MEADOW MARI PROSODY

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PREFACE

Mari (earlier known also as Cheremis) is a Finno-Ugric language of the Volga branch spoken by about 500,000 people in Central Russia. This book that presents new acoustic data of Meadow Mari prosody is a part of the project ”Finno-Ugric Prosody”, led and partly funded by Ilse Lehiste, Professor Emeritus of Linguistics at the Ohio State University. The main goal of the project is to provide new phonetic data of the prosodic structure of various Finno-Ugric languages in the same methodological framework and thus to produce a data-based comparative overview of Finno-Ugric prosody. A monograph that treats Erzya prosody was published in 2003 (Lehiste, Aasmäe, Meister, Pajusalu, Teras, Viitso 2003), initial results about Mari prosody were presented in 2001 (Lehiste, Meister, Pajusalu, Parve, Teras, Viitso 2001).

The leading expert of the project in Finno-Ugric languages is Tiit-Rein Viitso, Professor Emeritus of Finnic languages at the University of Tartu. The administrative leader of the project is Professor Karl Pajusalu, Head of the Department of Estonian and Finno-Ugric Linguistics at the University of Tartu. Several research fellows, students, and graduate students of the University of Tartu have been involved in the project. Vasilij Nikolajev participated in the project as a native speaker of Mari.

The book consists of four chapters. The first, introductory chapter gives an overview of research problems and the structure of the study. The second chapter presents outlines of previous phonological and phonetic treatments of Meadow Mari prosody. The chapter was drafted by Toomas Help, Karl Pajusalu, and Tiit-Rein Viitso, and elaborated by Ilse Lehiste. The third, central chapter contains the experimental-acoustic analysis of Meadow Mari prosodic structure. The principal author of the chapter is Pire Teras. The study is based on the measurements of speech samples of eight speakers of Mari. Each of them pronounced frame sentences with 100 test words in two sentence positions. The words were selected by Tiit-

Rein Viitso. The recordings were made by Einar Meister, Head of the Laboratory of Phonetics and Speech Technology at the Institute of Cybernetics of the Tallinn Technical University, and Pärtel Lippus, doctoral student at the University of Tartu. The acoustic measurements of the recordings were made by Pire Teras, Pärtel Lippus, Liina Leemet, Sander Pajusalu, Merike Parve, and Eva Liina Asu. Statistical analyses were made by Pire Teras and partly by Pärtel Lippus and Einar Meister. Einar Meister was also consulted throughout this work. The last chapter of the book summarizes the main results of the research. The primary acoustic data are presented in the Appendices. A map of Mari language areas and a division of the Uralic languages, both composed by Tiit-Rein Viitso, are also included in the Appendices. The introductory and final chapters of the book were written by Ilse Lehiste and Karl Pajusalu in consultation with the other authors. Ilse Lehiste has contributed to all parts of the book.

The authors of the book are most grateful to all the speakers of Mari who participated to the study. The book is dedicated to the Mari people, who this year hosted the Tenth International Congress of Finno-Ugric Studies in Joškar-Ola, the capital of their state.

CHAPTER 1

INTRODUCTION

According to the traditional view, a typical Finno-Ugric language is a language with word-initial stress, distinctive quantity alternations, a rich vowel system, and vowel harmony, as found in Finnish or Hungarian. However, the languages spoken in the center of the Finno-Ugric language area — among them the Mordvin and Mari languages — do not share many of these ”typically Finno-Ugric” features. For example, the prosody of Meadow (or Eastern) Mari that is the research object of this study is described in literature as lacking regular quantity distinctions, and instead of fixed stress on the first syllable, it is said to be characterized by unbounded word stress following specific rules. There is a considerable amount of disagreement about the nature of these rules, and the phonetic observations on which they are based are not always sufficiently extensive to justify the generalizations that have been drawn on the basis of these observations.

The primary goal of our project, ”Finno-Ugric Prosody”, is to provide researchers with reliable acoustic-phonetic data about such less studied, typologically diverse Finno-Ugric languages, using modern experimental methods that were not available to former researchers.

The first monograph that has resulted from our project deals with the phonetic characteristics of Erzya prosody (cf. Lehiste, Aasmäe, Meister, Pajusalu, Teras, Viitso 2003). The results of that study demonstrate that there is neither contrastive quantity nor tone in Erzya, and that neither duration nor pitch serve as unambiguous stress cues. Vowel reduction constitutes the most significant feature that distinguishes unstressed syllables from syllables bearing stress, but there is no categorical substitution of a full vowel by a reduced vowel. Rather, vowel reduction is a process in Erzya that involves gradual movement of a vowel in the acoustic space from a relatively peripheral toward a central position. According to our results, the basic function of word stress in Erzya is to establish and reflect the rhythmic structure of utterances, which involves the establishment of higher-level prosodic units. The present study of Meadow Mari will make it possible to compare the characteristics of Erzya prosody with the prosody of this cognate language.

The vague status of quantity and tone in Mari, its complicated rules of stress assignment and vowel reduction have become a touchstone for modern phonological theory. In the traditional description of Meadow Mari the distinction of full and reduced vowels is presented as a principal phonological contrast (cf. Kangasmaa-Minn 1998: 223); in some analyses, an attempt has been made to define the alternation of full and reduced vowels as an opposition in vowel length (Hayes 1985).

Similarly to Erzya, word stress is claimed to be non-phonemic in Mari; but unlike in Erzya, it appears to be determined by the segmental structure of the word. A common claim is that stress falls on the last full vowel of the word; if there are no full vowels (i.e. if all vowels in the word are reduced vowels), the initial syllable receives stress (cf. Kangasmaa-Minn 1998: 224). In a modern theory of phonology (OT, Optimality Theory), the system is described as a DTO (default to opposite side) system where stress falls on the rightmost heavy syllable; in the absence of heavy syllables, stress falls on the leftmost syllable (Baković 2004). Even though mid vowels count as full vowels, they can have reduced allophones in word-final position, in which case stress is likewise shifted to the leftmost syllable. Thus, while there are several similarities between Erzya and Meadow Mari prosody, we can anticipate sharp differences between them as well.

The presentation of the prosodic structure of Meadow Mari in the succeeding parts of the book follows the same research plan and methodology as in the above-mentioned study of Erzya.

The chapter following this introduction (Chapter 2) offers a condensed survey of previous studies. A general overview of the topic and of basic features of the Meadow Mari sound system is followed by an outline of early descriptions of the language, beginning with the 18th century. Treatments of Mari prosody in traditional Finno-Ugric scholarship are mentioned next, followed by a brief presentation of Western structuralist and generative points of view. An essential part of Chapter 2 is the characterization of previous phonetic research. It becomes evident that in all former experimental studies the number of speakers has been small (1—3), and often it is unclear to what extent the results have been reliable enough for theoretical generalizations. Thus it appears to be obvious that there is a need for more thorough experimental research that is the task of the present study.

The core part of the book is Chapter 3, which presents the results of our acoustic analysis of Meadow Mari prosody. The speech material, basic data about the eight speakers, and applicable methodology are described first. The analysis focuses on potentially contrastive prosodic features — duration, fundamental frequency, and stress and its phonetic manifestation. The analyzed corpus consisted of 100 test words, placed in sentence frames where they occurred in both phrase-final and sentence-final position. Thus the total number of analyzed test words was 1600 (eight speakers, 100 words occurring twice). The measurements included the duration of segmental sounds, fundamental frequency, and the formant structure of vowels in each of 1600 test words. The main research questions addressed in Chapter 3 are the following:

a) is there contrastive quantity in Mari? What would be the linguistic status of possible phonetic differences in sound duration?
b) what is the role of fundamental frequency in Meadow Mari prosody?
c) what is the relationship between vowel quality and the prosodic system?
d) what are the phonetic manifestations of stress?
e) what is the role of stress in the phonological structure of Meadow Mari?

The main results of our experimental study are summarized in the concluding chapter (Chapter 4) from a typological point of view. Here we offer our responses to the research questions that had been faced earlier by phoneticians and phonologists of various academic backgrounds, such as the relationship between vowel reduction and prosodic phenomena, the connection between stress and higher-level prosodic units, and how do the special features of Meadow Mari prosody express phonological universals.

The book contains additionally a bibliography of studies on Meadow Mari phonetics and phonology, a map showing the Mari settlement and dialect areas (Appendix 1), a schematic presentation of the Uralic languages (Appendix 2), a list of the test words used in the study (Appendix 3), and additional measurement results obtained in the course of the acoustic analysis (Appendix 4).

CHAPTER 2

SURVEY OF PREVIOUS RESEARCH ON MEADOW MARI PROSODY

2.1. Introduction

In this chapter, we offer a review of previous studies dealing with Meadow Mari prosody. The topic has been approached from several points of view; in subsections of this chapter we attempt to look at these studies grouping them under certain unifying principles.

First, however, we will define our topic more precisely. The version of Mari that we are working with is one of the two main variants of the language: Meadow Mari. One of the reasons for choosing the Meadow Mari variant over Hill Mari is the fact that the prosodic structure of Hill Mari appears to be relatively simple, while that of Meadow Mari appears to be much more complicated. There seems to be general agreement that the prosodic system of Hill Mari involves placement of stress on the penultimate syllable, while stress placement in Meadow Mari appears to follow rules that are formulated in different ways by different scholars (Kangasmaa-Minn 1998: 220). An experimental phonetic study can make a contribution by offering objective data, on which a reinterpretation can be based.

The peculiarities of the Meadow Mari stress system have been attributed to language contact. Kovedjajeva (1970: 72—75) has even claimed that the whole modern stress pattern of Meadow Mari has been borrowed from a Turkic language, namely from Ancient Bolgar, the predecessor of modern Chuvash, with which the predecessor of Meadow Mari was in intimate contact. The Mari stress systems thus may be viewed as a combination of the Finno-Ugric principle of word-initial stress and the borrowed Turkic principle of word-final stress.

Modern Mari is currently subjected to massive phonetic and phonological influence of Russian through Mari-Russian bilingualism and the official role of the Russian language (cf. Zorina 1998). However, it is worth observing that during the first centuries of Russian influence on Mari, borrowed Russian words entered the Mari language without affecting its sound structure to a significant degree.

The research reported in the present study aims to establish the role of duration, fundamental frequency, and stress in the prosodic structure of Standard Meadow Mari. The segmental structure is of interest to the extent that it interacts with the prosodic structure. Thus we will include the special characteristics of full and reduced vowels in our presentation, but will omit discussion of such phenomena as vowel harmony and consonant alliteration. We use the term "Standard Meadow Mari" with reservations, knowing full well that the influence of literary standards is still relatively weak in spoken Mari, and that the language represents a dialect continuum. In describing the speakers whose productions we have analyzed, we provide the necessary background information that might help explain some of the exceptional productions that may be due to dialect differences.

The form of Standard Meadow Mari that we are describing has the following phoneme inventory (Kangasmaa-Minn 1998: 220—222):

There are eight vowels: /i/, /ü/, /e/, /ö/, /u/, /o/, /a/, /ə/. The symbol /ə/ stands for the reduced vowel whose acoustic characteristics will be described later in detail. According to Kangasmaa-Minn, there is a certain amount of balance in the vowel system: the four front vowels /i, ü, e, ö/ are opposed by the four back vowels /u, o, a, ə/, and the four rounded vowels /u, ü, o, ö/ contrast with the four unrounded vowels /i, e, a, ə/. The system is not equally balanced with regard to vowel height: there are three high vowels /i, u, ü/, four mid vowels — /e, o, ö, ə/, and one low vowel, /a/. (Note that Kangasmaa-Minn classifies the reduced vowel as a back vowel, which will turn out not to be exact in terms of acoustic structure.) The vowel inventory does not contain diphthongs.

The nineteen consonant phonemes of Meadow Mari include the voiced and voiceless stops /b, d, g, p, t, k/, voiced and voiceless sibilants /s, š, z, ž/, an affricate /č/, four nasals — /m, n, ŋ, ń/ (the palatalized counterpart of /n/), the lateral /l/ and its palatalized counterpart /l'/, the trill /r/ and the glide /j/. The voiced plosive /b/ has an allophone [*w*], and /č/ has a voiced allophone. There are no geminate consonants in Meadow Mari, except for so-called false geminates that arise at morpheme boundaries (cf. Lehiste, Meister, Pajusalu, Parve, Teras, Viitso 2001: 262—263).

