A STUDY OF CONSONANT QUANTITY IN WEST GREENLANDIC

Hideo Mase and Jørgen Rischel

1. Introduction

The phonetic structure of Eskimo words is characterized by very heavy constraints on the possible clusterings of consonantal segments. These constraints become heavier the further one proceeds toward the East. In Greenland, which is the easternmost part of the contiguous region in which Eskimo is spoken, the surface phonetic word structure is characterized by a very monotonous distribution of consonant segments (see section 2. below; also cf. Bergsland 1955 p. 3, where it is shown that this is an innovation of modern Greenlandic).

On the other hand, Greenlandic is characterized by a high degree of utilization of the contrast between short and long, or single and geminate, segments. This is true of vowels as well as consonants. The importance of quantity was emphasized already in the earliest grammar of West Greenlandic (Egede 1760 p. 6-7), where it is stated that there are two kinds of "accent", viz. long and short. The data given are somewhat confusing, but there are at least some examples which - also in modern West Greenlandic - are perfect minimal pairs, e.g. /manna/[1] 'this' (Egede: Mánna) versus /maanna/'now' (Egede: Mânna); /agi(j)utaa/ 'his file' (Egede: Aggiutá) versus /aggi(j)utaa/ 'his day of arrival'

---

1) For practical reasons we frequently refer to a slightly modified version of the autonomous phonemicization found in such works as Swadesh (1946), Bergsland (1955). Slant lines are used only with autonomous phonemic notations; abstract representations of a generative phonology are underlined when occurring in running text.

(Egede: Aggiúta). - In contemporary language the functional load of the quantity contrast has obviously increased compared to the eighteenth century, because far-reaching assimilation processes have been at work after that time. Several of these processes survive as rules of grammar in modern West Greenlandic: there are numerous clusters of unlike consonant segments or of unlike vowel segments in the morphophonemic representation, but most of these do not appear at the surface phonetic level, because they are subject to assimilation (or other processes, e.g. metathesis).

The long or geminate consonant segments that occur in West Greenlandic sometimes have a clearly heteromorphemic origin. There is a suffix meaning 'new' which occurs with initial /t/ in such forms as /irnirtaaq/ 'new son' (cf. /irniq/ 'son', which shows that the uvular element "/r/" is a variant of the stem final segment). When the suffix is added to stems ending in a non-uvular consonant, e.g. the stem in /kamik/ 'boot', we get /tt/ (ɔ: [t:]) by complete assimilation: /kamittaaq/ 'new boot'. This is an extremely common type of process with most types of suffix initial consonant.

There is, however, another major source of Greenlandic long/geminate consonant segments, namely the process generally referred to as gemination (see Bergsland 1955 p. 9-13). This process is apparently rather independent of morpheme boundaries. In many cases it affects a (synchronically) morpheme internal consonant which is geminated in connection with the addition of certain suffixes (that also often condition a modification of the final part of the stem), e.g. /nukaq/ 'younger sibling (of same sex)', plural /nukkat/; /sanawuq/ 'he works (with woodden material)', /sannawik/ 'a workshop'. (An attempt at a description of this process will be given in section 2.4. below.)

There is much disagreement among scholars on the cause of gemination as a historical process, and it is also a crux in synchronic phonology. It is obviously of importance for the appraisal of different explanations of this process to study various aspects of the phonetic relationship between forms with long and short consonant segments in Eskimo.

In the current phonemicization long/geminate consonants are denoted by double consonants (irrespective, of course, of their origin). In addition it posits two types of consonant clusters: (1) uvular fricative plus consonant, and (2) a unique cluster /ts/. It has, however, been noted by various scholars that the quantity relationships in these clusters are very peculiar.

In clusters such as /rn/[2] in /irniq/ 'son' the second segment of the alleged consonant cluster (i.e. /n/) clearly sounds long, and native speakers asked to utter the word slowly and chopped into syllables definitely tend to say "irn-niq" rather than "ir-niq". However, it is open to question whether different types of consonants behave differently in this respect. Moreover, it is open to question whether the post-uvular segment should be classified in systematic phonetic terms as a truly long segment (essentially similar to /nn/ in /inniq/ 'fire'), or whether it is only a somewhat prolonged variety of the short type of segment (as in /ini(q)/ 'room').

As for the cluster that is generally rendered as /ts/ (in e.g. /tatsit/ 'lakes', /natsat/ 'caps', /tuqutsiwuq/ 'he performs killing') the phonetically trained listener hears the first, i.e. occlusive, portion of it as long or geminate, whereas the fricative portion seems to be short. It thus makes sense to transcribe the auditory impression of this cluster as a long affricated [t:^{s}] or as a combination of stop plus affricate [t¢].[3] However, its rela-

---

2) The symbol r is generally used to denote a uvular fricative in Eskimo.

3) The symbol ¢ denotes a rather advanced affricate.

tionship to other types of short (single) and long (geminate) coronal stops is a problem.

The question of <u>short (single) or long (geminate)</u> in these clusters is of interest from a general theoretical point of view, because the phonological processes that apply to them are controversial. Before entering into this it is necessary to repeat that the clusters in question are not the only <u>underlying</u> clusters in the language. Long consonant segments often reflect a succession of two consonants separated by morpheme boundary, since in most types of clusters (except uvular plus consonant and t+s) we find a complete, regressive assimilation, e.g. k+t → tt ([t:]), k+s → ss ([s:]). Hence it makes sense to assume a priori that clusters like r(+)n, t(+)s should be comparable in duration to the ordinary long consonant segments occurring in the phonetic surface representation of West Greenlandic, since the underlying representations are of similar complexity.

As for the clusters of uvular plus consonant the general problem may be put quite briefly like this: are these clusters (1) subject to a peculiar phonological rule that lengthens the second segment, or are they (2) subject to a very ordinary assimilation rule according to which a greater or lesser part of the first segment is assimilated to the second (with regard to some or all features) and hence produces the effect of a prolongation of the latter? - As for /ts/ one might likewise suggest two phonological explanations of the longer closure hold: (1) there is a rule that lengthens stop before homorganic sibilant, (2) the sibilant is partly assimilated to the preceding homorganic stop.

It has been amply demonstrated in phonetic literature that the phonological categories "long" and "short", or "single" and "geminate", cannot be generally defined in terms of absolute values of physical duration. The actual duration of a segment is conditioned by a complex of factors having to do both with the context in which the segment occurs and with inherent features of the segment itself. Nevertheless, it can hardly be denied that a phonological grammar that assigns the values "long" and "short" to particular phonetic segments is more successful in doing so if there is a reasonable correlation between these terms and measurable quantities. If, now, we assume that the extra segment length in the clusters above is due to segment lengthening rules, then this account would seem to be corroborated if the total duration of these clusters clearly exceeds the duration of other entities of the same phonological size (i.e. if the total duration of, say, q+t → rt considerably exceeds that of k+t → tt, [t:], etc.). Conversely, the assumption that we have to do with a purely assimilatory phenomenon would seem to be corroborated if the total duration of the clusters in question is essentially similar to that of ordinary long (geminate) segments, such as [t:] from underlying k+t, etc.

As regards /ts/ the phonological situation is quite complex. There exists in the language an affricate [t^s] or, in an alternative transcription, [¢], which in all respects counts phonologically as a single, short segment. It is the obligatory reflex of underlying t before i (e.g. in such forms as /tii(q)/ 'tea', /atiq/ 'name', /aallartippaa/ 'he lets him travel away'), and this affrication is found also with the long stop segment arising from non-uvular consonant plus t before i (e.g. in /allatti/ 'secretary', with tt from underlying k+t). Obviously, t and s are neutralized in the position between t and i. Phonetically there is only one long segment or cluster beginning with a coronal stop in the position before i, which may be transcribed [$t{:}^s$] or [t¢]. It sometimes derives from underlying t(+)s and sometimes from underlying $\left\{\begin{matrix}t\\k\end{matrix}\right\}$(+)t, but there is no distinction between "/ts/" and "/tt/" before /i/ on an autonomous phonemic level (see section 2.2. below concerning the inadequacy of the current autonomous phonemicization). This double origin of the long coronal affricate must be taken into consideration in formulating the rules deriving it from t(+)s. To put it in a somewhat oversimplified way, one may ask whether tt becomes ts before i (and hence is affected by some, probably late, rules which modify the durational relationship between t and s in this cluster), or whether ts and tt become a long (geminate) affricated stop segment by entirely different rules (these very rules producing the neutralization).[4] It must clearly be of interest to check the phonetic adequacy of such different analyses by measuring whether the affrication of the long affricate is so similar to the affrication of the short affricate (derived from single t before i) that they can be considered the same articulatory gesture. If this appears to be true, it seems beyond dispute that we should derive the affrication of underlying tt and t before i by the same rule(s) rather than assume that /tt/ takes a different path (via ts) through the phonological rules. If, on the other hand, we are faced with two clearly different kinds or degrees of affrication, the other solution may not be a priori out of question.

The phonological problems mentioned above are clearly not just problems of the synchronic description but just as much problems of diachrony. What is the nature of the historical processes that have produced the present consonant pattern of Greenlandic Eskimo? Measurements of physical segment duration do not in themselves provide answers to such questions, but they may help to show whether the phonetic framework on which the phonological explanations are based, is a plausible model of what actually goes on.

---

4) The apparent third possibility: ts → tt/_i is out of question, since ts behaves essentially alike before all vowels.

The remainder of this paper contains first a more detailed presentation of the role of consonant length (gemination) and affrication in the phonology of modern West Greenlandic, arguments being adduced in favour of a particular conception. - After this follows the presentation of a rather extensive set of measurements of consonant duration in West Greenlandic, and finally a brief discussion of how the results agree or disagree with the phonetic model implied by the phonological rules.

2. Elements of West Greenlandic phonology

2.1. The traditional description: autonomous phonemic pattern

The phonemicization that is generally used in transcribing West Greenlandic and related dialects in linguistic papers and manuals, comprises the following inventory (disregarding some quite peripheral items):

vowels:	/a i u/
stops:	/p t k q/
nasals:	/m n ŋ/
sibilants:	/s ṣ/
other continuants:	/w l j g r/

Some of these symbols are sufficiently self-explanatory (in terms of the IPA standard) for the purpose of the present paper. Note, however, the following:

(stops:) /k/ is midpalatal/prevelar; /q/ is uvular.

(sibilants:) /ṣ/ (generally transcribed /ʃ/) is nonanterior.

(others:) /l/ is sometimes lateral, sometimes flapped or articulated as a slightly fricative tongue-tip [ɹ] ; /j/ (generally transcribed

/y/) is a palatal glide; /g/ (often transcribed /ɣ/ is a midpalatal/prevelar fricative; /r/ (often transcribed /ɣ̣/)[5] is a uvular fricative.

The most important[6] rules of allophonic variation according to this type of analysis are:

(aperture:) all vowels are lowered and retracted before uvulars; on the other hand, /a/ is raised before non-uvular consonants in the same syllable (i.e. before consonant clusters or word final consonants); in other positions /i u/ are (essentially) high, /a/ low.

(length:) in the cluster /ts/ the first consonant is long; in other clusters of two different consonants the second consonant is long.

(voice:) stops and sibilants are unvoiced; nasals are voiced; other consonants are voiced in those positions where they are manifested as short segments, but unvoiced elsewhere.

The rules of combinability of autonomous phonemes depend heavily on the interpretation of such sequences as [...i^{j}a...], [...u^{w}i...] (see section 2.2. below). If we assume (somewhat arbitrarily) that there is a consonant segment in this position, the rules for syllabification become very simple, and the other rules of combination become simple as well:

(syllabification:) Two vowel phonemes in succession form one syllable. The vowels of adjacent syllables (within

5) The presentation in Hill (1958 p. 420-421) is erroneous due to a confusion of the symbols used by Swadesh (1946).

6) Phenomena not directly relevant to the present paper are disregarded here.

one "word")[7] are separated by one or two consonants. The initial syllable of the word may begin with zero or one consonant, the final syllable may end with zero or one consonant.

(distribution of vowels:) All vowels occur single and geminate. There is one diphthong /ai/, which however occurs only in absolutely word final position.

(distribution of consonants:) All consonants (excluding /j/, which was defined above as a glide) occur single as well as geminate. Word initially only noncontinuants, i.e. stops and nasals (except /ŋ/), are found. Word finally only stops are found. In addition to the phonemic geminates there is a series of clusters consisting of /r/ plus consonants which occur intervocalically. The second constituent of these clusters may be any consonant, except that /k g/ as well as the glide /j/ do not combine with /r/. Finally there is a unique cluster /ts/ occurring in intervocalic position.

2.2. Some major inadequacies of the autonomous phonemic notation

In contemporary phonological work the interest has shifted very much from autonomous phonemics to models that can be integrated into a transformational generative grammar. It has been argued that autonomous phonemic descrip-

---

7) For practical reasons we use the straightforward term "word" (i.e. phonological word) instead of some other term such as "phrase" or "stretch" (Bergsland's term) in referring to such complex entities as /qiturnartaaŋŋu(w)aq/ 'a little newborn child'. From a phonological point of view, at least, they are no less words than such forms as loneliness, regretfully, or man-eater in English.

tions do not constitute a significant level of linguistic structure. Nevertheless, people still find it expedient to refer to some kind of broad, i.e. more or less genuinely autonomous phonemic, notation in discussing matters of phonology. In our opinion the expediency of such a level of reference is most conspicuous in the case of Eskimo, and we have chosen to use it in the later, experimentally oriented sections of this paper. It may, therefore, be well-motivated to consider why this paradoxical situation arises for languages in general and for Eskimo in particular.

Probably the most general argument against autonomous phonemes in a generative grammar is that phonological rules operate on single phonological features (such as [±voice]) rather than on phoneme-sized segments. This means that phonemes must at any rate be interpreted as abbreviations (ad hoc symbols) for feature matrices. In itself, however, this is no real break with earlier theories.

A more specific objection against autonomous phonemes is based on the fact that phonological rules seem to be at least partly ordered. This means that there is no particular level between beginning and end of a rule complex. It should be noted, however, that this does not a priori <u>exclude</u> the possibility of devising a broad or autonomous phonemic notation whose symbols can be interpreted as abbreviations for feature matrices at some specific point in the sequence of phonological rules. If we consider the autonomous phonemic description of Greenlandic outlined above, it is rather evident (on closer inspection) that its allophonic (manifestation) rules would somehow reappear as late generative rules with no effect on deeper processes of the phonological component. This does not directly mean that the phoneme symbols reflect matrices as they appear at a particular break between "early" and "late" rules, but rather that they can be easily translated into such matrices. Therefore, the autonomous notation constitutes an expedient frame of reference in illustrations of early as well as late rules: in the former case it is possible to refer to the output of the rules without cumbersome and irrelevant indications of phonetic phenomena introduced by late rules (such as the aperture of Greenlandic /a i u/ or the voicedness of nonsibilant continuants), in the latter case it is possible to mention forms that satisfy the structural description of the late rules without indicating irrelevant high-level information. It may be theoretically preferable to have specific, letter-sized transcriptions for the input and output of every rule (as is widely done in Chomsky and Halle 1968), but this gives many technical problems and sometimes makes it rather difficult for readers not familiar with the subject-matter to keep track of the material that is used for documentation.

