the numerator are not strictly comparable to those used for the denominator. In particular, the denominator contains no value for tun which would raise the value of the averaged Tun ratio (see Section 3.4 and Appendix I, Tables 12-15-18) and lower the exceptional value 1.2 to a value probably less than one.

For sequences of all types we have:

	Low V		High Front V		High Back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{CVCC ratio}}{\text{CVC ratio}}$	.75	.79	.60	.62	.60	.80
$\frac{\text{CVVCC ratio}}{\text{CVVC ratio}}$	.87	.92	.72	.90	.82	.95

In general, in French, the ratio of vowel to sequence is reduced when vowels are followed by geminate consonants, from .60 to .95 of its value before single consonants. Therefore vowels seem reduced in length when followed by geminate consonants because they naturally involve a smaller fraction of the duration of the total sequence.

3.7.3 Comparison of Both Languages

It can be said that the ratio of vowel to sequence is reduced more in Eskimo than in French by gemination of following consonants, but that the effect is a very definite

shortening in both languages; and that in both languages the effect of gemination on preceding single vowels is proportionally greater than on preceding double vowels.

The difference between the Eskimo and French results may be related to the fact that the phonological status of gemination is not the same in both languages. In Eskimo gemination occurs internally in words, whereas it occurs only across word boundaries in my French data.

For DeLattre (1971:31) "gemination applies here to the meaningful perceptual doubling of a consonant phoneme. It occurs frequently across word boundaries . . . in French il l'aime vs. il aime. It also occurs, but less generally within word boundary . . . il serrerait vs. il serrait . . ." In this experiment all the French gemination sequences which were analysed were across word boundary (see Appendix II).

DeLattre's findings lead him to the following conclusions (1971:43-44): ". . . vowels before geminates are on the average only slightly shorter than vowels before single consonants. A rapid sampling gives the following averaged ratios: Spanish .94 to 1, English .96 to 1, French .96 to 1, German .97 to 1."

DeLattre was working with a limited number of minimal pairs and was less concerned about the effects on vowel length. He investigated mostly the differences in consonant duration between single and geminate consonants. The investigation carried out in this experiment is different in

nature from the one carried out by Delattre and also more data was used. The pairs examined had word boundaries and also morpheme boundaries. The experiments were centered on the surface output, i.e., what is really transmitted and heard without considering in detail the internal or "deep" structure of the sequences.

The Eskimo speaker uses word internal gemination and he reduces his vowels before geminates more than the French speaker who has gemination across word boundaries. Therefore we may theorize that the word boundaries involved in the French data serve to "protect" vowels from some of the potential shortening effects of following consonant gemination (see Section 1.5). Though the surface output in both languages sometimes result from similar processes (for example, deletion of consonant or vowel) these processes involve word boundaries in the French but not in the Eskimo.

3.8 Influence of Assumed Doubling of Vowel on Vowel Length

The reason for the title containing the word "assumed" is that, as a native speaker of French, I can be sure that the doubling of the vowel in French comes from an underlying double vowels but I am less sure of the status of the underlying vowels in the Eskimo language (see Section 1.5 above).

To investigate the influence of the doubling of a vowel on the vowel length, we divided the ratio of double vowel to

sequence by the ratio of single vowel to sequence.

3.8.1 In Eskimo

The following results were obtained;

	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{CVVC ratio}}{\text{CVC ratio}}$	1.76	1.73	1.87	1.69	1.60	1.59
$\frac{\text{CVVCC ratio}}{\text{CVCC ratio}}$	2.22	2.3	2.47	2.47	1.92	2.05

These figures show us that in Eskimo the doubling of a vowel does not mean that the vowel is necessarily doubled in length.

Before single consonants the ratios of vowel to sequence are on the average 1.7 larger for the double vowels than for the single vowels. The above table also shows us that before geminate consonants the ratios of vowel to sequence are on the average 2.23 larger for the double vowels than for the single vowels.

The difference which exist between those two different environments (i.e., final single consonants vs. final geminate consonants), can be explained from the results of the preceding section in which we discovered that in general geminate consonants have a bigger effect on single vowels than on double ones.

In the present case the ratios of vowel to sequence for CVCC sequences are made smaller bacause of the

proportionally greater influence of gemination on single vowels and therefore when we compute the numerical value of

$$\frac{\text{CVVCC ratio}}{\text{CVCC ratio}}$$

the shortening influence of gemination is greater on the denominator than on the numerator and we thus obtain a larger value when geminates are involved.

It can be remarked that for Eskimo the vowel /i/ seems to be the most lengthened by doubling, whereas /u/ is least lengthened. This supports the "neutral position" theory outlined in section 3.3 above. The extra lengthening of /i/ can be explained by the fact that the tongue must move from a retracted neutral position to the fronted /i/ position, remain on this target for the "intrinsic" duration of the vowel and then return to its back neutral position. This extra fronting movement is not required for either /u/ or /a/.

3.8.2 In French

We obtained the following results:

	Low V		High front V		High back V	
	Male	Female	Male	Female	Male	Female
$\frac{\text{CVVC ratio}}{\text{CVC ratio}}$	1.30	1.35	1.57	1.48	1.67	1.6
$\frac{\text{CVVCC ratio}}{\text{CVCC ratio}}$	1.52	1.57	1.88	2.14	2.2	1.92

And for Eskimo we have two different results (one before single consonant, another before geminates) as on the average CVVC ratios = 1.5 of CVC ratio and

CVVCC ratios = 1.87 of CVCC ratio

The same reason as the one outlined for Eskimo in section 3.8.1 can be given here to explain the difference between the effects of following single and geminate consonants.

It can be remarked that the doubling of a vowel in French produces the following descending rank order of lengthening /u/, /i/, /a/.

The vowel /a/ is comparatively less lengthened by doubling than the other vowels in French. This may be due to the fact that in French this vowel is intrinsically much longer then /i/ and /u/ (cf. section 3.5). The neutral position theory (see section 3.3) can explain the fact that /u/ is more lengthened than /i/ if we assume a more fronted neutral position for French than for Eskimo.

3.8.3 Comparison of Both Languages

In general the following observations were made:

ESKIMO	FRENCH
CVVC ratio=1.7 of CVC ratio	CVVC ratio=1.5 of CVC ratio
CVVCC ratio=2.23 of CVCC ratio	CVVCC ratio=1.87 of CVCC ratio

For both types of contexts investigated the doubling of a vowel in French does not lengthen the vowel as much as the doubling of a vowel in Eskimo.

We are sure that doubling of a vowel in French comes from an underlying double vowel. But we are less sure of the deep analysis of the Eskimo in which the underlying forms may contain one of several different vowel combinations such as two short vowels, two long vowels, or various combinations of long and short.

4 VOWEL QUALITY

4 VOWEL QUALITY

4.1 Introduction

In this chapter, the influence of two main factors and the effect of their combinations, on the quality of vowels in Eskimo and French will be investigated. These factors are:

1. Consonant gemination following single and double vowels.
2. Vowel doubling itself.

It has been observed in the preceding chapter that gemination of following consonants and vowel doubling had an effect on the quantity of a vowel in a sequence. The next phenomenon investigated was the influence of those two factors on the quality of the vowel in these sequences.

It was decided to limit the investigation to sequences with final voiceless stops and particularly to sequences of the type tV(V)t(t) so that the vowels between the two stops would have the same formant transition on both "ends".

Following Delattre's theory that "The quality of a vowel can be investigated by observing the positions of the different formants of this vowel" (Delattre 1966:229), it was decided to examine the frequencies of the formants for the different vowels. Delattre (1966:223) states that:

> The relation between formant 1 position and articulatory position should be stated in the following terms: there is a direct relation between F1 frequency rising and overall opening of the oral tract. The higher the frequency of formant 1, the wider the overall opening; and inversely.

He also claims (1966:232) that:

> There is a direct relation between back-and-up tongue retracting and formant 2 frequency lowering: the more the tongue is retracted the more the frequency of formant 2 is lowered; and inversely.

But it should be kept in mind that there is no necessary one-to-one relationship between acoustic features and articulatory movements--see, for example, Ladefoged's results for perceptual rounding of vowels with expert phoneticians (Ladefoged, 1967). This, coupled with the fact that I made no direct investigation of articulatory movements but rather examined their acoustic results only, means that any statements which I make about articulatory movements are very tentative.

4.2 Vowel Formant Frequency Measurements

It is a well known fact that "measurements of the peaks of the vowel envelope curves provide the most meaningful data regarding vowel frequency". (Peterson, 1959:183).

The reader is referred to Section 2.4 for a description of the method used to produce the vowel envelope curves using the spectrograph.

The biggest problem was to determine the place in

time where the sections should be made. It was decided to choose the place in time where the formants of the vowels were the most "steady". In the cases where the vowels showed obvious transitions to the consonants at both ends, the middle point was chosen, i.e., the lowest or highest frequency point for a particular formant, particularly F2 since it carries so much information about vowel quality (see for reference Fischer-Jørgensen, 1958:121-125).

The next step was to draw by eye a smoothly curved spectrum of each vowel by joining the peaks of each harmonic component on the expanded scale section. This meant that in many cases one arrived at a (centre) frequency and intensity for a given formant which did not coincide with the frequency or intensity of any single harmonic component displayed in the section. The same method as the one described by G. Fairbanks and P. Grubb (1961:208) was used:

> It was decided that it would be preferable to make direct measurements at the points of maximum amplitude as recorded on the section with due regard to the shaping characteristics of the system. In most instances one component was obviously most prominent, but two adjacent components were equal in amplitude in some formants and here the arithmetic mean was used.

We encountered a few problems here, the same ones Ladefoged mentions in his book Three Areas of Experimental Phonetics (1967:81)

> The centre of formant one is difficult to locate when it is low in frequency. In all vowels there is usually a great deal of energy at the fundamental frequency. When a formant is within one and one-half octaves of the fundamental it is more difficult

> to specify its centre frequency, because in these circumstances usually only the frequency components higher than the assumed centre frequency decrease in amplitude; there is thus no peak in the spectrum and it is difficult to know whether to specify the formant centre as being nearer to the fundamental or to the second harmonic. This difficulty occurs typically with [i] and [u]. . . . When formant one is close to formant two it is difficult to locate the centre frequencies of either of these formants. This situation often occurs in back vowels, particularly [a] and [u].

Since we are concerned here with three of the vowels mentioned above, we had to face these problems. It was decided to take for the vowels /i/ and /u/ the value of the frequency half way between the fundamental and the second harmonic (first overtone) or sometimes the value of the frequency of the first overtone depending on the overall shape of the spectrum.

Ladefoged (1967:87) also mentions that:

> It is known that the perception of equal intervals of pitch cannot be exactly correlated with either equal intervals or equal ratios of frequencies; and it seems probable that in the same way the perception of quality differences is not simply related to either the formant frequency intervals or to the formant frequency ratios.

Therefore it was decided to convert the frequencies (in Hz.) of the vowel formants, into pitch (in mels) using the method described in Ladefoged's, Three Areas of Experimental Phonetics (1967:87), i.e., by "Using a graph showing the relation between frequency (in Hz.) and pitch (in mels) drawn from the data of Beranek (1949)". The values of the formant frequencies (in Hz.) and their converted values in pitch (in mels) for F1 and F2 are tabulated in Tables I to N.

TABLE I

Eskimo Low Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tat/	475	570	475	570	1250	1145	1550	1320	2500	2700
	500	600	450	550	1275	1165	1550	1320	2525	2750
/tatt/	375	475	525	615	1400	1235	1650	1385	2500	2500
	400	500	450	550	1375	1225	1750	1420	2475	2625
/taat/	600	680	750	820	1200	1120	1425	1245	2225	2350
	600	680	750	820	1225	1130	1425	1245	2325	2400
/taatt/	650	630	950	965	1275	1165	1350	1210	2275	2450
	650	630	950	965	1300	1180	1400	1235	2325	2450

TABLE J

Eskimo High Front Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tit/	325	425	275	375	2200	1625	2500	1765	2675	2950
	325	425	300	400	2150	1610	2475	1760	2650	3100
	325	425	300	400	2175	1620	2450	1750	2650	3000
/titt/	275	375	275	375	2150	1610	2325	1690	2600	2700
	250	350	300	400	2100	1585	2350	1700	2625	2700
	250	350			2100	1585			2625	
/tiit/	250	350	300	400	2275	1670	2600	1810	2600	3000
	250	350	300	400	2275	1670	2600	1810	2625	2950
/tiitt/	325	425	300	400	2325	1690	2675	1830	2675	3200
	325	425	300	400	2275	1670	2675	1830	2600	3200

TABLE K

Eskimo High Back Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tut/	300	400	325	425	1300	1180	975	880	2500	1700
	275	375	325	425	1375	1225	1025	1015	2600	1800
/tutt/	450	550	375	475	1225	1130	1000	1000	2400	1675
	475	570	375	475	1225	1130	1050	1030	2400	1700
/tuut/	375	475	375	475	1100	1060	900	925	2250	
	450	550	400	500	1100	1060	875	905	2275	
/tuutt/	450	550	350	450	1200	1120	1050	1030	2350	
	450	550	350	450	1200	1120	1000	1000	2325	

TABLE L

French Low Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tat/	750	820	825	860	1275	1165	1725	1405	2950	2875
			800	850			1750	1420		2900
			800	850			1750	1420		2975
/tatt/	875	915	825	860	1250	1145	1750	1420	2950	3000
			850	890			1725	1405		2975
/taat/	825	860	950	980	1250	1145	1650	1385	3100	2800
			975	980			1650	1385		2825
/taatt/	900	925	975	980	1250	1145	1650	1385	2950	2800
			975	980			1650	1385		2775

TABLE M

French High Front Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tit/	250	350	250	350	2000	1540	2400	1720	2875	3250
	250	350	250	350	2050	1560	2425	1735	2900	3200
/titt/	200	300	225	325	2150	1610	2475	1760	2950	3225
			225	325			2475	1760		3250
/tiit/	300	400	250	350	2350	1700	2650	1820	3400	3350
			225	325			2675	1830		3350
/tiitt/	225	325	375	475	2250	1650	2650	1820	2800	3350

TABLE N

French High Back Vowel Formant Frequencies and Pitches

Sequences	F1				F2				F3	
	Male		Female		Male		Female		Male	Female
	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Mels	Hz.	Hz.
/tut/	300	400	325	425	1300	1180	975	980	2500	1700
	275	375	325	425	1375	1225	1025	1015	2600	1800
/tutt/	450	550	375	475	1225	1130	1000	1000	2400	1675
	475	570	375	475	1225	1130	1050	1030	2400	1700
/tuut/	375	475	375	475	1100	1060	900	925	2250	
	450	550	400	500	1100	1060	875	905	2275	
/tuutt/	450	550	350	450	1200	1120	1050	1030	2350	
	450	550	350	450	1200	1120	1000	1000	2325	

In this way a better picture of vowel quality at the perceptual level was obtained.

> Since a formant specification is an account of some of the main features of the spectrum of a sound we may begin comparing vowels by displaying them graphically in terms of their formants . . ., axes have been arranged so that the traditional forms of representating vowels is preserved (Ladefoged, 1967: 92).

Following Ladefoged's procedures the different vowels were plotted on graph paper (cf. Figs. 1-4) and arrows were drawn joining the points representing different vowels to illustrate the influence of vowel doubling (arrows labelled L), and following consonant gemination (arrows labelled G) on the quality of the vowel. The directions of those arrows enabled us to make some very tentative comments about the changes in the quality of the vowels. On the Figures 1-4:

L1 Represents vowel doubling before single consonants.