In surveying previous publications, we will concentrate on the possible contrastive role of duration, fundamental frequency, and the various phonetic correlates of stress.

2.2. Mari prosody: Traditional Finno-Ugric scholarship and structuralist analyses

Comparative studies of the Finno-Ugric languages developed in parallel with similar research in Indo-European. Some of the earliest treatments of Mari appeared as part of that stream from the middle of the 19th century to the beginning of the 20th, e.g. those by M. A. Castrén (Castrén 1845), F. J. Wiedemann (Wiedemann 1837; 1847), A. Genetz (Genetz 1889), M. Veske (1889), E. Lewy (Lewy 1922), and Y. Wichmann (1923). Comparative Uralic linguistics continued until the emergence of structural linguistics in the middle of the 20th century. Classical treatments can be found in E. Itkonen's numerous works (Itkonen 1954; 1955a; 1955b; 1966) and in B. Collinder's publications (Collinder 1960; 1965). As a representative view one might consider the statement by Collinder (1965: 42—43): ”In some of the dialects of chE (= Eastern Cheremis), the main stress is on the etymologically long vowels (see under etymological phonology); if there is no etymologically long vowel in the word, the main stress is usually on the first syllable. In the easternmost Cheremis dialects there is a tendency to put the main stress on the last syllable; this may be owing to Turkic influence.”

Structuralist linguists introduced a new type of approach, using direct elicitation of linguistic material from actual informants. One of the first publications within this school of linguistics was the ”Eastern Cheremis Manual” by T. Sebeok and F. Ingemann (Sebeok, Ingemann 1961). The authors base their observations on original research, eliciting forms and texts from one speaker of Eastern Mari. Their informant was born and raised in Apštjal, a Mari-speaking village located between Birsk and Burajevo, in what was then the Bashkir Autonomous Soviet Socialist Republic, and is now Baškortostan. The ”Eastern Cheremis Manual” contains subchapters on phonology, morphophonemic alternations, grammar and texts. The phoneme inventory contains eight vowels, /i, ü, u, e, o, ö, a, ə/ (the symbol /ə/ is used here to denote schwa). There is a listing of allophones, the occurrence of which is described as being positionally determined; there is no reference to conditioning by stress. For example, on pp. 7—8 /e/ is listed as having six allophones, four of which are described as ”mid to high, front to central, unrounded reduced vowel or mid front unrounded vowel” that occur ”finally in polysyllabic words, except when preceding vowel is a back vowel”, and two that are described as ”lower (usually) to higher mid front unrounded vowel”, occurring ”elsewhere”.

Sebeok and Ingemann state (p. 8) that they assume that stress is not phonemic: they caution that this generalization is based on their limited corpus. They list five conditions under which words may have two stress patterns; these conditions involve vowel harmony. It is to be noted that the reduced vowel, /ə/, can follow all seven full vowels and can carry stress. Depending on segmental structure (= vowel harmony), some words are always stressed on the last vowel (but morphological factors may enter in — some final morphemes never carry stress). Which of the two possible stress patterns occurs appears to depend on sentence-level prosody — intonation and rhythm.

Sebeok and Ingemann do not mention the possible contrastive role of quantity; from the description of allophones, however, it can be deduced that duration is at least occasionally a boundary marker, since /i /, /ü/, /u/ and /o/ are listed as having lengthened allophones in final position.

Similar uncertainty in the description of Mari stress is found in the article by Ristinen (1960). Ristinen's informant was the same person whose speech was analyzed by Sebeok and Ingemann. On p. 259 Ristinen states: "It has not been possible for us to make any satisfactory statement about the occurrence of stress, although certain syllables seem to be more prominent than others, and this prominence affects the occurrence of certain allophones, particularly of /r/. Throughout the texts obtained from Mr. Jewskij, we find the same word stressed (to our ear) on one syllable in one instance and on another syllable in another instance. [---] There are statements and discussions in the literature on the occurrence of stress in Eastern Cheremis, but they are of little help in arriving at any solution. Some investigators admit that they know of no satisfactory solution, while others offer inapplicable generalizations. The most reliable rule we have been able to formulate is rather unsatisfactory. It is that the final syllable of a word is most generally stressed, but certain non-initial morphemes, words such as /kən/ 'if' are never stressed."

In footnote 28, pp. 284—285, Ristinen discusses the Itkonen 1955b reference that Hayes (1985) later used as one of the three sources for his theory about stress in Eastern Mari. Ristinen writes: "Itkonen (op. cit. p. 27, fn. 20) states that in Eastern Cheremis the last vowel of a word is stressed, unless it is historically a reduced vowel. Even if this were true of our informant's Cheremis, which it appears not to be, it would of course not be possible to state the conditions governing the position of stress without knowing the history of each morpheme."

A rather traditional overview of Mari phonology by Eeva Kangasmaa-Minn is included in the 1998 survey of Uralic languages edited by Daniel Abondolo (The Uralic Languages 219—248). On p. 224 Kangasmaa-Minn states: "Word stress is non-phonemic. In Eastern Mari it falls on the last phonologically full vowel, e.g.; *olma·* 'apple', but *mu·no* 'egg' (phonologically /munə/), *munən* 'of an egg'. If a word contains only reduced vowels, the stress falls on the first syllable, e.g. *tə·ləzəm* 'moon' (accusative)."

2.3. MARI PROSODY: WESTERN PHONOLOGICAL TREATMENTS

In the western research tradition, the article that most contemporary phonologists quote is Kiparsky 1973. Kiparsky's source is Itkonen 1966. According to Itkonen quoted by Kiparsky (p. 101; Itkonen 1966: 156), certain dialects of Eastern Mari have the following rule: (a) The accent falls on the syllable containing the last full vowel of the word; (b) If the word has only reduced vowels, the accent is usually on the first syllable.

An influential publication by Bruce Hayes (1985) quotes Kiparsky 1973, Sebeok, Ingemann 1961 (quoted by Hayes as Ingemann-Sebeok), and Itkonen 1955b. Hayes assumes that the distinction between full and reduced vowels depends on vowel length, which he equates with gemination (p. 57). He motivates this by observing that full vowels are phonetically longer than reduced vowels, and by assuming that ”there are apparently no languages having an underlying three-way distinction of the type reduced vowel: full short vowel: full long vowel. This would follow automatically from the assumption that both the full-reduced and the long-short distinctions must be represented underlyingly by gemination.”

It is generally assumed that stress in Eastern Mari falls on the last full vowel or a word, and on the initial vowel if the word contains only reduced vowels. It may be deduced from Hayes' statement that he assumes an opposition between short and long vowels in Mari; in the transcription of the five words he brings as examples, the vowels /i/, /a/, and /u/ are written as geminates (with two letters), the reduced vowel [ə] is written with a single letter. Hayes (1995) and Kenstowicz (1994) are mentioned by Urbanczyk (1999: 402) as sources for her inclusion of Mari among languages avoiding stressed schwa.

A recent OT-analysis (Optimality Theory) of unbounded stress systems by Eric Baković (2004) describes Meadow Mari — similarly to Classical Arabic, Chuvash, Selkup etc. — as being a language of the DTO (default to opposite side) system with stress on the rightmost heavy, or else on the leftmost syllable.

Unbounded stress is traditionally seen as lacking any rhythmic or alternating regularities. According to this view, unbounded stress falls on heavy syllables irrespective of the distance from word edge or other stresses. If there is no heavy syllable, an edgemost light syllable is stressed. In the case of a DTO system stress is attracted to a heavy syllable farthest from that edge.

Considering the fact that in unbounded stress systems stress is attracted to heavy syllables, there is a need for a weight-to-stress constraint. Baković applies the Weight-to-Stress Principle (WSP, introduced by Prince 1980 explaining Estonian quantity degrees). The principle postulates that all heavy syllables are prominent in feet and on the grid, being stressed foot heads. Thus, WSP is only relevant in forms with heavy syllables (Baković 2004: 204—207).

The issue that remains to be solved is the relationship between main and secondary stresses in the case of DOT systems. Baković includes a subset of constraints for defining the head of a prosodic word. The head is the foot that bears main stress (Baković 2004: 208—211). Baković states that in the context of his analysis it is necessary to claim that stress is partially independent of foot structure (Baković 2004: 211—212). It is obvious that a more precise treatment of optimal foot structures must be added. The presence of an obligatory secondary-stressed initial foot is also a question that calls for further phonetic investigation.

In considering the treatment of the Meadow Mari stress system by the above-mentioned authors, it should be kept in mind that all these theories are ultimately based on the limited empirical material presented in Sebeok, Ingemann 1961. Although a certain amount of experimental information has been available since 1960 (cf. Gruzov 1960), it appears that a detailed experimental-phonetic study of the prosody of Meadow Mari could make an essential contribution not only to the analysis of the language itself, but also to linguistic theory.

2.4. Mari prosody: Local pre-experimental descriptions

Since the first descriptions of the Mari language, attention has been paid to the question of word stress. In the first Mari grammar of 1775 (Sočinenija 1775) of the Sankt-Petersburg Academy of Sciences (cf. Sebeok, Raun 1956), word stress has been considered a special property of any word. For example, a Mari noun was said to be characterized by declension, number, case, and stress. Problems of stress were also considered in the succeeding early treatments of the Mari language: ”Čeremisskaja grammatika” of 1837 by an unknown author, Castrén 1845, Wiedemann 1837, 1847, Veske 1889, Genetz 1889, and Ramstedt 1902.

Among the early writings, an interesting concept of Mari stress was presented in F. Vasiľjev 1887. Vasiľjev does not recognize the specific status of the reduced vowel /ə/ and derives it from a full vowel appearing in unstressed position, e.g. in the contrastive pair *ške·ndən* ’of yourself’ (sing.) vs. *škenda·n* ’of yourself’ (plur.). According to Vasiľjev, the two sound strings consisted of the same sounds; the phonological distinction was due to contrastive stress. Although this approach is clearly influenced by the structure of Russian, here the inherent significance of different stress patterns in Meadow Mari is given due attention.

Karmazin (1936) provides the following main rules for word stress in Meadow Mari:
1) stress can fall on the first, last, or intermediate syllable: *i·mńe* 'horse', *mu·no* 'egg', *o·do* 'white', *mura·ltəš* 'managed', *ača·* 'father', *izi·* 'small';
2) if there are other vowels than /ə/ in the word, /ə/ will be unstressed: *šo·rək* 'sheep', *a·šnəktəšəm* 'forced to feed', *əštəne·že* 'has decided to do';
3) if there are no other vowels than reduced /ə/ in the word, the first syllable will be stressed: *nə·lət* 'four', *ə·rəktəšəm* 'I warmed up';
4) stress will usually not fall on final /o, ö, e/: *tü·rtö* 'thread', *mu·no* 'egg'.

Formulations such as those by Karmazin emphasize the importance of the difference between full vowels and reduced vowels. The various Mari dialects differ with respect to the number of reduced vowels. In fact the area where Mari dialects are spoken constitutes a dialect continuum (Ivanov 1981). The dialect that forms the basis of the Meadow Mari literary language has only one reduced vowel. Rules based on the relationship between full vowels and reduced vowels differ depending on the number of reduced vowels in the vowel systems of the different dialects. The extent of mutual influences of the literary language and the local dialects is not unequivocally established.

Rules for the placement of stress continue to be formulated by Mari linguists; one of the most recent examples can be found in Kuklin 2003 (pp. 104—108). Kuklin's orthoepic rules specify the location of stress with reference not only to phonetics, but to morphology, syllabic structure, parts of speech, and native versus borrowed history of the lexicon. A basic principle is the interdependence of stress location and the constituent vowel patterns: if the vowel of the final syllable qualifies for word stress, it will be stressed; if not, the vowel of the preceding syllable is subjected to the same kind of evaluation, and the process is repeated towards the beginning of the word until the location of the stress is fixed.

2.5. Previous phonetic research

Early experimental phonetic research concerning the prosodic structure of Mari was summarized by E. I. Kovedjajeva in her book "Проблемы акцентуации марийского языка" (1970). It appears that the first linguist to use experimental techniques was L. P. Gruzov, whose dissertation (Gruzov 1960) contained a section dealing with stress. Gruzov based his conclusions on kymography, a research technique used for measuring volume-velocity of airflow out of the vocal tract.