Now, in order for a broad or autonomous transcription to be at all meaningful as a frame of reference it must at least be a notation in which neutralized segments are indicated by one common symbol (Kiparsky 1968 takes the autonomous phonemic specification to mean essentially this). However, much of the work that was done previously in autonomous phonemics was based on a conception of the phoneme which did not allow for neutralization. Hence in cases of factual neutralization one or the other phoneme is indicated, often arbitrarily. This is also true of the phonemicization of Eskimo. A closer consideration of some of these cases neatly reveals the fallacy of the belief that such problems can be resolved by appeal to "symmetry of distribution".

As regards /j/ and /w/, the former is not distinct from zero at the surface level in the sequences /i(j)a/, /i(j)u/, and the latter is not distinct from zero at the surface level in the sequences /u(w)a/, /u(w)i/. These segments have a twofold origin: from underlying obstruents and as secondary segments due to a rule of glide insertion.

p. 186, l. 3-4, read: We follow Bergsland's (1955) practice of indicating these consonants (though without parentheses);

Since the glides are weak (often virtually inaudible) it is a problem in autonomous phonemics whether to represent them as segments or not. We follow Bergsland's (1955) practice of giving them in parentheses; from a generative point of view it can be shown that they *are* segments at a near-surface level, but it would be outside the scope of the present paper to go further into this.[8]

The affricate cluster /ts/ or /tt/ before /i/ poses another problem, which was outlined in section 1. above. Comparison with the behaviour of /t/ before /i/ suggests that we have /tt/ in forms like "/tatsit/" 'lakes', whereas comparison with the long affricate that occurs before /a/ in forms like "/natsat/" 'caps' suggests /ts/. From a generative point of view the long affricate has a double origin, but there is no obvious reason to claim that either ts → tt, or tt → ts, before i. Rather, if we define an affricate ¢, it is reasonable to claim that

ts → t¢ (in all environments)
tt → t¢/ ___ i

by two different processes. If it is to be meaningful, the autonomous phonemic notation must represent the outputs of these two rules, and we therefore suggest that the cluster should be rendered as /t¢/. Since the latter part of the cluster auditorily resembles the manifestation of single /t/ before /i/, it would seem more consistent also to restate the analysis of the latter by splitting the autonomous phoneme "/t/" into two, viz. /t/ and /¢/ (a form like "/atiq/" 'name' being restated as /a¢iq/). Adherents of autonomous phonemics should note that /t/ and /¢/ are

---

8) Positing these segments allows us to refer to syllable number on a well-defined basis.

distinct in the environments /t__a/, /t__u/, cf. /attat/ 'button' versus /nat¢at/ 'caps', or /tuttut/ 'reindeers' versus /put¢ut/ 'clouds (of smoke or the like)'.

From a generative point of view the restatement of the single coronal stop as an affricate before the high front vowel implies that the second rule above is just a special case of the more general rule

t → ¢/___ i

In the absence of evidence to the contrary it seems strongly motivated to claim that this is the case, i.e. that affrication of all occurrences of underlying t before i takes place before the point in the rules that is (roughly) reflected by the autonomous notation.

We therefore tentatively change the notation as suggested above, i.e. we contend that there is a segment ¢ with the same feature specification in both /a¢iq/ and /tat¢it/, or in the pair /na¢iq/ 'floor' - /nat¢iq/ 'a kind of seal'. The validity of this contention from an acoustic point of view will be tested below.

There remains one major inconsistency in the autonomous notation, viz. the uvular entity in such forms as /aqqa/ 'his name'. The non-uvular stops occur, according to the autonomous notation, both as geminates (/tt/ etc.) and in clusters with preceding /r/ (/rt/ etc.). This leaves us with a distributional problem: should the form above be transcribed /aqqa/ or /arqa/? The existence of this problem is, in our opinion, a symptom of the basic inadequacy of transcriptions like /rt/. A satisfactory solution implies a complete restatement of clusters in general, and it would thus remove the notation very much from current practice. We have preferred to leave the autonomous notation used as reference as it is on this point (i.e. we write /qq/ but /rt/), but the problem will be approached within a generative framework in the section below.

2.3. The regressive assimilation rule

As stated in section 1. above there is an assimilation rule which assimilates a non-uvular consonant to a following consonant within the same word. If ordered after the (progressive assimilation) rule that changes t+s into t$\not{s}$, the regressive assimilation rule applies without exception, as long as the first consonant is non-uvular, i.e. does not have the feature configuration

$$\begin{bmatrix} +\text{back} \\ -\text{high} \end{bmatrix}$$

(according to the feature theory of Chomsky and Halle (1968)).

Now it lies close at hand to assume that the (subjective impression of) length in the second segment of clusters like "/rp/", "/rt/", "/rn/" is a consequence of the same rule rather than due to a spurious lengthening rule. This would mean that the regressive assimilation applies also if the first segment is uvular, but only partially in this case. The difficulty with the formulation of such a partial assimilation rule is that it is not easy to determine on a purely auditory basis what is going on. The uvularity is signalled most clearly by the influence on the preceding vowel.

It holds true generally that vowels assume a highly different quality before uvulars than before non-uvulars, cf.

qimmiq	[qim:ə-q]	'dog'
qimmit	[qim:iṭ]	'do., pl.'
tuukkaq	[tu:k:ɑq]	'harpoon'
tuukkat	[tu:k:et]	'do., pl.'

and the (late) rules that introduce this modification ("uvularization") of vowel before uvular applies also when a vowel is followed by one of the controversial clusters exemplified above. It is not clear, on the other hand, how much is left of the uvular consonant segment.

In terms of ordered rules nothing prevents us from assuming that the "uvularization" of vowels takes place before regressive consonant assimilation. If this is true, the assimilation of a uvular to a following consonant may be complete without any loss of distinctiveness, the distinction between forms like "/irniq/" and "/inniq/" being carried over to the preceding vowel. However, nothing else seems to suggest that "uvularization" of vowels is an early rule. On the contrary, it must at any rate be later than the affrication rule (see section 2.2.). Affrication of t (rt, tt) takes place also before i modified by a following uvular, but not before the high variety of a, cf.

atiq [aøə-q] vs. attat [et:et]

This does not seem phonetically reasonable unless the affrication takes place before the vowel modifications.

The alternative, and immediately more attractive solution is that there is partial assimilation of uvular to a following consonant, but still a uvular component left to trigger the "uvularization" of the preceding vowel by a later rule. This may be conceived either in such a way that the initial portion of the uvular keeps intact (cf. the partial progressive assimilation of s to preceding t), or so that the segment is completely assimilated to the following except for the features defining its "uvularity" (in clusters like "/rt/" or "/rs/" this implies that we get a coronal stop or continuant with "uvularity" as an extra articulation - it must then be left to later rules to specify how such segments are realized in the phonetic output, be it with "pre-uvularization" or in some other way).

Though apparently less natural, the latter interpretation may seem to get support from another rule according to which *t* is assibilated to *s* after an underlying *i*. This latter rule (whose applicability has to do with very abstract properties of the underlying pattern) applies also if a consonant intervenes, cf. in conventional autonomous notation /suraarsippaa/ (from *sura+ir+t...*) 'he lets him discontinue his work' versus /aallartippaa/ (in our revised notation: /aallar¢ippaa/) 'he lets him travel away'. *If* this is a rule conditioned by phonological features rather than morphological diacritics (which is disputable since is depends on the analysis of the underlying vowel system as a three-vowel or four-vowel system) it seems immediately most favourable for the formulation of this rule to have regressive assimilation precede it. The two forms above then have the coronal sequence $\underline{{}^{r}tt}$ as input to the rule, and we get straightforward assibilation to $\underline{{}^{r}ss}$ after *i* in /suraarsippaa/ (but later affrication of $\underline{{}^{r}tt}$ to $\underline{{}^{r}t¢}$ before *i* in /aallar¢ippaa/). However, there are good reasons for claiming that the alternation between stop and sibilant is *not* a phonological process.

Leaving open the question whether phonological simultaneity (in the output of the assimilation rule) of "uvularity" and other articulations implies ultimate phonetic simultaneity or successivity, we may tentatively formulate the assimilation rule without regard to the temporal relationships within the first segment of clusters. The formulation becomes rather involved since it must state that assimilation with regard to the features [±high] and [±back] fails to take place if the first segment has "minus" for the first and at the same time "plus" for the second feature:

$$\begin{bmatrix} -\text{syllabic} \\ \left\langle \left\{ \begin{matrix} [+\text{high}] \\ [-\text{back}] \end{matrix} \right\} \right\rangle \end{bmatrix} \rightarrow \begin{bmatrix} \alpha\,\text{anterior} \\ \beta\,\text{coronal} \\ \gamma\,\text{continuant} \\ \delta\,\text{nasal} \\ \left\langle \begin{matrix} \varepsilon\,\text{high} \\ \theta\,\text{back} \end{matrix} \right\rangle \end{bmatrix} \Big/ \_\_\_ \begin{bmatrix} -\text{syllabic} \\ \alpha\,\text{anterior} \\ \beta\,\text{coronal} \\ \gamma\,\text{continuant} \\ \delta\,\text{nasal} \\ \varepsilon\,\text{high} \\ \theta\,\text{back} \end{bmatrix}$$

(It should be noted that the complexity of this rule may be due to inadequate specification of the features of underlying forms. It is likely that either the so-called velars or midpalatals should be specified as nonback, or the uvulars (Swadesh's "velars") are characterized by a special feature of extreme backness. Such a feature is, however, not available in the currently used feature theory. It would lead too far to discuss the evidence for either of the two proposals in the present paper.)

If we denote residual uvularity by an index letter $\underline{r}$, the derivation of forms like "/qajartaaq/" 'new kayak' can be represented like this:

$$\text{qajaq+taaq} \longrightarrow \text{qaja}^{\text{r}}\text{ttaaq}$$

Note that the assimilation thus stated does <u>not</u> imply that the first segment has an intervening stage where it is a fricative /r/ of full segment length.

<u>2.4. Syllable structure and consonant gemination</u>

If we adopt the glide notation discussed in section 2.2., the semi-surface structure of Greenlandic wordforms can be given like this:

(C)V(V)(C)CV(V)(C)CV(V)(C)....

i.e. except for the first syllable every syllable contains the CV sequence, which may be followed by none or one vowel segment plus none or one consonant segment. This kind of structure may be generated by the syllable formula

$$[CV(V)(C)]_{o}$$

if we add the rule that word initial C may be specified as zero,[9] whereas initial C in other syllables is obligatory (see the discussion of glides in section 2.2.).

It is postulated by the formula that (i) an intervocalic consonant goes to the following syllable, and (ii) syllable initial or syllable final clusters do not occur: in case of intervocalic consonant clusters the first constituent goes with the preceding syllable and the second with the next.

The adequacy of this analysis is shown by the fact that vowels are influenced strongly by the first member of a following consonant cluster but not by a following intervocalic consonant, unless it is uvular. Word final consonants have the same effect as the first member of clusters, i.e. in both cases do we have a closed syllable. The syllable division is easily heard in slow speech, where there is loose contact before one intervocalic consonant but close contact before a cluster. The syllable division in clusters was noted already by Kleinschmidt, who for example indicated the pronunciation of /aggirpuq/ 'he comes' as <u>ag-gerp-poq</u> (Holtved 1964 p. 29). Note that this analysis applies also to the long consonants generated from uvular plus consonant.

As for "uvularization" of a vowel by a following uvular this phenomenon is found also when there is a syllable border according to the formula above, e.g. in forms like

---

9) Bergsland (1955 p.4) gives the taxonomically more adequate formula (C)V(V)[(C)CV(V)](C). However, it seems to us that the unit within square brackets has no relationship to any linguistically significant unit (such as the syllable). We therefore prefer the formula given above in spite of the need of accompanying restrictional rules.

/niqi/ 'meat'. However, the domain of the rule involved does not extend further than the syllable just before the uvular, cf. that /ii/, /aa/ are modified in their entirety in such forms as /¢iiq/ 'tea', /taaq/ 'shadow', but only /a/ is modified in /agijaq/ 'fiddle', and only /i/ in /tuwiq/ 'shoulder' (note that the controversial segments /j/ and /w/ define syllable boundary in these forms).

The impression of word rhythm in Greenlandic seems to depend on the specific "weight" of each syllable. According to Kleinschmidt (1851, also see Holtved 1964 p. 30) a vowel segment counts as 2, and a syllable final consonant as 1. Hence syllables have increasing weight as follows:

V	VC	VV	VVC
2	3	4	5

There is no lexically distinctive category of stress. A certain degree of stress is generally heard on the ultimate and/or the antepenultimate syllable (in longer words sometimes on earlier syllables as well), but the impression of stress placement seems rather dependent both on the specific weight of the syllables and on the intonation. As for the latter, the tonal contour of the word is closely bound to the vowel segments. For example, the typical contour before a non-final pause is characterized by nonlow tone on the antepenultimate and ultimate vowels, and low tone on the penultimate, no matter how they are distributed on syllables;[10] schematically:

(–) ‾ – ‾   (–) ‾ – ‾

aawaa 'he fetches it'   akiwara 'I answer him'

The tonal rules are as yet quite imperfectly understood, but there is evidence that the vowel segment (the "syllabic") plays at least as important a role as the syllable in prosodic rules.

---

10) A somewhat different presentation is given in Petersen (1970).

If we turn now to the segments that contribute to syllable "weight" in Kleinschmidt's sense, it would be expedient to have a common term for these. Although we have not demonstrated any prosodic relevance of these segments, we suggest mora as a classificatory term for them. We may then speak of a vocalic mora, i.e. (C)V(V)(C) (first vocalic mora) or (C)VV(C) (second vocalic mora) and of a consonantal mora, i.e. (C)V(V)C. (Opinions may differ as to the status of word final C with respect to the category "mora", see below.)

The validity of a category such as "mora" in Greenlandic Eskimo appears from the phenomena associated with gemination as a process in Greenlandic morphology. The explanation of this process is one of the most intricate problems in the grammar of the language.[11] Anyway, gemination often has the apparent effect of "compensating" for the deletion of one or several final segments before an affix, cf. the difference between the two plural forms below:

nuna 'country', pl. nunat
qiŋaq 'nose', pl. qiŋŋat

or the difference between the two derivations below:

urnippuq 'comes' - urniguppaa 'comes with it'
ȼiŋiwuq 'flies away' - ȼiŋŋuppaa 'flies away with it'

(stems: urnik versus tiŋi, of which the latter drops the final vowel and gets gemination of the preceding consonant instead).

Gemination also often has the overt effect of compensating for deletion of part of the affix, cf. the two

11) See Ulving (1953), Bergsland (1955), Petersen (1970) for some attempts at diachronic and synchronic explanations.
Also see footnote 13 below.

variant forms below:

sanawuq 'works (with wood)' -

$\left\{\begin{matrix}\text{sanaappaa}\\ \text{sannappaa}\end{matrix}\right\}$ 'makes something (of wood) for him'

(the underlying affix begins with u, which is assimilated to a in the first of the two alternative formations but deleted in connection with gemination of stem internal n in the latter).

