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Quantity Manifestation and Mora in West Greenlandic Eskimo: Preliminary Analysis

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Abstract
Acoustic measurements of the quantity contrast in West Greenlandic Eskimo were analysed in relation to the concept of mora as a temporal unit. Results from two experimental settings as well as comparison with other data have shown that: (1) durational behaviour of mora differed depending on the speaking style and depending on whether it is a vowel or consonant, and that (2) such effects as 'mora-timing' may be likely to arise as a result of careful quantity manifestation in slow speech.

INTRODUCTION

The purpose of the present study is to analyse the acoustic duration of single/geminate segments in West Greenlandic Eskimo with reference to the concept of mora as a temporal unit. In phonetic literature, the acoustic realization of mora as a temporal unit has been presented exclusively with data from Japanese. A specific issue concerning the Japanese mora is that it has been claimed to have roughly constant duration regardless of its internal segmental structure (Bloch 1950, Hockett 1955, Ladefoged 1975). This means, strictly speaking, that whether the mora is composed of CV, V, or C, it takes about the same time to pronounce it. So far evidence has been controversial. Both positive (Han 1962, Port et al. 1980, 1987, Homma 1981) and negative (Beckman 1982) evidence has been reported. Researchers usually agree, however, that mora has at least psychological status in Japanese because of the moraic Kana writing system. It would therefore be interesting to look at the durational characteristics of West Greenlandic Eskimo since it does not have a moraic writing system, and since the previous description of mora in Eskimo is free from such a claim as being roughly constant in duration.

Previous work on West Greenlandic Eskimo has shown that a carefully spoken word from a single speaker could indeed be analysed in terms of such an abstract temporal unit (Nagano-Madsen 1988). When more and more moras were added to the stem, the total duration of the phonological word linearly increased. The result was that from a given acoustic measurement, it was possible to predict the number of temporal units (moras) contained in the utterance. It was not possible, on the other hand, to predict the number of segments or syllables. However the 1988 study was rather limited, and similar results may not be obtained in more natural speech. In the present study, the same speaker (E.M.H.) was used reading different materials. In addition, another speaker D.T. was used for Experiment 1 for comparison. The results will be discussed under two headings: (1) variation in moraic value, and (2) comparison with Japanese mora.

MORA IN WEST GREENLANDIC ESKIMO

West Greenlandic Eskimo is a typical quantity language in which almost all the segments have the single/geminate dimension of contrast. The rhythm of spoken Eskimo closely resembles that of Japanese, a language in which the notion of 'mora-timing' has been well established and has been one of the central phonetic issues for some time (cf. Beckman 1982, Port et al. 1986). The resemblance is even greater in slow careful speech. Danish learners of Eskimo often have difficulty in acquiring the correct rhythm of Eskimo. They tend to make one mora or syllable in a word prominent and reduce the rest. In addition geminate segments are generally not produced long enough.

The rhythmic pattern of Eskimo words was analysed by Kleinschmidt using the concept of syllable weight (Holtved 1964, Mase & Rischel 1971). According to his rhythmic rules, a single vowel counts as 2, while a syllable-final consonant counts as 1. Following the possible syllable structure, the weight of a syllable may thus vary as follows:

V	2
CV	2
VC	3
CVC	3
VV	4
CVV	4
VVC	5
CVVC	5

These vowels and consonants that contribute to syllable weight in Kleinschmidt's sense are termed 'mora' in Mase & Rischel (1971). The

mora may be either vocalic, as in (C)V(V)(C) and (C)VV(C), or consonantal, as in (C)V(V)C.

The validity of mora in Eskimo as a unit of prosodic measure has been most convincingly demonstrated in relation to the phrase final intonation. Rischel 1974 describes phrase-final intonation as being manifested on the vowel mora bases rather than on the syllable bases. Measurements of the mean fundamental frequency (F0) have supported his auditory analysis (Mase 1973). In Nagano-Madsen 1988 it was shown that the timing of F0 fall and rise remained very constant for the last three moras when F0 contours were lined up at the end point.