On the basis of his measurements Gruzov concluded that Mari stress is based exclusively on duration, and that neither fundamental frequency nor intensity play any role. Change in the position of stress can change the meaning of a word; Gruzov offers a few examples, like *še·rge* ’dear’ — *šerge·* ’comb’. Vowels in pretonic syllables are 30% shorter than vowels in stressed syllables. There is no vowel reduction associated with lack of stress; the so-called reduced vowel is a phoneme in its own right, even though it is shorter than so-called full vowels. The reduced vowel can carry stress (in words where there is no other vowel present that might attract stress to itself due to its greater length).

In a later publication, Gruzov (1964a) claimed a role for intensity in the manifestation of stress. He found that in several productions of the pair *še·rge* ’dear’ and *šerge·* ’comb’, and the sequence *še·rge šerge·* ’dear comb’, ”the first /e/ in both words was almost exactly identical with respect of the absolute value of intensity, even though in the first word it is stressed and in the second word unstressed. Relative to the vowel of the second syllable, its intensity was in each case higher — from 106% to 120%.” (Translation by I. L.)

Gruzov also used x-rays to compare various Mari vowels from the articulatory point of view (Gruzov 1964b). On the basis of these studies, he established the articulatory differences between Mari reduced vowels (in several dialects) and the Russian vowel symbolized as *ы*.

E. I. Kovedjajeva (1970) gives a critical overview of Gruzov’s conclusions. In her opinion, a stressed vowel is perceived as having higher intensity due to its greater duration and comparatively higher intensity than other vowels, or vowels in the same word (p. 98). In evaluating the role of intensity in the production and perception of a vowel as being stressed, one has to take into account the characteristic duration and intensity of vowels (the terms usually employed are ’intrinsic intensity’ and ’intrinsic duration’ — high vowels like [*i*] and [*u*] have lower intensity and are shorter than low vowels like [*a*], all other factors being kept constant — I. L.). Kovedjajeva bases her comments on work done with respect to stress in Russian by L. V. Zlatoustova (1962).

Kovedjajeva agrees with Gruzov that the reduced vowel is not a reduced allophone of a full vowel (like in Russian), but is a phoneme in its own right, and offers three (near-) minimal pairs to substantiate the claim (p. 67: *šə·že* ’autumn’ — *ši·že* ’received, 3.pers.imperf.; *tə·šte* ’here’ — *tu·što* ’there’; *šə·de* ’anger’ — *šu·do* ’grass’). She disagrees with Gruzov about the possible meaning-differentiating role of stress placement (p. 71), saying that even though there are some instances where stress position plays such a role, their number is so small — and basically they are due to borrowed lexicon — that one should not assume that stress plays a contrastive role in the Mari language.

Kovedjajeva’s own major contribution is the first spectrographic analysis of Mari vowels (pp. 111—127). She had one female speaker (with a basic fundamental frequency between 230 and 250 Hz), who produced a set of words with counting intonation. A list of the words is given in the Appendix; there were 13 examples for [*a*], 12 for [*o*], 12 for [*u*], 13 for [*ə*] (the reduced vowel), 9 for [*e*], 8 for [*ö*], 13 for [*ü*], and 9 for [*i*]. Twenty-two figures present spectral cross-sections for stressed and unstressed vowels in different positions within the words. Of special interest is the representation of the reduced vowel [*ə*] in stressed and unstressed position (figures 10 and 11, p. 119). According to Kovedjajeva's analysis, the vowel has three formants with intensity peaks between 500—1000 Hz, at 1600 Hz, and between 3200—8000 Hz, and is clearly differentiated from other vowels by its formant structure.

Among Kovedjajeva's findings is the observation that while there is no qualitative difference between stressed and unstressed vowels in what she calls their quasi-stationary part, some unstressed vowels (especially [*e*] and [*o*]) have a tendency to move toward the schwa-position in their final phase. Also, the formants of unstressed vowels are usually characterized by a shift toward higher values.

A more recent experimental study of Mari vowels is an article by L. V. Bobkova (1975). (The same publication where Bobkova's article appeared contains an article by N. M. Novoselova about the formant structure of sonorant consonants in Mari.) Bobkova's research presents the average frequencies of the first three formants of eight vowels, obtained through spectrographic analysis of 172 words pronounced by each of three speakers. A Visible Speech -type spectrograph was used to produce the spectrograms. Measurements were made at what the author calls quasi-stationary stage of the vowels. A comparison of stressed and unstressed vowels in various positions within the word led to the conclusion that there is no difference in vowel quality that would be caused by lack or presence of stress.

A study of Hill Mari vocalism by Z. G. Zorina (1982) also offers some experimental data concerning Meadow Mari. Her material consisted of 1600 monosyllabic and polysyllabic words produced by three male speakers of the Hill Mari variant of the literary norm (for a total of 4800 recorded words). The recordings were analyzed oscillographically and using the spectrograph; listening tests were also carried out. In separate chapters, Zorina treats duration, intensity, fundamental frequency, and spectral characteristics of vowels. Her results include the following.

In the Meadow Mari variant, stress can be on various syllables. To a certain extent, the position of stress depends on the distribution of phonemes. The phonemes /e/ and /ö/ are not found in post-stress syllables before consonants; /ü/ occurs only under stress and in pre-stress syllables; /ə/ (the reduced vowel) is not used in absolute final position, and /ə/ can be stressed only in such words where other vowels are missing: /kə·zət/ 'immediately', but /kəša·/ 'footprint' (Zorina 1982: 46).

Zorina also found that stressed vowels were always longer than unstressed vowels, and considers duration to be one of the components of stress in Hill Mari (Zorina 1982: 74). Intensity, however, is not a correlate of stress (Zorina 1982: 85). As regards the role of fundamental frequency, Zorina found that Hill Mari and Meadow Mari differ essentially with respect to F0 movement on vowels. In the Meadow variant, stressed and unstressed vowels have the same kind of tonal movement; in the Hill variant, stressed vowels have a rising F0 curve and unstressed vowels have a falling F0 curve (Zorina 1982: 96). These conclusions were based on material consisting of isolated words, produced with list-reading intonation. Zorina realizes that analysis of isolated words is not sufficient for drawing final conclusions.

Her study of spectral characteristics of Hill Mari vowels demonstrated that there is no essential difference between the F1 and F2 positions of vowels occurring in stressed and unstressed syllables, but that there was a difference in the position of F3, which was higher in stressed vowels.

Baitchura 1988 offers a detailed critique of the instrumental-phonetic studies of the Mari language published by several authors (Gruzov, Kovedjajeva, Bobkova), and summarizes the results of his own work since 1958. His book is divided into five chapters, dealing with vowel length (pp. 35—58), intonation and stress (pp. 59—106), sentence intonation (pp. 107—144), tone and sound-intensity movement (pp. 145—180), and offering some data on the length of consonants (pp. 181—212). The evaluation of previous research is presented in the introduction (pp. 9—34) and in the conclusive materials (pp. 211—234) containing also an overview of Baitchura's own research.

The material on which the results offered in the book are based was recorded from two informants. The first informant was a 20-year-old student at the Kazan University, coming from the village of Novyj Torjal, who represents the Meadow dialect; he was recorded in 1958 at the Laboratory of the Kazan Pedagogical Institute. The second informant was a faculty member of the Mari State University in Joškar-Ola; according to Baitchura, his pronunciation represents the literary Mari language (p. 67). His materials were recorded in 1969 at the Laboratory of Leningrad University. The recording was performed using kymographs available at the two laboratories. The texts consisted both of isolated words and of sequences of two words constituting phrases of three, four, and five syllables. The exact number of items is not listed, but can be deduced to a certain extent from the tables. Thus there were 5 monosyllabic words in the material recorded by the second informant, 31 isolated disyllabic words produced by the first informant, and 9 isolated disyllabic words produced by the second informant. That speaker also produced 16 trisyllabic words and word combinations, 15 tetrasyllabic combinations of two disyllabic (or one trisyllabic and one monosyllabic) words, 5 pentasyllabic combinations of two words (disyllabic and trisyllabic), and 22 sentences that were analyzed from the point of view of sentence intonation.

On the basis of measurements from these recordings, Baitchura differentiates two degrees of length in Mari: the reduced vowel /ə/ tends to be two or more times shorter than the ”vowels of full formation” in analogous phonetic position. He says that this indicates the possibility of distinguishing two degrees of vowel length in Mari dependent on their quality. He also finds that high vowels are unstable and can be reduced in certain positions. At the absolute end of an utterance, the length of all vowels is nearly the same and reaches its maximum, often surpassing by almost two times that of the preceding ones (p. 43).

The part dealing with stress and tone is based on kymographic analysis of part of the material recorded by the two informants: 22 isolated disyllabic words produced by the first informant, and 10 disyllabic words produced by the second informant. That informant's productions of several polysyllabic words were also analyzed (10 trisyllabic isolated words and 7 trisyllabic word combinations, and 8 quadrisyllabic combinations). As some words were apparently produced twice, there are measurements reported for 40 productions by Informant 1 and 46 productions by Informant 2. The data are presented both as tables and as reproductions of kymograph recordings.

For calculating intensity, Baitchura used the following formula: $f = a^2n^2$ or $f = a^2/l^2$, where f denotes acoustical energy, a = the amplitude of vibration, n = the frequency of vibrations, and l = the length of the vibration (p. 145). Baitchura found that ”the sound intensity of a vowel is, as a rule, in concordance with the tone, mostly following the latter even up to details, and both the tonic accent and the intensity stress fall usually on the vowel of the initial syllable, the exclusions being rare” (p. 146).

Baitchura recognizes increase of sound intensity as intensity stress, and an increase in tone height (and/or its special movement) as the tonic accent. As both of them as a rule fall on the first syllable of disyllabic Mari words, he concludes that such words had initial stress, in spite of the fact that the second vowel was usually longer (p. 65). In sentences, stress may change its position in a word due to what Baitchura calls ”rhythmo-melodical requirements of the language: it could happen because here the place of stress was not of phonological importance for the word in a given situation. However, one should not draw the conclusion that the stress is not phonologic in Cheremis in general. There are many languages, e.g. of the Ural-Altaic group in which the stress can have phonologic function in some cases and have none in other cases. To all appearances, Cheremis belongs to this kind" (p. 109).

Baitchura reports also measurements of consonant duration and finds a length difference between what he calls "strong consonants" (/k, t/) and "weak consonants" (/g, d/) — the strong consonants are by more than two times longer than the corresponding weak ones (p. 182).

As far as sentence intonation is concerned, Baitchura concludes that there is a general tendency to a more or less falling tone in the sentence. Incompleteness is signalled by a final rise. Sentence intonation predominates over, or is in concordance with, the tone movement in intonation (or sense) groups of words, whereas the latter predominate, in turn, over the intonation of individual words. This does not exclude the existence of word stress, or accentuation of individual words, but when it has no phonological function in a given situation, it can be subjected to what Baitchura calls rhythmo-melodical structure of the concrete context of speech. Such changes are only possible under certain conditions prescribed by the phonetic and other laws of a given language (pp. 134—137).

The book contains 16 pages of reproductions of kymograms and 55 pages of tables, in addition to considerable amounts of measurement results given in the text. References to research by others are given in footnotes; there is no bibliography.

2.6. Summary of current views

As can be seen from the overview offered above, there is still considerable disagreement about the nature of Meadow Mari prosody. Most researchers dismiss the idea that duration has a contrastive function — but Gruzov (1960) as well as Baitchura (1988) interpret the durational difference between full vowels and the reduced vowel as a phonological opposition based on vowel quality, and Hayes (1985) treats it as a difference between geminates and (non-geminate) single vowels. There appears to be general agreement that there is no contrastive tone in Meadow Mari; heightened fundamental frequency may play a role in identifying a stressed syllable, but word-level pitch patterns are subordinated to sentence intonation. The descriptions of the phonetic manifestation of stress seem to offer the greatest number of opposing points of view.

The basic question of whether the position of stress can be contrastive receives somewhat hesitant support. While there are indeed minimal pairs in the language where a difference in meaning is associated with different placement of stress, the number of such minimal pairs appears to be small, and there seems to be a suspicion that at least some of them involve borrowed lexicon (Kovedjajeva 1970). Researchers have made relative firmer claims about the phonetic realization of stress. Duration is considered to be a reliable stress correlate by, e.g., Gruzov (1960) and Zorina (1982). However, greater length is not the absolute determinant, since the reduced vowel — systematically shorter than full vowels — can nevertheless carry stress. The role of intensity is ambiguous because of the interaction of intensity with vowel quality — stressed high vowels can have lower intensity than unstressed low vowels, due to differences in intrinsic intensity. Nevertheless, Baitchura (1988) found that initial syllables were usually characterized both by greater intensity and by heightened pitch.