Gemination is frequently accompanied by changes in the feature composition of the geminated segment (particularly alternation between fricative and stop, cf. /miiraq/ 'child', pl. /miiqqat/). There are even underlying segments which are entirely deleted unless they are geminated (such as underlying intervocalic g in /puuq/ 'bag', pl. /puggut/). The pattern of these alternations is not directly relevant to the quantity problem and will be disregarded here.

If we look closer at the "compensatory" effect of gemination it is interesting that it adds a mora in the sense defined above, and that this "compensation" happens together with the deletion of one (or several) mora. In the immediately transparent inflectional and derivational forms gemination does not normally occur if a consonant that is not mora-forming is dropped. The plurals of /umik/ 'hair of beard' and /inuk/ 'human being' are /umiit/, /inuwit/ with loss of k before the syllabic ending in both cases (and later glide insertion in the second example). Here the loss of a consonant entails no loss of mora, since the underlying full forms would be divided as follows into syllables:

u-mi-kit   i-nu-kit

with syllable-initial and hence not mora-forming k. In plural forms like /qiŋŋat/, on the other hand, a mora is deleted no matter whether we assume underlying it or t as the plural affix; if we construct an underlying form by adding the former affix shape we get a hypothetical syllable division

*qi-ŋa-qit

and if we construct it with the latter affix shape we get a hypothetical

*qi-ŋaqt

Deletion of <u>qi</u> in the former case means loss of a vocalic mora, viz. <u>i</u>, and deletion of <u>q</u> in the latter case means loss of a consonantal mora. Gemination of the stem internal consonant in both cases restores the mora number of the full plural forms:

qiŋ-ŋat

As regards the number of consonantal mora in the wordform, the effect of gemination with this type of plural formation is the same as the effect of adding an overtly syllable-forming ending in another type of plural formation, cf. (with hyphens still indicating the mechanical division into syllables):

tu-piq 'tent' - pl. (tup-qit →) tuq-qit (added: one mora)

In this word the second vowel of the stem - which may be defined as an underlying segment whose feature specification differs somewhat from that of a "normal <u>i</u>" - is syncopated with the effect that the preceding consonant <u>p</u> comes to stand in a position where it forms a mora.[12]

Thus, if we count mora, we find a high degree of regularity in noun inflection (though the pattern is variegated enough in other respects). There are two reservations that must be made to this. Firstly, the gemination rule has no effect if there is already a consonant cluster at the place where gemination should occur, i.e. in such forms as

---

12) Cf. the vowel deletion process in Japanese discussed by McCawley (1968), p. 115f.

qim-miq 'dog' - pl. qim-mit

and secondly it must be stated that the types of plural formation exemplified above are not distributed according to quite rigid principles in modern usage (one hears such forms as /tupit/ 'tents'; cf. below). Nonetheless, the addition of one mora in plural versus singular forms is found in a vast number of words.

The tendency that inflection or derivation with a particular affix morpheme entails a fixed increment of the mora number in spite of morphological variation, can be observed in several types of formation, cf. the (semantically equivalent) morphological variants (explained above):

sa-naap-paa } identical number of mora
san-nap-paa }

or the (semantically differentiated) variants /sannawik/ 'workshop' and /sanawwik/ 'place where to work':

san-na-wik } identical number of mora
sa-naw-wik }

In trying to explain the mechanism behind this surface regularity one must realise there is a skewness in the relationship between stems ending in a vowel and stems ending in a consonant. This is clearly seen if we compare /nuna/ and /qiŋaq/ inflected with a nonsyllabic and a syllabic ending:

singular	plural	stem + a̲ 'his'
nu-na	nu-nat	nu-naa
qi-ŋaq	qiŋ-ŋat	qi-ŋaa

If a word final consonant counts as a mora then we have the same increment of mora number in the two plural forms. If, on the other hand, the final consonant is considered irrelevant to the "weight" of the word, we may state that we have the same increment of mora number with a syllabic affix (note that a stem final consonant is retained or dropped before such an affix, depending on the vowel preceding it; this does not affect the mora number at all, since the consonant will become syllable initial anyway). It seems that <u>deletion of an underlying consonant segment only counts as a mora loss if the non-deletion of the segment would result in a consonant cluster</u>. (The deletion of <u>q</u> in the plural of <u>qiŋaq</u> is thus a loss of mora since its retention before plural <u>t</u> would result in the structurally impossible form *<u>qiŋaqt</u>.)

The tendency in contemporary Greenlandic goes in the direction of morphological simplification, including the gradual abolishment of certain forms with "irregularities" such as gemination. It may be foreseen that it will become increasingly more common to say /qiŋat/ 'noses' instead of /qiŋŋat/, etcetera. This can be explained as partly due to a formal ambiguity of singular forms in <u>q</u>. In essential respects this segment behaves as part of the stem, but it is clearly felt as a singular marker. If it is taken as part of the stem it is clear that the plural formation entails a mora loss which must be compensated for by gemination. If, on the other hand, the final consonant is interpreted as a member of a paradigm

$$\left\{\begin{array}{ll} \text{q} & \text{'singular'} \\ \text{(i)t} & \text{'plural'} \end{array}\right\}$$

it is obvious that the substitution of one ending for the other should not lead to any compensatory effects; it would be entirely parallel to the inflection

nuna - nunat

where <u>t</u> replaces another singular marker, viz. the absence of any affix.

As for the compensatory effect of consonant gemination it is not simple to determine with certainty whether it compensates for the deletion of an underlying mora-forming consonant or vowel in the forms cited above (Bergsland 1955 claims that it always accompanies syllable syncopation). We shall not go further into this here, nor attempt to formulate a synchronic syncopation rule as a phonological process (Underhill (1970) argues that gemination should be considered "morphological" in contemporary West Greenlandic).

3. Acoustic-phonetic investigation

As shown by the preceding sections there are three main questions concerning consonant duration in Greenlandic: (i) the relationship of "long" or "geminate" to "short" or "single" consonants, (ii) the relationship of rC-clusters to either of these types, and (iii) the relationship of the long coronal affricate to other segments or clusters. The remaining sections present some phonetic data bearing upon these questions.

3.1. Recording of material

The material for this investigation (see section 3.2. below) was recorded at the Institute of Phonetics (on Lyrec tape recorders) at several occasions in 1970-71. Informants were three male adults, Mr Robert Petersen, mag. art., amanuensis at the Institute of Eskimology ("RP"), Mr Carl Christian Olsen, teaching assistant at the Institute of Eskimology ("CCO"), and Mr Isak Heilmann, teacher ("IH"). The informants speak slightly different varieties of standard West Greenlandic as spoken in the central part of West Greenland. Besides being native speakers of Greenlandic all three informants have a scholarly insight into the language which has been of much help to us. The research presented in this paper was in fact inspired by discussions with them and with other participants at Mr Petersen's seminars on problems of Greenlandic grammar. We are highly indebted to them for this co-operation.

It is a well-known fact that durational measurements require a carefully selected material in order to be meaningful. First of all, items to be compared must of course be recorded under comparable conditions, uttered with comparable speed, etc. Even if this is so, there is a wide range of possible types of material, ranging from a piece of normal conversation as one extreme to a set of nonsense words as the other extreme. The former of these extremes is preferable if it is crucial to find the absolute average durations of segments in the particular language in running speech; the other extreme is preferable if the study is to throw light upon basic, general phonetic questions concerning articulatory gestures and their timing.

The present study does not satisfy any of these desiderata. It is in fact rather a prerequisite to such studies, the emphasis being exclusively on the basic questions presented above, i.e.: what is the difference or ratio between segments that are generally considered long and segments that are generally considered short? and: what is the status of certain controversial segments such as consonant after uvular or the coronal affricate - are these long or short in systematic phonetic terms as regards the oral closure phase?

We have not used nonsense words as material for this study though it would have simplified the first phase of the research. One reason for not doing so is that it would probably be difficult to read such a text aloud with natural tempo relationships among the sound segments. Greenlandic words are highly analysable, and in reading a strange wordform one is likely to make attempts to reinterpret it as something more familiar or reasonable, particularly with the current orthography, which the reader may not expect to be correctly used in a handwritten or typewritten text. Even with grammatical wordforms this problem may arise. In our text /tutuppuŋa/ 'I am covered with ingrained dirt' was occasionally misread as /tuttuppuŋa/ 'I have caught a reindeer'.

Another problem is that since Greenlandic words are often extremely long (the average syllable number seems to exceed 4 in normal, running prose) the use of short test words (i.e., ideally of the type VCV or VCCV, where the consonants to be studied intervocalically are put in a minimum frame) would not necessarily show the typical manifestation of the quantity contrast. It would at least be desirable to see also what happens in words of average length, rather than dealing only with the extreme case.

We have preferred to use natural words for the present study, and in order that the raw data should also throw some light upon the range of manifestation of the durational features we have measured a variety of wordforms of varying length. A logical follow-up would be to investigate the influence of word length and other factors on the values measured. We have devoted a few remarks to this problem here and there below, but a closer analysis of the data from this point of view has not yet been undertaken. In the present paper, on the contrary, we have set out to find out whether there is a certain constancy in the durational relationships in spite of variations in word structure.

The type of constancy one would look for in durational measurements is of course not to be found in the absolute values but in the difference or ratio between the durations of segment types. Hence the material was so arranged that there were minimal or sub-minimal pairs for the segment types to be compared. - The subjective impression of stress and tone contours suggests that in order for segments in analogous environments to be durationally comparable the two words should exhibit the same number of syllables, and each syllable pair should have the same number of vocalic and consonantal mora. We tried to avoid examples that did not exhibit syllable or mora isomorphy, but is was not always possible. We also attempted to find word pairs with identical vowel environments for the consonants to be compared; among the pairs of words that were subminimal in this respect some were left out because the degree of openness of a preceding or following vowel obviously influenced the consonant duration considerably, but others had to be included because we had not been sufficiently successful in finding good minimal pairs for the contrast in question. - Some of the word pairs in the material differ as to the presence or absence of a word initial consonant. The measurements showed that the durations of all segments of the first and second syllable are influenced by the presence or absence of this consonant, i.e. there is an apparent tendency toward similar overall duration of such sequences as /#CVCV.../ and /#VCV.../. A subminimal pair like /anija/ 'his pain': /mannija/ 'its egg' thus gives a somewhat erroneous figure because the segments of the latter word are somewhat shortened (in this case the difference /n/:/nn/ becomes less than it is in truly minimal pairs). Some of the recorded words had to be left out on these grounds. (For a recent study of tendencies toward constant rate of syllable production see Slis 1968.)

3.2. Word lists

The material consists of the word pairs listed in Table I.[13] The words are given in autonomous phonemic notation according to section 2. above. In the case of /t¢/ (see section 2.2.) the morphophonemic and orthographic status is indicated in parentheses: "(tt)" means that the long affricate is derived from underlying t(+)t (in the Kleinschmidt orthography ʹt, vt, or gt), "(ts)" means that it is derived from t+s or is the geminate counterpart to surface /s/ in forms like /tasiq/ - /tat¢it/ (orthographically ts). - The consonants measured are underlined.

---

13) Several of the word pairs were suggested by Isak Heilmann or Robert Petersen, the rest by one of the authors (JR). Although some of the latter examples may be slightly old-fashioned or unusual in some other respect, none of the wordforms were deemed phonologically abberant at all.

The original, randomized lists were composed at different times. Due to an oversight three word pairs (i.e. 6 words in all) occurred twice in the word lists recorded, and separate averages of the measures were made. We have left them in, but they are marked as repetitions in Table I. -(Cf. section 3.4. below.) - Note also that there are several words (occurring once only in the randomized lists) which enter into two, sometimes even three different contrastive pairs, e.g. /t/ in /niqiturpuq/ is contrasted to /tt/ in /nipitturpuq/, /rt/ in /amirturpuq/, and /tɕ/ in /akitɕurpuq/. Thus the recorded material is not as huge as it looks in Table I.

In a couple of instances the words in CCO are numbered differently than in RP and IH, because some few words were not spoken by CCO. These differences are indicated in Table I.

3.3. Phonetic analysis

All the material was registered on mingograms displaying a "duplex oscillogram", a fundamental frequency curve, and two, three, or mostly four intensity curves (normally with an integration time of 5 ms) for the purpose of temporal segmentation.[14] As regards the signal to the intensity meters different kinds of frequency filtering (highpass, lowpass, or bandpass filtering with different cutoff frequencies) were employed in order to facilitate the segmentation, which was found to be difficult particularly with /n/. - Examples of mingograms are shown in Figs. 1-7.

As for the strategy of segmentation we did our best to define the starting-point of the stop or nasal in such a way that no possible element of fricative or vocalic "r" in the sequences /rp, rt/ etc. was included. The oral clo-

---

14) The devices employed (mingograph, fundamental frequency meter, intensity meter, and filters) are surveyed in ARIPUC 4/1969 (197o), p. IIff.

TABLE I

List of word pairs

(Numbers in parentheses refer to CCO's word list only.)

/pp/ - /p/

1. /ippak/ - /ipak/
2. /napparput/ - /napapput/
3. /¢illuppallaqaa/ - /¢illupallaqaa/
4. /nappaqqut/ - /napaqqut/
5. /uppippuq/ - /upippuq/
6. /¢ippapput/ - /¢ipapput/
7. /aluppaat/ - /alupaat/
8. /uqaluppaluppuq/ - /uqalupiluppuq/
9. (8) /anippallappuq/ - /anipallappuq/
1o. (9) /nappaqqut/ - /napaqqut/ (repetition of pair No.4)
11.(1o) /tappipput/ - /tapipput/
12.(11) /apputaa/ - /aputaa/
13.(12) /qamippaa/ - /qalipaa/
14.(13) /ippirtuwuq/ - /ipirtuwuq/
15.(14) /kamippak/ - /qalipak/
16.(15) /ulappupput/ - /ulapipput/
17.(16) /aappaluppuq/ - /taapalippuq/
18.(17) /aapparput/ - /aapapput/

/rp/ - /p/

1. /nirpiqarpuq/ - /nipiqarpuq/
2. /a¢irpallarijarlugit/ - /a¢ipallarijarlugit/
3. /alurpaat/ - /alupaat/
4. /anirpallappuq/ - /anipallappuq/
5. /illarpalaarpuq/ - /illapalaarpuq/
6. /sirpiqarpuq/ - /¢ipiqarpuq/
7. /tarparpuq/ - /tapappuq/
8. /uqarpugut/ - /aqupiwuq/

TABLE I (continued)

/pp/ - /rp/

1.	/nipaappuq/ - /niparpuq/
2.	/uppik/ - /urpik/
3.	/nipipput/ - /nipirput/
4.	/siippuq/ - /siirpuq/
5.	/u¢ipput/ - /u¢irput/
6.	/tuttupput/ - /tutturput/
7.	/miluppaa/ - /milurpaa/
8.	/uppiŋŋuwaq/ - /urpiŋŋuwaq/
9.	/tukkupput/ - /tukkurput/
1o.	/tuuppaa/ - /tuurpaa/
11.	/miluppara/ - /milurpara/
12.	/aluppaat/ - /alurpaat/
13.	/uqaluppaluppuq/ - /sijanirpaluppuq/
14.	/anippallappuq/ - /anirpallappuq/
15.	/asaluppuq/ - /asalurpuq/
16.	/qaappuq/ - /qaarpuq/