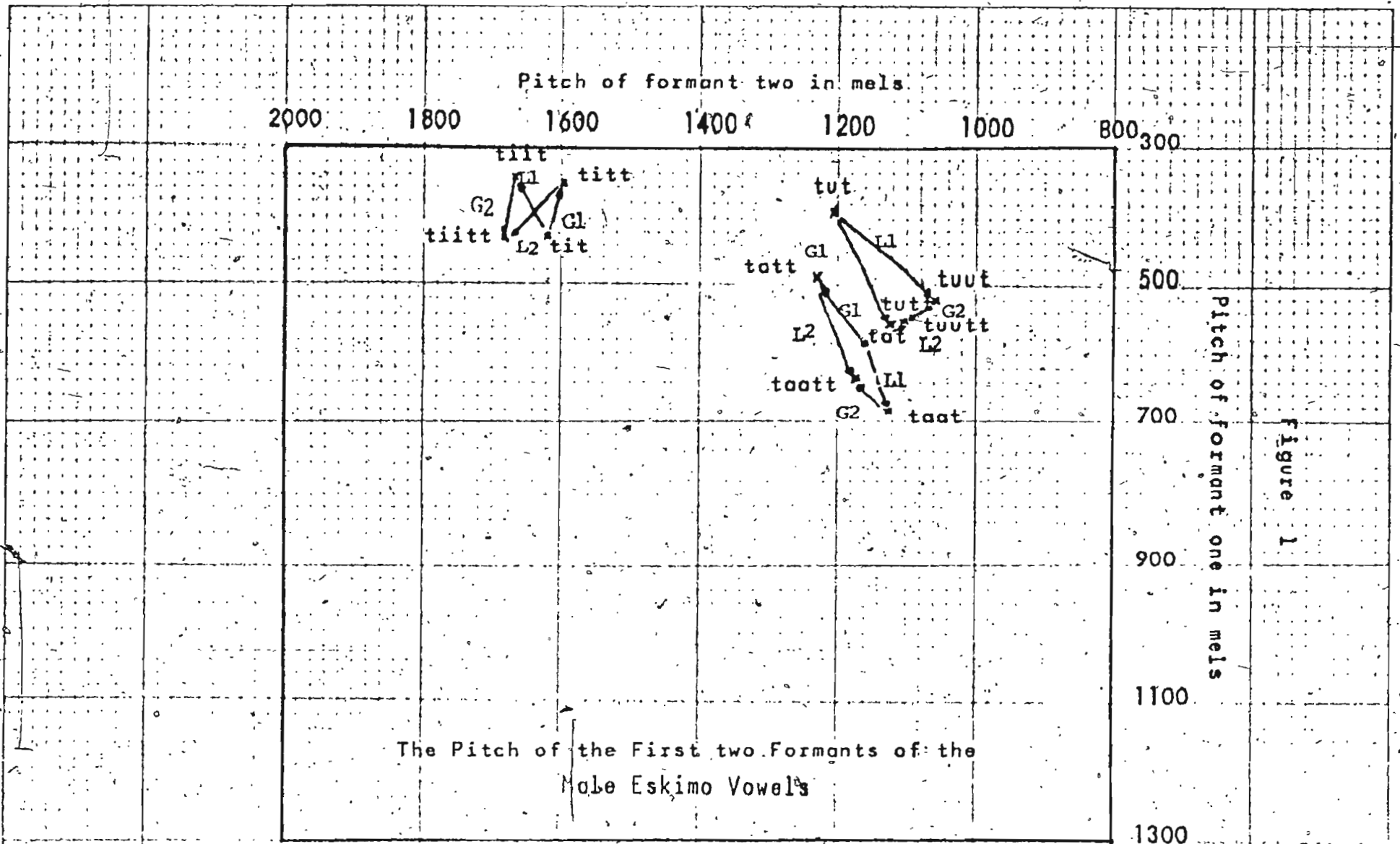
L2 Represents vowel doubling before geminate consonants.

G1 Represents consonant gemination following single vowels.

G2 Represents consonant gemination following double vowels.

From the Figures 1-4, tables were made to illustrate in both languages and for each vowel the influence which the doubling of the vowel and the consonant gemination have on the quality of the vowel. See Tables P and Q.

One can observe from Fig. 1 that the so-called low vowel /a/ and the high front vowel /i/ of the Eskimo male



The Pitch of the First two Formants of the Male Eskimo Vowels

Figure 1

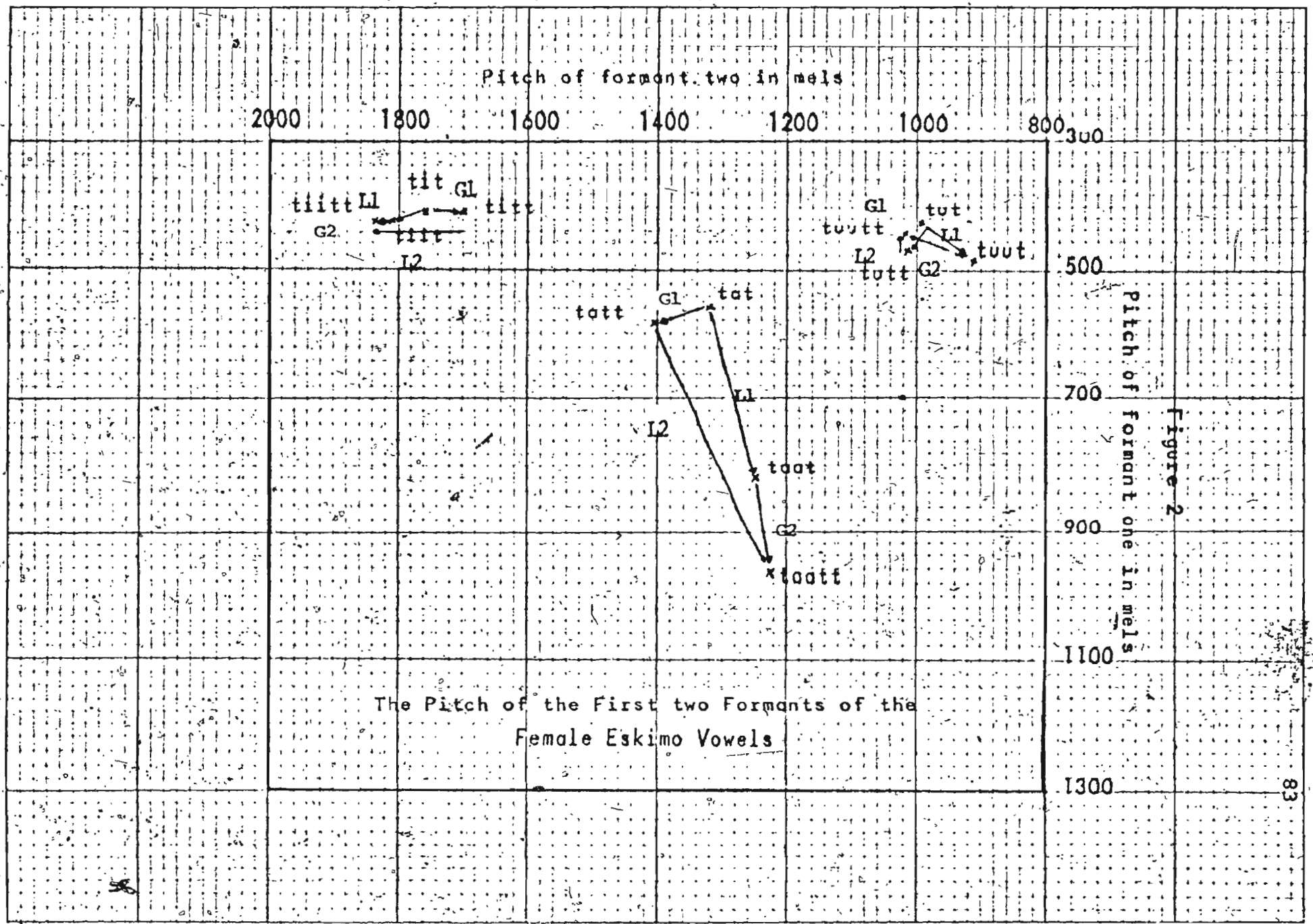


Figure 2

The Pitch of the First two Formants of the Female Eskimo Vowels

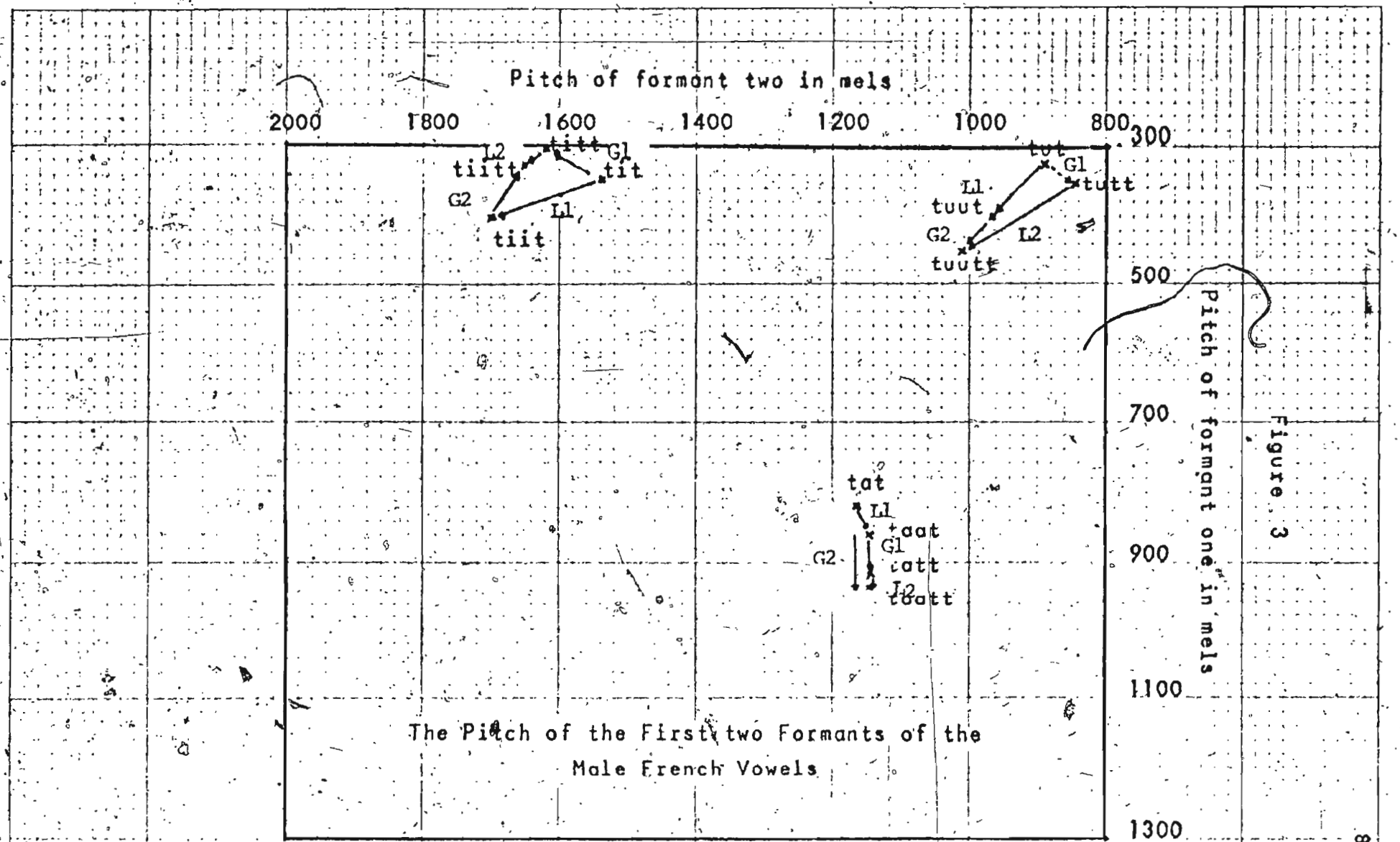


Figure 3

The Pitch of the First two Formants of the Male French Vowels

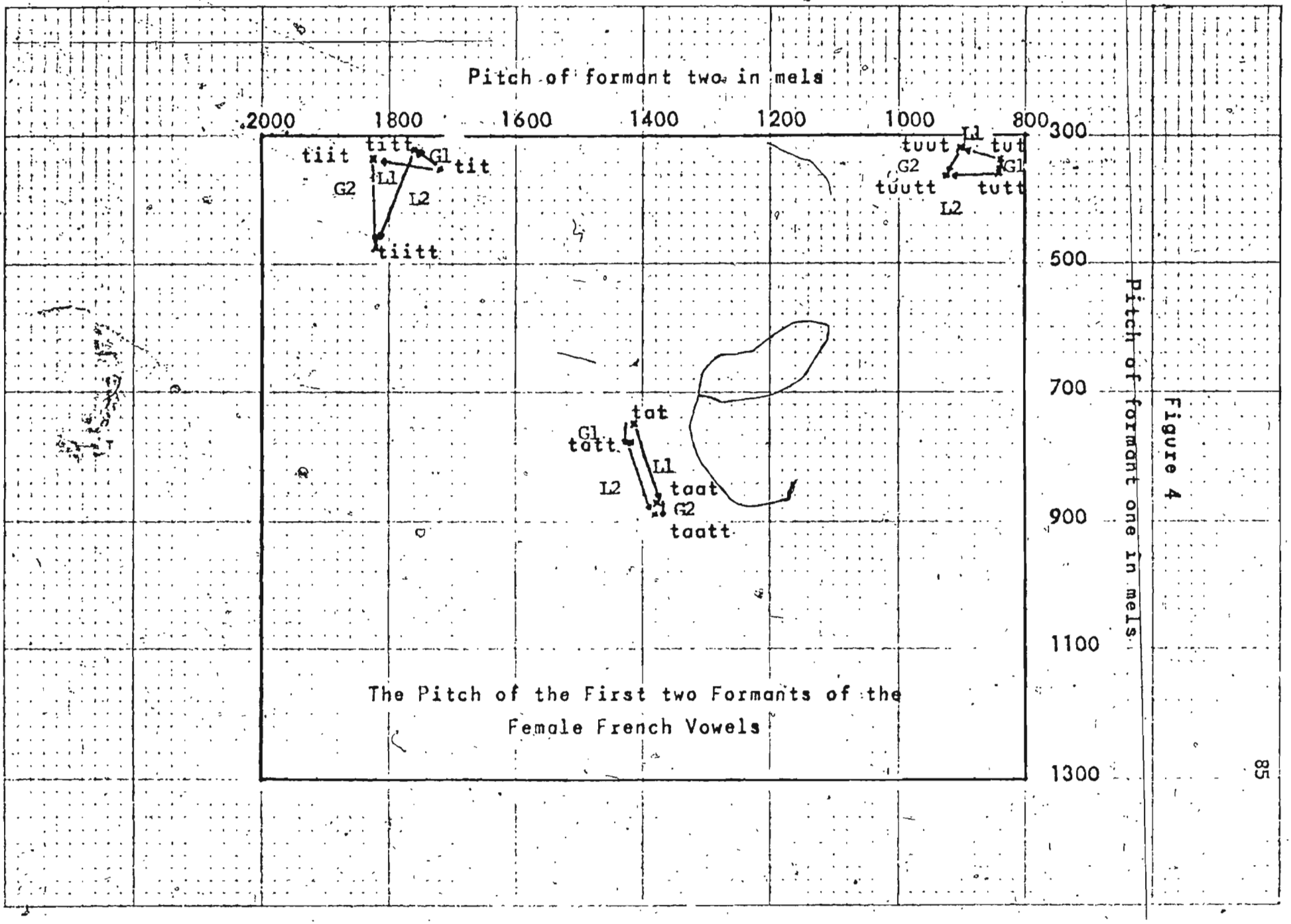


Figure 4

The Pitch of the First two Formants of the Female French Vowels

TABLE P

Influence of L. and G. on Eskimo Vowels

Sequences	Male	Female
tat $\xrightarrow{L1}$ taat	Lowering & Backing	Lowering & Backing
taat $\xrightarrow{L2}$ taatt	Lowering & Backing	Lowering & Backing
tat $\xrightarrow{G1}$ tatt	Raising & Fronting	Lowering & Fronting
taat $\xrightarrow{G2}$ taatt	Raising & Fronting	Lowering & Backing
tit $\xrightarrow{L1}$ tiit	Raising & Fronting	Same & Fronting
titt $\xrightarrow{L2}$ tiitt	Lowering & Fronting	Lowering & Fronting
tit $\xrightarrow{G1}$ titt	Raising & Backing	Same & Backing
tiit $\xrightarrow{G2}$ tiitt	Lowering & Fronting	Same & Fronting
tut $\xrightarrow{L1}$ tuut	Lowering & Backing	Lowering & Backing
tutt $\xrightarrow{L2}$ tuutt	Raising & Backing	Raising & Backing
tut $\xrightarrow{G1}$ tutt	Lowering & Backing	Lowering & Fronting
tuut $\xrightarrow{G2}$ tuutt	Lowering & Same	Lowering & Same

TABLE Q

Influence of L. and G. on French Vowels

	Male	Female
tat —L1→ taat	Lowering & Backing	Lowering & Backing
tatt —L2→ taatt	Lowering & Backing	Lowering & Backing
tat —G1→ tatt	Lowering & Backing	Lowering & Backing
taat —G2→ taatt	Lowering & Same	Lowering & Same
tit —L1→ tiit	Lowering & Fronting	Raising & Fronting
titt —L2→ tiitt	Lowering & Fronting	Lowering & Fronting
tit —G1→ titt	Raising & Fronting	Raising & Fronting
tiit —G2→ tiitt	Raising & Backing	Lowering & Same or Backing
tut —L1→ tuut	Lowering & Fronting	Raising & Fronting
tutt —L2→ tuutt	Lowering & Fronting	Lowering & Fronting
tut —G1→ tutt	Lowering & Backing	Lowering & Same
tuut —G2→ tuutt	Lowering & Fronting	Lowering & Fronting

informant, are situated in a relatively close position with respect to each other. It should be noted that there exists differences in pitch between those vowels as follows:

between	tut and tat	about 200 Mels difference for F1
between	tuut and taat	about 130 Mels difference in F1
between	tutt and tatt	about 70 Mels difference in F1 and 100 Mels difference in F2
between	tuutt and taatt	about 80 Mels difference in F1 and 100 Mels difference in F2.