The interaction of vowel quality with stress receives — and deserves — a great deal of attention. It is a general observation that lack of stress may be associated with vowel reduction; this is a phenomenon that has been observed in a large number of languages. Acoustically, the term ”vowel reduction” refers to a specific change in the position of the vowel in the acoustic space defined by formant positions. Stressed vowels usually occupy more extreme positions within the vowel space, while unstressed vowels move toward the center of the vowel space in greater or lesser degree. The system of Meadow Mari offers special problems, since in Meadow Mari the central vowel — the position toward which the unstressed vowels are expected to move — is a phoneme in its own right. The authors quoted in the overview have differing opinions about vowel reduction in Meadow Mari. Gruzov (1960) claims that there is no vowel reduction associated with lack of stress. Kovedjajeva (1970) observes that some unstressed vowels have a tendency to move toward the schwa-position in their final phase, even though there is no qualitative difference between stressed and unstressed vowels in their steady-state part. Bobkova (1975) likewise found no difference in the quality of stressed and unstressed vowels. Zorina (1982) found differences between stressed and unstressed vowels with regard to the F3 position.

Most of the quoted studies were based on the analysis of a relatively small number of speakers (Gruzov 1960 — 1, Sebeok and Ingemann 1960 — 1, Ristinen 1960 — 1, Kovedjajeva 1970 — 1, Bobkova 1975 — 3, Zorina 1982 — 3, Baitchura 1988 — 2). A serious problem with the use of one or a very small number of informants is the question to what an extent the results characterize the idiolect of the speaker, and to what an extent they can be generalized to the language. It appeared of interest to us to investigate the phonetic reality behind the various analyses of Meadow Mari prosody, using a more representative number of speakers, and applying contemporary experimental phonetic techniques. We also believe that more accurate phonetic data will constitute a more reliable foundation for phonological theory.

CHAPTER 3

ACOUSTIC ANALYSIS OF MEADOW MARI PROSODY

3.1. INTRODUCTION

As described in the preceding chapter, there has been a considerable amount of research on Mari prosody in earlier times. However, extensive acoustic-phonetic data have not yet been presented. This is what we are offering in the current chapter.

The presentation proceeds in the following order. The analyzed material and the methodology of analysis are described first. Quantity issues are dealt with next, followed by a treatment of questions concerning the role of stress and its possible phonetic manifestations. The analysis is based on the averaged results of all eight speakers; details concerning individual speakers are presented in Appendix 4.

3.2. MATERIALS AND METHOD

A text corpus was recorded from eight speakers with 100 test words of one to four syllables placed in the frame ”*Кызыт* …, *вара* …” (‘I said … not …’). Every word occurred both in the phrase-final and sentence-final position. Thus every speaker produced 200 test words, for a total of 1600 for the group. The speakers are listed in the order in which they were recorded, depending on availability. The list of words is given in Appendix 3.

The speakers were as follows:

EI — female. Born 17.01.1976 in Šoršola, Mari El. Received her secondary education in Mari El. During the recording resided and studied in Tallinn.

AA — male. Born 16.10.1974 in Joškar-Ola, Mari El. Received his secondary education in Mari El. During the recording resided and studied in Tallinn.

ST — female. Born in 1977 in Golovino, Mari El. Received her secondary education in Mari El. During the recording resided and studied in Tallinn.

JT — male. Born in 1963 in Maska-Rodo, Mari El. Received his secondary education in Mari El. During the recording resided and studied in Tallinn.

LV — female. Born 26.09.1981 in Čerlak, Baškortostan. Since 2000 in Estonia, studies at Tartu University.

NK — female. Born 06.11.1976 in Toktaj-Beljak, Kužener, Mari El. Since 2001 studying at Tartu University.

VN — male. Born 23.05.1967 in Engermučaši (Vaśkino), Suksun, Perm Region. Since 1991 in Estonia, studies at Tartu University.

VA — male. Born 15.08.1971 in Tiškino, Morki, Mari El. Since 1992 in Estonia, working.

The recordings were made (the first 4 speakers) by Einar Meister at the Laboratory of Phonetics of the Institute of Cybernetics of the Tallinn Technical University in 2000 and (the last 4 speakers) by Pärtel Lippus at the University of Tartu in 2004. The text of the first 4 speakers was recorded with a microphone Sony ECM-44B and DAT-recorder Casio. The recordings were stored in the computer as Nsp-files sampled at 20 kHz. The text of the last 4 speakers was recorded with a microphone Philips SBC MD 680 and DAT-recorder Sony TCD-D 100. The recordings were stored as mono Wave files sampled at 48 kHz with a resolution of 16 bits.

The acoustic analysis was carried out using the Kay Elemetrics CSL 4300B speech analyzer and the analysis program Praat, version 4.2. Measurements were made of the duration of each segmental sound (except word-initial consonant), of the fundamental frequency of words at the beginning and end of each vowel, and the values of the three first formants of vowels.

The acoustic analysis was carried out by Eva Liina Asu, Pärtel Lippus, Liina Leemet, Sander Pajusalu, Merike Parve, and Pire Teras. The location of stress was ascertained by Vasilij Nikolajev, a native speaker of Mari, through repeated listening.

3.3. Quantity

The duration of all sounds (except word-initial consonants) was measured. There were instances of vowel omission in the productions of some of the speakers. The female speaker EI did not pronounce the second vowel of the word *mokšən* 'liver (gen. sg.)' > *mokšn* in sentence-final position. The male speaker AA did not pronounce the vowel of the second syllable of the words *nələtənat* 'foursome' > *nəltənat* and *kutšəneda* 'you (pl.) want to catch' > *kutšneda* in sentence-final position. The female speaker ST pronounced the word *ijəm* 'ice (acc. sg.), I swam' without the second vowel (*ijm*) in sentence-final position. In the speech of the male speaker VN there were more vowel omissions: he omitted the first vowel in *indeše* 'nine' > *ndeše*, the second vowel in *kiddəme* 'handless' > *kitme*, *luddəmo* 'unreadable, unread; boneless' > *lutmo, ludənam* 'I read (praet. II)' > *ludnam*, and the third vowel in *nələtənat* 'foursome' > *nələtnat* in phrase-final position, and the first vowel in *čəke* 'little haystack' > *čke* and *kəša* 'footprint' > *kša* and the second vowel in *ijəm* > *ijm* in sentence-final position. As a slip of the tongue, he pronounced the 4th word of the 3rd bloc as *da* instead of *ida* 'don't (2pl. imper.)'; thus that word could not be included in the analysis. The word *lu* 'ten, bone', first word of the first bloc, produced in phrase-final position, could not be included because of a technical error.

3.3.1. Vowel duration

3.3.1.1. Duration of vowels of open syllables

The vowel system of Meadow Mari consists of 8 (short) monophthongs: the high vowels /i, ü, u/, mid vowels /e, ö, o, ə/, and the low vowel /a/. There are no diphthongs, but the combination of /i/ and the glide /j/ occurs in words like *vijdəme* 'powerless'. The status of /ij/ will be discussed below.

The total number of stressed and unstressed open syllables occurring in the one- to four-syllable test words is 127. For all eight speakers and for both sentence positions, this amounts to 2032 instances; but because of the above-mentioned vowel omissions, the actual number of analyzed open syllables is 2023. The first syllable of disyllabic words, the first and second syllable of trisyllabic and the first and third syllable of four-syllable words (there was no stress on the second syllable) are considered as non-final stressed syllables. Here, open syllables with secondary stress are not included, as their duration is much shorter that that of other stressed syllables.

The duration of vowels in open stressed syllables in phrase-final and sentence-final positions is given in Table 1 (as for data by speakers, cf. Appendix 4, Table 1A). Separate consideration is given to the duration of the reduced vowel /ə/ in a stressed syllable, the duration of the vowel in stressed syllable in word-internal and word-final position, and the duration of a vowel in monosyllabic words (the corpus included only two monosyllabic words consisting of an open syllable). There were no words with a stressed /ə/ in word-final position.

Table 1

Vowel duration in milliseconds (ms) in open stressed syllables occurring in non-final and final positions in the test words. Phrase-final (PF) and sentence-final (SF) occurrences are presented separately. N — number of tokens, x̄ — average duration, s.d. — standard deviation

Position		/ə/ (nonfinal)		V (nonfinal)		V (final)		Monosyllabic	
		N	x̄	N	x̄	N	x̄	N	x̄
PF		66	90	180	107	111	180	15	179
	s.d.		18		19		33		58
SF		72	93	177	104	109	174	16	183
	s.d.		22		21		31		44
Overall		**138**	**92**	**357**	**106**	**220**	**177**	**31**	**181**
average	s.d.		**20**		**20**		**32**		**51**

The duration of vowels in open stressed syllables appears to be determined both by vowel quality and by position of the syllable in the word. The reduced vowel schwa is significantly shorter than the other ("full") vowels in comparable positions (non-final open stressed syllables); the difference between the averages (92 ms for /ə/, 106 ms for full vowels) is shown by analysis of variance (ANOVA) to be significant at the $p < 0.0001$ level.

The difference associated with position in the word is considerably greater: vowels in open stressed syllables in non-final position had an average duration of 106 ms, and in word-final syllables — 177 ms. The difference between the averages is shown by analysis of variance (ANOVA) to be significant at the $p < 0.0001$ level.

The duration of vowels in monosyllabic words was comparable to that of vowels in word-final open stressed syllables. No significant difference was found between the durations of vowels in stressed syllables of words occurring in phrase-final and sentence-final position (significance of the difference between the duration of stressed non-final vowels occurring in phrase-final and sentence-final position — $p = 0.5$, stressed word-final vowels — $p = 0.3$, non-final stressed /ə/ — $p = 0.4$).

As can be seen from Table 1A in the Appendix 4, all speakers had the longest vowels in word-final open stressed syllables and in monosyllabic words. Speaker VA had exceptionally long vowels in monosyllabic words, both in phrase-final and in sentence-final position; it might be appropriate to recall here that only two monosyllabic words consisting of an open syllable occurred in the corpus.

The duration of vowels in open unstressed syllables is given in Table 2 (cf. Appendix 4 Table 2A as well). Separate consideration is given to the reduced vowel /ə/ in unstressed syllables in non-final position and to the duration of vowels in unstressed syllables in word-internal and word-final position. The corpus did not contain words with an unstressed /ə/ in final position.

Table 2

Vowel duration (ms) in open unstressed syllables in phrase-final (PF) and sentence-final (SF) words (N — number of tokens, $\bar{x}$ — average, s.d. — standard deviation)

Position		/ə/ (nonfinal)		V (nonfinal)		V (final)	
		N	$\bar{x}$	N	$\bar{x}$	N	$\bar{x}$
PF		197	58	174	71	268	124
	s.d.		10		9		24
SF		195	54	178	67	265	119
	s.d.		5		8		25
Overall		**392**	**56**	**352**	**69**	**533**	**121**
average	s.d.		**7**		**8**		**25**

The longest unstressed vowels occurred in the final open syllable of a word in phrase-final position. The considerable difference between durations of vowels in analogous word-internal and word-final positions suggests the presence of word-final lengthening, as had been observed for vowels in stressed syllables (cf. Table 1).

The reduced vowel /ə/ had the shortest duration of vowels in unstressed syllables — shorter than that of other vowels in unstressed word-internal position. Speakers ST and NK produced these word-internal unstressed vowels with durations that were not different from each other at a statistically significant level ($p = 0.2$ for both speakers). But within the group, the difference between the reduced vowel and full vowels was statistically significant ($p < 0.0001$).

The situation is comparable with regard to unstressed syllables in sentence-final words. Here, too, the reduced vowel was shorter than a full vowel in the same position, the difference being statistically highly significant ($p < 0.0001$).

In general, the duration of vowels in stressed syllables is greater in every position, compared to the duration of unstressed vowels. The duration of vowels in unstressed syllables amounts to approximately 64—69% of the duration of vowels in comparable stressed syllables in phrase-final position, and 58—69% of the duration of stressed vowels in sentence-final position. The difference is statistically significant ($p < 0.0001$) for both phrase-final and sentence-final occurrences. This applies also to the duration of /ə/, where the difference between the durations of stressed and unstressed occurrences is significant at the same level ($p < 0.0001$).