/tt/ - /t/

1.	/nunatta/ - /nunataq/
2.	/tuttuppuŋa/ - /tutuppuŋa/
3.	/¢ikittarput/ - /¢ikitarput/
4.	/puuguttaminik/ - /puugutaminik/
5.	/naalattuwarpara/ - /asatuwarpara/
6.	/mattuwuq/ - /matuwuq/
7. (5)	/¢ikittarpuq/ - /puwiṣitarput/
8. (6)	/nipitturpuq/ - /niqiturpuq/
9. (7)	/kasuttakkat/ - /kutappuq/
1o. (8)	/imaattuwinnarpuq/ - /kaatuwinnarpuq/
11. (9)	/pilattuut/ - /silatuut/
12.(1o)	/attappaa/ - /katappaa/
13.(11)	/mattuwuq/ - /matuwuq/
14.(12)	/atturpaa/ - /aturpaa/

<u>TABLE I</u> (continued)

/rt̲/ - /t̲/

1. /tuqqurt̲aq/ - /uqqut̲aq/
2. /imirt̲arput/ - /puwiṣit̲arput/
3. /amirt̲urpuq/ - /niqit̲urpuq/
4. /aturt̲arpuq/ - /kut̲appuq/
5. /imaart̲uwinnarpuq/ - /kaat̲uwinnarpuq/
6. /tart̲unaq/ - /mat̲uwuq/
7. /art̲urpaa/ - /at̲urpaa/
8. /purt̲uwuq/ - /put̲uwuq/

/t̲¢̲/ (ts) - /t̲/ (comparison of stop intervals)

1. /aat̲¢̲aat/ - /aat̲aat/
2. /irinit̲¢̲apput/ - /puwiṣit̲arput/
3. /akit̲¢̲urpuq/ - /niqit̲urpuq/
4. /kut̲¢̲appuq/ - /kut̲appuq/
5. /qat̲¢̲urpuq/ - /at̲urpuq/
6. /put̲¢̲uwalippuq/ - /put̲uwijarpuq/
7. /aat̲¢̲arput/ - /aat̲arput/
8. /akit̲¢̲urpuq/ - /niqit̲urpuq/ (repetition of pair No. 3)
9. /siwit̲¢̲uut/ - /silat̲uut/

/t̲¢̲/ - /¢̲/ (comparison of stop and fricative intervals)

(a) /t¢/ = "ts"

1. /naat̲¢̲irpaa/ - /naa¢̲irpai/
2. (1) /¢ikit̲¢̲irpara/ - /kuul¢i¢̲irpara/
3. (2) /nat̲¢̲iq/ - /na¢̲iq/
4. (3) /put̲¢̲irpuq/ - /u¢̲irpuq/
5. (4) /inat̲¢̲it/ - /iga¢̲it/
6. (5) /naat̲¢̲irpaa/ - /naa¢̲irpai/ (repetition of pair No. 1)

(b) /t¢/ = "tt"

7. /masat̲¢̲irpara/ - /kuul¢i¢̲irpara/ (second word same as in 2.)
8. (6) /kit̲¢̲irut/ - /qi¢̲irut/

TABLE I (continued)

/tt/ - /rt/

1. /inuttut/ - /inurtut/
2. /uqquttarpaat/ - /tuqqurtarpaat/
3. /¢ikittarpuq/ - /imirtarput/
4. /nipitturpuq/ - /amirturpuq/
5. /kasuttakkat/ - /aturtarpuq/
6. /imaattuwinnarpuq/ - /imaartuwinnarpuq/
7. /mattuwuq/ - /tartunaq/
8. /atturpaa/ - /arturpaa/
9. /paatturluni/ - /paarturluni/
10. /taatturippuq/ - /naartulirpuq/

/tt/ - /t¢/(ts) (comparison of stop intervals)

1. /¢ikittarpuq/ - /irinit¢apput/
2. /nipitturpuq/ - /akit¢urpuq/
3. /kasuttakkat/ - /kut¢appuq/
4. /pilattuut/ - /siwit¢uut/
5. /paatturluni/ - /aat¢urluni/
6. /misigittarpuq/ - /irinit¢appuq/

/rt/ - /t¢/(ts) (comparison of stop intervals)

1. /imirtarput/ - /irinit¢apput/
2. /amirturpuq/ - /akit¢urpuq/
3. /aturtarpuq/ - /kut¢appuq/
4. /paarturluni/ - /aat¢urluni/

/qq/ - /q/

1. /quuqqut/ - /quuqut/
2. /aniqquwaa/ - /aniquwaa/
3. /tuqqurtaq/ - /tuqutaq/
4. /aqqarpaa/ - /aqarpaa/

TABLE I (continued)

5. /nuwiqqarpuq/ - /nuwiqarpuq/
6. /aallaqqugumma/ - /aallaqugumma/
7. /nunaqqa¢iqarpuq/ - /nunaqa¢iqarpuq/
8. /qulissirasuwaqqullugu/ - /qulissirasuwaqullugu/
9. /uqquttarpaat/ - /tuquttarpaat/
10. /piqqarpuq/ - /piqarpuq/
11. /aqquppaa/ - /aquppaa/
12. /iqqaawuq/ - /iqaarpuq/

13. /siniqqarpuŋa/ - /iniqarpuŋa/
14. /nijaqqugut/ - /nijaqurut/
15. /iqqurpuq/ - /iqurpuq/
16. /tuqqugaq/ - /tuqutaq/
17. /uqqippuq/ - /uqippuq/
18. /siniqqarpuq/ - /iniqarpuq/

/nn/ - /n/

1. /maanna/ - /maana/
2. /sinniq/ - /piniq/
3. /alijannaarpuq/ - /alijanaappuq/
4. /akunnappuq/ - /takunarpuq/
5. /anniq/ - /maniq/
6. /inniqarpuq/ - /iniqarpuq/
7. /unnirluni/ - /unilluni/
8. /maanniq/ - /taaniq/
9. /annippaa/ - /anippaa/
10. /uunnappuq/ - /uunarpuq/

/rn/ - /n/ (comparison of nasal intervals)

1. /maarniq/ - /maana/
2. /pirniq/ - /piniq/
3. /agijarnarpuq/ - /alijanaappuq/
4. /takurnarpuq/ - /takunarpuq/

TABLE I (continued)

5. /marniq/ - /maniq/
6. /irniqarpuq/ - /iniqarpuq/
7. /urnilluni/ - /unilluni/
8. /qaarniq/ - /taaniq/

/nn/ - /rn/ (comparison of nasal intervals)

1. /maanna/ - /maarniq/
2. /sinniq/ - /pirniq/
3. /alijannaarpuq/ - /agijarnarpuq/
4. /akunnappuq/ - /takurnarpuq/
5. /anniq/ - /marniq/
6. /inniqarpuq/ - /irniqarpuq/
7. /unnirluni/ - /urnilluni/
8. /maanniq/ - /qaarniq/

sure hold, and the explosion or affrication were measured separately for stops before the total duration was calculated as the sum of the two. In the case of single /q/ the point of explosion was often impossible to determine since the whole consonant was more or less fricative. It seems to be a general difference between /q/ and /qq/ that the single consonant is much more loosely articulated. The total duration could, however, be measured with a fair degree of accuracy, in spite of the unstable character of the oral articulation. There were no similar problems with the other types.

The measurements of consonant duration was made by one of the authors (HM) according to "conventions" for segmentation agreed upon. Random checks on examples measured by both authors showed generally a good agreement; in a minority of cases (less than ten per cent of the single word tokens) there was a disagreement amounting to one cs or (occasionally) more. This means that there is a margin

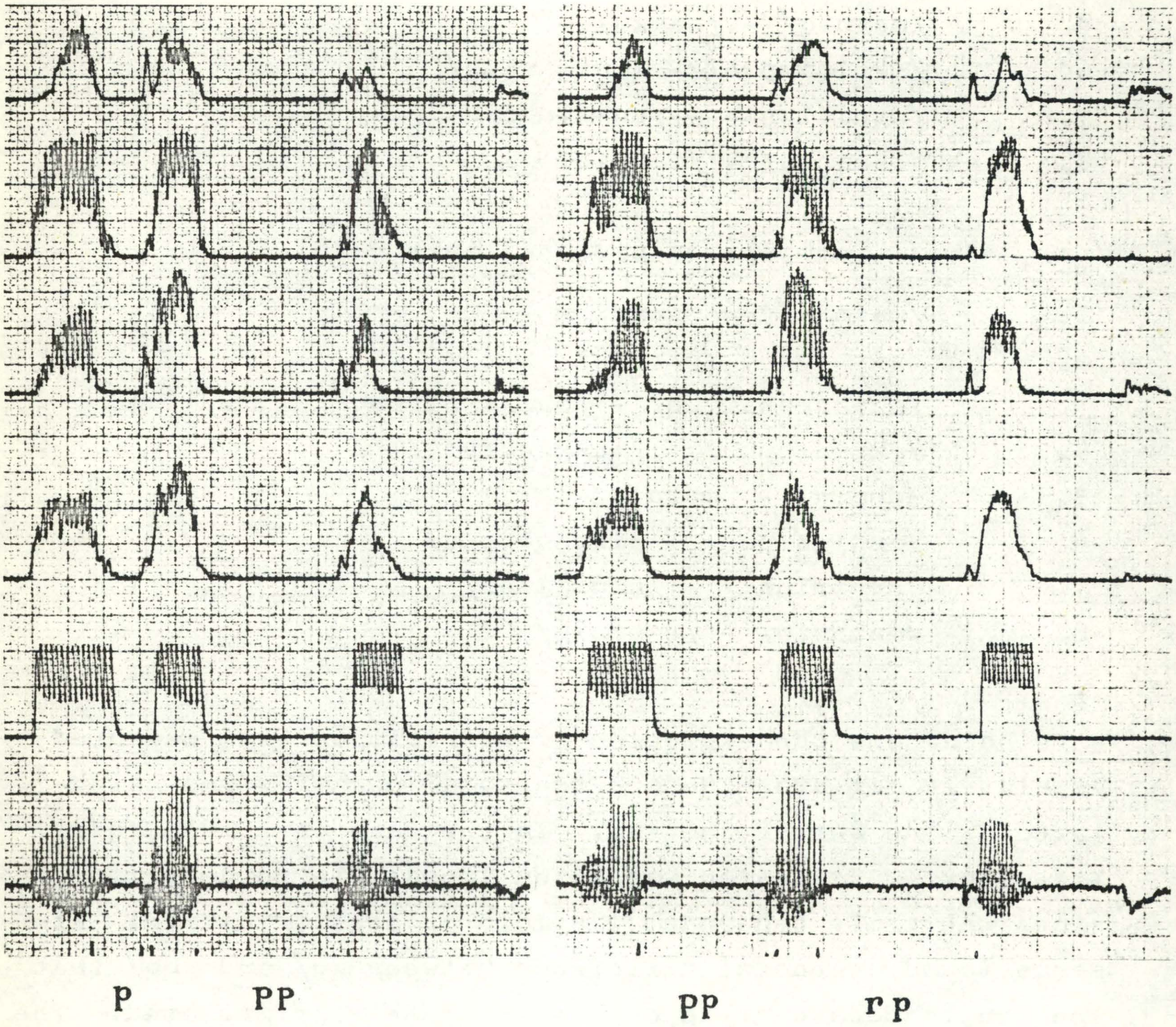

Fig. 1.

Words: /napapput/ and /napparput/. Speaker: RP.

Traces from top to bottom: four intensity curves with different filtration (integration time: 5 ms), fundamental frequency curve, and duplex oscillogram.

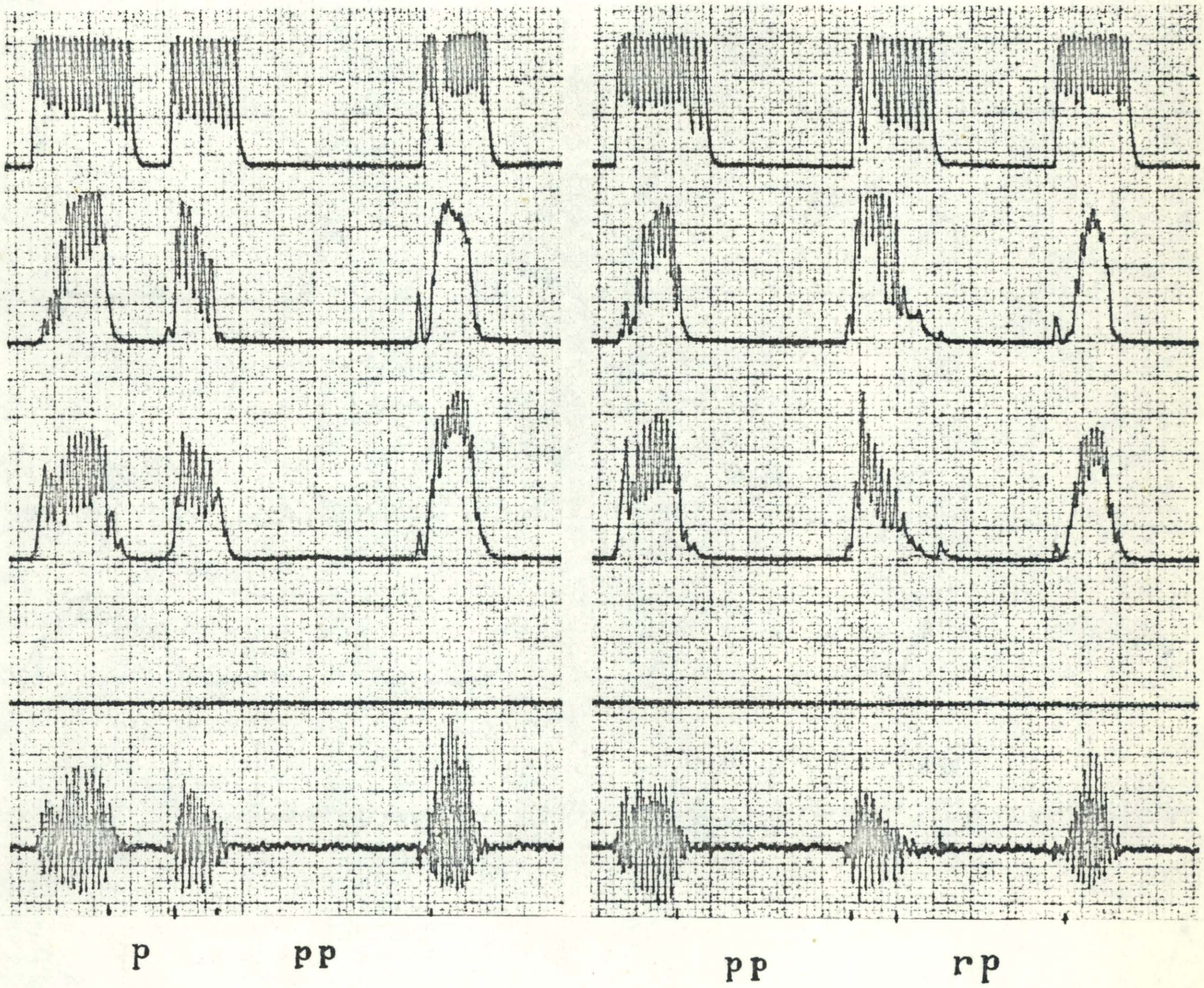

Fig. 2.