It must be noted that Fig. 1 is based only on two formant frequencies whereas one must consider the whole spectrum of the two vowels in order to specify this difference in quality. In general, the intensities of the third formant for /u/ vowels were extremely small compared to the intensities of F3 for /a/ vowels (see Tables R-T) below. So the overall spectra differ widely and the auditory differentiation of these phonemes presents no problem.

It was also noted earlier (Section 3.5) that the low vowel /a/ is on the average longer than the high front and high back vowels /i/ and /u/. All those cluses no doubt contribute to the auditory distinctiveness of the three vowels.

It can be seen that for the male informants in Eskimo and French, both the low vowels /a/ and the high front vowel /i/ appear to be more back than the same vowels for the female informants in both languages. The following are tentative explanations:

1. This distinction could come from the fact that the vocal tract is usually larger in all dimensions for males so that the resonant frequencies associated with the cavities tends to be lower.
2. This distinction could simply come from the fact that for Eskimo male and female informants come from different dialect areas in Labrador--(cf. Section 2.2); and for French, as it was noted in Section 1.5, the male French informant uses consistently more retracted allophones of the single open vowel phoneme, whereas the female informant has more fronted allophones. Figures 3-4 seem to confirm my auditory judgements concerning this fact.

4.3 Influence of vowel doubling on formant frequencies

From the Figures 1-4 and the Tables P-Q it can be observed that vowel doubling has an influence on the quality of the vowel in voiceless stop sequences of the type tV(V)t(t).

In Eskimo

In general - the low vowel /a/ is lowered and backed by doubling
- the high front vowel /i/ is fronted by doubling

- the high back vowel /u/ is lowered and backed by doubling.

In French

In general - the low vowel /a/ is lowered and backed by doubling
- the high front vowel /i/ is fronted by doubling
- the high back vowel /u/ is lowered and fronted by doubling.

Comparison

The effect of the doubling of a vowel seems to be similar in Eskimo and French for the low vowel /a/ and the high front vowel /i/. The vowel /u/, however, is fronted when doubled in French while it is backed in Eskimo. The fact that /u/ is fronted when doubled may come from the effect of consonant anticipation--the consonant or consonants following the double vowel /uu/ being /t/ or /tt/.

In Eskimo the short vowels are all more mid-central than their long or double correlates (no distinction will be made between long and double since we have not done a "deep" analysis of Eskimo phonology). Therefore in Eskimo the set of single or short vowels is closer to the center than the set of their long or double correlates, while in French this is true for the vowels /i/ and /a/ but not for the double vowel /uu/ which appears to be more mid-central than its

single correlate.

The Eskimo short /a/ appears to be more mid-central than the French /a/. It is noticeable from Fig. 1 and 2 that in Eskimo the lowering of the low vowel /a/ when doubled is much greater than the lowering due to the doubling of the same vowel in French. This explains, perhaps, why some phoneticians would like to distinguish two phonemes in Eskimo, namely /a/ and /a:/ or /ʌ/ and /a/.[1]

4.4 Influence of consonant gemination on formant frequencies of preceding vowel

The analysis of the Tables P and Q enables us to make the following observations:

In Eskimo

In general - for low vowel /a/: Male /a/ and /aa/ are raised and fronted by gemination; Female /a/ and /aa/ are both lowered and /a/ is fronted but /aa/ is slightly backed by gemination;

- for high front /i/: single /i/ is raised and backed by gemination; double /ii/ is fronted by gemination.
- for high back /u/: single /u/ is lowered and backed or fronted by gemination; double

[1]For more information about vowel representation see Smith, 1974 or Pyle, 1971, in Section 1.5 of this thesis.

/uu/ is lowered by gemination.

Smith's statement (1974) that:

> Single vowels are stressed and reduced in quality and length before consonant clusters:
>
> /a/ ⟶ [ă]
> /i/ ⟶ [ĭ] - CC'
> /ū/ ⟶ [ŭ]

is therefore verified. The coarticulation effects of the /t-t/ context may explain the single apparent exception, the raising of the male /i/ vowel.

In French

In general - for low vowel /a/: single /a/ is lowered and very slightly backed by gemination; double /aa/ is lowered and very slightly backed by gemination.
- for high front /i/: single /i/ is raised and fronted by gemination; double /ii/ is backed by gemination.
- for high back vowel /u/: single /u/ is lowered and backed by gemination; double /uu/ is lowered and fronted by gemination.

Comparison of both languages

A distinction in quality seems to be apparent in both languages between the influence of the gemination of the following consonant after a single vowel and the gemination of the following consonant after a double vowel.

Short Vowels

-Short /a/ is in general lowered by following consonant gemination in both languages except for the Eskimo male informant where it is raised.

-Short /i/ is in general raised by such gemination in both languages.

-Short /u/ is in general lowered by such gemination in both languages.

Long Vowels

-Long /aa/ is lowered by following consonant gemination in both languages except for the Eskimo male informant where it is raised.

-Long /ii/ is in general fronted by such gemination in French while it is backed in Eskimo.

-Long /uu/ is in general lowered by such gemination in both languages.

Comparison of Effects of Vowel Doubling and Consonant Gemination

A look at the relative lengths of the arrows on Figures 1-4 shows us that the effect of L. (doubling of the vowel) is greater than the effect of G. (Gemination of the following consonant) in both languages; the arrows being in general longer when they join single vowels to double vowels sequences than when they join single final consonants to double final consonants sequences.

4.5 Vowel Formant Intensity Measurements

It was also decided to analyse the intensities of vowel formants. We took as a reference the intensity of the first formant of the single vowel /u/ before a single voiceless stop /t/. The values of the intensities of all the other formants were computed relative to that value (measurements were made from sections where 1/32" equaled a difference of 1 dB). Also, corrections were made for the use of the H-S weighting device on the Sonagraph. This device amplifies the intensity of the higher formants. The corrections were made using the calibrated frequency-response curve of the spectrograph when operating in the H-S mode. This curve shows us that the machine amplifies smoothly the intensities of Frequencies from 6 dB. at 1 KHz. to about 15 dB at 8 KHz. This produces accurate results only when the measured vowels are on the same spectrogram as is the reference vowel. In all other cases errors may be introduced by the lack of adequate controls over several variables, particularly the reproduce level, though no adjustments were made in the recording level for a given speaker. The manufacturer of the Dyne microphone used specifies a flat frequency response from 50Hz to 10KHz but we did not in fact calibrate this microphone.

The values obtained are listed in the Tables R to T below.

TABLE R

Vowel Formant Intensities Relative to F1 of /u/ for Each Informant

Informant	For-mant	/tat/			/tatt/		/taat/		/taatt/	
Eskimo	F1	8		4	9	4	4	2	3	3
	F2	- 2		-12	- 4	-12	3	- 1	+ 2	+ 2
Female	F3	-16		-28	-22	-25	- 3	- 6	- 3	- 3
Eskimo	F1	7		0	4	4	4	4	8	8
	F2	0		- 7	-10	- 5	+ 7	+ 5	14	12
Male	F3	- 6		-15	- 8	-13	-13	-11	3	3
French	F1	- 1	- 1	- 2	2	6	4	5	6	3
	F2	-11	-12	-15	-15	- 6	0	1	- 2	- 2
Female	F3	-22	-14	-21	-21	-23	8	-15	-22	-23
French	F1	10			10		9		11	
	F2	4			- 1		+13		8	
Male	F3	- 2			0		-11		- 6	

TABLE S

Vowel Formant Intensities Relative to F1 of /u/ for Each Informant

Informant	For-mant	/tit/			/titt/			/tiit/		/tiitt/	
Eskimo	F1	1	1	2	- 6		1	1	1	4	3
	F2	- 2	- 2	- 9	-16		- 7	-13	- 9	- 2	- 3
Female	F3	- 7	- 7	-14	-14		-11	-18	-12	- 1	- 2
Eskimo	F1	3	8	12	8	4	0	5	5	3	3
	F2	- 5	- 4	3	- 1	- 7	-15	2	2	- 6	- 5
Male	F3	- 6	- 5	2	- 1	-13	-12	1	0	- 8	- 7
French	F1	2		0	0		0	3	0	0	0
	F2	-17		-16	-23		-23	-13	-15	-14	-13
Female	F3	-14		-15	-18		-19	-11	-13	-17	-17
French	F1	11		12	4			14		14	14
	F2	- 8		- 7	- 7			0		2	1
Male	F3	- 6		- 5	- 2			-12		- 3	3

TABLE T

Vowel Formant Intensities Relative to F1 of /u/ for Each Informant

Informant	Formant	tut		tutt		tuut		tuutt	
Eskimo	F1	0	- 4	1	1	0	1	- 1	0
	F2	-25	-28	-12	-13	-13	-13	-16	- 8
Female	F3	-22	-20	- 7	-10			-30	-25
Eskimo	F1	0	0	4	4	4	3	3	4
	F2	-24	-14	-12	-13	- 8	-11	- 6	-14
Male	F3	-22	- 8	-19	-19			-27	
French	F1	0	-10	0	0	0	0	0	0
	F2	-10	-21	- 4	- 3	- 8	- 7	3	- 7
Female	F3	-14	-26	-11	- 9	-21	-17	-12	-17
French	F1	0		10		10		14	
Male	F2	-12		-17		- 6		7	

4.6 Influence of Vowel Doubling on Formant Intensities

By referring to the Tables R-t and comparing tVt with tVVT sequences and tVtt with tVVtt sequences, we obtain the following results.

In Eskimo

Vowel doubling has the following effects on Intensities

Low vowel /a/ - F2 is increased in intensity and so is F3.

High front vowel /i/ - F2 seems to be increased in intensity and so is F3.

High back vowel /u/ - F2 seems to be increased in intensity.

In French

Low vowel /a/ - F2 is increased in Intensity whereas the results for F3 seem inconsistent for the Female but a definite decrease in intensity is observable for the Male.

High front vowel /i/ - The intensity of F2 is increased also observable is a slight increase in the intensity of F3.

High back vowel /u/ - F2 is increased in Intensity.

Therefore, in both languages we can observe a slight increase in the intensities of formant two when the vowel is doubled.

It is interesting to compare the results obtained here with those obtained by Wells (1963) for British English steady vowels. Wells results show that in English, there exists a difference in the intensity spectra between tense and lax vowels: the lax vowels having higher formant intensities for F2 and F3 (and usually F1), than do the corresponding tense vowels. The table below illustrates these differences. On the contrary, my results show that in

Formant Intensity Increases for English Lax Vowels (after Wells)[1]

Tense/Lax	F1	F2	F3
i/I	+ 7	+14	+11
u/U	+ 2	+12	+ 5
ɑ/ʌ	+ 2	+ 3	+ 5
ɔ/ɒ	0	+ 4	+ 7
Mean increase	+ 2.75	+ 8.25	+ 7.0

Eskimo and in French, the intensities of F2 and F3 are slightly increased when the vowels are doubled. This indicates that English vowels possess a so-called tense/lax distinction whose phonetic correlates are very different from the correlates of the single/double distinction in Eskimo and French.

It was also decided to compare the differences existing between formant frequencies of the lax/tense vowel

[1]It can be noted that this effect is more pronounced in the two high vowel pairs than in the two low vowel pairs.

pairs in Wells (1963) with the corresponding differences for the single/double vowel pairs in Eskimo and French. Tables U-W list those frequencies.

If we consider the differences which exist between the formant frequencies of the lax vs. tense vowels of Wells on the one hand and the differences between the formant frequencies of single vs. double vowels of the male informants in Eskimo and French on the other, we may notice that:

- For the low vowel:

In English the biggest difference is an F2 frequency difference of 153 Hz. Whereas the biggest difference is an F1 frequency difference of 113 Hz. in Eskimo and 75 Hz. in French.

- For the high front vowel:

In English we observe the biggest difference between F1 and F2 frequencies, namely 71 Hz. for F1 and 275 Hz. for F2. In Eskimo the F1 difference is 75 Hz. and the F2 difference is 125 Hz. In French the F1 difference is only 50 Hz., the F2 change is 350 Hz., and there is also a large difference of 525 Hz. in F3.

- For the high back vowel:

In English we have the biggest difference in formant frequencies in F3 where we find a difference of 120 Hz.; whereas in both Eskimo and French we observe a big difference in F1 and F2 frequencies, especially a difference of 250 Hz.

TABLE U

Low Vowel Formant Frequencies in Three Languages

English	Eskimo		French	
25 Males	1 Male	1 Female	1 Male	1 Female
/a/ F1 677	/aa/ F1 600	750	/aa/ 825	962
F2 1083	F2 1212	1425	1250	1650
F3 2540	F3 2275	2375	3100	2812
/ʌ/ F1 722	/a/ F1 487	462	/a/ 750	812
F2 1236	F2 1262	1550	1275	1750
F3 2537	F3 2512	2725	2950	2925

(after Wells, 1963).

TABLE V

High Front Vowel Formant Frequencies in Three Languages

English	Eskimo		French	
25 Males	Male	Female	Male	Female
/i/ F1 285	/ii/ F1 250	300	/ii/ 300	250
F2 2373	F2 2275	2600	2350	2650
F3 3088	F3 2600	3000	3400	3350
/I/ F1 356	/i/ F1 325	300	/i/ 250	250
F2 2098	F2 2150	2475	2000	2400
F3 2696	F3 2650	3000	2875	3200

(after Wells, 1963).

TABLE W

High Back Vowel Formant Frequencies
in Three Languages

English		Eskimo		French	
25 Males		Male	Female	Male	Female
/u/	F1 309	/uu/ F1 410	387	/uu/ 425	387
	F2 939	F2 1100	900	1100	887
	F3 2320	F3 2260		2262	
/U/	F1 376	/u/ F1 300	325	/u/ 287	325
	F2 950	F2 1350	1000	1350	1000
	F3 2440	F3 2550	1750	2550	1750

(after Wells, 1963).

in F2 for both languages.

These differences in formant frequency show differences in quality in all pairs of vowels in all three languages (see Section 4.1), but no real pattern can be discerned in the differences between the lax/tense English contrasts and the single/double contrasts of the Eskimo and French male informants. However, for the high front vowel in each language we observe a significant difference for the frequencies of both F1 and F2.

We may therefore conclude that formant intensities provide more consistent clues than do formant frequencies for both the lax/tense vowel distinction in English and the single/double vowel distinction in Eskimo and French.

4.7 Influence of Consonant Gemination on Formant Intensities of Preceding Vowels

By referring to the Tables R-T and comparing tVt with tVtt sequences and tVVt with tVVtt sequences, we obtain the following results:

In Eskimo

Consonant gemination has the following effect on Intensities:

Low vowel /a/ - no apparent result, except for male informant: taat vs. taatt where we see an increase in the

intensity of F2 and F3 when the double vowel preceeds a geminate /tt/.

High Front Vowel /i/ - no apparent pattern.

High Back Vowel /u/ - Formants Intensity of single vowel /u/ seems to be increased when preceding a geminate consonant.

In French

Low vowel /a/ - Intensity of F2 seems to be decreased when preceding a geminate.

High Front Vowel /i/ - For the female informant we note a slight decrease in the intensity of F2 and F3. No pattern for the male informant was observable.

High Back Vowel /u/ - Only for the female informant do we notice a slight increase in the Intensity of F2.

Conclusion

It seems that there is no apparent influence of following consonant gemination on the intensities of the vowel formants in Eskimo and French.

4.8 Concluding Remarks

It can be deduced, that in both languages the doubling of the vowel has a greater effect on the quality of a vowel than has the gemination of the following consonant. However the reliability of these results may be questioned since this study was undertaken with the use of only the sound spectrograph. More sophisticated equipment would produce more valid results. Also spectra were drawn by eye (see Section 4.1 above) so that only rough approximations of formant frequencies and intensities were obtained.

5 CONCLUSION

5.1 Some Generalizations

5.2 Evaluation of the Reliability of the Results

5 CONCLUSION

5.1 Some Generalizations

It has been shown in this thesis that the doubling of a vowel had a larger effect on the quantity and quality of this vowel than does the gemination of the consonant following it.

The gemination of a following consonant was shown to have a more reducing effect on the duration of a preceding vowel in a language which has gemination within word boundaries (Eskimo) than in a language which has gemination across word boundaries (French).

It was proposed that gemination of a consonant has a greater effect, in both the above types of languages, on the duration of a preceding single vowel than on that of a preceding double vowel.

Regarding the lax/tense vowel opposition in English on the one hand and the single/double vowel opposition in Eskimo and French on the other (see section 4.7 above), the experiments indicate that each of the two oppositions involves several acoustic cues (e.g., duration, formant frequency, formant intensity) whose manifestations are not the same for both oppositions. It also appears that, in general, formant intensities provide more consistent cues than do formant frequencies for the single/double vowel distinction in Eskimo

and French (see section 4.7 above). Perhaps the same is true also for the English lax/tense vowel distinction. The relative durations of the consonants and vowels in CV(V)C(C) sequences seems to be very significant for gemination in French and Eskimo. Further investigations are needed to test all the above conclusions.