The variability of the duration of vowels was greatest in word-final position, as evidenced by the standard deviations (stressed vowel in phrase-final position — 33 ms, unstressed vowel — 24 ms; stressed vowel in sentence-final position — 31 ms, unstressed vowel — 25 ms). The big variation of the duration of vowels in monosyllabic words (average standard deviation of 51 ms) may be due to the relatively small number of tokens (there were only two open-syllable monosyllabic words in the corpus).

The averaged duration of the vowels in stressed and unstressed syllables is compared on Figure 1.

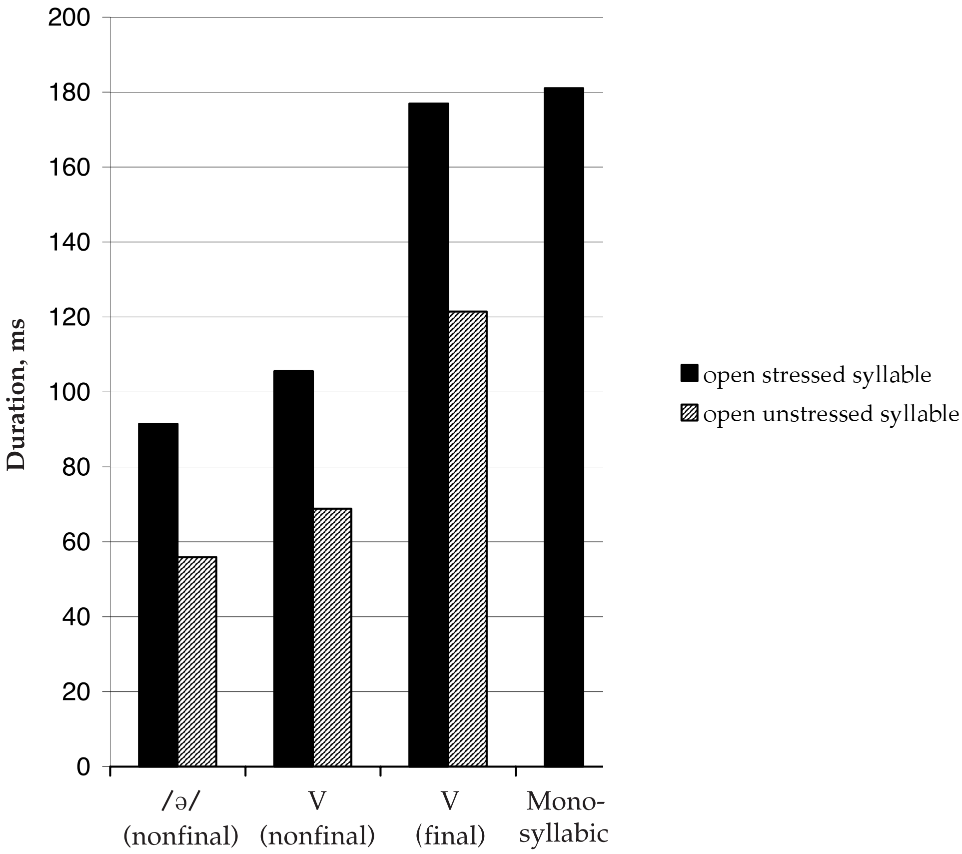

Figure 1. **The duration of vowels (ms) in open stressed and unstressed syllables. Both positions (phrase-final and sentence-final) are combined.**

Among the test words there were some containing a long high front vowel. We analyze this syllable nucleus as consisting of a sequence of the vowel /i/ + the high front glide /j/. The reasons are primarily distributional: the language appears to have no length opposition in the other vowels, and the syllable nucleus inventory (cf. Chapter 2, section 1) contains no diphthongs.

Table 3 contains average durations of /i/ and /ij/ in words constituting the near-minimal pair *piže* and *ijže* ('his/her dog' — 'let him/her swim') and the minimal pair *ida* — *ijda* ('don't (2pl. imper.)' — 'your ice, year'), as well as the duration of the second vowel. In the minimal pair, stress is expected to fall on the second syllable, but Speaker LV produced both of them with stress on the first syllable, and Speakers VN (both phrase- and sentence-final words) and VA (phrase-final words) pronounced the word *ijda* with stress on the first syllable. Individual data are presented in Appendix 4, Table 3A.

Table 3

The duration (ms) of the short /i/ and the combination of /i/ and the glide /j/ as well as the vowel of the following syllable (the duration of the vowel in a stressed syllable in boldface)

Speaker	*piže*		*ijže*		*ida*		*ijda*	
	V1	V2	V1	V2	V1	V2	V1	V2
PF	**135**	145	**191**	132	**112**	149	**173**	176
					85	**215**	134	**208**
SF	**126**	114	**177**	120	**102**	145	**158**	129
					85	**212**	146	**192**
Overall average	**131**	130	**184**	126	**107**	147	**166**	153
					85	**214**	140	**200**

As shown in Table 3, the stressed /i/ in /piže/ was regularly shorter than the stressed /ij/ in /ijže/, with a ratio of 0.71. The unstressed second vowel /e/ had approximately the same duration as the stressed /i/ in /piže/, with a ratio of 1.01, but the long syllable nucleus of /ijže/ was considerably longer than its unstressed second vowel, with a ratio of 1.46. (Individual data are presented in Appendix 4, Table 3A.)

In the minimal pair /ida/ — /ijda/ the first word was stressed on the first syllable by one, and the second word by three of the eight speakers (Speaker VA produced /ijda/ with stress on the first syllable in phrase-final position, and on the second syllable in sentence-final position. Cf. Appendix 4, Table 3A for individual speakers' data). In these cases, the durations of the stressed syllable nuclei were comparable to those in the first pair, with a ratio between the durations of /i/ and /ij/ of 0.65. The duration of the unstressed second vowel /a/ was considerably greater than that of unstressed /e/, resulting in smaller ratios between the two syllable nuclei of the words: in /ida/, the ratio between stressed /i/ and unstressed /a/ was 0.73, and in /ijda/, the ratio between /ij/ and /a/ was 1.08.

In productions with stress on the second syllable, certain differences are observable. The ratio between the durations of unstressed /i/ and /ij/ is 0.61, which resembles the relationship found in their stressed counterparts, but the actual durations are considerably shorter. This may be attributed to the presence versus absence of stress. The main difference between the two word pairs is in the duration of the second vowel, which, when stressed, is longer than the stressed /ij/ in either word pair.

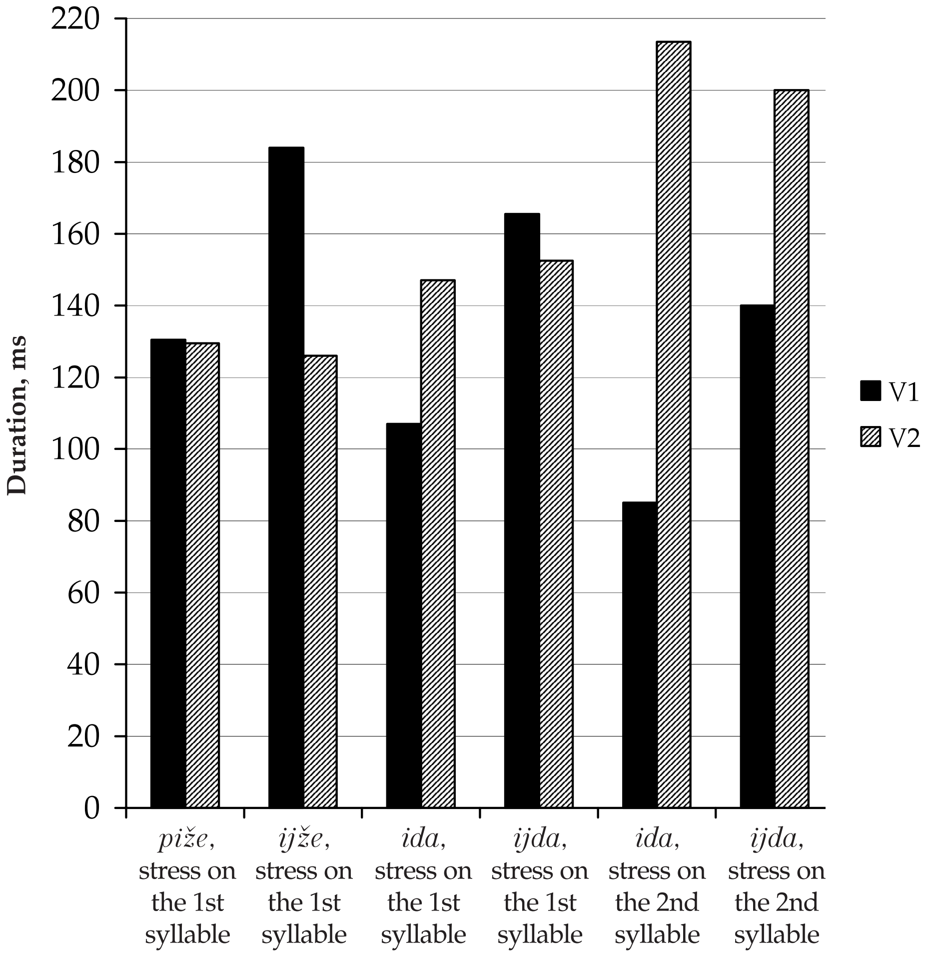

Figure 2. **Average durations (ms) of V1 and V2 in words containing /i/ and /ij/. Both positions (phrase-final and sentence-final) are combined.**

In words with stress on the second syllable, the ratios between the durations of the syllable nuclei were 0.40 for /ida/ and 0.70 for /ijda/. On the basis of these limited data, there appears to be no difference in duration associated with position in the sentence (p = 0.532195).

3.3.1.2. Vowel duration in mono- and disyllabic words

The set of test words contained ten monosyllabic words, of which 2 consisted of an open syllable and 8 a closed syllable. Each vowel occurred in phrase-final and sentence-final position, for a total of 20 tokens.

In the case of disyllabic words, four kinds of combinations of syllable type were represented:
(1) CV.CV both syllables open
(2) CVC.CV closed first syllable (ending in a consonant cluster or the first part of a geminate), open second syllable
(3) CV.CVC open first syllable, closed second syllable
(4) CVC.CVC both syllables closed.

In some of the words, the first syllable was stressed; in others, stress occurred on the second syllable. The average duration of vowels in stressed and unstressed syllables in the two positions within the word is presented separately.

3.3.1.2.1. Monosyllabic words

The average duration (ms) of the vowels in monosyllabic words in open and closed syllables is given in Table 4 (for data by speakers cf. Appendix 4, Table 4A; the word *lu* 'ten, bone', produced in phrase-final position by Speaker VN, could not be included because of a technical error).

Table 4

Average duration (ms) of vowels and coda consonants in monosyllabic words in open and closed syllables (PF — phrase-final, SF — sentence-final, N — number of tokens, x̄ — average, s.d. — standard deviation)

Position		Open		Closed		
		N	V	N	V	C
PF	x̄	15	179	64	112	103
	s.d.		58		28	40
SF	x̄	16	183	64	108	118
	s.d.		44		32	45
Overall average	x̄	**31**	**181**	**128**	**110**	**111**
	s.d.		**51**		**30**	**43**

In both phrase-final and sentence-final positions, the average duration of vowels is longer in monosyllabic words constituting an open syllable than in those consisting of a closed syllable, with a ratio of 1.65 (the difference between the vowels in open and closed monosyllables is significant at the $p < 0.0001$ level). The difference in duration due to phrase-final or sentence-final position is not significant (open syllable $p = 0.93225$; closed syllable $p = 0.499912$).

3.3.1.2.2. Disyllabic CV.CV words (both syllables open)

The duration of vowels in disyllabic CV.CV words is given in Table 5 (for individual speakers cf. Appendix 4, Table 5A). Speaker LV pronounced all words in this group with stress on the first syllable. In sentence-final words she pronounced one word (*vita* 'seeps through') with stress on the second syllable. In sentence-final position, Speaker VN pronounced two words without a vowel in the first syllable (*čəke* 'little haystack' > *čke*, *kəša* 'footprint' > *kša*), and made a slip of the tongue while pronouncing the word *ida* 'don't (2pl. imper.)'. Speaker VN pronounced one word (*kəne* 'cannabis') with stress on the second syllable, but there the vowel in the first syllable was almost completely elided (V1 — 16 ms, V2 — 140 ms), and the word was not included in the analysis.