The durational reality of mora has partially been reported in the study of consonant quantity by Mase and Rischel 1971. The quantity contrast was manifested very clearly and consistently, with the quantity ratio exceeding 2:1 in general. Extending the analysis of mora, the temporal role played by mora was reported by Nagano-Madsen 1988 as described in the previous section.

METHOD AND MATERIAL

The subjects were two native speakers of Central West Greenlandic (E.M.H. and D.T.). They were a teaching assistant and a student at the Department of Greenlandic, Århus University. All the recordings were made in a soundproof studio.

Experiment 1

Eight test words were prepared. They differed in the type of intervocalic consonant as well as in quantity contrast. They were embedded in a carrier sentence "tassa _____ ilaat" (it's one of the _____ s). Each subject read the list five times. This experiment was designed so that the results would be comparable to those obtained for Japanese (cf. Beckman 1982). In order to make the phonetic environments similar, some nonsense words were included. However, they differed very little from existing words and neither of the two speakers had difficulty in reading them. Since there has been no parallel data on Japanese vowel quantity, the present experiment on West Greenlandic Eskimo concentrated on the consonant quantity excluding vowels from the first experiment.

word list		
	tapaq	tappaq
	tataq	tattaq

takaq takkaq
taqaq taqqaq

The durations of the VOT for the initial consonant, first vowel, consonant closure, VOT, and second vowel were measured from spectrograms.

Experiment 2

In the second experiment, a text describing Greenlandic town was read by EMH at a comfortable speaking rate. The duration of a vowel was measured from the onset of regular phonation to the obvious point of constriction for the following consonant. The transitions of consonants were regarded as part of the preceding or following vowel. VOT was measured separately. The text included some 148 phonological words and 573 syllables. The number of tokens obtained for each syllable type were as follows: CV 228, CVC 168, V 56, VC 52, CVV 31, CVVC 30, VVC 5, and VV 2.

RESULTS AND DISCUSSION

Variation in Moraic Value

The duration of mora, mean durations of single and geminate segments, and quantity ratio are presented in Tables 1 and 2 for consonants and vowels respectively. VOT duration is included in consonant duration in order to make comparison with previous studies. The mean durations for the single/geminate consonants and the quantity ratio obtained in the present experiments are in close agreement with those presented in the study of consonant quantity by Mase & Rischel 1971, despite differences in the material used in the two studies. In their material, word citation forms were used.

At present there is no agreed upon method of deciding as to exactly where the syllable and mora boundary should be located during the phonetically long segments. Phonetically long consonants are analysed as being composed of a syllable final, mora forming consonant plus a syllable initial consonant. For Japanese material, Han 1962 obtained the duration of moraic consonants by subtracting the duration of matching single consonants from that of geminate consonants. The same method is used in the present study extending it also for vowels. In other words, a phonetically long vowel in such a syllable as CVV is analysed as being composed by a single vowel belonging to the CV mora plus a vowel mora.

In order to compare the results in accordance with speaking style obtained from the same speaker, the figures obtained in Nagano-Madsen 1988 were recalculated and included in the table as (A). Results of Experiment 1 are referred to as (B) and Experiment 2 as (C). The column for /p/ is absent in (C) since there was no occurrence of single /p/ at intervocalic position in the text. As for vowel quantity, figures were compared only in materials (A) and (C). The duration of vowels excluded those in prepausal positions since they are usually much longer.