Various problems were brought to light, which deserve to be more thoroughly investigated. For example, in Chapter 3 the concept of (language specific) neutral tongue position was introduced and this idea, along with Öhman's co-articulation theory (1966, 1967), served to explain tentatively some very interesting points in the different sections of Chapter 3, concerning the relative length of the different vowels in Eskimo and French. Such a neutral position theory as proposed by Honikman (1964), has not received the attention which it deserves from experimental phoneticians. We hope that some future research on vowel duration will seek to test this concept.

My findings indicate that phonetic distinctiveness is usually maintained whenever there is an underlying phonemic distinction. Therefore we have not had to appeal to the Chomsky-Halle (1968) theory of perception mentioned in section 1.4 above.

There are several phonetic cues associated with any one phonemic distinction so that if one cue (e.g., absolute length) fails to phonetically maintain a distinction then

others (such as relative length, quality, including not only formant frequencies but also relative formant intensities, etc.) are available to the hearer.

One possibility which remains to be investigated is that the overall pattern of formant change in time (in either frequency or intensity or both) could be used to distinguish vowels which are identical in all other respects. Another unexamined possibility is that of acoustic discontinuities which may mark "boundaries" between the two members of a double vowel in Eskimo or French.

5.2 Evaluation of the Reliability of the Results

1. Dialectal Effects

The two Eskimo informants were born in two different communities of Labrador (see Section 2.2) and learnt the Eskimo language between the ages of 1 and 6. This is the period when a child really acquires a language and this is when he is influenced most by the dialect which he is learning.

Rose, when discussing the language spoken around Hebron, where Sam comes from, once said that "People around there (Hebron) seem to be 'dragging' their words and speak more slowly than people around Nain". Also, when asked, after the experiments were conducted, if she noticed a difference in pronunciation between the two dialects she said that

"people around Hebron (like Sam) would have a tendency to speak with "dark" /a/'s. This would confirm my findings in Section 4.2.

2. Idiolectal Effects

Especially for the St. Pierre dialect the male informant, Marcel, is a natural "imitator". He can imitate very accurately any dialect or idiolect, this is why he is very gifted in learning foreign languages. This fact may have interferred with the study in that he might have slightly exaggerated his idiolect, when he was asked to speak in every-day 'St. Pierrais". I was present in the anechoic room when the recordings were made, but as a speaker of the same dialect I could not notice any such exaggeration in Marcel's speech.

3. Statistical Validity of the Results

Time and funds permitted an investigation with only two informants (one of each sex) for both languages studied. A broader investigation using the same sequences but with more informants, say five or ten of each sex, and using more sophisticated equipment, could, of course, give us more reliable results. Such a thorough investigation may be carried out at a later date in order to confirm or invalidate the results stated in this thesis.

Concerning the fourth chapter of this thesis, it is to be noted that the quality of the vowels were observed in tV(V)t(t) sequences only. Therefore the results cannot be

considered as generally valid and the quality of vowels in sequences of the type pV(V)p(p) or kV(V)k(k) or other combinations of phonemes may be investigated at a later date in order to obtain more conclusive results.

A LIST OF ABBREVIATIONS USED IN THE BIBLIOGRAPHY

IJAL	International Journal of American Linguistics, Baltimore.
IRAL	International Review of Applied Linguistics in Language Teaching.
JASA	Journal of the Acoustical Society of America.
JSHR	Journal of Speech and Hearing Research, Washington, D.C.
PMLA	Publications of the Modern Language Association of America, New York.
RLS	Regional Language Studies, Department of English Language and Literature, Memorial University of Newfoundland.
STL - QPSR	Speech Transmission Laboratory Quarterly Progress and Status Report.
TCLP	Travaux du Cercle Linguistique de Prague.

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INTRODUCTION TO APPENDIX I

Each page is made of four columns. The left half of the page contains figures for single vowel sequences; the right half for double vowel sequences. Each half page subdivides into figures for male informants on the left and female on the right. This yields the following correspondences:

Column 1 - Single vowel, male
2 - Single vowel, female
3 - Double vowel, male
4 - Double vowel, female

Each column contains two numbers. The first of these is a two digit whole number and represents the duration of the sequence in centiseconds (see section 3.1 for measurement method); the second is a fraction correct to 3 places of decimals representing the ratio of vowel duration to the sequence duration on its left.

The symbol # represents a word boundary. In the Eskimo corpus it occurs only in sequence initial position in some of the data, and is therefore shown before the fraction correct to 3 places of decimals in such cases. In the French corpus however, word boundaries occur initially, medially, and (rarely) finally in sequences. It was therefore necessary to add an extra column between male and

female columns in order to show the occurring word boundaries in French.

The single digit numbers (two or three) in parentheses occasionally following the ratio number means that results were identical from two or three separate measurements.

Table 1 /t/ + low vowel in Eskimo

tap		taap	
15 #.266	21 #.380(2)	25 .480	
16 #.321		26 .500	
17 #.294			
tapp		**taapp**	
26 #.077	27 #.148	30 .300	42 .333
27 #.111	28 #.142	33 .303	42 .357
		46 .369	
tat		**taat**	
14 #.357(2)	20 #.400	28 .714	31 .645
	22 #.454	31 .645	32 .656
		17 .647	26 .615
		18 .666	27 .592
tatt		**taatt**	
30 #.133	34 #.235	33 #.363(2)	38 #.394
32 #.156	35 #.228		44 #.409
			46 #.456
tak		**taak**	
12 #.250	19 #.315	22 #.591	27 #.592
15 #.266	20 #.350(2)	22 #.636	30 #.566
11 #.272	22 #.318		
13 #.307	16 #.312		
12 #.333(2)	18 #.388		
takk		**taakk**	
17 .176	25 .160	31 #.322	40 #.450
15 .200	28 .178	33 #.303	42 #.428
28 #.107			
32 #.094			
tan		**taan**	
13 .461	18 .444	26 #.730(2)	30 #.666
14 .500(2)	20 .400(2)		35 #.685
			38 #.684

Table 1 (continued)

tann		taann	
28 #.178	33 #.242	34 #.441	41 #.454
29 #.206	35 #.228	34 #.382	44 #.463
	36 #.250		

tas		taas	
21 #.333(2)	30 #.290	27 .592	35 .571
	31 #.266	35 .600	40 .525

tag		taag	
16 .312	15 .466	37 #.648	39 #.743
17 .353	18 .444	36 #.639	36 #.694
15 .333			

taq	
19 #.368	26 #.307
20 #.400	32 #.212
23 #.391	30 #.333

taqq	
23 #.174(2)	32 #.156
30 #.166(2)	39 #.179
33 #.181	35 #.151

Table 2 /t/ + High front vowel in Eskimo

tip			tiip		
14	#.285	22 #.272	20	.500	26 .500
15	#.266	25 #.280	21	.571	30 .500
20	#.300	26 #.230			
tipp			**tiipp**		
26	.153	30 .100	35	.228(2)	33 .272
27	.148	33 .153			40 .250
30	.133	32 .093			
31	.129	35 .085			
tit			**tiit**		
14	#.357(2)	22 #.363	20 #.450		
15	#.333	23 #.348	21 #.476		
titt			**tiitt**		
32	#.125	25 #.160			
32	#.156	27 #.185			
tik			**tiik**		
14	.285(2)	18 #.333	17 #.529		20 #.555
12	#.166(2)	21 #.333	19 #.526		25 #.560
		24 #.291			
		18 #.222			
		19 #.263			
tikk			**tiikk**		
26	#.115	25 #.120	26	.269	30 .266
27	#.111	30 #.133	27	.296	33 .303
			28	.285	
tin			**tiin**		
11	#.363	20 #.300	20 #.650		34 #.588
12	#.333(2)	23 #.391	21 #.619		38 #.578
		23 #.347			
tinn			**tiinn**		
		32 .187(2)	21	.476	27 .407
			21	.428	

Table 2 (continued)

tis				tiis			
20	.250	26	.192(2)	34	.588	40	.450
19	.263(2)			37	.594	41	.536
tig				**tiig**			
18	.444	21	.428	34	.735	32	.625
20	.400	20	.400	30	.666	30	.733
tiq				**tiiq**			
16	.250	17	.352	31	.580	37	.486
16	.312			34	.588		
tiqq				**tiiqq**			
35	#.171(2)	31	#.161				
		37	#.162				

Table 3 /t/ + High back vowel in Eskimo

tup			tuup		
15 #.300	20 #.250		22 .591(2)	33 .545	
18 #.277	23 #.260(2)				
tupp			**tuupp**		
29 #.138	33 #.121		28 .285	32 .312	
31 #.129	34 #.147		28 .321		
	35 #.171				
tut			**tuut**		
12 #.214	16 #.312		22 .636	31 .483	
14 #.250	18 #.444		26 .654		
tutt			**tuutt**		
28 #.143	31 #.161		31 .290	33 .363	
31 #.129	33 #.242		32 .281	35 .342	
tuk			**tuuk**		
14 #.357	17 #.235		29 #.620	30 #.466	
15 #.333(2)	20 #.250		31 #.645	34 #.441	
	14 #.285		32 #.625		
tukk			**tuukk**		
31 #.129	33 #.151		40 #.200	33 #.242	
33 #.151	38 #.131		41 #.195	37 #.216	
28 #.107	24 #.125				
30 #.133					
tun			**tuun**		
16 #.375	21 #.333		22 .682(2)	22 .545	
15 #.400	25 #.360			26 .576	
	27 #.296				
tunn			**tuunn**		
30 #.166	32 #.218		22 .409(2)	30 .266	
26 #.154	36 #.250			36 .277	

Table 3 (continued)

tus				tuus			
20	#.400	24	#.250	27	.555	36	.444(2)
19	#.368	27	#.222	26	.538	38	.447
				30	.566	39	.512
				31	.580		

tug				tuug			
15	.400	20	.400	26	.655	38	.710
16	.375	16	.437	29	.538	40	.700
13	.384						

tuq			
16	.437	18	.388
		19	.421

tuqq	
32	.187
31	.193

Table 4 /p/ + low vowel in Eskimo

pap		paap	
17 #.294	21 #.381	22 .681	
11 #.272	20 #.400	21 .714	
12 #.250			
papp		**paapp**	
30 .200	31 .193	28 .357	45 .400
26 .192(2)	32 .197	26 .346	
pat		**paat**	
13 #.384(2)	22 #.318(2)	24 .666	29 .586
	23 #.347	25 .680	30 .566
patt		**paatt**	
25 #.120	36 #.222	32 .312(2)	33 .393
27 #.148	35 #.200		34 .411
28 #.142(2)	27 #.185		
	24 #.208		
pak		**paak**	
15 #.400(2)	22 #.454	31 #.709	31 #.580
17 #.411	25 #.400	31 #.677	33 #.606
	26 #.423		
pakk		**paakk**	
27 #.185	32 #.250	32 .375	35 .400
29 #.172	35 #.285	30 .383	37 .459
	36 #.277		
pan		**paan**	
13 #.461	25 #.400	32 #.781	32 #.722
14 #.500	26 #.384	32 #.750	36 #.656
18 #.444		33 #.757	30 .633
		22 .722	34 .676
		35 .771	
pann		**paann**	
30 #.129	36 #.194	38 .368	36 .500
31 #.133	38 #.210	38 .395	40 .475

Table 4 (continued)

pas	paas	
21 #.428	37 #.540	42 #.476
20 #.400(2)	36 #.527	40 #.425

Table 5 /p/ + High front vowel in Eskimo

pip		piip	
13 #.384	19 #.263	23 #.565(2)	28 #.428
13 #.307	15 #.266		31 #.483
pipp		**piipp**	
27 #.148	31 #.129	28 #.285	33 #.272
29 #.138	34 #.117	30 #.233	34 #.294
pit		**piit**	
16 #.312	19 #.263	25 .640	27 .518
15 #.333	21 #.285	24 .660	29 .517
10 #.300	23 #.260		
11 #.272	21 #.238		
18 #.333			
pitt		**piitt**	
29 #.103	27 #.148	30 #.200	33 #.324
30 #.100	27 #.111	32 #.218	37 #.303
pik		**piik**	
10 #.300(3)	18 #.277	19 #.473	26 #.500(2)
13 .304	20 #.300	21 #.476	
17 .353	16 .250		
	15 .266		
pikk		**piikk**	
26 #.115(2)	34 #.117(2)	28 #.285	40 #.375
23 .174	26 .115	30 #.300	41 #.365
24 .166(2)	27 .148		
27 .148			
pin		**piin**	
10 #.400	16 #.375	19 #.579	26 #.500
11 #.454(2)	17 #.353	20 #.600	28 #.571
	18 #.388	22 #.636	32 #.625
pinn		**piinn**	
28 #.107	21 #.143	26 #.384(2)	30 #.433
28 #.143	24 #.208		36 #.416
	26 #.192		

Table 5 (continued)

pis		piis	
17 #.352	26 #.192	37 #.622	44 #.454
20 #.350	29 #.241	38 #.631	50 #.520
21 #.285	29 #.271		

Table 6 /p/ + high back vowel in Eskimo

pup		puup	
16 #.312	22 #.363	19 #.526	24 #.458
18 #.277	25 #.320		26 #.461
pupp		**puupp**	
31 .129	33 .121	28 .250	28 .285
32 .093	35 .143	31 .258	33 .303
put		**puut**	
14 .357	21 .285	29 .689	31 .527
15 .333	22 .272	30 .666	36 .516
16 .312	20 #.350	37 .675	
11 #.272	23 #.347		
13 #.307			
14 #.285			
putt		**puutt**	
26 .115	27 .148	34 .294	38 .368(2)
28 .143	30 .133	36 .277	
27 #.111	27 #.148		
28 #.143	29 #.103		
32 #.156			
puk		**puuk**	
16 #.353	20 #.300	20 #.500	26 #.500
17 #.375	22 #.318	23 #.521	28 #.500
pukk		**puukk**	
23 #.130	21 #.143	33 #.212	38 #.289
24 #.125	24 #.125	38 #.210	41 #.292
pun		**puun**	
15 .533(2)	17 .352	25 .600	27 .555
	18 .444	25 .640	30 .533
punn		**puunn**	
27 .222	31 .161	30 .400	38 .447
27 .185	33 .151	30 .333	38 .421
pus		**puus**	

Table 7 /k/ + low vowel in Eskimo

kap			kaap		
14	#.357	22 #.318	27	#.666	34 #.529
16	#.375	23 #.304(2)	27	#.703	34 #.558
17	#.411	22 #.227	28	#.607	
17	.294				
15	.266				

kapp			kaapp		
25	.160(2)	28 .143	34	.323(2)	41 .390
		29 .138	36	.333	44 .363

kat			kaat		
14	#.285	25 #.240	27	#.666	36 #.527
15	#.266	27 #.296	29	#.689	37 #.567
16	#.312		30	#.666	

katt			kaatt		
27	.185(2)	31 .193	31	.290	46 .369
30	.200	36 .194	34	.294	47 .361

kak			kaak		
13	#.307	19 #.421	25	#.600(2)	26 #.576
14	#.285	21 #.381			27 #.592
15	#.266				

kakk			kaakk		
27	#.222(2)	25 #.240	30	.400(2)	38 #.394
		30 #.233			43 #.372

kan			kaan		
11	.454	21 .285	28	.714	38 .605
12	.416	22 .363	31	.774	40 .625
14	.500	20 .400			
13	.461	21 .381			

kann			kaann		
25	.160	31 .129	28	.393	38 .473
26	.154	32 .187	30	.366	
		36 .194			

Table 7 (continued)

kas				kaas			
18	.222	23	.173	35	.514	43	.465(2)
17	.235	24	.208	32	.531		

Table 8 /k/ + high front vowel in Eskimo

kip			kiip		
15	#.266	26 #.230	37	.629	34 .470
16	#.250	28 #.250	31	.645	35 .514
17	#.294	21 .238			
		22 .227			
kipp			**kiipp**		
29	.103	35 .085	38	#.316	38 #.289
32	.125	36 .083	39	#.256	41 #.268
kit			**kiit**		
13	#.230(2)	26 #.192	28	#.571	34 #.500
20	#.300(2)	29 #.275	28	#.607	40 #.525
17	.235	24 .250	30	#.566	
16	.250	23 .217			
kitt			**kiitt**		
30	.100(3)	30 .100	34	.294	37 .324
27	.111	36 .138	37	.297	39 .333
25	.120	25 .120			
31	.096	31 .096(2)			
26	.154	32 .125			
kik			**kiik**		
15	#.333	20 #.250	23	#.608	25 #.560
17	#.353	21 #.238	26	#.615	28 #.571
18	#.333				
kikk			**kiikk**		
30	#.133	32 #.093	28	.285	32 .277
33	#.151	35 #.085	31	.290	36 .281
			33	.303	
kin			**kiin**		
11	#.272(2)	26 #.307	23	#.609	34 #.529
10	#.300	30 #.300	25	#.680	38 #.526