Table 5

Vowel durations (ms) and V1/V2 duration ratios in disyllabic CV.CV words

Position		First syllable stressed								Second syllable stressed							
		N	/ə/	V2	V1/V2	N	V1	V2	V1/V2	N	/ə/	V2	V1/V2	N	V1	V2	V1/V2
PF	x̄	26	99	126	0.78	54	113	138	0.82	22	46	170	0.27	18	78	202	0.39
	s.d.		18	9			21	21			10	17			14	17	
SF	x̄	26	102	117	0.87	52	107	128	0.84	19	45	169	0.27	19	73	192	0.38
	s.d.		16	14			16	21			9	22			18	23	
Overall average	x̄	**52**	**101**	**122**	**0.83**	**106**	**110**	**133**	**0.83**	**41**	**46**	**170**	**0.27**	**37**	**76**	**197**	**0.39**
	s.d.		**17**	**12**			**19**	**21**			**10**	**20**			**16**	**20**	

As becomes evident from the table, both stress and position within the word have an influence on the duration of the vowels. A stressed V1 is longer than an unstressed V1 (110 vs. 76 gives a ratio of 1.45). The same applies to V2 (stressed V2 vs. unstressed V2 — 197/133 = 1.48). The behavior of /ə/ resembles that of the full vowels (except for the fact that /ə/ is always shorter than a comparable full vowel). The ratio of stressed /ə/, to unstressed /ə/ is 2.2.

The influence of position is evident in the fact that both stressed and unstressed V2 is longer than the corresponding V1. In the case of CV.CV words with stress on the first syllable, the unstressed V2 is longer than the stressed V1; in the case of CV.CV words with stress on the second syllable, the contribution of position increases the difference in duration between V1 and V2. This phenomenon is tentatively explained as pre-boundary lengthening rather than pre-stress shortening, since both stressed and unstressed syllables experience pre-boundary lengthening.

3.3.1.2.3. Disyllabic CVC.CV words (first syllable closed, second syllable open)

The duration of vowels in disyllabic CVC.CV words is given in Table 6 (for individual data, cf. Appendix 4, Table 6A). The test set included words with stress on the first syllable as well as words with stress on the second syllable, and in general, the speakers agreed with each other. The Speaker LV pronounced all the words in this group with stress on the first syllable; Speaker VN pronounced three words (/ludde/ 'without reading', /purde/ 'without biting' in phrase-final position, /akla/ 'he/she evaluates (2sg.)' in sentence-final position) with stress on the second, and all other words with stress on the first syllable.

Table 6

Vowel and coda consonant durations (ms) and V1/V2 duration ratios in disyllabic CVC.CV words

Position		First syllable stressed					Second syllable stressed				
		N	V1	C.	V2	V1/V2	N	V1	C.	V2	V1/V2
PF	x̄	83	102	113	121	0.84	37	67	119	191	0.35
	s.d.		25	42	23			14	32	18	
SF	x̄	85	102	119	122	0.83	35	71	135	182	0.39
	s.d.		24	43	21			19	48	21	
Overall average	x̄	**168**	**102**	**116**	**122**	**0.84**	**72**	**69**	**127**	**187**	**0.37**
	s.d.		**25**	**42**	**22**			**17**	**40**	**20**	

A first observation regarding the duration of vowels in closed first syllables is the similarity of these durations to that of vowels in open first syllables. In Table 5, the average duration for vowels in open first syllables was 110 ms, when that syllable was stressed, and 76 ms in the unstressed case; here the duration of the vowel in a stressed closed syllable was 102 ms, and 69 ms in unstressed position. This invites comparison with monosyllabic words (Table 4), where the vowel duration in a closed syllable was considerably shorter than was the case with open syllables (110 ms vs. 181 ms).

The question raised by these results concerns the relationship between segmental timing and syllabic timing. In monosyllabic words ending in a consonant, the average duration of the final consonant was 111 ms; this compensates for the shortening of the syllable nucleus and yields an overall duration of 221 ms for the nucleus + coda of the closed monosyllable.

(Word-initial and syllable-initial consonants are not contrastive and are not included in this discussion. The duration of consonants is treated in more detail in section 3.3.2. below.) The difference between the overall durations (181 ms vs. 110 + 111 ms) is significant ($p = 0.000284$). Even though the difference between the overall durations is significant, the timing of monosyllabic words shows a tendency toward syllabic isochrony.

On the basis of the observed structure of monosyllabic words, one would expect the overall duration of stressed CVC-syllables to match that of stressed CV-syllables. A comparison of vowel durations in the first syllables of CVC.CV words, given in Table 6, with the duration of vowels in analogous position in CV.CV words given in Table 5, shows that the difference between vowel durations is not significant (vowel duration in stressed CVC — 102 ms, unstressed 69 ms; vowel duration in stressed first CV — 110 ms, unstressed 76 ms, stressed V1 $p = 0.052475$, unstressed V1 $p = 0.082891$). Since the duration of the CVC-syllables includes the duration of the coda consonant, the timing here appears to be taking place on the segmental level rather than syllabic level. The problem will be considered further in connection with other word types.

The open second syllable of CVC.CV words behaved comparably to the open second syllable in CV.CV words: shorter in unstressed position, longer when bearing stress, with a ratio of 122/187 = 0.65. (For CV.CV words, the corresponding ratio was 133/197 = 0.68.) Preboundary lengthening was observed in both stressed and unstressed final open syllables. Position within the sentence had no significant influence on vowel duration ($p = 0.766547$).

3.3.1.2.4. Disyllabic CV.CVC words (first syllable open, second syllable closed)

The duration of vowels in disyllabic words with an open first syllable and a closed second syllable is presented in Table 7. (For individual data, cf. Appendix 4, Table 7A).

Table 7

Vowel and coda consonant durations (ms) and V1/V2 duration ratios in disyllabic CV.CVC words

Position		First syllable stressed					Second syllable stressed				
		N	V1	V2	C	V1/V2	N	V1	V2	C	V1/V2
PF	x̄	64	104	73	122	1.41	69	70	136	139	0.52
	s.d.		20	17	54			20	25	49	
SF	x̄	67	104	68	124	1.53	66	67	143	136	0.47
	s.d.		21	17	47			21	22	48	
Overall average	x̄	**131**	**104**	**71**	**123**	**1.47**	**135**	**69**	**140**	**137**	**0.50**
	s.d.		**21**	**17**	**50**			**21**	**24**	**49**	

The vowels in open syllables show a consistent pattern: longer in stressed first position, shorter in unstressed first position. The vowel of the closed second syllable is likewise shorter in unstressed position, and longer in stressed final position, where preboundary lengthening appears to contribute extra length. In the interpretation of the durational patterns in CV.CVC words, the fact should be taken into account that the second vowel in words with stress on the first syllable was /ə/ in every case.

A comparison of the measurements in this table with those of Table 5 (CV.CV words) raises again the question of whether timing patterns are based on segment durations or syllabic durations. If the patterns are based on segment durations, a CVC-syllable can be expected to have greater duration than a CV-syllable; ratios based only on the vowel component of a CVC-syllable are larger or smaller than in CV.CV words, depending on whether the CVC syllable is in initial or final position in the disyllabic word. If the durations of syllables are more or less constant, the syllabic ratios should not depend on the segmental composition of the syllables, and vowels in CVC-syllables should be shorter than those in CV-syllables.

The temporal structuring of monosyllabic words (Table 4) favors syllabic isochrony: the duration of the vowel in open monosyllables was longer than that of the vowel in closed monosyllables (vowel duration in CV-words — 181 ms, vowel duration in CVC-words — 110 ms, final consonant duration 111 ms, for a total of 221 ms). The results presented in Tables 6 and 7, where one of the syllables was open and one was closed, suggest that syllable duration is at least to some extent segmentally determined.

3.3.1.2.5. Disyllabic CVC.CVC words (both syllables closed)

The duration of vowels in disyllabic words with two closed syllables is presented in Table 8. (For individual data, cf. Appendix 4, Table 8A).

Table 8

Vowel and coda consonant durations (ms) and V1/V2 duration ratios in disyllabic CVC.CVC words

Position		First syllable stressed						Second syllable stressed					
		N	V1	C.	V2	C	V1/V2	N	V1	C.	V2	C	V1/V2
PF	x̄	33	97	78	60	102	1.63	48	67	89	123	133	0.55
	s.d.		25	20	13	45			13	30	18	47	
SF	x̄	31	101	76	59	93	1.71	49	66	102	134	143	0.50
	s.d.		20	19	18	30			17	49	19	55	
Overall average	x̄	**64**	**99**	**77**	**60**	**97**	**1.67**	**97**	**67**	**96**	**129**	**138**	**0.53**
	s.d.		**23**	**19**	**16**	**37**			**15**	**39**	**19**	**51**	

In the two previous tables, the two syllables differed in their segmental structure, and the temporal structure of the word could be expected to be influenced by the difference in syllable type. In the present table, both syllables are closed; thus the influence of stress is more obvious. Regardless of position, the vowel in the stressed syllable is approximately twice as long as the vowel in the unstressed syllable. Pre-boundary lengthening can be deduced from the fact that the vowel of the stressed second syllable is longer than the vowel of the stressed first syllable. In the words with stress on the first syllable, the vowel of the unstressed second syllable was schwa.

3.3.1.2.6. Overview of the durations of vowels in disyllabic words

A comparison of vowel durations in the four kinds of disyllabic words described above is offered in Figure 3.

The figure is to be read as follows. The first two double columns on the left show the average duration of vowels in CV.CV words (both syllables open), with stress on the first syllable; the second two double columns give durations of vowels in CV.CV words with stress on the second syllable. The difference in vowel durations reflects both stress and position within the word.

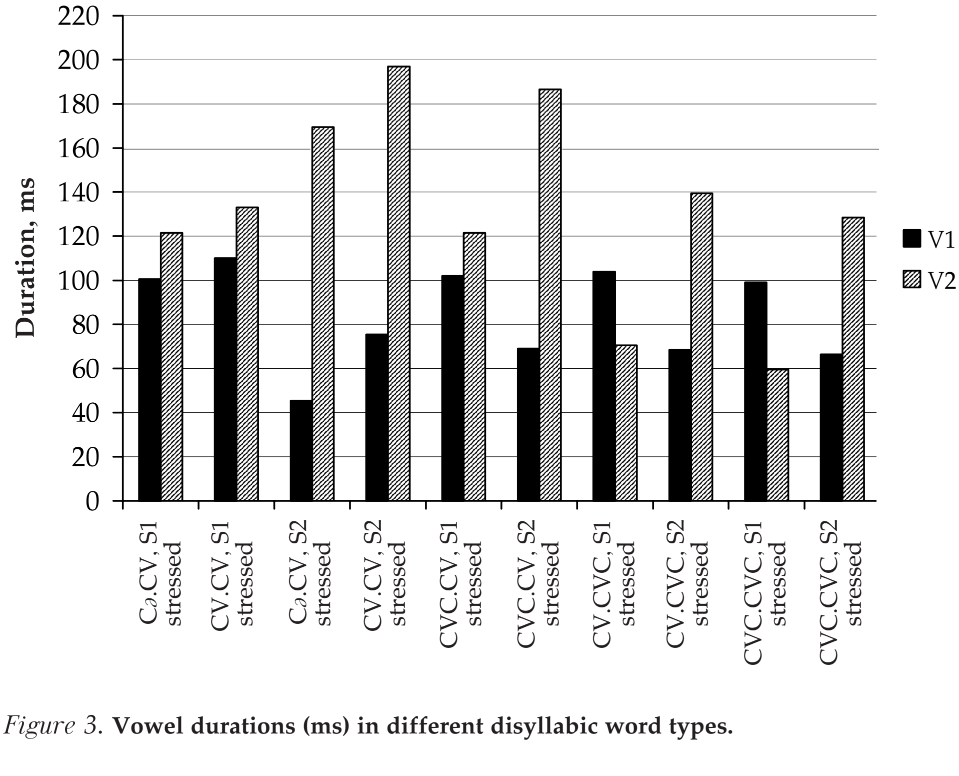

Figure 3. **Vowel durations (ms) in different disyllabic word types.**

As can be seen from the figure, in CV.CV words the vowel in a stressed syllable is longer than a vowel in an unstressed syllable in the same position within the word. First or second position within the word is likewise reflected in duration: a stressed first vowel is longer than an unstressed first vowel, but shorter than either a stressed or unstressed second vowel. We interpret the extra length of the second vowel as preboundary lengthening, and consider this as evidence for the existence of disyllabic feet as units within the phonological hierarchy. The relative importance of stress and position in the temporal structure of the disyllabic words is evidenced by the fact that the increase in the duration of stressed vowels in preboundary position is considerably greater than the increase due to stress in the first position.