Table 1. Mean durations in milliseconds for mora and single/geminate consonants and quantity ratio. Standard deviation is shown in the bracket. A= figures obtained from Nagano-Madsen1988. B=Experiment 1, C=Experiment 2.

	mora value	single		geminate		ratio
A						
/t/	132	95	(6.7)	227	(13.2)	**2.4**
n		12		12		
B						
/p/	118	91	(7.9)	209	(4.7)	2.3
/t/	97	95	(10.2)	192	(10.3)	2.0
/k/	86	94	(6.2)	180	(5.9)	1.9
/q/	95	103	(15.8)	198	(11.0)	1.9
n		5		5		
				mean ratio		**2.0**
C						
/t/	81	93	(18.4)	174	(21.4)	1.9
n		16		8		
min-max		73-135		150-203		
/k/	68	117	(24.0)	185	(17.2	1.6
n		6		5		
min-max		90-173		166-214		
/q/	109	108	(24.6)	217	(19.8)	2.0
n		14		7		
min-max		69-154		172-225		
				mean ratio		**1.8**

Table 2. Mean durations in milliseconds for mora and single/geminate vowels and quantity ratio. A= from Nagano-Madsen 1988, C=Experiment 2.

	mora value	single		geminate		ratio
A						
/a/	129	91	(11.2)	220	(14.1)	**2.4**
n		12		12		
C						
/i/	107	59	(20.1)	166	(39.2)	2.8
n		112		10		
min-max		21-107		102-217		
/a/	119	66	(19.2)	185	(36.9)	2.8
n		120		45		
min-max		23-113		85-267		
/u/	127	56	(18.2)	183	(21.0)	3.3
n		68		6		
min-max		19-103		162-204		
				mean ratio		**3.0**

The durations of consonant mora and vowel mora from careful speech (A) were about the same, clustering around 130ms. The quantity ratio was exactly the same. As the speech material becomes more natural, the duration of mora decrease as expected. However, it is the quantity ratio rather than the absolute duration of mora that gives more information concerning the moraic value of the segment in a given speech material.
One of the arguments concerning the ratio between single and geminate segment is that the ratio found in a language like Japanese generally exceeds 1:2, which is the ratio that simple gemination would lead us to expect. The higher the ratio, the more plausible is the mora analysis.

The most notable observation was that consonant mora and vowel mora behave differently when speech material becomes more natural. The quantity ratio for consonants has reduced in the present experiments, but that of vowels has increased. In other words, the value of consonant mora

has decreased while that of vowel mora has increased.The durational change of speech segments for different rates of speech has been known for some time but the exact difference between the vowels and consonants in durational behaviour is still inconclusive (Kozhevnikov & Chistovitch 1965, Wood 1973).

There was very little difference between the figures obtained from Experiment 1 and Experiment 2, viz. between a reading of words embedded in a carrier sentence and a reading of text. The tables shows that quantity ratio differs depending on the experimental settings and depending on whether the tested segment is a consonant or vowel. There is a regular tendency for the ratio of consonants to be reduced as the speech material becomes more natural. This reduced ratio in consonant quantity results from the fact that the durations of single consonants differ very little in all the experimental settings, while that of geminate consonants tends to be shortened in continuous speech. The large difference in duration between /k/ in (B) and that in (C) may be due to the influence of the segmental material. While /k/ was in between vowel /a/ in (B), it frequently appeared before /i/ in (C) where VOT was found to be very long. Since VOT was calculated as part of the consonants, the duration of /k/ increased consequently.

The durations of vowels, on the other hand, were reduced both for single and geminate. Consequently, the quantity ratio was not reduced but rather increased. Vowels were very short when they occurred word initially followed by a voiceless consonant.

There was durational overlapping between single and geminate vowels when the entire material was gathered. However, there was no overlapping within the phonological word. That there was no overlapping in duration for consonant quantity may be simply due to the fact that consonant tokens were much smaller than the vowel tokens in the material obtained from continuous speech. In fact, the maximum value of single consonants and the minimum value of the geminate consonants did not differ greatly.

Comparison with Japanese Mora

Two types of calculations were made in order to compare the durational features of mora with that of Japanese. First is the quantity ratio between single and geminate segments, and second is the duration of the moraic consonant calculated in the same way as described in the previous section.