Table 8 (Continued)

kinn				kiinn			
25	.120	32	.125	30	.400(2)	33	.333
27	.111	36	.138			34	.353

kis				kiis			
20	.300	26	.269	33	#.575	40	#.450
21	.333	29	.206	34	#.529	35	#.371
		31	.193				

Table 9 /k/ + high back vowel in Eskimo

kup				kuup			
13	#.230	21	#.285	21	.571	29	.482
14	#.285	22	#.317	23	.565		
15	#.266						
kupp				**kuupp**			
28	.071	32	.093	31	.226	36	.277
30	.100	34	.088	34	.235		
kut				**kuut**			
12	#.416			40	#.650	33	#.487
14	#.285			33	#.606	41	#.515
16	#.312			33	#.666		
21	#.381						
kutt				**kuutt**			
28	.107	30	.142	34	.277	40	.350
29	.103	35	.100	36	.294	43	.372
kuk				**kuuk**			
16	#.312	18	#.388	25	#.560	26	#.500
17	#.294	20	#.300	26	#.538	28	#.464
18	#.277					28	.428
kukk				**kuukk**			
33	#.121	30	#.200	38	#.184	39	#.231
34	#.117	31	#.129	40	#.200	42	#.262
kun				**kuun**			
15	.300(2)	18	.277	25	.720	34	.588
		20	.250	27	.703	34	.529
kunn				**kuunn**			
25	.160	32	.125	28	.321	30	.333
26	.153	34	.176	29	.345	33	.363

Table 9 (continued)

kus				kuus			
20	.400	22	.318	33	#.545	40	#.425
21	.381	24	.291	36	#.527	37	#.432
		25	.240				

Table 10 /t/ + low vowel in French

tap					taap				
15	.466	#tap-	20	.450	24	.834	#t#a#ap-	21	.524(2)
17	.410	#tap-	21	.426	25	.720	#t#a#ap-	19	.526
18	.388(2)	#tap-	13	.384	25	.800	#t#a#ap-	22	.545
18	.333	#tap-	14	.428					
		"	15	.400					
tapp					**taapp**				
26	.384	#tap#p-	22	.227	33	.484	#t#a#ap#p-		
21	.381	#tap#p-	19	.211	34	.500(2)	#t#a#ap#p-		
21	.334	#tap#p-							
tat					**taat**				
11	.545	#ta#t-	19	.421(2)			#t#a#at-	22	.590
		"	16	.375			"	24	.625
		"	16	.250					
tatt					**taatt**				
21	.333	#tat#t-	27	.371	36	.666	#t#at#t-	35	.572
		#tat#t-	28	.357(2)			"	38	.553
		#tat#t-	27	.371					

Table 10 (Continued)

tak					taak				
21	.476(4)	#tak-	27	.407	26	.577(2)	#t#a#ak-	21	.523
					24	.583	#t#a#ak-		
					23	.739	#t#a#a#k-	20	.600(2)
					27	.593	#t#a#a#k-	24	.666
					27	.630	#t#a#a#k-		
					28	.643	#t#a#a#k-		
takk					taakk				
19	.315	#tak#k-	22	.363	26	.461	#t#a#ak#k-	31	.548
17	.352(2)	#tak#k-			28	.464	#t#a#ak#k-	35	.486
		-tak#k-	26	.384	31	.451	#t#a#ak#k-		
		-tak#k-	29	.379	33	.484	#t#a#ak#k-		
					33	.454	#t#a#ak#k-		
tan					taan				
17	.470(2)	#ta#n-	18	.444	30	.633	#ta#an-	23	.608
18	.444	"	20	.400	32	.656	"	24	.625
		"	21	.381	33	.636	"		
tann					taann				
20	.350	-tan#n-			36	.555	#ta#an#n-		
21	.285	"			38	.552	"		
21	.333	"							

Table 10 (Continued)

tas					taas				
21	.475	#ta#s-	25	.360	35	.515	#t#a#as-	27	.555
22	.409	"	27	.444	37	.541	"	29	.517
		"	31	.322					

tass					taass				
30	.400	#tas#s-	30	.366	43	.488	#t#a#as#s-	42	.524
31	.322	"	35	.314	35	.457	"	43	.488
		"	36	.333					

taz			taaz
23	.478(2)	-t#az-	
24	.458	"	

tazz			taazz
26	.423(2)	-taz#z-	
27	.407	"	

Table 11 /t/ + high front vowel in French

tip					tiip				
20	.350	#tip-	30	.300	31	.645	-ti#ip-	28	.536
21	.333	#tip-					"	30	.534
26	.308	#tip#							
tipp					**tiipp**				
26	.250	#tip#p-	23	.218					
30	.200	#tip#p-							
tit					**tiit**				
6	.166	#tit-	19	.421	22	.590	- ti#i#t-	28	.500
8	.250	#tit-	17	.411			- ti#i#t-	27	.518
10	.200	#tit-	16	.375			"	28	.428(2)
		"	18	.333					
titt					**tiitt**				
20	.250	-tit#t-	20	.250	26	.384	-ti#i#t#t-	36	.361
		"	17	.235	29	.379	"	36	.333
tik					**tiik**				
19	.210	#tik-	25	.333	20	.400	-ti#i#k-	25	.400
20	.250	#tik-	30	.333	21	.428	-ti#i#k-	26	.384
					22	.409	-ti#i#k-		

Table 11 (Continued)

tikk						tiikk			
18	.111(2)	-tik#k-	20	.200					
20	.150	-tik#k-	27	.185					
tin						tiin			
15	.333	-t#in-	17	.235(2)		26	.538	-t#i#in-	26 .500
17	.294	"				23	.565	"	28 .500
20	.250	"				25	.560(2)	"	
tinn						tiinn			
14	.143	-tin#n-	20	.150					
16	.125	"	22	.181					
tis						tiis			
23	.217	#tis-				34	.500	#t#i#is-	27 .407
24	.208	"				35	.514	"	32 .437
						36	.500	"	
tiss						tiiss			
25	.192(2)	#tis#s-	27	.172		30	.400(2)	#t#i#is#s-	35 .307
		"	29	.185		34	.353	"	39 .285

Table 11 (Continued)

tiz			tiiz			
25	.440	#tiz-	22	.550(2)	-ti#iz-	
26	.384	"				
26	.461	"				
tizz			tiizz			
24	.333	#tiz#z-				
25	.320	"				

Table 12 /t/ + high back vowel in French

tup						tuup					
16	.250	#tup-	18	.333		20	.450	#tu#u#p-	21	.524(2)	
17	.235	#tup-	20	.350		22	.454	#tu#u#p-			
		"	21	.333		25	.480	#tu#u#p-			
20	.250	#tu#p-	17	.235							
tupp						**tuupp**					
23	.174	-tup#p-	21	.142							
24	.208	-tup#p-	23	.130							
25	.200	-tup#p-	30	.133							
tut						**tuut**					
12	.500	#tut#	11	.417		24	.750	#tu#u#t-	23	.565	
17	.411	#tut-	12	.364				"	26	.538	
tutt						**tuutt**					
21	.143	#tut#t-	22	.228		27	.334	-tu#u#t#t-	28	.394	
23	.174	#tut#t-	25	.240		30	.400	-tu#u#t#t-	31	.419	
25	.160	#tut#t-	24	.208							
		"	21	.191							

Table 12 (Continued)

tuk						tuuk					
11	.545	#tu#k-	18	.333		21	.476	-tu#u#k-	28	.571	
		"	20	.400		23	.478	-tu#u#k-	30	.566	
17	.235	#tuk-	27	.370		23	.521	"			
18	.222	#tuk-	28	.357							
tukk						tuukk					
29	.172	#tuk#k-	29	.172		33	.333	#tu#uk#k-	35	.514	
		"	33	.212		36	.388	"	38	.421	
tun						tuun					
19	.368	#tu#n-									
20	.400	"									
tunn						tuunn					
23	.174	-tun#n-	20	.250							
24	.208	"	28	.250							
25	.160	"									
29	.172	"									
tus						tuus					
26	.384(2)	#tu#s-				28	.464	#tu#u#s-	28	.500	
						30	.466	"			
						33	.575	"			

Table 12 (Continued)

tuss			tuuss	
26	.192(2)	#tus#s-	31	.225
23	.173	#tus#s-	33	.212

tuz			tuuz		
19	.368(2)	#tu#z-	28	.535	#tu#u#z-
20	.400	"	29	.551	"
22	.363	"	29	.517	"

tuzz			tuuzz		
22	.272	-tuz#z-			
24	.291	"			
24	.333	"			

Table 13 /p/ + low vowel in French

pap						paap					
15	.400	#pap-	17	.294		25	.480	pa#a#p-	25	.600	
16	.375	#pap-	17	.353		26	.538	pa#a#p-	25	.640	
17	.352(2)	#pap-	20	.350		26	.576	pa#a#p-	26	.577	
						27	.555	pa#a#p-			
papp						paapp					
23	.260(2)	#pap#p-	26	.307		34	.470	#pa#ap#p-			
22	.318	#pap#p-	27	.222		38	.473	#pa#ap#p-			
pat						paat					
17	.529	#pat-	13	.462(3)		23	.654(2)	#pa#at-	30	.666	
27	.518	#pat#	25	.520		23	.696	#pa#at-			
24	.500	#pat#	25	.480							
patt						paatt					
22	.428	#pat#t-	22	.354(2)		30	.566	#pa#at#t-	33	.576	
17	.353(2)	#pat#t-				36	.556	#pa#at#t-	34	.500	
18	.333	#pat#t-									
pak						paak					
17	.706	#pak-	19	.421		20	.650	#pa#a#k-	20	.650	
16	.500	#pa#k-	19	.368							
14	.571	"	20	.400							
		"	17	.353							

Table 13 (Continued)

pakk					paakk				
16	.375	#pak#k-	26	.308	34	.529	#pa#ak#k-	33	.424
17	.411	"	28	.322			"	35	.457
14	.428	"							
22	.409	"							
pan					paan				
13	.384	#pa#n-	15	.533	23	.652	#pa#an-	24	.666
18	.388	"	16	.500	24	.666	"	28	.607
15	.533	#pan-	18	.444	28	.714	"		
16	.562(2)	"	18	.500	28	.678	"		
17	.529(2)	"	15	.466					
pann					paann				
21	.238	#pan#n-	24	.333	26	.423	#pa#an#n-	30	.600
23	.260(2)	"	26	.384	26	.461	"	30	.533
32	.312	"			27	.481	"		
					28	.571	"		
pas					paas				
26	.384	#pas-	21	.428	30	.500(2)	#pa#as-	29	.517
27	.370	"	22	.409	32	.500	"	30	.500
					32	.562	"	32	.500
pass					paass				
21	.333(2)	#pas#s-	25	.320	42	.476	#pa#as#s-	33	.485
22	.363	"	28	.358					

Table 13 (Continued)

paz

23	.652	#pa#z-
26	.615(2)	"

pazz

paaz

34	.617	#pa#az-
34	.647	"
37	.675	"

paazz

38	.710	#pa#az#z-
40	.700	"

Table 14 /p/ + high front vowel in French

pip						piip					
20	.400	#pip-		21	.381(2)	29	.621	-pi#ip-		32	.500
18	.445	#pip-		16	.312	31	.645	-pi#ip-		30	.466
pipp						**piipp**					
23	.218	#pip#p-		23	.260(2)						
		"		25	.200						
		"		27	.222						
pit						**piit**					
15	.266	#pit-		13	.384	18	.500(2)	#pi#i#t-		22	.545
15	.333	#pit-		14	.357(2)			"		23	.521
18	.277	#pit-		17	.353						
pitt						**piitt**					
18	.166	-pit#t-		22	.136	31	.322	#pi#i#t#t-		31	.290
19	.157	-pit#t-		23	.130	33	.363	#pi#i#t#t-		33	.303
20	.150	-pit#t-									
pik						**piik**					
12	.416	#pik#a-		11	.454	17	.529	#pi#i#k-		24	.500
13	.386	#pik#a-		12	.416	20	.500	#pi#i#k-		26	.539
18	.388	#pik-				21	.523	#pi#i#k-			
21	.380	"									
22	.363	"									

Table 14 (continued)

pikk					piikk				
17	.176	#pik#k-	16	.250	29	.448	#pi#ik#k-	24	.584
18	.166	#pik#k-	17	.177	32	.437	#pi#ik#k-	25	.560
19	.210	#pik#k-							

pin					piin				
16	.312	#pin-	20	.250	29	.586	#pi#in-	29	.448
16	.375	"	20	.300	29	.551	"	30	.500
18	.277	"	21	.285	30	.600	"		
19	.315	"							

pinn					piin				
15	.200	-pin#n-	20	.200					
19	.210	"	22	.181					
20	.200	"							

piss					piis				
29	.344	#pis-	20	.250					
25	.320	"	20	.200					
27	.333	"	18	.222					
25	.400	"							
24	.416(2)	"							

piss					piiss				
24	.291	#pis#s-	26	.153					
25	.280	"	27	.148					

Table 15 /p/ + high back vowel in French.

pup						puup					
17	.235	#pup-	16	.312		17	.470(2)	-pu#u#p-	23	.480	
20	.250	#pup-	18	.277		18	.444	-pu#u#p-	25	.434	
21	.333	#pup-	19	.315							
22	.318	#pup-									
pupp						**puupp**					
23	.174	#pup#p-	26	.230							
25	.160(2)	#pup#p-	27	.185							
		"	27	.148							
put						**puut**					
13	.312(2)	#pu#t-	17	.353		15	.437	-pu#u#t-			
16	.307	#pu#t-	17	.294		16	.533	-pu#u#t-			
						17	.470	-pu#u#t-			
						28	.607	-pu#u#t-			
						30	.600	-pu#u#t-			
putt						**puutt**					
21	.238	#put#t-	22	.182		34	.470	-pu#u#t#t-			
		"	27	.185		34	.500	-pu#u#t#t-			

Table 15 (continued)

puk					puuk				
12	.333	#pu#k-	14	.357					
		"	18	.333					
pukk					puukk				
pun					puun				
12	.250	#pu#n-	22	.272	22	.500	-pu#u#n-	22	.545
14	.214	"			23	.521	"	22	.454
					24	.500	"		
punn					puunn				
pus					puus				
26	.192	#pus-			23	.478(2)	-pu#u#s-	25	.480
27	.185	"			21	.476	"	26	.461
puss					puuss				
23	.130(2)	#pus#s-	24	.166					
21	.142(2)	#pus#s-	26	.192					
puz					puuz				
15	.266	-puz-			26	.423	#pu#u#z-		
16	.250(3)	"			30	.433	"		
					34	.441	"		

Table 15 (continued)

puzz			puuzz
23	.130	-puz#z-	
24	.125	"	
26	.115	"	

Table 16 /k/ low vowel in French

kap					kaap				
18	.444	#ka#p-	15	.400(2)	26	.423	#ka#ap-	31	.580
20	.400(2)	#ka#p-			27	.481	#ka#ap-	32	.625
					27	.518	#ka#ap-	33	.575
							-ka#a#p-	28	.500
							"	30	.500

kapp					kaapp				
25	.280	#kap#p-	26	.230					
		"	31	.258					
		"	22	.272					

kat					kaat				
20	.500	#kat-	20	.400			#ka#at-	20	.500
		"	21	.381			"	21	.476
		"	21	.428					

katt					kaatt				
22	.318	#kat#t-	24	.291	29	.517	#k#a#at#t-		
24	.333	"	25	.280(2)	30	.500	"		
25	.320	"					#ka#a#t#t-	27	.407
							"	30	.400

Table 16 (continued)

kak						kaak					
26	.423	#kak-				24	.625	#ka#ak-			
27	.444	#kak-				25	.640	#ka#ak-			
27	.407	#kak-				26	.615	#ka#ak-			
						22	.545	#ka#a#k-			
						23	.565	#ka#a#k-			
						21	.571	#ka#a#k-			
kakk						**kaakk**					
20	.300	-kak#k-									
22	.318	-kak#k-									
23	.304	-kak#k-									
kan						**kaan**					
17	.470	#kan-	15	.333(3)		30	.566	#ka#an-			
19	.421	"				30	.600(2)	"			
20	.400	"						#ka#a#n-	22	.454	
20	.450	"						"	23	.478	
								"	24	.458	
kann						**kaann**					
21	.285	#kan#n-	22	.272		30	.500	#ka#an#n-	30	.500	
27	.259	"	26	.307		32	.562	"	30	.533	
						32	.468	"			

Table 16 (continued)

kas						kaas					
32	.312	#kas-	34	.352		34	.535	#ka#as-	25	.440(2)	
33	.333	"	40	.300		35	.514	"			
34	.352	"	30	.333		37	.540	"			
kass						**kaass**					
33	.242	#kas#s-	27	.259		35	.400	#ka#as#s-	33	.393	
34	.324	"	28	.285		37	.432	"	35	.400	
37	.270	"	31	.290		40	.475	"			
kaz						**kaaz**					
30	.566 (2)	#kaz-				30	.666	#ka#a#z-			
30	.600	"				32	.656	"			
						32	.625	"			
kazz						**kaazz**					
22	.454	#kaz#z-									
23	.434	"									
25	.440	"									
25	.480	"									