Words: /napapput/ and /napparput/. Speaker: IH.
Traces from top to bottom: fundamental frequency curve, two intensity curves with different filtration (integration time: 5 ms), and duplex oscillogram.

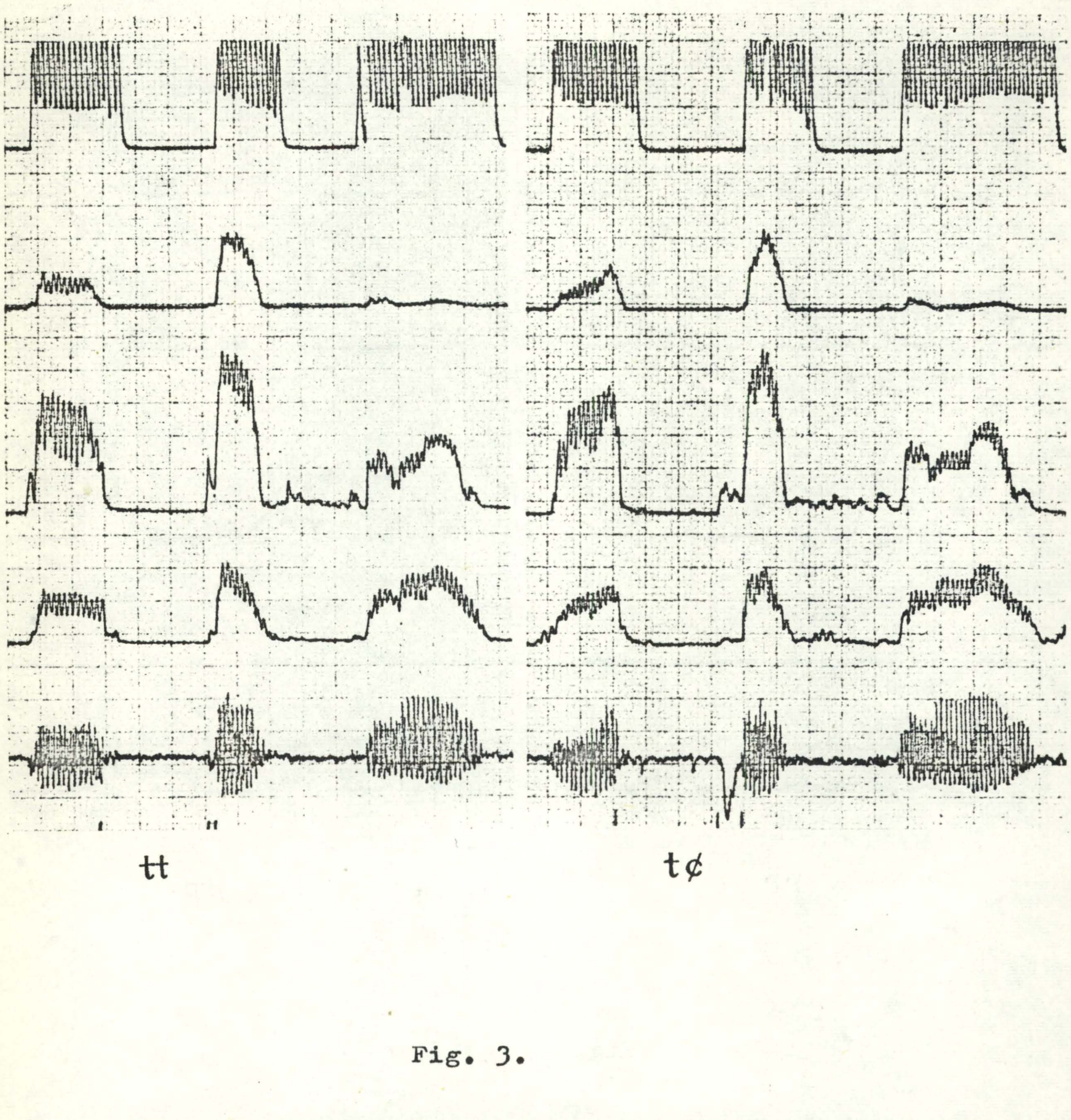

Fig. 3.

Words: /paatturluni/ and /aat¢urluni/. Speaker: RP.
Traces from top to bottom: fundamental frequency curve, three intensity curves with different filtration (integration time: 5 ms), and duplex oscillogram.

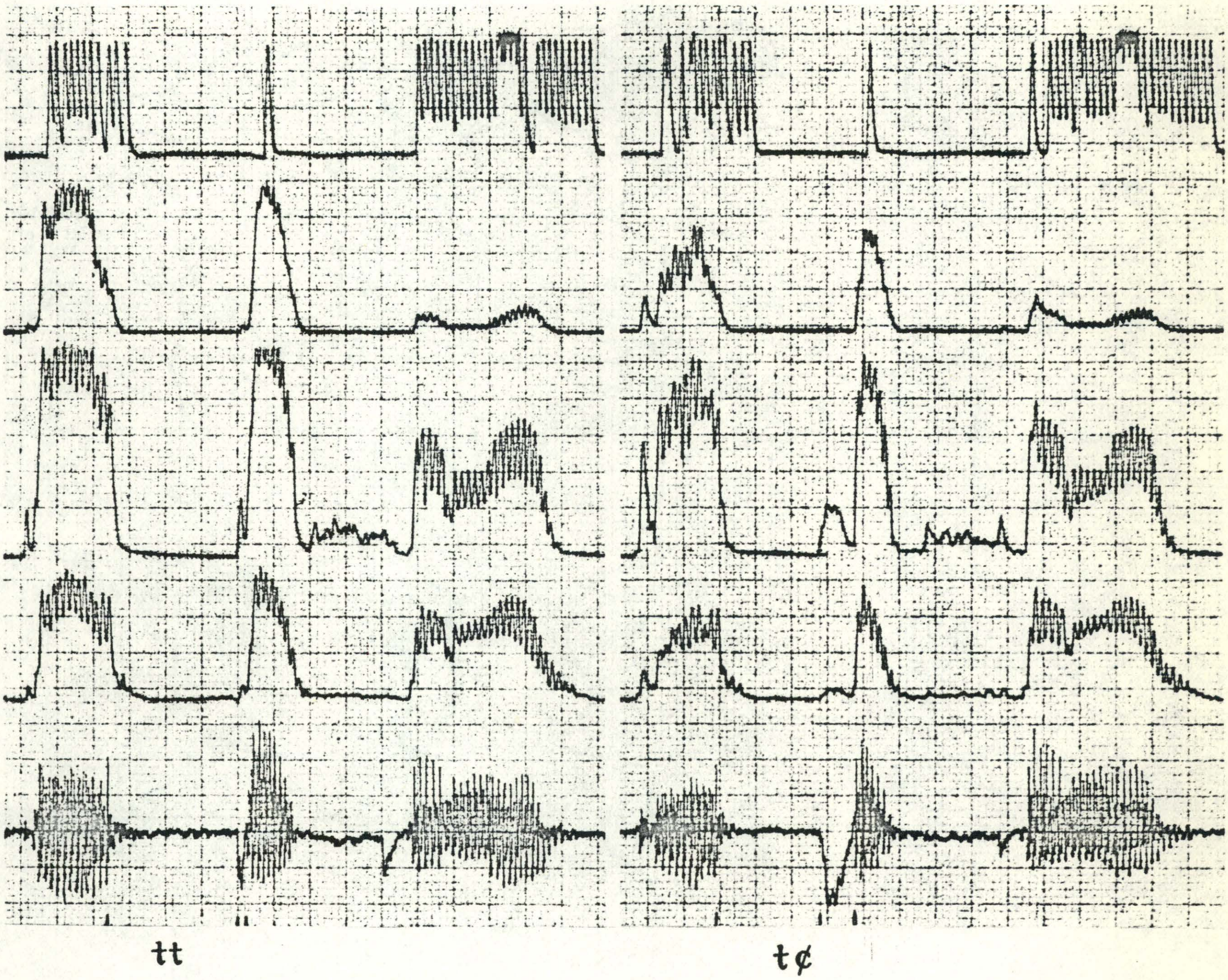

Fig. 4.

Words: /paatturluni/ and /aat¢urluni/. Speaker: CCO.

Traces from top to bottom: fundamental frequency curve, three intensity curves with different filtration (integration time: 5 ms), and duplex oscillogram.

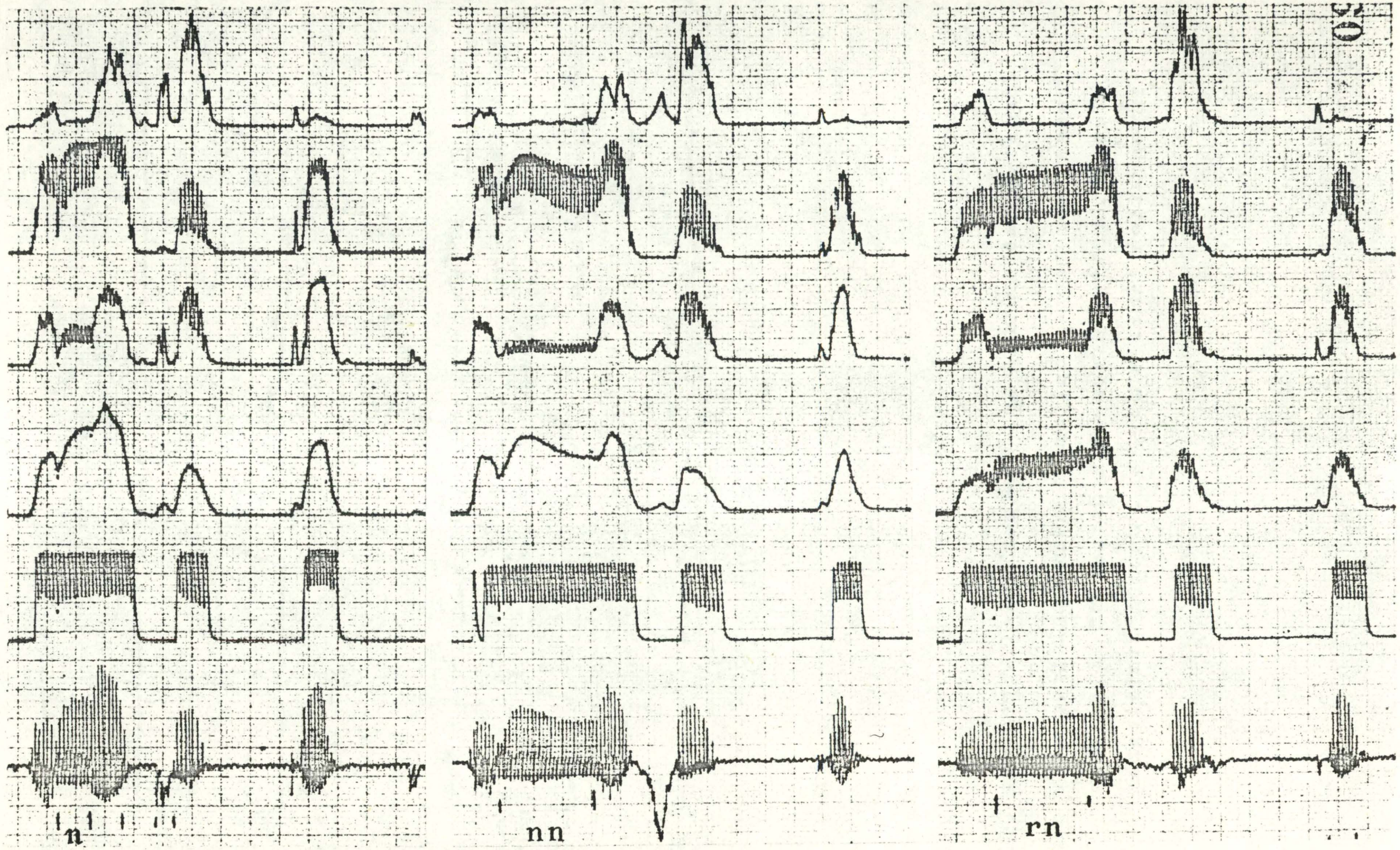

Fig. 5. Words: /iniqarpuq/, /inniqarpuq/, and /irniqarpuq/. Speaker: RP.
As for traces, see Fig. 1.

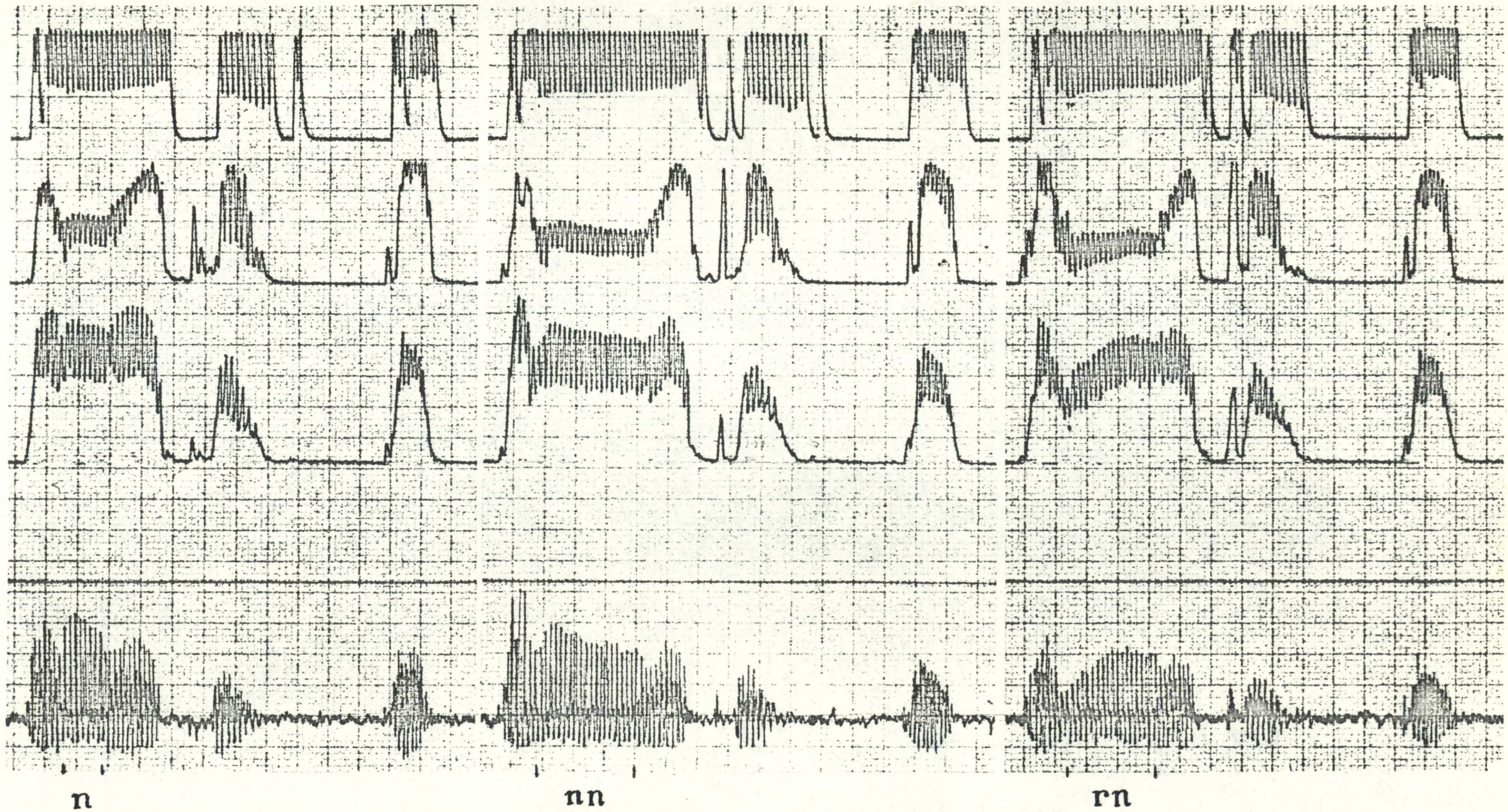

Fig. 6. Words: /iniqarpuq/, /inniqarpuq/, and /irniqarpuq/. Speaker: IH. As for traces, see Fig. 2.