The fifth and sixth double columns represent the durations of vowels in CVC.CV words (closed-open), with stress on the first syllable (fifth set) and on the second syllable (sixth set). The seventh and eighth double columns represent vowel durations in CV.CVC words (open-closed), with stress on either syllable; the ninth and tenth double columns show vowel durations in CVC.CVC words (both syllables closed) with stress on either the first or the second syllable.

The comparison of patterns in all ten double columns makes it possible to draw some generalizations. Vowels in second syllables are always longer than vowels in first syllables, except in two cases: CV.CVC words with stress on the first syllable, and CVC.CVC words with stress on the first syllable. Vowels in stressed syllables are longer than vowels in unstressed syllables, except in the first stressed syllable of CV.CV and CVC.CV. Vowels in open syllables are longer than vowels in closed syllables, except in CV.CVC words with stress on the second syllable.

3.3.1.3. Vowel duration in trisyllabic words

Among the test words there were 24 trisyllabic words in both sentence positions (48 in all). In those words the first, second, and the third syllable could be stressed. One word containing the combination of /i/ and the glide /j/ (*vijdəme* 'powerless') was not included in analysis. Speaker VN pronounced some words without some vowels: *kiddəme* 'handless' > *kitme*, *luddəmo* 'unreadable, unread; boneless' > *lutmo*, *ludənam* 'I read (praet. II)' > *ludnam*.

The durations of vowels in trisyllabic words are given in Table 9 and Figure 4 (cf. as well Appendix 4, Table 9A). The data are taken on the basis of the syllable under consideration. For example, "stressed open first syllable" gives the average of vowel durations in the stressed first syllable in words with both open and closed second and third syllables.

Table 9

Average duration (ms) of vowels in the stressed and unstressed syllables of trisyllabic words in closed and open syllables

Position	Syllable type	N			Stressed V1			N			Stressed V2			N			Stressed V3		
					V1	V2	V3				V1	V2	V3				V1	V2	V3
PF	open	59	57	61	87	62	113	0	16	16		137	117	69	47	24	62	69	158
	s.d.				18	12	20					11	13				16	22	27
	closed	26	26	27	77	55	70	17	2	2	64	131	80	12	33	57	50	70	126
	s.d.				17	8	14				19						16	19	18
SF	open	60	57	58	87	60	112	2	16	18	53	136	119	66	46	20	58	66	165
	s.d.				20	11	19					5	19				18	19	25
	closed	24	27	26	84	49	73	17	3	1	72	84	91	15	35	61	43	75	129
	s.d.				20	9	17				8	78					5	28	15
Overall average	open	**119**	**114**	**119**	**87**	**61**	**113**	**2**	**32**	**34**	**53**	**136**	**118**	**135**	**93**	**44**	**60**	**67**	**161**
	s.d.				**19**	**12**	**20**				**11**	**8**	**16**				**17**	**21**	**26**
	closed	**50**	**53**	**53**	**81**	**52**	**71**	**34**	**5**	**3**	**68**	**107**	**83**	**27**	**68**	**118**	**46**	**72**	**127**
	s.d.				**18**	**9**	**16**				**13**	**78**	**15**				**10**	**23**	**16**

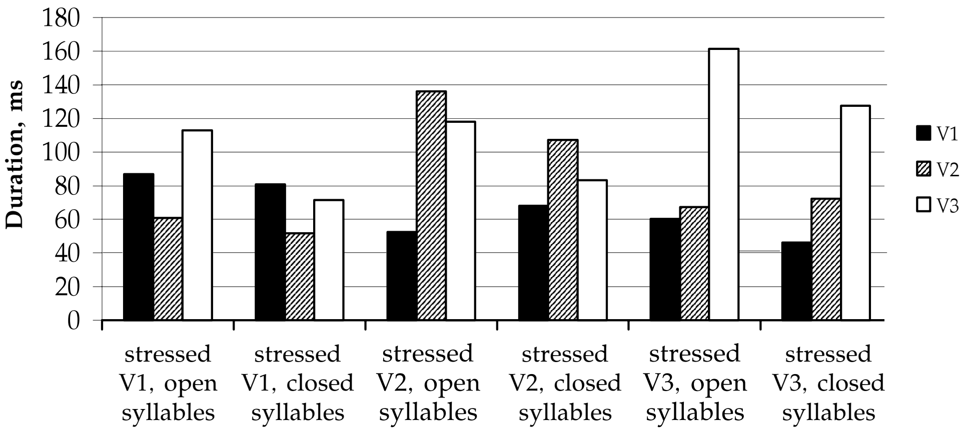

Figure 4. **Average duration of vowels (ms) in open and closed syllables in trisyllabic words with stress on the first, second, and third syllable.**

The figure is to be read as follows. The first set of three columns shows the average duration of vowels in open syllables in trisyllabic words with stress on the first syllable. The second set contains comparable information for words with closed syllables. The next set of three columns presents the average duration of vowels in open syllables in trisyllabic words with stress on the second syllable; the following set gives analogous information for vowels in closed syllables. The last two sets of columns give average durations of vowels in open and closed syllables in words stressed on the third syllable.

The durational patterns in trisyllabic words resemble those observed in disyllabic words. A stressed syllable is longer than a comparable unstressed syllable (open or closed) in an analogous position. The vowel in an open syllable is generally longer than a vowel in a closed syllable (but see an exception pointed out below).

An interaction between lengthening due to stress and preboundary lengthening can be observed to take place; however, it is not as straightforward as with disyllabic words. The vowel of a stressed final syllable (V3) is longest both in CV and CVC syllables, where both stress and position contribute to its duration. The vowel of a stressed closed final syllable is, however, shorter than the vowel of the open second syllable, when that syllable carries word-level stress. Nevertheless, V3 in those words is longer than the equally unstressed V1, which confirms the presence of preboundary lengthening.

There is one case that contradicts expectations. This is the duration of V1 in open syllables in words with stress on the second syllable: one would expect V1 in an open syllable to be longer than V1 in a closed syllable (shown in the next set of columns). The values, however, based on only two tokens.

3.3.1.4. Vowel duration in four-syllable words

Among the test words there were 6 four-syllable words. The averaged duration of their vowels is given in Table 10 (cf. as well Appendix 4, Table 10A). In four-syllable words the first syllable was either with main or secondary stress, the second syllable unstressed, the third syllable either unstressed or with main stress (in one word: *kučəneže* 'he/she wants to catch'), the fourth syllable either with main or secondary stress (in the word with the stressed third syllable the fourth syllable was unstressed).

Table 10

The duration of vowels in four-syllable words (ms)

Position	V1		V2	V3		V4		
	primary	secondary	unstressed	primary	unstressed	primary	secondary	unstressed
PF	78	42	54	133	58	140	75	114
s.d.	20	6	9	21	8	18	28	45
SF	82	42	52	125	58	150	79	97
s.d.	20	7	6	16	7	23	19	31
Overall average	**80**	**42**	**53**	**129**	**58**	**145**	**77**	**105**
s.d.	**20**	**7**	**7**	**18**	**7**	**21**	**23**	**38**

In the case of syllables with main stress the longest vowels are in the word-final syllables of phrase-final words (140 ms) and the shortest vowels in the first syllable with main stress (78 ms). The vowels in syllables with secondary stress are almost twice as short as the vowels in syllables with main stress and their duration is comparable to the duration of vowels in unstressed syllables. In case of unstressed syllables, again, the longest vowels are in word-final unstressed syllables.

In sentence-final words as well, as for vowels in syllables with the main stress, the longest vowels are the word-final ones (150 ms) and the shortest vowels those in the first syllables with main stress (82 ms). The vowels in stressed syllables in sentence-final words are longer than the vowels in stressed syllables in phrase-final words. In sentence-final words as well, the vowels in syllables with secondary stress are almost twice as short as the vowels in syllables with main stress. Similarly, the vowels in the final syllable with secondary stress are longer than the vowels in the first syllable with secondary stress. Among the vowels in unstressed syllables, the longest vowels are word-final. This is probably due to final lengthening.

A comparison of the duration of vowels in syllables with main stress indicates that the difference in duration of V1 and V3 is statistically significant ($p < 0.0001$); the same applies to the duration of V1 and V4 ($p < 0.0001$). Although the difference between V3 and V4 is smaller in absolute values, this is likewise statistically significant as well ($p = 0.03$). The difference in the duration of vowels in the first syllable with both main and secondary stress and the final syllable is also statistically significant ($p < 0.0001$ in both cases).

3.3.2. Consonant duration

The consonant system of Meadow Mari consists of the following consonants: /p, t, k, b, d, g, č, s, š, z, ž, m, n, ń, ŋ, l, l′, r, j/. The recorded corpus contained occurrences of contrastive single and geminate consonant pairs: /n/ — /nn/, /d/ — /dd/, /l/ — /ll/. The syllable boundary within the geminate usually coincides with a morpheme boundary. The duration of these consonants and preceding vowels is given in Table 11 and shown graphically on Figure 5. (Individual data are included in Appendix 4, Table 11A.)

The last column of Table 11 contains the duration of what we consider to represent the duration of a closed syllable, consisting of the vowel and the first part of the geminate. The duration of that first part was calculated by subtracting the average duration of a single intervocalic consonant from that of the long consonant. The duration of the syllable-initial consonant is not contrastive.

Table 11

The duration of short and long consonants and the duration of vowels preceding them (ms) (N — tokens)

Position		N	V	/n/	N	V	/nn/	V+/n/
PF	$\bar{x}$	71	56	80	41	62	189	163
	s.d.		20	18		14	36	
SF	$\bar{x}$	71	52	82	41	62	207	188
	s.d.		22	17		16	39	
Overall	$\bar{x}$	**142**	**54**	**81**	**82**	**62**	**198**	**176**
average	s.d.		**21**	**18**		**15**	**38**	
Position		N	V	/d/	N	V	/dd/	V+/d/
PF	$\bar{x}$	151	77	74	40	62	193	181
	s.d.		25	18		19	32	
SF	$\bar{x}$	149	75	81	39	62	211	191
	s.d.		26	17		22	28	
Overall	$\bar{x}$	**300**	**76**	**78**	**79**	**62**	**202**	**186**
average	s.d.		**26**	**18**		**21**	**30**	
Position		N	V	/l/	N	V	/ll/	V+/l/
PF	$\bar{x}$	78	76	66	25	71	181	186
	s.d.		24	17		17	26	
SF	$\bar{x}$	78	80	68	25	74	183	189
	s.d.		27	12		22	21	
Overall	$\bar{x}$	**156**	**78**	**67**	**50**	**73**	**182**	**188**
average	s.d.		**26**	**15**		**20**	**24**	

The small differences in the number of tokens are due to the fact that on occasion, speakers pronounced a word differently from how it was written in the list. In phrase-final words, ST pronounced *tolənna* 'we came (praet. II)' instead of *toləna* 'we come (1pl.)', and JT produced *pəllan* 'to the cloud (all. sg.), on the cloud (adess. sg.)' instead of *pəlan* 'cloudy'. In sentence-final words ST pronounced again *tolənna* instead of *toləna*, and JT a geminate in *pəllan* instead of *pəlan.* In sentence-final words, ST also pronounced *idda* instead of *ijda* 'your (pl.) ice, year', and *viddəme* instead of *vijdəme* 'powerless' (these productions were not included in the calculations). Speaker VN pronounced *kidavlak* instead of *kiddavlak* 'your (pl.) hands' (which was not included in the calculations) and made a slip of the tongue while pronouncing *ijda*. JT pronounced *pəllan* instead of *pəlan* and *nəllənnan* instead of *nələnnan* 'of us four (gen. sg.)' (the latter word was not included in the calculations).