Table 17 /k/ + high front vowel in French

kip						kiip					
16	.250	-kip-				27	.483	#ki#ip-	24	.333	
19	.210	-kip-				31	.481	#ki#ip-	26	.384	
20	.250	-kip-									
kipp						**kiipp**					
23	.086	-kip#p-	23	.130(2)							
24	.083	-kip#p-									
kit						**kiit**					
12	.333(2)	#ki#t-				23	.434(2)	#ki#i#t-	28	.357	
						20	.500	#ki#i#t-	30	.333	
						24	.500	#ki#i#t-			
						31	.516	-ki#i#t-	23	.478	
						29	.517	-ki#i#t-	26	.467	
kitt						**kiitt**					
27	.185(3)	#kit#t-	19	.157		33	.294	-ki#i#t#t-			
		"	19	.109		34	.303	-ki#i#t#t-			
kik						**kiik**					
15	.266	#kik-	15	.266		20	.500	-ki#i#k-			
15	.333	#kik-	14	.214		22	.500	-ki#i#k-			
16	.312	#kik-				24	.541	-ki#i#k-			
kikk						**kiikk**					

Table 17 (continued)

kin					kiin				
					22	.545	#ki#in-	25	.400
					25	.560	"	27	.370
					26	.538			

kinn					kiinn				
23	.130	-kin#n-	21	.190					
23	.174	"	26	.192(2)					
25	.120								

kis					kiis				
22	.227	#ki#s-	25	.280(3)	#kis-	39	.461	#ki#is-	34	.352
24	.208	"			"	40	.500	"	36	.333
27	.222	"								

kiss					kiiss				
		-kis#s-	28	.178(2)				-ki#is#s-	30	.433
								-ki#is#s-	26	.346

kiz					kiiz				
19	.421(2)	-kiz-							
20	.400	"							
10	.300	-ki#z-							
11	.363(2)	"							
14	.357	"							

Table 17 (continued)

kizz		kiizz
21	.142	-kiz#z-
22	.136	"
22	.181	"

Table 18 /k/ + high back vowel in French.

kup					kuup				
19	.315	#kup-			21	.476	#ku#u#p-	24	.375(2)
21	.333	"			21	.428	#ku#u#p-		
kupp					**kuupp**				
28	.148	#kup#p-	19	.263					
30	.166	#kup#p-	20	.250					
19	.210	#kup#p-	23	.260					
		"	23	.217(2)					
kut					**kuut**				
20	.300	#kut-	26	.307(2)	21	.523(2)	#ku#u#t-	22	.409
21	.285	#kut-	22	.409	22	.545	#ku#u#t-	23	.434
22	.318	#kut-							
26	.423	-kut#							
kutt					**kuutt**				
21	.238	-kut#t-	27	.222	38	.421	#ku#u#t#t-	29	.310
		-kut#t-	28	.272	38	.447	#ku#u#t#t-	33	.303
								33	.333
kuk					**kuuk**				
14	.357	#ku#k-			28	.607	#ku#u#k-		
15	.400	#ku#k-			31	.580	#ku#u#k-		

Table 18 (continued)

kukk					kuukk			
kun					kuun			
		#ku#n-	13	.153				
		"	14	.142				
		"	15	.133				
kunn					kuunn			
		-kun#n-	20	.150				
kus					kuus			
22	.181(2)	#kus-	15	.266	22	.363	#ku#u#s-	27 .259
23	.217	"	14	.214	22	.409	#ku#u#s-	28 .250
24	.208(2)	"						
18	.333	"						
kuss					kuuss			
24	.204	-kus#s-	21	.142				
		"	23	.130				
kuz					kuuz			
25	.320(2)	#kuz-			30	.566	#ku#u#z-	
26	.346(2)	"			33	.600	"	
					34	.588	"	

Table 18 (continued)

kuzz			kuuzz
25	.160	#kuz#z-	
27	.185	"	

APPENDIX II

This Appendix is the key to Appendix I. Besides each sequence, the Eskimo word is given with its English meaning. It was chosen to adopt the following convention for convenience: in these tables /q/ = [x] and /g/ = [ ], the /ŋ/ is the velour nasal sound found in English '<u>singer</u>'. For the French sequences the words or utterances corresponding to each minimal pair is given besides each sequence; the (slg) sign means slang and (coll) means colloquial. No English translation was given for those utterances.

KEY TO TABLE 1

tap	/tapik/ addition, to go through two layers	taap	/nutaapikkua/ Those up there are new
tapp	/tappaani/ up there	taapp	/pitaappaa/ if he gets one
tat	/tatavuk/ it is full	taat	/ataatak/ father /ataatakkuka/ my father & Co.
tatt	/tattuuk/ fog	taatt	/taattuk/ dark
tak	/takuvuk/ he sees /takanani/ in there /takanna/ that one	taak	/taakittuk/ small shadowed
takk	/takkuvuk/ /ataatakkuka/ my father & Co.	taakk	/taakkua/ those
tan	/atanik/ king, queen	taan	/taanik/ the shadowing
tann	/tannak/ big, fat	taann	/taanna/ that one
tas	/tasik/ pond	taas	/qimmitaasimajuk/ he has acquired dog
tag	/nutagak/ baby	taag	/taaga/ south
tagg		taagg	
taq	/taqak/ vein	taaq	
taqq	/taqqa/ here it is	taaqq	

KEY TO TABLE 2

tip	/tipik/ the smell	tiip	/atiipimmat/ go ahead he has done it
tipp	/atippat/ if when he puts on /tutippaa/ he steps on him	tiipp	/atiippaa/ if he puts his garment on
tit	/titik/ to mark	tiit	/Tiituusi/ Titus
titt	/tittipuk/ boiled	tiitt	
tik	/tikik/ finger /tikiinnatuk/ he always arrives	tiik	/tiikittuk/ weak tea
tikk	/tikkuavuk/ he points	tiikk	/atiikka/ my two names
tin	/tinik/ low tide	tiin	/tiina/ Tina
tinn	/atinnik/ the returning	tiinn	/allatiinnataga/ I always make him write
tis	/atisi/ your names	tiis	/atiisi/ or you all go ahead
tig	/atigik/ coat	tiig	/atiigik/ two coats
tiq	/atiqanntuk/ he has no name	tiiq	/itiiqivuk/ he has bare bottom
tiqq	/tiqqaak/ seal		

KEY TO TABLE 3

tup	/tupik/ tent	tuup	/ittuupikkua/ those two up there are old men
tupp	/tuppat/ when it lands	tuupp	/inutuuppat/ if he is alone
tut	/tutippaa/ he steps on him	tuut	/taggatuutik/ mirror
tutt	/tuttuk/ caribou	tuutt	/putuuttaga/ he is drilling a hole
tuk	/tukik/ to kick /tukivuk/ he kicks	tuuk	/tuukak/ the pecking
tukk	/tukkak/ football (the kicking). /tukkapaannak/ don't you be kicking too much	tuukk	/tuukkak/ harpoon head
tun	/tuniit/ /tunuk/ back side	tuun	/inutuuniattut/ he will be alone
tunn	/tunniit/ your landing /tunnuk/ caribou fat	tuunn	/inutuunnina/ his being aloneness
tus	/tusavuk/ he hears	tuus	/inutuusuuk/ he can be alone /tiituusi/ Titus
tug	/atuguk/ use it	tuug	/putuugik/ to make a hole
tugg		tuugg	
tug	/putugannituk/ it has no hole	tuuq	
tugg	/putuqqavuk/ it has a hole	tuuqq	

KEY TO TABLE 4

pap	/papikak/ short tailed	paap	/illupaapit/ your big houses
papp	/upappat/ if he comes to you in a threatening way	paapp	/ilupaappat/ if, when she puts on her slip
pat	/patik/ marrow	paat	/ilupaatik/ your slip (female garment)
patt	/pattak/ ball /pattijuut/ baptism	paatt	/napaattuk/ tree
pak	/pakik/ to screw (slg)	paak	/paaka/ parka
pakk	/pakkua/ those up there	paakk	/ilupaakkik/ slips (female garments)
pan	/panik/ daughter	paan	/paani/ up there /tappaani/ up there
pann	/pannik/ dry tree	paann	/tukkapaannak/ don't you be kicking too much
pas	/pasik/ to blame	paas	/paasuuk/ he can wrestle

KEY TO TABLE 5

pip	/pipikittuk/ small "pipiked"	piip	/piipak/ paper
pipp	/pippat/ if he does	piipp	/piippat/ if it comes off /piippuk/ he came off
pit	/pituk/ bridle /pitaappaa/ if he gets one	piit	/tappiituk/ he has poor eyesight
pitt	/pittuvuk/ it drifts	piitt	/piittuk/ not slippery
pik	/pikani/ up there /pipikittuk/	piik	/piikak/ peacock
pikk	/pikkua/ those up there /nutaapikkua/ those up there are new /ittuupikkua/ those two old men up there	piikk	/piikka/ mine (Dual)
pin	/pinik/ the insole	piin	/piinik/ negativeness
pinn	/pinnavuk/	piinn	/piinniquk/ it has come off
pis	/pisuk/ to walk	piis	/piisi/ peas

KEY TO TABLE 6

pup	/pupik/ eczema	puup	/puupikkua/ those 2 are bags
pupp	/ipuuuk/ he is paddling	puupp	/supuuppat/ if he blows
put	/aputik/ snow /putuvuk/ he holes it	puut	/ipuutik/ oar
putt	/iputtajuk/ he carries paddles /puttavuk/ he floats	puutt	/supuutuk/ he is blowing
puk	/ipukuk/ to pick chips	puuk	/puukavuk/ jumping
pukk	/pukkituk/ stand low in water	puukk	/puukka/ my bags
pun	/ipuniattuk/ he'll row	puun	/supuuniattuk/ he will blow
punn	/apunnik/ the bumping	puunn	/napuunnik/ two bars
pus		puus	

KEY TO TABLE 7

kap	/kapik/ /tukkapaannak/ don't you be kicking too much	kaap	/kaapak/ copper
kapp	/nukappiak/ child	kaapp	/kaappuk/ he goes accross
kat	/katak/ to fall	kaat	/kaatak/ garter
katt	/qikatti/ the inactive one	kaatt	/ikaatuuk/ one who goes across
kak	/kakivak/ fish spear	kaak	/kaakittuk/ he has small hunger
kakk	/kakkivuk/ he blows his nose	kaakk	/ikaakkiit/ do you go to the opposite side
kan	/takanani/ up there /pikani/ up there	kaan	/ikaani/ on the opposite side
kann	/takanna/ that one	kaann	/ikaanniatuk/ he will go accross
kas	/nuukasaak/ to nearly move	kaas	/ikaasuuk/ he can go across

KEY TO TABLE 8

kip	/kipik/ to cut off	kiip	/sikkiipuk/
kipp	/akippaa/ he replied to him	kiipp	/kiippat/ if he bites
kit	/kitaa/ side away from wind /akitik/ pillow	kiit	/kiita/ only
kitt	/ikittuk/ very little /kaakittuk/ he has small hunger /pipikittuk/ small "pipiked"	kiitt	/akiittuk/
kik	/ikikik/ small flamed	kiik	/kiikittuk/ has small bite
kikk	/kikkut/ who? (plural)	kiikk	/akiikka/ my prices (dual)
kin	/kina/ who (sing)	kiin	/kiinak/ face
kinn	/ikinna/ that one	kiinn	/tikiinnatuk/ he always arrives
kis	/tukisik/ to understand /kisak/ anchor	kiis	/kiisivuk/ he bites him

KEY TO TABLE 9

kup	/kupuk/ to pick chips	kuup	/ittukuupikkua/ two old men up there
kupp	/ikuppak/ leaned on	kuupp	/qakqakuuppat/ if he goes by the hill
kut	/kuti/	kuut	/kuuti/ God
kutt	/akuttak/ to throw a ball	kuutt	/qakqakuuttuk/ he is walking over the hill
kuk	/kukik/ finger nail	kuuk	/kuukittuk/ he has small brook
kukk	/kukkivuk/ he has something between his teeth	kuukk	/kuukka/ my brooks
kun	/ukununa/ to these ones	kuun	/ikuuna/ throw that way
kunn	/akunnik/ long time	kuunn	/qakqakuunnatuk/ you have to climb over a hill
kus	/ikusik/ elbow	kuus	/kuusuuk/ running streem)

KEY TO TABLE 10

#tap-	tapette (slg.)	#t#a#ap-	t'as appuyé t'as apporté
#tap#p-	tapes pas comme ça (coll.)	#t#a#ap#p	t'as "hâpe" putain! (slg.)
#ta#t-	ta tête	#t#a#at-	t'as attendu
#tat#t-	tâtes ta tête	#t#a#at#t-	t'as hâte tu sais!
#tak-	taquin	#t#a#ak-	t'as accompagné t'as à côté
#tak#k-	le tac que fait la montre	#t#a#ak#k-	t'as "ac" couillon (slg.)
#ta#n-	ta noce	#ta#an-	t'as Annie (coll.)
-tan#n-	le métane n'est pas bon	#ta#an#n-	t'as "Âne" non pas "mule"
#ta#s-	ta salle	#t#a#as-	t'as assez
#tas#s-	tasse salle	#t#as#s-	t'as as'simple
-t#az-	c'est azur		
-taz#z-	extaze zélée		

KEY TO TABLE 11

#tip-	typique	-ti#ip-	le parti "hypié"
#tip#	type		
#tip#p	un type pas bête		
#tit	Titi	-ti#i#t-	Titi i' tape (coll.)
-tit#t-	petit tapette	-ti#i#t#t-	Titi i't'tape (coll.)
#tik-	tiket	-ti#i#t-	Titi i'casse (coll.)
-tik#k-	une pratique couchée		
-t#in-	c'est inné	-t#i#in-	c'est'y inné coll.)
-tin#n-	Martine ne le voit pas		
#tis	tissage	#t#i#is-	c'est-y ici? (coll.)
#tis#s-	elle tisse sa toile	#t#i#is#s-	c'est'y "hisse" savez vous? (coll.)
#tiz-	tison	-ti#iz-	la partie izométrique
#tiz#z-	expertize zélée		

KEY TO TABLE 12

#tup-	toupet	#tu#u#p-	tout ou pas une
#tu#p-	tout pouri		
-tup#p-	étoupe pourie		
#tut#	toute	#tu#u#t-	tout ou ta vie
#tut-	toutou		
#tut#t	toute ta vie	-tu#u#t#t-	il a cherché partout ou t'trouver
#tu#k-	tout cassé	-tu#u#k-	âtout ou carreau
#tuk-	toucan		
#tuk#k-	touque cassée	#tu#uk#k-	tout "houc" qu'il est il n'me fait pas peur
#tu#n	tout noir		
-tun#n-	Martoune ne veut pas		
#tu#s-	tout ça	#tu#u#s-	tout ou sa vie
#tus#s-	il tousse sans arrêt		
#tu#z-	tout zéro	#tu#u#z-	tout ou zéro
-tuz#z-	partouze zelée (slg.)		

KEY TO TABLE 13

#pap-	papa	pa#a#p-	papa a pas vu (coll.)
#pap#p-	le pape Pie XII	pa#ap#p-	pas "hape" putain! (slg.)
#pat-	Paturel	#pa#at-	j'ai pas attendu
#pat#	pattes pâte		
#pat#t-	des pâtes toulonaises	#pa#at#t-	j'ai pas hâte tu sais
#pak-	paquet		
#pa#k-	pas catholique	-pa#a#k-	pas à côté
#pak#k-	Pâques catholiques	#pa#ak#k-	pas "ac" couillon "ic" (slg.)
#pa#n-	pas nouves	#pa#an-	c'est pas Annie
#pan-	panique		
#pan#n-	une panne nocive	#pa#an#n-	c'est pas Anne non plus
#pas-	passage	#pa#as-	pas assez
#pas#s-	passe surtout à droite	#pa#as#s-	c'est pas as simple!
#pa#z-	pas un	#pa#az-	c'est pas azur
#pa#az#z	pas "haze zébrée"		

KEY TO TABLE 14

#pip-	pipi	-pi#ip-	un hypie hypique!
#pip#p-	la pipe parait verte		
#pit-	pitanche	#pi#i#t-	et pis i'tape! (Coll.)
#pit#t-	épit'trop long	#pi#i#t#t-	et pis i't'tape! (coll.)
#pik#a-	pique assiette	#pi#i#k-	et pis i'connait (coll.)
#pik-	piquet		
#pik#k-	pique cassé	#pi#ik#k-	le pis "hic" qui existe
#pin-	piné (slg.)	#pi#in-	un Pi inné
-pin#n-	épine noire		
#pis-	pissou (slg.)		
#pis#s-	pisse sous la porte (slg.)		