Since data on vowel mora is conspicuously lacking from Japanese, only the consonant mora was compared. The results are shown in Table 3 and Table 4.

Table 3 shows the quantity ratio for the four stop consonants used in the first experiment. In Beckman 1982, one bisyllabic word containing /t/ and three bisyllabic words containing /k/ as an intervocalic segment were used. The mean durations were calculated from 15 tokens produced by five speakers for each word in her study. The comparison shows that the durational feature of consonant mora is very similar in Japanese and West Greenlandic Eskimo. Like Japanese, the duration of VOT did not differ depending on whether the consonant was single or geminate. The ratios were 2.03 and 2.22 for speaker E.M.H. and 2.33 and 2.72 for speaker D.T. The ratio from the latter is particularly similar to the figures presented for Japanese.

Table 3. Comparison of consonant quantity manifestation. Mean duration in milliseconds and ratio.

	VOT as part of stop	VOT as part of vowel
Speaker E.M.H.	2.03	2.22
Speaker D.T.	2.33	2.72
Japanese*	2.25	2.79

*From Beckman 1982.

Table 4. Comparisons of the duration of moraic consonants in milliseconds.

	VOT as part of stop	VOT as part of vowel
Speaker E.M.H.	99	99
Speaker D.T.	113	115
Japanese*	106	108

*From Beckman 1982.

The figures in Table 3 and 4 also indicate that speech rate is in a close relationship with the durational realization of mora. The duration of consonant mora decreases as the quantity ratio decreases. The higher quantity ratio for consonants generally indicates that speech is slower. As discussed in the previous section, the reverse was true for the vowels.

CONCLUSIONS

The main result obtained in this study was that the consonant mora and vowel mora differ in durational manifestation as speech material differs. There was an indication that the rate of speech is in a close relationship with the quantity ratio and hence the realization of mora. In the present material, higher speech tempo tended to decrease the quantity ratio and the moraic value of consonant mora, but for vowels the situation was reversed. This difference in durational behaviour resulted from the fact that the duration of single consonants did not differ greatly in accordance with speech material, while the duration of both single and geminate vowels decreased.

One of the central concepts related to mora is its generality. When mora is claimed to be a temporal unit, it becomes possible to generalize C and V as mora and give, theoretically speaking, the same value to both of them. The result of the present study did not support such generality shared between consonants and vowels as far as their durational behaviour was concerned.

The comparison of consonant mora from West Greenlandic Eskimo with that of Japanese has shown that the quantity manifestation of single/geminate consonants is very similar for the two languages. The durational characteristics obtained in this study may be of general interest for the issue of mora-timing in Japanese. As far as West Greenlandic Eskimo is concerned, I am inclined to think that such an impression as mora-timing resulted largely from a side-effect of careful quantity manifestation found in slow speech.

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Glide strengthening

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In Olsson 1989:135 f., I accounted for the fact that glides prevent (intermorphemic) epenthetic vowels from showing up to their immediate left, while allowing them on their immediate right, by a rule which makes glides condition epenthesis when preceding any consonant at a morpheme boundary. The parallel asymmetry with *v* in voicing assimilation was incorporated into the rule. In this squib, the background to the glide rule will be given, with explicitly mentioned examples and some prior accounts of the problems with the glides. Only the original solution, without rule features, will be presented.