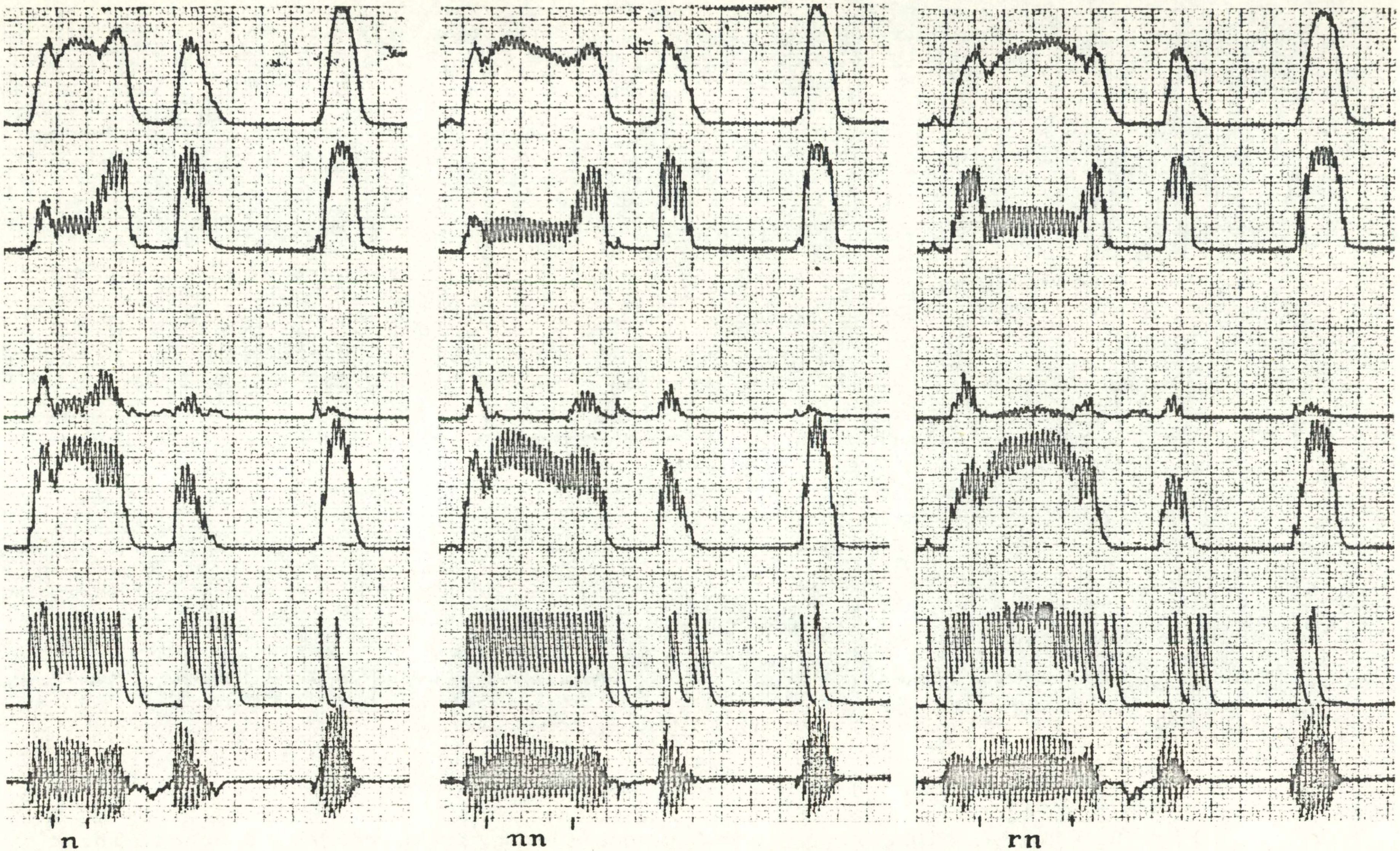

Fig. 7. Words: /iniqarpuq/, /inniqarpuq/, and /irniqarpuq/. Speaker: CCO.
As for traces, see Fig. 1.

of error (which can hardly be avoided since several instances are genuinely problematic due to imperfect mouth closure or other factors which are more or less impossible to recognize on the basis of acoustic curves). However, the error is diminished due to the fact that every bit of data entered in the tables represents an average of typically five individual measures.[15]

3.4. Results

The average measures of the duration of stops and nasals are given in Tables II, III, and IV. The printed symbols are to be understood as follows:

RN VERSUS N etc.: measurements on word pairs differing as stated (in casu /rn/ versus /n/ intervocalically), cf. Table I

RP, QQ, TS, T, C, etc.: duration of (what appears to be) oral closure plus explosion/affrication in wordforms with these phonemic representations (TS = /t¢/, C = /¢/)

RN, NN, N: duration of nasal consonant in wordforms with these phonemic representations

RT/T, etc.: ratio between two measures

RT-T, etc.: difference in centiseconds between two measures

3.5. Discussion

The main part of this section will be devoted to the durations of the stop and nasal segments with which the paper is specifically concerned. The durational characteristics of their environments will be more briefly treated later.

---

15) Word tokens that were obviously misread were of course excluded. The total number of such omissions is very small.

TABLE II

Average measures for each word pair: absolute durations in cs, differences, and ratios. Subject: RP.

SUBJECT RP CONSONANTS PP VERSUS P

PAIR	PP	P	PP-P	PP/P
1	26.5	10.9	15.6	2.43
2	19.3	8.2	11.1	2.35
3	17.6	8.3	9.3	2.12
4	20.3	9.6	10.7	2.11
5	21.8	8.3	13.5	2.63
6	20.6	8.0	12.6	2.57
7	26.0	12.3	13.7	2.11
8	16.9	9.4	7.5	1.80
9	18.3	8.6	9.7	2.13
10	19.8	7.8	12.0	2.54
11	23.0	10.2	12.8	2.25
12	19.4	10.2	9.2	1.90
13	25.0	11.7	13.3	2.14
14	20.3	9.0	11.3	2.26
15	20.6	10.3	10.3	2.00
16	17.4	8.2	9.2	2.12
17	16.3	8.1	8.2	2.01
18	20.0	8.6	11.4	2.33

SUBJECT RP CONSONANTS RP VERSUS P

PAIR	RP	P	RP-P	RP/P
1	18.2	9.1	9.1	2.00
2	17.7	8.8	8.9	2.01
3	16.7	9.0	7.7	1.86
4	17.3	8.8	8.5	1.97
5	19.1	7.5	11.6	2.55
6	20.8	10.0	10.8	2.08
7	22.9	12.3	10.6	1.86
8	18.7	8.6	10.1	2.17

TABLE II - continued

SUBJECT RP CONSONANTS PP VERSUS RP

PAIR	PP	RP	PP-RP	PP/RP
1	20.3	20.0	0.3	1.01
2	26.5	25.5	1.0	1.04
3	22.6	22.8	-0.2	0.99
4	21.4	21.5	-0.1	1.00
5	21.5	22.4	-0.9	0.96
6	21.1	22.8	-1.7	0.93
7	24.6	25.5	-0.9	0.96
8	22.1	23.3	-1.2	0.95
9	21.8	22.5	-0.7	0.97
10	24.8	23.5	1.3	1.06
11	19.4	21.2	-1.8	0.92
12	26.0	22.9	3.1	1.14
13	16.9	16.2	0.7	1.04
14	18.3	18.7	-0.4	0.98
15	18.8	19.6	-0.8	0.96
16	20.6	20.4	0.2	1.01

SUBJECT RP CONSONANTS TT VERSUS T

PAIR	TT	T	TT-T	TT/T
1	22.4	8.9	13.5	2.52
2	19.9	9.0	10.9	2.21
3	19.0	7.5	11.5	2.53
4	18.6	8.6	10.0	2.16
5	19.5	10.8	8.7	1.81
6	21.4	10.3	11.1	2.08
7	19.4	7.4	12.0	2.62
8	19.6	7.8	11.8	2.51
9	21.5	7.6	13.9	2.83
10	17.3	11.1	6.2	1.56
11	23.5	11.5	12.0	2.04
12	19.2	7.5	11.7	2.56
13	20.2	10.4	9.8	1.94
14	20.5	8.7	11.8	2.36

TABLE II - continued

SUBJECT RP CONSONANTS RT VERSUS T

PAIR	RT	T	RT-T	RT/T
1	20.1	7.3	12.8	2.75
2	19.0	7.4	11.6	2.57
3	20.3	7.8	12.5	2.60
4	19.4	7.6	11.8	2.55
5	19.3	11.1	8.2	1.74
6	20.6	10.4	10.2	1.98
7	21.2	8.7	12.5	2.44
8	20.1	10.4	9.7	1.93

SUBJECT RP CONSONANTS TS VERSUS T

PAIR	TS	T	TS-T	TS/T
1	19.6	7.4	12.2	2.65
2	21.0	7.8	13.2	2.69
3	19.8	7.6	12.2	2.61
4	25.9	13.1	12.8	1.98
5	24.0	11.5	12.5	2.09
6	19.7	8.4	11.3	2.35
7	20.3	10.3	10.0	1.97
8	18.9	9.0	9.9	2.10
9	19.8	7.2	12.6	2.75

SUBJECT RP CONSONANTS TS VERSUS C

PAIR	TS	C	TS-C	TS/C
1	21.3	11.5	9.8	1.85
2	20.5	8.4	12.1	2.44
3	24.2	11.6	12.6	2.09
4	21.6	9.5	12.1	2.27
5	21.8	12.2	9.6	1.79
6	19.6	10.8	8.8	1.81
7	19.0	8.4	10.6	2.26
8	21.5	13.2	8.3	1.63

TABLE II - continued

SUBJECT RP CONSONANTS TT VERSUS RT

PAIR	TT	RT	TT-RT	TT/RT
1	22.0	22.4	-0.4	0.98
2	18.3	17.8	0.5	1.03
3	19.4	19.0	0.4	1.02
4	19.6	20.3	-0.7	0.97
5	21.5	19.4	2.1	1.11
6	17.3	19.3	-2.0	0.90
7	20.2	20.6	-0.4	0.98
8	20.5	21.2	-0.7	0.97
9	17.5	18.6	-1.1	0.94
10	16.2	16.3	-0.1	0.99

SUBJECT RP CONSONANTS TT VERSUS TS

PAIR	TT	TS	TT-TS	TT/TS
1	19.4	19.6	-0.2	0.99
2	19.6	21.0	-1.4	0.93
3	21.5	19.8	1.7	1.09
4	23.5	24.0	-0.5	0.98
5	17.5	17.6	-0.1	0.99
6	17.2	18.7	-1.5	0.92

SUBJECT RP CONSONANTS RT VERSUS TS

PAIR	RT	TS	RT-TS	RT/TS
1	19.0	19.6	-0.6	0.97
2	20.3	21.0	-0.7	0.97
3	19.4	19.8	-0.4	0.98
4	18.6	17.6	1.0	1.06

TABLE II - continued

SUBJECT RP			CONSONANTS	QQ VERSUS Q
PAIR	QQ	Q	QQ-Q	QQ/Q
1	22.5	12.0	10.5	1.88
2	23.0	12.0	11.0	1.92
3	22.1	11.1	11.0	1.99
4	22.5	10.6	11.9	2.12
5	20.3	10.0	10.3	2.03
6	14.5	9.1	5.4	1.59
7	15.3	8.6	6.7	1.78
8	18.7	9.8	8.9	1.91
9	23.5	10.4	13.1	2.26
10	21.9	9.5	12.4	2.31
11	23.4	10.5	12.9	2.23
12	25.0	11.9	13.1	2.10
13	17.7	10.3	7.4	1.72
14	21.4	10.8	10.6	1.98
15	22.0	10.1	11.9	2.18
16	18.9	11.0	7.9	1.72
17	22.9	10.6	12.3	2.16
18	19.0	9.1	9.9	2.09

SUBJECT RP			CONSONANTS	NN VERSUS N
PAIR	NN	N	NN-N	NN/N
1	16.6	4.0	12.6	4.15
2	19.3	5.3	14.0	3.64
3	16.4	4.8	11.6	3.42
4	16.4	3.8	12.6	4.32
5	22.0	5.8	16.2	3.79
6	16.3	5.1	11.2	3.20
7	17.4	5.5	11.9	3.16
8	12.4	4.8	7.6	2.58
9	16.3	5.8	10.5	2.81
10	16.0	4.5	11.5	3.56

TABLE II - continued

SUBJECT RP — CONSONANTS RN VERSUS N

PAIR	RN	N	RN-N	RN/N
1	17.0	4.0	13.0	4.25
2	18.9	5.3	13.6	3.57
3	15.6	4.8	10.8	3.25
4	14.9	3.8	11.1	3.92
5	19.6	5.8	13.8	3.38
6	15.5	5.1	10.4	3.04
7	15.1	5.8	9.3	2.60
8	16.2	4.5	11.7	3.60

SUBJECT RP — CONSONANTS NN VERSUS RN

PAIR	NN	RN	NN-RN	NN/RN
1	16.6	17.0	-0.4	0.98
2	19.3	18.9	0.4	1.02
3	16.4	15.6	0.8	1.05
4	16.4	14.9	1.5	1.10
5	22.0	19.6	2.4	1.12
6	16.3	15.5	0.8	1.05
7	16.3	15.1	1.2	1.08
8	16.0	16.2	-0.2	0.99

TABLE III

Average measures for each word pair: absolute durations in cs, differences, and ratios. Subject: CCO.