KEY TO TABLE 15

#pup-	poupée	-pu#u#p-	ton époux ou papa
#pup#p-	la poupe pourie		
#pu#t-	un pou tout gras	-pu#u#t-	ton époux ou ton frère j'ai dis à ton époux où taper
#put#t-	une poûtre trop longue	-pu#u#t#t-	j'ai dis à ton époux où t'taper (doll.)
#pu#k-	époux qui vit		
#pu#n-	un pou nocif	-pu#u#n-	c'est ton époux ou Nono
#pus-	il poussa		
#pus#s-	pousse-ça	-pu#u#s-	ton époux ou son frère
-puz-	il épousa	#pu#u#z-	ton poul ou zéro
-puz#z-	épouse zélée		

KEY TO TABLE 16

#ka#p-	un cas pas beau (coll.)	#ka#ap-	"K" appelle
#kap#p-	le cap percé le cap pas beau	-ka#a#p-	un Inous à poil
#kat-	catin	-ka#at-	cas attirant
#kat#t-	quat'tapettes	#k#a#at#t-	toi qu'as hûte tu sais bien
#kak-	kaki	#ka#ak-	cas actif
		#ka#a#k-	un cas à connaître
-kak#k-	le maçaque connait		
#kan-	canard canapet	#ka#an-	le cas Annie
		#ka#a#n-	le cas à nuire
#kan#n-	la canne noire	#ka#an#n-	le cas Anne n'est pas bon
#kas-	cassé	#ka#as-	un cas assez grave
#kas#s-	casse ça	#ka#as#s-	le cas "as simple"
#kaz-	casé	#ka#a#z	le cas à Zurich
#kaz#z-	la case zéro		

KEY TO TABLE 17

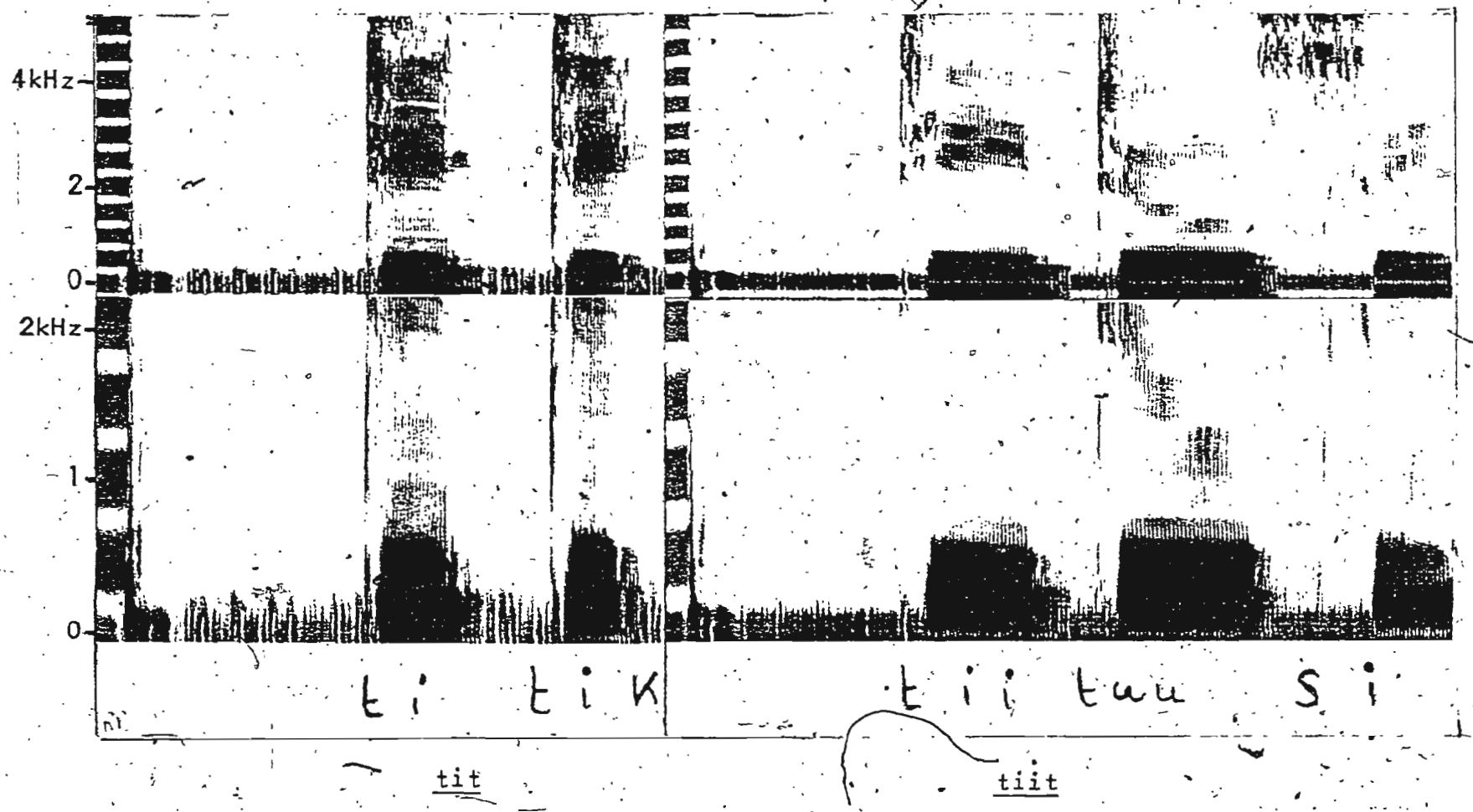
-kip-	équipage	#ki#ip-	c'est qui Hypolite
-kip#p-	l'equipe peut jouer	#ki#i#t-	celui qui y touche
#ki#t-	qui t'as dit ça	-ki#i#t-	Kiki i'tape
#kit#t-	tu quites tôt	-ki#i#t#t-	Kiki i't'tape
#kik-	Kiki	-ki#i#k-	Kiki i'casse
-kin-n-	enquiquine nous (coll.)	#ki#in-	c'est qui inocent
#ki#s-	qui ça	-ki#is-	Kiki hystérique
-kis#s	esquisse sale	-ki#is#s-	Kiki hisse sa voile
-kiz-	maquisard		
-ki#z-	marquis zélé		
-kiz#z-	marquise zélée		

KEY TO TABLE 18

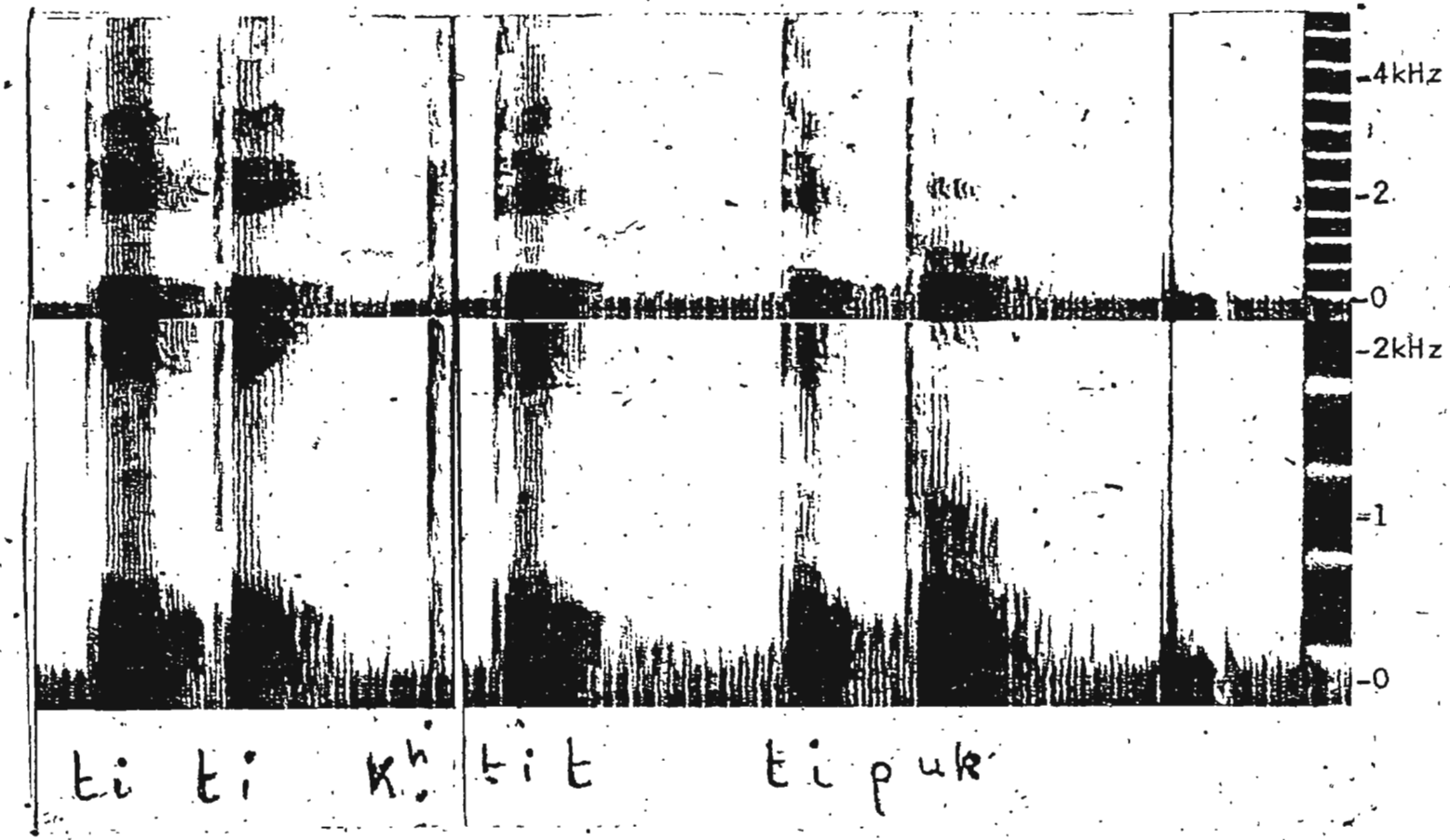
#kup-	coupure	#ku#u#p-	un coup ou pas tout
#kup#p-	coupe percée coupe ps ça		
#kut-	couture écoute	#ku#u#t-	un coup où tout compte
-kut#t-	écoute tout ça	#ku#u#t#t-	un coup ou t'toucher
#ku#k-	un cou cassé	-ku#u#k-	c'est "cou" ou "con"
#ku#n-	un coup nouveau		
#ku#s-	à coup sûr couscous coussi-coussa		
-kus#s-	couscous salé		
#kuz-	cousu	ku#u#z-	un coupon zéro
#kuz#z-	qu'elle couse zéro!		

APPENDIX III

Example of Spectrographic displays used for duration measurements.

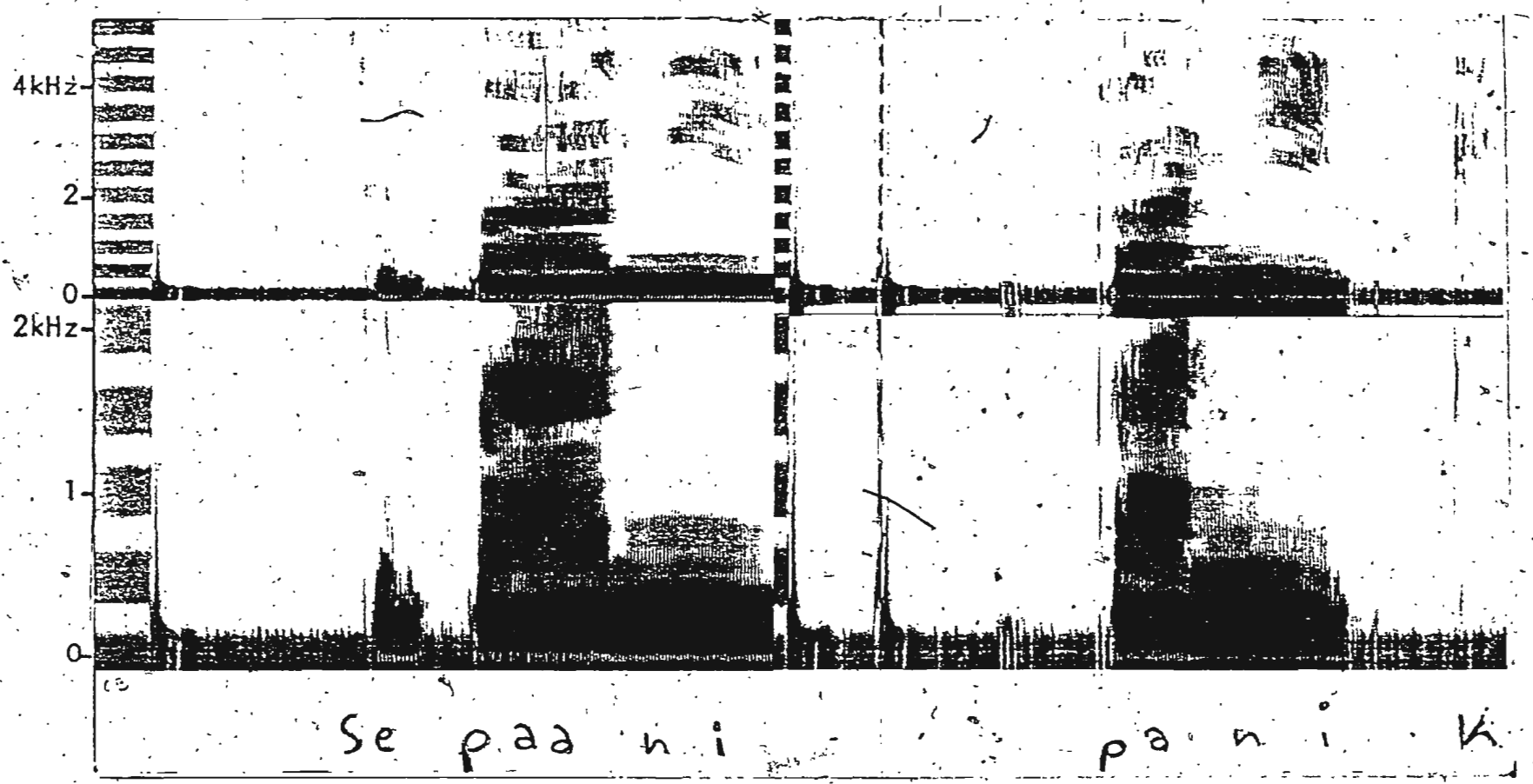


Vowel Doubling Before Stop : Eskimo Female (see Table 2)



tit titt

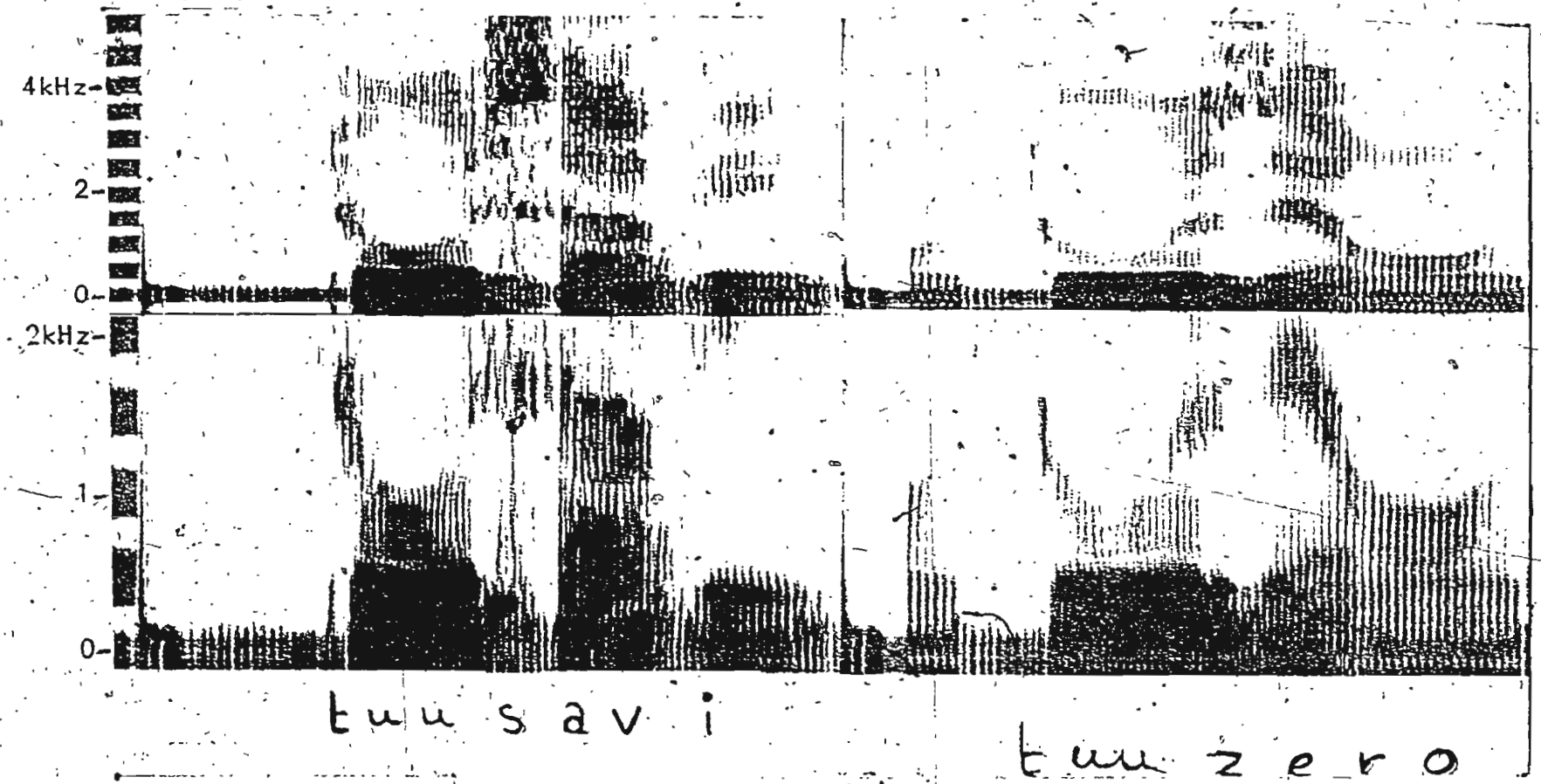
Consonant Gemination : Eskimo Male (see Table 2)