In Standard Hungarian voicing assimilation, *v* only participates passively. Preconsonantally, *v* belongs to the obstruent class and is devoiced if the following consonant is voiceless (and thus an obstruent), but *v* cannot voice a preceding obstruent. In *szívtelen* 'heartless' and *hatvan* 'sixty', the medial consonant sequences are thus pronounced as *ft* and *tv*, respectively. Barkaï and Horvath 1978, who say that the same ambiguity in *v* as regards voicing assimilation exists in Hebrew and Russian, assume that a sonority hierarchy solves the problem with *v*. They also make use of the sonority hierarchy to solve the problem with Hebrew vowel epenthesis in root-final consonant clusters, where final *v* behaves in the same way as obstruents. In Hebrew, epenthesis only takes place in a final consonant cluster when the final consonant is an obstruent - we thus have *hajden* < *Haydn* and *sarter* < *Sartre*, but *mozart*, *zift*, *ford*, *serv*. The last example implies that *v* here works as an obstruent. Another conceivable solution, which would obviate the problem (but one that decisive examples may overrun), would be that a final sequence of obstruent + sonorant is necessary for epenthesis to take place. Bolozky 1978 states the more general fact that in Hebrew a sonorant must be in direct contact with a vowel (thus, forms like Greek *Mnemosyne*, Slavic *Mladen* and possibly Swedish *vrida* 'to wring' are not possible forms in Hebrew). By making use of the sonority scale, Barkaï and Horvath succeed in eliminating a rather limited sonorization rule for *v* and, in addition, get rid of the extrinsic order. But of the four references to the sonority scale (in the voicing assimilation rule and the Hebrew epenthesis rule) one ($m \geq 1 = \leq 7$) covers all consonants (is thus redundant), another ($n \geq 4$) refers to excluding sonorants, while yet another ($m \leq 3$) refers to including obstruents (I refer to a group which in a certain position agrees with *v* in its reaction to a certain process as *including*). The fourth reference ($n \leq 2$), finally, stands for excluding obstruents. The formalism rather obscures the generalization that *v* belongs to the obstruents preconsonantally, but acts as a sonorant elsewhere. The algebraic denominations, moreover, make reading the rule difficult by not instantly relating to a positive or negative value for the parameter voice.

Vago 1980 represents a more traditional account, as he does not notice - it seems - the similarity between the glides and *v* regarding the two rules in Hungarian. In a note concerning his epenthesis rules (87 f., note 5), he says that he does not take any stand as to whether the symbol C in the description means [-syll] or [+cons]. He explains, however, that the evidence suggests the following state: In environment $(C)_a\, C_b \_\_ C_c\, (C)_d$, C_c is interpreted as [+cons], the others as [-syll]. The special position of *v* in voicing assimilation is taken care of by positing obstruents and *v* as the inputs for his rule (35), which makes it look hardly natural:

(1) Voicing assimilation

$$\left\{\begin{matrix}[-son]\\ \begin{bmatrix}+cons\\ -cor\\ +cont\end{bmatrix}\end{matrix}\right\} \longrightarrow [\alpha voi]\ /\_\_\ (\#) \begin{bmatrix}-son\\ \alpha voi\end{bmatrix}$$

(Obstruents and /v/ are assimilated to a following obstruent in voicing.)

The sonority model means an improvement over the traditional account, as it makes it possible to perceive the similarity between epenthesis and voicing assimilation in regard to glides and *v*. Voicing assimilation, the Hebrew epenthesis and the Hungarian epenthesis are all - however - more rewardingly explained by regarding preconsonantal *v*, *j* and *h* as articulatorily stronger than the same segments in postconsonantal position. This solution is satisfactory, at least for Hungarian. Investigating the instances where the glides trigger (+) or hinder (-) voicing assimilation and epenthesis in the positions before and after another consonant, respectively, gives the following scheme:

(2) Reactions to rules in a sequence of glide plus consonant

	voicing assimilation	epenthesis
vC	+	+
hC	/	+
jC	-	+
Cv	-	-
Ch	+	-
Cj	-	-

Regarding the sequence hC it may be noticed that the underlying *h* disappears in the derivation before a consonant, which makes the question of voicing assimilation undecidable. Examples are e.g. *a juhból* [(Ø)b] 'out of the sheep' and *a juhtól* [(Ø)t] 'from the sheep'.