SUBJECT CCO CONSONANTS PP VERSUS P

PAIR	PP	P	PP-P	PP/P
1	25.4	12.2	13.2	2.08
2	22.0	8.2	13.8	2.68
3	17.2	8.0	9.2	2.15
4	21.0	8.9	12.1	2.36
5	21.8	8.7	13.1	2.51
6	20.3	7.8	12.5	2.60
7	26.1	13.2	12.9	1.98
8	20.7	10.0	10.7	2.07
9	22.4	9.2	13.2	2.43
10	24.6	11.5	13.1	2.14
11	21.9	11.7	10.2	1.87
12	25.3	14.0	11.3	1.81
13	22.6	8.8	13.8	2.57
14	20.8	11.4	9.4	1.82
15	21.1	9.1	12.0	2.32
16	18.1	9.9	8.2	1.83
17	20.4	8.9	11.5	2.29

SUBJECT CCO CONSONANTS RP VERSUS P

PAIR	RP	P	RP-P	RP/P
1	18.6	10.8	7.8	1.72
2	18.8	8.9	9.9	2.11
3	26.1	13.2	12.9	1.98
4	19.9	10.0	9.9	1.99
5	16.8	8.4	8.4	2.00
6	19.8	9.6	10.2	2.06
7	22.3	8.5	13.8	2.62
8	22.7	12.9	9.8	1.76

TABLE III - continued

SUBJECT CCO CONSONANTS PP VERSUS RP

PAIR	PP	RP	PP-RP	PP/RP
1	20.4	20.0	0.4	1.02
2	24.7	24.7	0.0	1.00
3	23.2	21.8	1.4	1.06
4	22.5	22.2	0.3	1.01
5	23.0	22.4	0.6	1.03
6	21.6	22.1	-0.5	0.98
7	25.2	27.1	-1.9	0.93
8	21.6	21.5	0.1	1.00
9	21.1	21.2	-0.1	1.00
10	25.6	24.6	1.0	1.04
11	22.0	22.9	-0.9	0.96
12	26.1	26.1	0.0	1.00
13	17.7	16.7	1.0	1.06
14	20.7	19.9	0.8	1.04
15	20.0	20.4	-0.4	0.98
16	22.0	23.3	-1.3	0.94

SUBJECT CCO CONSONANTS TT VERSUS T

PAIR	TT	T	TT-T	TT/T
1	23.0	10.7	12.3	2.15
2	19.0	7.8	11.2	2.44
3	20.9	9.4	11.5	2.22
4	17.4	8.5	8.9	2.05
5	19.6	8.6	11.0	2.28
6	20.8	10.1	10.7	2.06
7	18.6	8.3	10.3	2.24
8	17.5	10.8	6.7	1.62
9	22.6	13.1	9.5	1.73
10	24.0	8.2	15.8	2.93
11	24.8	11.5	13.3	2.16
12	23.3	8.7	14.6	2.68

TABLE III - continued

SUBJECT CCO			CONSONANTS	RT VERSUS T
PAIR	RT	T	RT-T	RT/T
1	21.7	8.5	13.2	2.55
2	18.8	8.6	10.2	2.19
3	19.4	10.1	9.3	1.92
4	19.9	8.3	11.6	2.40
5	18.0	10.8	7.2	1.67
6	23.5	11.5	12.0	2.04
7	22.6	8.7	13.9	2.60
8	23.4	10.6	12.8	2.21

SUBJECT CCO			CONSONANTS	TS VERSUS T
PAIR	TS	T	TS-T	TS/T
1	23.4	14.5	8.9	1.61
2	17.8	8.6	9.2	2.07
3	20.5	10.1	10.4	2.03
4	21.3	8.3	13.0	2.57
5	24.4	8.9	15.5	2.74
6	22.2	9.5	12.7	2.34
7	21.2	10.6	10.6	2.00
8	22.7	10.5	12.2	2.16
9	23.6	13.1	10.5	1.80

SUBJECT CCO			CONSONANTS	TS VERSUS C
PAIR	TS	C	TS-C	TS/C
1	19.4	8.4	11.0	2.31
2	26.7	11.8	14.9	2.26
3	23.4	9.9	13.5	2.36
4	24.1	11.6	12.5	2.08
5	19.8	11.4	8.4	1.74
6	24.1	13.8	10.3	1.75
7	19.3	8.4	10.9	2.30

TABLE III - continued

SUBJECT CCD CONSONANTS TT VERSUS RT

PAIR	TT	RT	TT-RT	TT/RT
1	21.8	22.6	-0.8	0.96
2	18.0	18.5	-0.5	0.97
3	19.6	18.8	0.8	1.04
4	20.8	19.4	1.4	1.07
5	18.6	19.9	-1.3	0.93
6	17.5	18.0	-0.5	0.97
7	24.8	23.5	1.3	1.06
8	23.3	22.6	0.7	1.03
9	19.0	19.7	-0.7	0.96
10	20.5	18.4	2.1	1.11

SUBJECT CCD CONSONANTS TT VERSUS TS

PAIR	TT	TS	TT-TS	TT/TS
1	19.6	17.8	1.8	1.10
2	20.8	20.5	0.3	1.01
3	18.6	21.3	-2.7	0.87
4	22.6	23.6	-1.0	0.96
5	19.0	19.8	-0.8	0.96
6	20.6	20.5	0.1	1.00

SUBJECT CCD CONSONANTS RT VERSUS TS

PAIR	RT	TS	RT-TS	RT/TS
1	18.8	17.8	1.0	1.06
2	19.4	20.5	-1.1	0.95
3	19.9	21.3	-1.4	0.93
4	19.7	19.8	-0.1	0.99

TABLE III - continued

SUBJECT CCO CONSONANTS QQ VERSUS Q

PAIR	QQ	Q	QQ-Q	QQ/Q
1	22.1	12.6	9.5	1.75
2	22.4	13.6	8.8	1.65
3	20.9	10.7	10.2	1.95
4	20.4	7.9	12.5	2.58
5	19.5	9.0	10.5	2.17
6	16.2	9.9	6.3	1.64
7	16.4	8.9	7.5	1.84
8	18.3	7.4	10.9	2.47
9	19.4	9.0	10.4	2.16
10	19.5	8.7	10.8	2.24
11	20.9	9.1	11.8	2.30
12	23.1	10.0	13.1	2.31
13	16.7	8.7	8.0	1.92
14	20.0	12.3	7.7	1.63
15	20.1	8.8	11.3	2.28
16	21.9	10.7	11.2	2.05
17	19.2	8.1	11.1	2.37
18	18.9	10.2	8.7	1.85

SUBJECT CCO CONSONANTS NN VERSUS N

PAIR	NN	N	NN-N	NN/N
1	15.4	7.3	8.1	2.11
2	19.6	6.5	13.1	3.02
3	14.7	7.3	7.4	2.01
4	14.2	5.2	9.0	2.73
5	20.2	6.4	13.8	3.16
6	15.4	6.8	8.6	2.26
7	16.5	4.8	11.7	3.44
8	16.4	6.7	9.7	2.45
9	16.5	4.8	11.7	3.44
10	16.2	6.4	9.8	2.53

TABLE III - continued

SUBJECT CCO CONSONANTS RN VERSUS N

PAIR	RN	N	RN-N	RN/N
1	16.0	7.3	8.7	2.19
2	18.6	6.5	12.1	2.86
3	15.2	7.3	7.9	2.08
4	14.8	5.2	9.6	2.85
5	17.8	6.4	11.4	2.78
6	15.6	6.8	8.8	2.29
7	16.6	4.8	11.8	3.46
8	15.6	6.7	8.9	2.33

SUBJECT CCO CONSONANTS NN VERSUS RN

PAIR	NN	RN	NN-RN	NN/RN
1	15.4	16.0	-0.6	0.96
2	19.6	18.6	1.0	1.05
3	14.7	15.2	-0.5	0.97
4	14.2	14.8	-0.6	0.96
5	20.2	17.8	2.4	1.13
6	15.4	15.6	-0.2	0.99
7	16.5	16.6	-0.1	0.99
8	16.4	15.6	0.8	1.05

TABLE IV

Average measures for each word pair: absolute durations in cs, differences, and ratios. Subject: IH.

SUBJECT IH — CONSONANTS PP VERSUS P

PAIR	PP	P	PP-P	PP/P
1	32.0	12.5	19.5	2.56
2	23.7	9.4	14.3	2.52
3	18.4	8.4	10.0	2.19
4	23.8	9.8	14.0	2.43
5	25.3	9.5	15.8	2.66
6	24.2	10.2	14.0	2.37

SUBJECT IH — CONSONANTS RP VERSUS P

PAIR	RP	P	RP-P	RP/P
1	19.9	9.8	10.1	2.03
2	19.2	8.6	10.6	2.23

SUBJECT IH — CONSONANTS PP VERSUS RP

PAIR	PP	RP	PP-RP	PP/RP
1	24.5	23.8	0.7	1.03
2	32.2	32.0	0.2	1.01
3	28.5	28.0	0.5	1.02
4	26.5	24.7	1.8	1.07
5	27.7	28.2	-0.5	0.98
6	22.9	25.1	-2.2	0.91
7	29.3	28.4	0.9	1.03
8	25.8	24.7	1.1	1.04
9	21.9	22.9	-1.0	0.96
10	28.6	26.6	2.0	1.08
11	23.4	23.3	0.1	1.00

TABLE IV - continued

SUBJECT IH CONSONANTS TT VERSUS T

PAIR	TT	T	TT-T	TT/T
1	30.7	9.5	21.2	3.23
2	22.3	8.7	13.6	2.56
3	24.9	8.9	16.0	2.80
4	21.4	9.4	12.0	2.28
5	19.2	11.5	7.7	1.67
6	24.9	11.9	13.0	2.09
7	23.7	7.7	16.0	3.08
8	23.8	8.3	15.5	2.87
9	23.9	7.3	16.6	3.27
10	17.7	9.0	8.7	1.97
11	24.9	11.5	13.4	2.17

SUBJECT IH CONSONANTS RT VERSUS T

PAIR	RT	T	RT-T	RT/T
1	23.9	9.3	14.6	2.57

SUBJECT IH CONSONANTS TS VERSUS T

PAIR	TS	T	TS-T	TS/T
1	22.1	7.7	14.4	2.87
2	23.0	8.3	14.7	2.77
3	24.7	7.3	17.4	3.38
4	25.4	11.5	13.9	2.21
5	26.0	13.7	12.3	1.90

SUBJECT IH CONSONANTS TS VERSUS C

PAIR	TS	C	TS-C	TS/C
1	21.1	10.2	10.9	2.07
2	23.4	7.3	16.1	3.21

TABLE IV - continued

SUBJECT IH — CONSONANTS — TT VERSUS RT

PAIR	TT	RT	TT-RT	TT/RT
1	28.6	29.9	-1.3	0.96
2	20.0	19.0	1.0	1.05
3	23.7	22.1	1.6	1.07
4	23.8	24.0	-0.2	0.99
5	23.9	22.2	1.7	1.08
6	17.7	18.5	-0.8	0.96

SUBJECT IH — CONSONANTS — TT VERSUS TS

PAIR	TT	TS	TT-TS	TT/TS
1	23.7	22.1	1.6	1.07
2	23.8	23.0	0.8	1.03
3	23.9	24.7	-0.8	0.97

SUBJECT IH — CONSONANTS — RT VERSUS TS

PAIR	RT	TS	RT-TS	RT/TS
1	22.1	22.1	0.0	1.00
2	24.0	23.0	1.0	1.04
3	22.2	24.7	-2.5	0.90

TABLE IV - continued

SUBJECT IH CONSONANTS QQ VERSUS Q

PAIR	QQ	Q	QQ-Q	QQ/Q
1	25.4	10.6	14.8	2.40
2	23.8	12.9	10.9	1.84
3	24.1	10.7	13.4	2.25
4	23.2	9.9	13.3	2.34
5	23.5	8.9	14.6	2.64
6	18.4	9.5	8.9	1.94
7	17.0	8.7	8.3	1.95
8	18.6	9.0	9.6	2.07
9	21.8	7.9	13.9	2.76
10	25.5	9.6	15.9	2.66
11	22.3	9.4	12.9	2.37
12	26.4	10.6	15.8	2.49
13	21.4	8.3	13.1	2.58
14	21.3	11.4	9.9	1.87
15	23.6	9.4	14.2	2.51
16	24.2	10.8	13.4	2.24
17	24.9	8.8	16.1	2.83
18	22.5	8.3	14.2	2.71

SUBJECT IH CONSONANTS NN VERSUS N

PAIR	NN	N	NN-N	NN/N
1	17.3	6.3	11.0	2.75
2	23.0	7.9	15.1	2.91
3	18.4	4.5	13.9	4.09
4	16.3	4.1	12.2	3.98
5	24.5	5.9	18.6	4.15
6	16.4	6.1	10.3	2.69

TABLE IV - continued

SUBJECT IH — CONSONANTS RN VERSUS N

PAIR	RN	N	RN-N	RN/N
1	17.0	6.3	10.7	2.70
2	21.2	7.9	13.3	2.68
3	17.0	4.5	12.5	3.78
4	14.2	4.1	10.1	3.46
5	19.8	5.9	13.9	3.36
6	15.0	6.1	8.9	2.46

SUBJECT IH — CONSONANTS NN VERSUS RN

PAIR	NN	RN	NN-RN	NN/RN
1	17.3	17.0	0.3	1.02
2	23.0	21.2	1.8	1.08
3	18.4	17.0	1.4	1.08
4	16.3	14.2	2.1	1.15
5	24.5	19.8	4.7	1.24
6	16.4	15.0	1.4	1.09

3.5.1. Geminate versus single consonant

As stated earlier, every measure of duration in the tables represents an average of generally five individual measurements. A statistical treatment[16] of the original raw data shows that there is a good deal of dispersion of the measures for each item (word). However, the durational difference between phonologically geminate (long) and phonologically single (short) consonant is found to be significant at a 99 per cent confidence level within each (sub-) minimal word pair.

There is absolutely no overlapping between long and short consonant within a word pair, and it was true for all three subjects that all occurrences of the long item were at least 1.7 times as long as any occurrence of the short (in the same word pair), with the following exceptions: nine words had a ratio between 1.6 and 1.7, and two words had a ratio of 1.56 and 1.59 respectively.

The quantity contrast is thus very clearly manifested. This is true both with respect to the absolute difference and with respect to the ratio long:short. The former exceeds 9 cs, and the latter generally exceeds 2:1. Generally, the lowest figures are found with /qq/ versus /q/, for which some word pairs differ by only some 6 cs and show a ratio of little more than 1.6:1. The opposite extreme occurs with /nn/ versus /n/ whose ratio sometimes exceeds 4:1.

The relatively low figures for the quantity contrast of /qq/: /q/ may have to do with the fact that /qq/ : /q/ to some extent differ also by weaker articulation of the latter. They may thus not be quite comparable. The other consonants studied are supposed to exhibit a more purely

---

16) We are indebted to Mr Jørgen Elgaard Knudsen, mag. scient., who has performed the data processing.

durational difference.

As for the nasal the high ratio is not due to excessive duration of /nn/ but to a tendency toward very short duration of /n/. It may be inherently shorter than the stops, but the difference may also in part be due to our principles of segmentation (with exclusion of the entire transitions in order to ensure a meaningful comparison of /nn/ with /rn/). Anyway, the difference between /nn/ and /n/ (which, of course, is not nearly as vulnerable to differences in the duration of /n/ as the ratio is) is similar to that of /tt/ to /t/, etc., viz. typically of the order of 1o cs.

A comparison of the two measures of quantity relationship: absolute difference and ratio, shows that within the word list belonging to each phonological contrast there is more variation in absolute difference than in ratio. If, however, we compare the averages for each word list with the averages for other word lists (cf. examples in Table V) the relative variation of the difference is clearly smaller than the relative variation of the ratio. Since each list represents a variety of different word types (differing in syllable and mora number, in the position of the measured consonants within the word, etc.), it seems that environments exert less influence on the ratio than on the absolute difference in duration, whereas the phonetic properties of the segments themselves exert less influence on the absolute difference of duration than on the ratio.