#pa#an-

#pan-

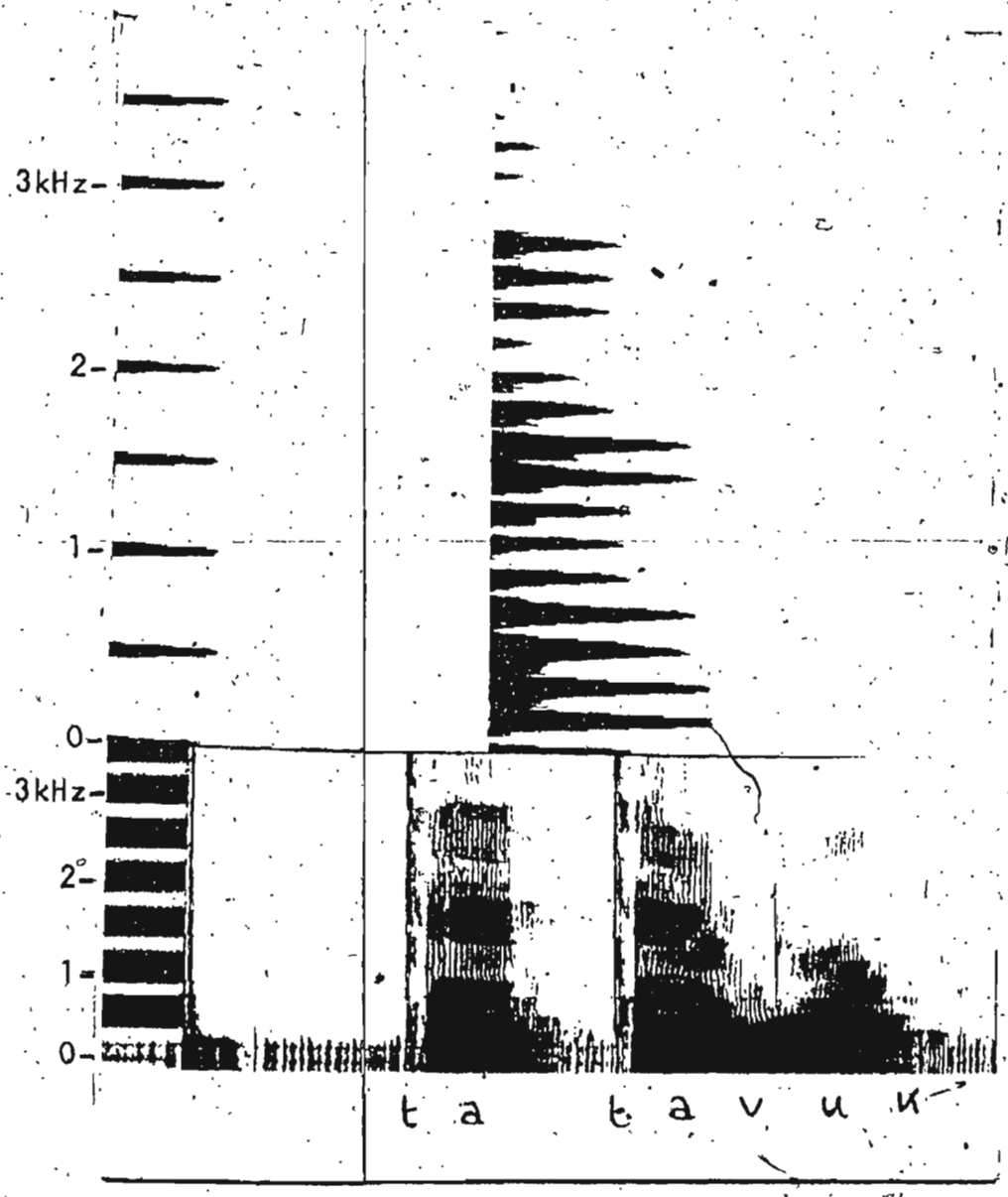
Vowel Doubling Before Nasal : French Female (see Table 18)



Voicing of Fricatives : French Male (see Table 12)

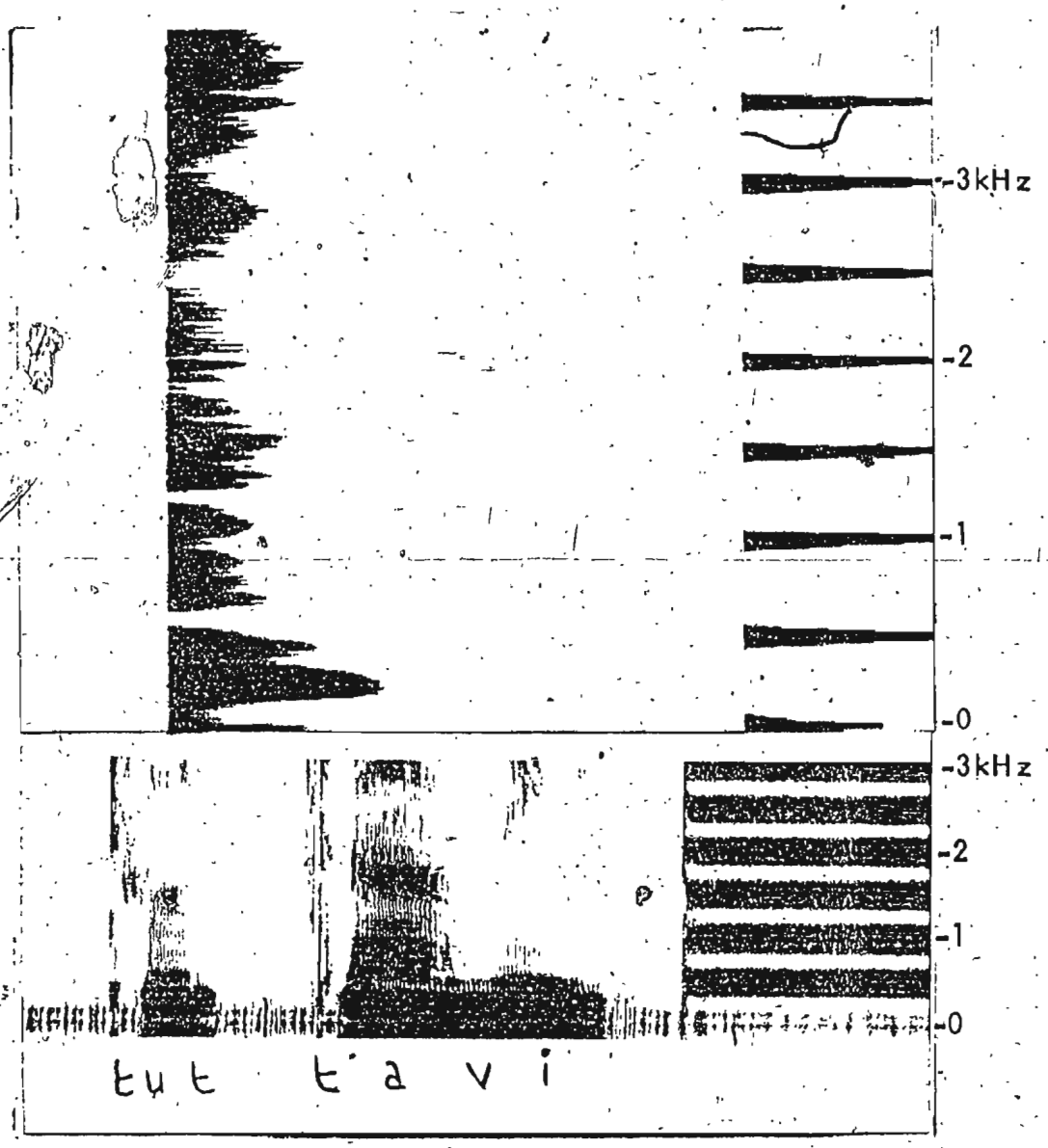
APPENDIX IV

Examples of vowel sections used in measuring frequencies and intensities of formants.



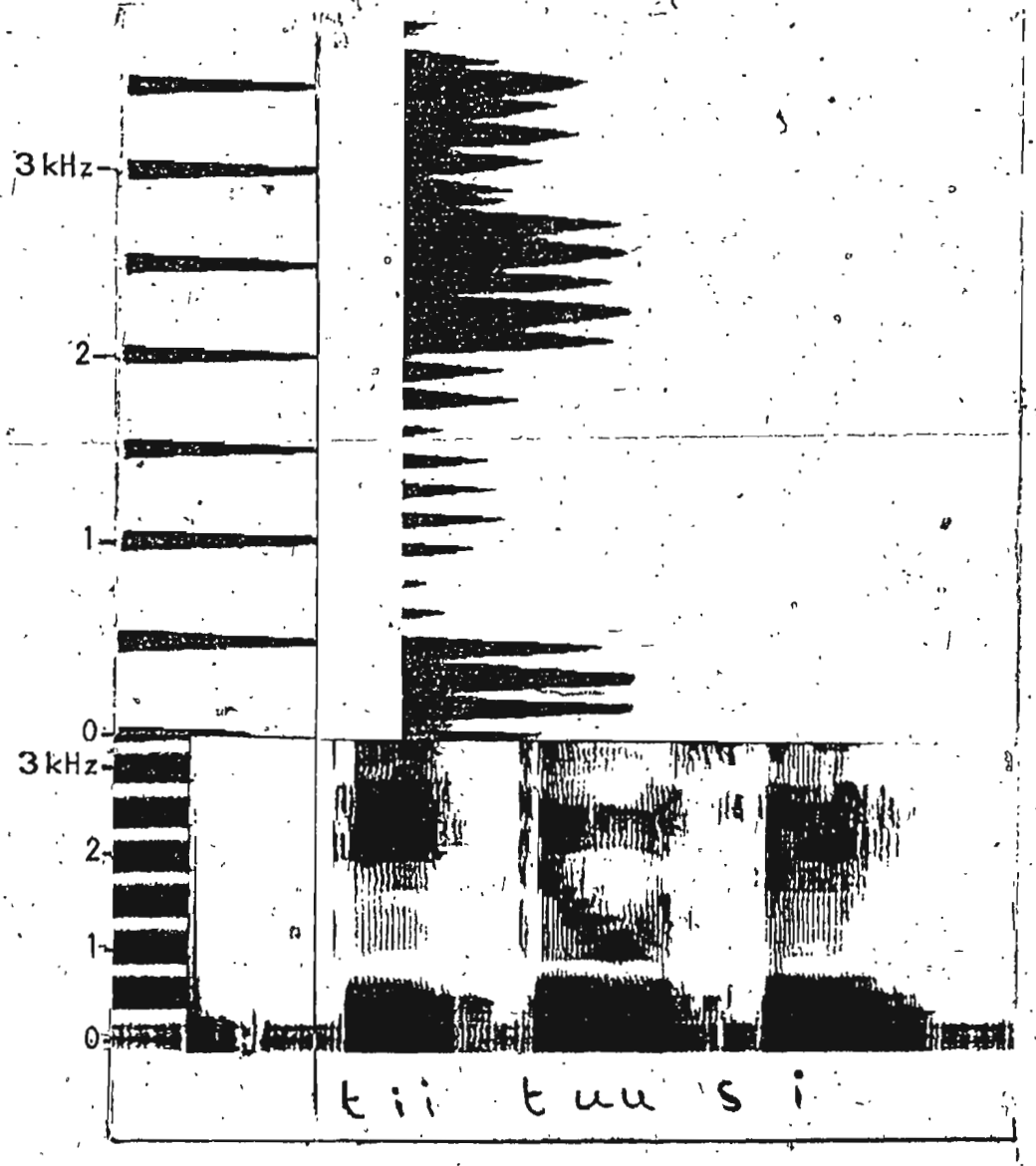
tat

Eskimo Female (see Table 1)



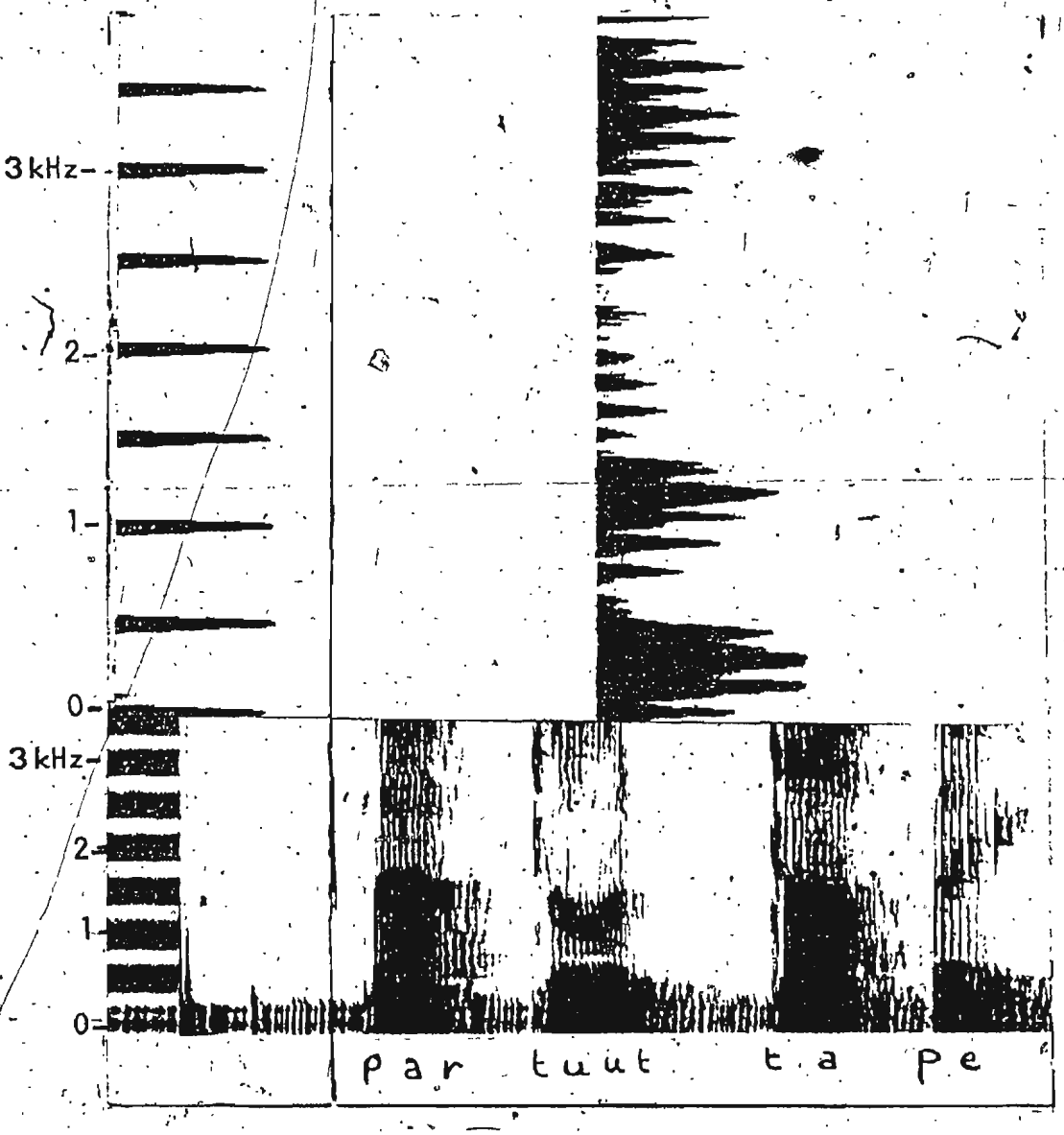
#tut#t-

French Female (see Table 12)



tiit

Eskimo Male (see Table 2)



-tu#u#t#t-

French Male (see Table 12)