The values are motivated by the examples in the following scheme (both voicing assimilation and epenthesis take place over a morpheme-boundary and therefore intermorphemic examples have been chosen, but the voicing assimilation rule also crosses word-boundaries):

(3) Examples of reaction disposition in the sequences

	voicing assimilation	epenthesis
vC	szív+telen [ft] heartless	szív-e-m my heart
hC	/	juh-o-m my sheep
jC	baj+talan+ul [jt] without worry	máj-a-k liver, pl.
Cv	hat+van [tv] sixty	oszt+va dividing (verbal adverb)
Ch	dob+hat [ph] throw away, pot.	oszt+hat divide, pot.
Cj	lop+ja [pj] steal, 3 sg. det.	áld+ja bless, 3 sg. det.

Verbal stems with a single final consonant take an epenthetic vowel relatively seldom, while verbal stems with a final consonant cluster only require one following consonant to trigger epenthesis (see e.g. Olsson 1987 a). As the examples show, epenthesis does not take place in the latter case if *j*, *v* or *h* follow. This could be taken to imply that all glides acquire a consonantal status (at least phonologically) in preconsonantal position.

The segments that participate in the voicing assimilation are characterized by their obstruent specification. The reason why a morpheme initial *h* devoices voiced obstruents would then be that it constitutes part of the obstruent class, just like all the other voiceless segments.

The transformation of glides into consonants parallels by and large the change of *v* into an obstruent. It is reasonable to assume that the partly identical conditions for glides in the two rules (having the same context and being subject to similar changes) make possible and probable that the glide changes be generalized into a single rule, which can be written as follows:

(4) Glide strengthening

$$\begin{bmatrix} \text{-cons} \\ \text{-voc} \\ \langle\text{+ant}\rangle \end{bmatrix} \longrightarrow \begin{bmatrix} \text{+cons} \\ \langle\text{-son}\rangle \end{bmatrix} \; / \_\_ \begin{bmatrix} \text{-syll} \\ \langle\text{-son}\rangle \end{bmatrix}$$

(Glides become consonantal before non-syllabic segments and, similarly, *v* becomes an obstruent before an obstruent.)

The context has to be specified as [-syll] and not as [+cons] because *h* - termed [-cons] - devoices a preceding *v*, e.g: *a szívhëz* [fh] 'to the heart'. Slightly changing the context into [-cons] __ would make the rule seem more elegant (involving no instance of [cons] and three instances of [syll]), but of course this solution (like every solution involving a preceding vowel as the determining factor) falls short of embracing all relevant examples - as is evidenced by e.g. *szërv+k szërvek* '(bodily / administrative) organs'. As I have in several earlier papers (first Olsson 1987 b) defined pause as a unit with negative value for all features and one which has to be marked [-segment] (thereof follow all other negative specifications), (4) also implies that glides are consonantal and *v* an obstruent in word-final position. Consonants are not devoiced in this position in connection with Hungarian voicing assimilation, but the context is apparently marked here as [+segment]. Russian devoicing in word-final position may on the other hand be regarded as part of a voicing assimilation rule where the change indicating context is not specified as to segmentality (cf. Halle 1959:64 who, however, thinks that there are two processes in Russian - one consonant final devoicing rule - P 2 - and one separate voicing assimilation rule - P 3a).

The rule proposed here is very general, although - as argued in Olsson 1989:135 f. - it seems to be less probable phonetically than the rule feature solution and also would make another rule less general. Nevertheless, it is still a viable alternative, especially - it is believed - as a general tendency for glides. It is notoriously difficult to make glides harmonize with the concept of natural classes according to the traditional Western dichotomization - thus, a) rule (4) apparently does not work for Hebrew epenthesis, b) is less general than the actual facts in some dialects of Hungarian imply regarding voicing assimilation (Olsson 1989) and c) seems to be obligatory or optional, but in fast speech often is unnecessary altogether in Hebrew voicing assimilation (Bolozky 1978). In all three cases the problem arises not because the rule is contradicted, but because *v* functions here like the other obstruents in all positions.

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