We suggested in section 2. above that geminates differ from single consonants not only by being "double" but also by belonging always to two syllables, as against single, intervocalic consonants which are syllable initial. This applies equally to double consonants that are related to single consonants by the gemination rule (see section 2.4.) and to double consonants that are derived from consonant clusters with complete assimilation (see section 2.3.). Hence, what we really compare is not, systematically speaking, a long and a short consonant in the same position (note that word

TABLE V Specimens of statistical treatment of ratios and differences.

SUBJECT RP CONSONANTS PP VERSUS P NUMBER=18

	MEAN	S.D.	M.E.	95 PCT.CF.LM.
PP/P	2.21	0.23	0.05	0.11
PP-P	11.19	2.14	0.51	1.07

SUBJECT CCO CONSONANTS PP VERSUS P NUMBER=17

	MEAN	S.D.	M.E.	95 PCT.CF.LM.
PP/P	2.21	0.29	0.07	0.15
PP-P	11.78	1.71	0.41	0.88

SUBJECT RP CONSONANTS PP VERSUS RP NUMBER=16

	MEAN	S.D.	M.E.	95 PCT.CF.LM.
PP/RP	0.99	0.06	0.01	0.03
PP-RP	-0.13	1.24	0.31	0.66

SUBJECT CCO CONSONANTS PP VERSUS RP NUMBER=16

	MEAN	S.D.	M.E.	95 PCT.CF.LM.
PP/RP	1.00	0.04	0.01	0.02
PP-RP	0.03	0.88	0.22	0.47

SUBJECT IH CONSONANTS PP VERSUS RP NUMBER=11

	MEAN	S.D.	M.E.	95 PCT.CF.LM.
PP/RP	1.01	0.05	0.01	0.03
PP-RP	0.33	1.22	0.37	0.82

TABLE V - continued

SUBJECT RP	CONSONANTS TT VERSUS T			NUMBER=14
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
TT/T	2.27	0.36	0.10	0.21
TT-T	11.06	1.95	0.52	1.13

SUBJECT CCO	CONSONANTS TT VERSUS T			NUMBER=12
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
TT/T	2.21	0.36	0.10	0.23
TT-T	11.32	2.48	0.72	1.58

SUBJECT IH	CONSONANTS TT VERSUS T			NUMBER=11
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
TT/T	2.54	0.55	0.16	0.37
TT-T	13.97	3.77	1.14	2.53

SUBJECT RP	CONSONANTS TT VERSUS RT			NUMBER=10
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
TT/RT	0.99	0.06	0.02	0.04
TT-RT	-0.24	1.09	0.35	0.78

SUBJECT CCO	CONSONANTS TT VERSUS RT			NUMBER=10
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
TT/RT	1.01	0.06	0.02	0.04
TT-RT	0.25	1.15	0.36	0.82

TABLE V - continued

SUBJECT RP	CONSONANTS QQ VERSUS Q			NUMBER=18
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
QQ/Q	2.00	0.20	0.05	0.10
QQ-Q	10.40	2.30	0.54	1.15

SUBJECT CCO	CONSONANTS QQ VERSUS Q			NUMBER=18
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
QQ/Q	2.06	0.30	0.07	0.15
QQ-Q	10.02	1.85	0.44	0.92

SUBJECT IH	CONSONANTS QQ VERSUS Q			NUMBER=18
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
QQ/Q	2.36	0.32	0.08	0.16
QQ-Q	12.96	2.43	0.57	1.21

SUBJECT RP	CONSONANTS NN VERSUS N			NUMBER=10
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
NN/N	3.46	0.55	0.17	0.39
NN-N	11.97	2.24	0.71	1.60

SUBJECT CCO	CONSONANTS NN VERSUS N			NUMBER=10
	MEAN	S.D.	M.E.	95 PCT.CF.LM.
NN/N	2.71	0.53	0.17	0.38
NN-N	10.29	2.17	0.69	1.55

final clusters and geminates are impossible), but a syllable final consonant versus zero before an identical, syllable initial consonant:

VC-CV

V-CV

although on the articulatory level we get a longer versus a shorter closure hold. If we denote the syllable final, "mora-forming", consonant by C_a, and the syllable initial consonant by C_b, we may suggest that (i) the addition of C_a to the sequence gives an increment of duration which is not highly dependent upon the specific features of C_a, whereas (ii) the duration of C_b is rather dependent upon its specific features. (- How properties of the environments influence C_aC_b and C_a remains to be studied in detail.)

Geminates tend to be more than twice as long as single segments. This is not true of all word pairs taken individually, but it holds true for the averages of all results within each type of contrast except /qq/:/q/, although the average ratios do not exceed 2:1 very much. The results are:

/pp/:/p/	RP 2.21:1	CCO 2.21:1	IH 2.46:1
/tt/:/t/	RP 2.27:1	CCO 2.21:1	IH 2.54:1
/qq/:/q/	RP 2:1	CCO 2.36:1	IH 2.36:1
/nn/:/n/	RP 3.46:1	CCO 3.43:1	IH 3.43:1

These figures have limited validity since they are averages from arbitrary sets of word pairs, but they do show a tendency.

3.5.2. rC-clusters

If we now turn to the sequences representing underlying uvular plus consonant, the figures in the tables show conclusively that the stop or nasal segments of these sequences are equal in duration to the geminates treated above but entirely different from single segments between vowels.

I.e., it can be stated that sequences containing an underlying uvular plus a stop or nasal are reflected phonetically by sequences containing a long stop or nasal, which according to its duration might be the reflex of an underlying geminate or consonant cluster.

3.5.3. Coronal affricate

In all types discussed above the explosion of stops was included in the (total) duration of the consonant. We have calculated the averages for closure and explosion phase separately before adding them together, but we have not given the figures here because we did not find that they contributed significantly to this discussion. The explosion is generally short (and rather weak).

As stated earlier, t before i is reflected by the affricate /¢/, and tt in this position coalesces with t(+)s into /t¢/. Our measurements clearly show that the affrication phase is of essentially the same duration in /t¢/ and and /¢/, viz. about 5 cs in both (slightly less for IH than for the other persons), as against the short explosions of 2 cs or less found in other consonants. At the same time the occlusive portion of /t¢/ is considerably longer than a normal segment, so that the total duration of /t¢/ closely resembles that of /tt/. Thus the transcriptions /¢/ and /t¢/ seem adequate from a phonetic point of view: the former is an affricate of which roughly the last 5 cs are taken up by affrication, the latter is equal to the same affricate preceded by the homorganic stop /t/.

3.5.4. Duration of the whole word

In the preceding sections we have been concerned only with the durations of the specific segments under consideration. In the case of quantity contrasts (not involving a uvular component) one might, however, expect some influence on the remainder of the words. We have measured the total duration (minus initial or final consonant) and the durations of the single segments of some chosen word pairs, see Table VI. This showed no clear pattern, except for the durational difference of the contrasting segments.

Sequences involving an underlying uvular consonant pose a more important problem. We have not found any reason to assume that the long oral closure hold (whose existence can be inferred from the mingograms) is a succession of two different consonants sharing a manner of articulation but differing with respect to point of articulation (i.e. uvular stop or nasal plus non-uvular stop or nasal). However, one might a priori assume that there should be a clearly distinguishable "r"-segment of a certain duration before the stop or nasal, since this is the way phonetically trained scholars have almost invariably transcribed the sequences. We have measured the total duration (minus initial or final consonant) and the durations of the individual segments of some chosen words with and without underlying r̲ before consonant, see Table VII. The measurements show that vowels affected by an underlying uvular are either as long as or slightly longer than their non-uvularized counterparts. This tendency is, however, very weak indeed, and we cannot decide at present whether it is a matter of inherent extra duration of more open types of vowels (the uvularized vowels require a more pronounced displacement of the tongue than the other vowels, which might account for their tendency toward longer duration). At any rate, the total duration of the vocalic segment (including the transition to stop or nasal) cannot be said to bear evidence that it represents a succession of two segments: vowel and r̲. If one wishes to derive it that way phonologically, the underlying r̲ segment must be said to be incorporated phonetically into the vowel. It may instead be meaningful to speak of pre-uvularization as a secondary feature of the otherwise assimilated consonant.

TABLE VI

Durational relationships of some chosen words.
Averages of 5 measurements.

	i i	p pp	a a	(k) (k)		
CCO	4.7 4.7	12.2 25.4	5.6 5.6		= =	22.5 35.7
RP	5.6 4.1	1o.9 26.5	6.1 5.4		= =	22.6 36.o
IH	6.7 4.7	12.5 32.o	6.3 6.1		= =	25.5 42.8

	u u	p pp	i i	pp pp	u u	(q) (q)		
CCO	3.9 4.6	8.7 21.8	5.1 6.o	24.1 21.5	5.o 5.6		= =	46.8 59.5

	(t) (t)	u u	t tt	u u	pp pp	uŋa uŋa		
CCO		4.5 4.5	7.8 19.o	4.8 4.6	21.2 17.5	2o.4 16.9	= =	58.7 62.5
RP		4.9 4.8	9.o 19.9	4.8 4.9	19.8 2o.5	17.9 17.2	= =	56.3 67.2
IH		6.2 5.3	8.7 22.3	4.9 5.3	25.2 19.3	2o.9 18.4	= =	65.9 7o.6

TABLE VII

Durational relationships of some chosen words. Averages of 5 measurements.

	u u	pp rp	i i	(k) (k)	
CCO	5.4	24.7	5.5	=	35.6
	6.6	24.7	5.6	=	36.9
RP	5.2	26.5	5.2	=	36.8
	5.4	25.5	4.9	=	35.9
IH	5.1	32.2	6.0	=	43.3
	6.5	32.0	6.0	=	44.5

	u u	pp rp	i i	ŋŋua ŋŋua	(q) (q)	
CCO	4.9	21.6	5.2	30.9	=	62.6
	5.3	21.5	5.5	30.7	=	63.0

	i i	n n	u u	tt rt	u u	(t) (t)	
CCO	6.3	4.5	6.9	21.8	6.0	=	45.5
	5.5	5.1	7.2	22.6	5.9	=	46.3
RP	5.9	5.3	6.0	22.0	4.5	=	43.5
	6.1	3.8	7.5	22.4	5.2	=	44.9
IH	6.2	6.0	7.1	28.6	5.3	=	53.2
	6.6	5.9	7.1	29.9	5.2	=	54.7

	i i	q qq	u u	rp rp	u u	(q) (q)	
CCO	4.4	8.8	6.7	21.4	5.7	=	47.0
	5.2	20.1	6.2	21.5	5.4	=	58.4
RP	5.4	10.1	5.1	21.4	4.4	=	46.4
	6.4	22.0	6.4	22.0	5.4	=	62.1
IH	7.0	9.4	5.7	27.8	5.8	=	55.7
	5.7	23.6	6.2	22.3	5.8	=	63.6

	i i i	n nn rn	i i i	q q q	a a a	rp rp rp	u u u	(q) (q) (q)	
CCO	4.8	6.8	5.2	9.4	4.2	21.2	4.9	=	56.5
	5.2	15.8	5.5	9.4	4.2	20.0	4.9	=	65.0
	6.8	15.6	4.2	9.3	4.5	19.6	5.6	=	65.6
RP	5.5	5.1	5.9	9.1	5.0	21.5	4.1	=	56.4
	6.4	16.3	5.5	9.0	5.3	22.6	4.4	=	69.4
	6.9	15.5	4.4	9.0	5.3	21.4	4.0	=	66.4
IH	5.3	6.1	7.8	8.4	5.2	23.2	5.0	=	61.0
	6.2	16.4	7.3	8.4	5.2	22.6	5.7	=	71.8
	7.9	15.0	5.9	9.1	5.4	22.3	6.0	=	71.5

3.6. Statistical treatment

Table V presents some specimens of a statistical treatment presenting overall ratios and differences. This approach is obviously of extremely limited validity since it involves a number of unwarranted (or contrary-to-fact) assumptions, such as (i) that for a given contrast there is a "true" overall figure for the ratio or difference as such, (ii) that this can be found from a "representative" sample of occurrences of the contrast, and (iii) that our sets of word pairs are such "representative" samples. This they are not very likely to be, particularly since the very concept of "representative" is anything but well-defined in this context. (For this reason we have left in a single repetition in RP's set of 18 word pairs with /pp/ versus /p/, although it is strictly speaking statistically dubious.)

The following figures are given for ratios as well as differences: (1) mean value of the total set (sample), (2) standard deviation, (3) standard error of the mean, and (4) maximum deviation of the sample mean from a hypothetical "true" mean estimated with a probability of 95 per cent.

Several of the sets which are not shown in Table V were too small for this kind of processing. However, they all show largely the same tendencies. Some of the information was given in section 3.5.1. above.

4. Conclusion

As shown in sections 3.5.1., 3.5.2., and 3.5.3. the phonetic measurements corroborate the assumptions about phonological rules made in the beginning of this paper. Firstly it is confirmed to be entirely adequate to describe geminates as clusters of two like consonants. Secondly clusters with an underlying uvular as the first segment behave phonetically as if the first segment is assimilated to the second as in other instances of assimilation, except that the feature of uvularity (uvularization) is retained somewhere in the sequence. Finally, the complex arising from t(+)t before i or from t(+)s can be described as a succession of stop and homorganic fricative, i.e. when derived from t(+)t it exhibits affrication before i, and when derived from t(+)s it exhibits partial assimilation of s to t.

References

Bergsland, Knut 1955: A Grammatical Outline of the Eskimo Language of West Greenland. Mimeographed (Oslo).

Chomsky, Noam and Morris Halle 1968: The Sound Pattern of English.

Egede, Paul 1760: Grammatica Grönlandica Danico-Latina. (In IDC microfiche editions.)

Hill, A.A. 1958: Introduction to Linguistic Structures, Appendix A: Eskimo (p. 419-440).

Holtved, Erik 1964: Kleinschmidts Briefe an Theodor Bourquin (= Meddelelser om Grønland 140,3).

Kiparsky, Paul 1968: How Abstract is Phonology? Mimeographed.

Kleinschmidt, Samuel 1851: Grammatik der grönländischen Sprache.

McCawley, James 1968: The Phonological Component of a Grammer of Japanese.

Petersen, Robert 1970: "On Phonological Length in the Eastern Eskimo Dialects", Folk 11-12, p. 329-344.

Slis, I. H. 1968: "Experiments on Consonant Duration Related to the Time Structure of Isolated Words", IPO Annual Progress Report 3, p. 71-80.

Swadesh, Morris 1946: "South Greenlandic (Eskimo)", in: Linguistic Structures of Native America, Viking Fund Publications in Anthropology and Linguistics, p. 30-54.

Ulving, Thor 1953: "Consonant Gradation in Eskimo", IJAL 19, p. 45-52.

Underhill, Robert 1970: "Greenlandic Morphophonemics", Paper read before the Conference on Eskimo Linguistics June 5-7 (available in the form of a tape recording kindly put at our disposal by Mr Robert Petersen).