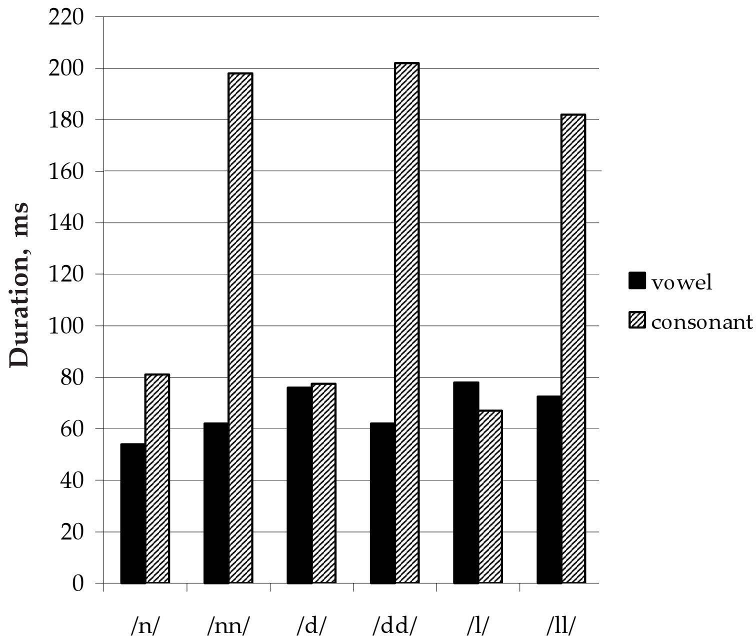

Figure 5. **The duration of short and long consonants and the duration of vowels preceding them (ms). Both positions (phrase-final and sentence-final) are combined.**

As can be seen from Table 11, there is a considerable difference between the durations of long and short consonants in both phrase-final and sentence-final positions. In phrase-final position, the duration ratios of long to short consonants are 2.4 for /nn/ vs. /n/, 2.3 for /dd/ vs. /d/, and 2.3 for /ll/ vs. /l/. In sentence-final position, the respective ratios are 2.3, 2.6, and 2.7. The larger ratios in sentence-final position are due to the greater duration of long consonants (except for /nn/): /dd/ is longer in this position by 23%, and /ll/ by 16%, than in phrase-final position. In general, the average duration of a geminate is 2.4 to 2.7 times greater than that of a single consonant.

Recalling that in monosyllabic words the vowels were shorter in closed syllables than in open syllables (cf. Table 4), it is of considerable interest whether there is a similar difference in the duration of vowels preceding a single intervocalic consonant (i.e. in an open syllable) and those preceding a geminate (i.e. in a closed syllable). The results presented in Table 11 show that this is not the case. The differences in vowel duration before single and geminate consonants are smaller than one standard deviation in every instance. The vowel is longer before /nn/ than before /n/, while in the other two pairs, the vowel is longer before the single consonant. The differences between the averages range from 5 ms to 14 ms and are comparable to the differences between the average durations of consonants.

The last column in Table 11 gives the duration of the closed syllable consisting of the vowel and the first part of the geminate. These durations range from 163 to 191 ms and are comparable to the durations of /i/ plus the glide /j/: as shown in Table 3, the average duration of /ij/ (in the stressed first syllable) in *ijže* 'let him/her swim (3sg. imper.)' was 191 ms and the average duration of /ij/ in *ijda* 'your (pl.) ice, year' was 173 ms in phrase-final position, and the corresponding averages in sentence-final position were 177 and 158 ms.

3.4. Fundamental frequency

The following section is devoted to the comparison of fundamental frequency contours associated with different stress patterns in words of one, two, three, and four syllables. The F0 contours in words produced by female speakers (EI, ST, LV, NK) and male speakers (AA, JT, VN, VA) are considered separately. The fundamental frequency of productions by the male speaker VN could not always be established because of the creakiness of his voice. F0 measurements were made at the beginning (Vbeg) and end (Vend) of every vowel.

3.4.1. Monosyllabic words

The F0 contours of monosyllabic words in phrase-final and sentence-final positions are presented in Table 12 and Figure 6. For data by individual speakers, cf. Appendix 4, Table 12A.

Table 12

The F0 contours of monosyllabic words (Hz) in phrase-final and sentence-final position (PF — phrase-final, SF — sentence-final, N — number of measurements)

Female	N		V1beg	V1end	Female	N		V1beg	V1end
PF	40	$\bar{x}$	256	314	SF	40	$\bar{x}$	216	205
		s.d.	23	33			s.d.	11	10
Male	N		V1beg	V1end	Male	N		V1beg	V1end
PF	39	$\bar{x}$	164	207	SF	40	$\bar{x}$	161	146
		s.d.	17	27			s.d.	15	12

On the average, both male and female speakers had a rising F0 in phrase-final words and a falling F0 in sentence-final words. Two speakers differed somewhat from the general pattern. Speaker LV had

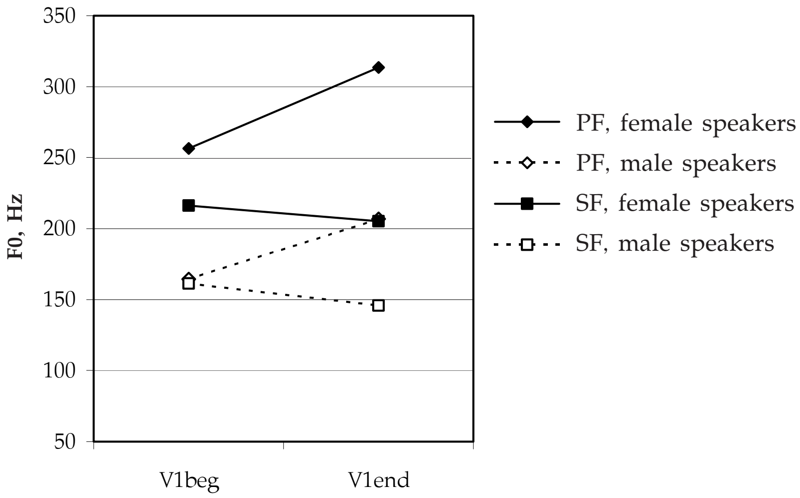

Figure 6. **The F0 contours of monosyllabic words in phrase-final and sentence-final position (4 female and 4 male speakers).**

a rising F0 in both positions, but the rise was smaller in sentence-final position than in phrase-final position (4% and 9% respectively). Speaker VN produced the words practically on a monotone in both positions (average F0 values 161—165 Hz in phrase-final position and 164—165 Hz in sentence-final position).

The F0 contours appear to reflect sentence structure, rising F0 signalling continuation, and falling F0 signalling termination of the sentence.

3.4.2. Disyllabic words

The set of disyllabic words included words stressed on the first syllable as well as words stressed on the second syllable. The two subsets are described separately.

3.4.2.1. Disyllabic words with stress on the first syllable

The fundamental frequency of disyllabic words with a stressed first syllable is presented in Tables 13 and 14 and on Figure 7. Table 13 offers data for words in which the stressed first syllable was followed by an unstressed second syllable with rising F0 in both phrase-final and sentence-final position; Table l4 gives comparable information for words in which the unstressed second syllable was produced with a falling intonation.

Table 13

The F0 of disyllabic words with a stressed first syllable, followed by an unstressed second syllable with rising F0 (Hz) in phrase-final and sentence-final position (PF — phrase-final, SF — sentence-final, N — number of measurements)

Female	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	2	$\bar{x}$	268	310	299	315	29	227	208	209	216
		s.d.	6	15	1	3		15	9	8	9
Male	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	49	$\bar{x}$	167	151	203	252	3	212	158	142	156
		s.d.	22	28	27	33		54	27	27	32

Table 14

The F0 of disyllabic words with a stressed first syllable, followed by an unstressed second syllable with falling F0 (Hz) in phrase-final and sentence-final position (PF — phrase-final, SF — sentence-final, N — number of measurements)

Female	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	139	$\bar{x}$	271	306	255	215	110	232	213	219	203
		s.d.	20	20	27	18		17	15	17	12
Male	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	90	$\bar{x}$	191	208	179	154	137	173	151	147	135
		s.d.	19	22	31	36		18	14	12	11

The fundamental frequency of the stressed first syllable may be rising or falling; there is no systematic relationship between the F0 direction on the stressed first syllable and the direction of the F0 movement on the unstressed second syllable. In phrase-final position, female speakers had a rising F0 on the first syllable, which could be followed by either a rising or a falling second syllable. In sentence-final position, the stressed first syllable had a falling F0, which could be followed by either a rising or a falling unstressed second syllable.

Male speakers had both rising and falling F0 movements on the stressed first syllable in words in phrase-final position. The stressed first syllable with a falling F0 was followed by a rising second syllable, while the first syllable with a rising F0 curve was followed by a falling second syllable. In sentence-final position, the F0 movements were less extensive, and the F0 curves on the stressed first syllable were falling. The falling first syllable could be followed by either a rising or a falling unstressed syllable.

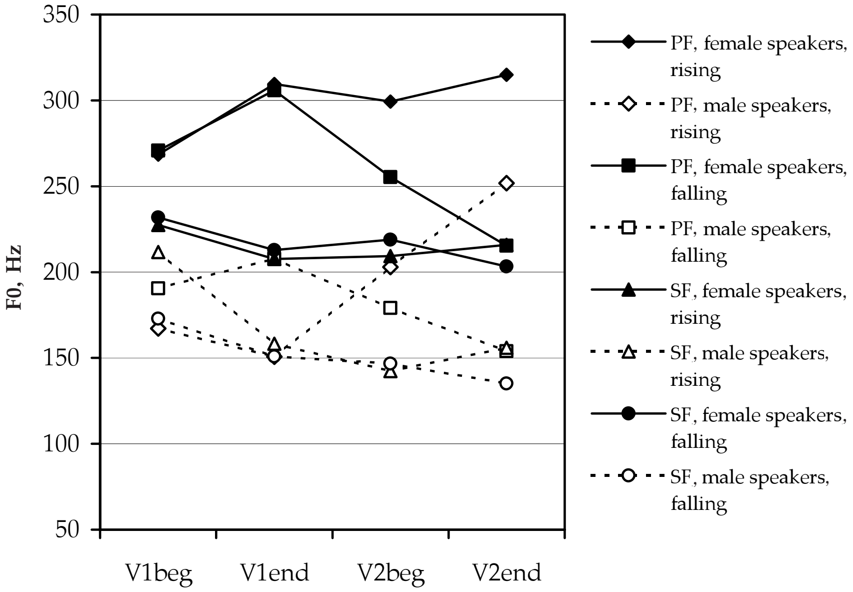

Figure 7. **The F0 of disyllabic words with a stressed first syllable (with rising and falling F0 on the unstressed second syllable), produced by four female and four male speakers.**

Individual data are presented in Appendix 4, Tables 13A and 14A. Some cases might be mentioned here. In phrase-final words the F0 direction was usually falling at the end of the word, i.e. on the unstressed second syllable (in 82% of the words). Some speakers, however, produced the second syllable with rising F0 (two words in productions by the female speaker ST, several by the male speakers AA and JT). In sentence-final position, 89% of the words were produced with falling F0 on the second syllable. However, the female speakers EI and ST had a rising F0 at the end of the words, the rise being less extensive than in phrase-final position. The male speaker AA produced three sentence-final words with a rising F0 on the final syllable. Several speakers produced some stressed first syllables with level F0 in both positions (AA and VN in phrase-final position, ST, LV, and VN in sentence-final position).

3.4.2.2. Disyllabic words with stress on the second syllable

The fundamental frequency on disyllabic words with a stressed second syllable is presented in Tables 15 and 16, and on Figure 8. Table 15 offers data for words in which the stressed second syllable was produced with a rising F0 in both phrase-final and sentence-final position; Table 16 gives comparable information for words in which the stressed second syllable had a falling F0. Individual data are included in Appendix 4, Tables 15A and 16A.

Table 15

The F0 of disyllabic words with a stressed second syllable with rising F0 (Hz) in phrase-final and sentence-final position (PF — phrase-final, SF — sentence-final, N — number of measurements)

Female	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	95	x̄	235	223	245	300	45	224	207	203	219
		s.d.	16	14	19	21		19	14	11	12
Male	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	88	x̄	154	144	165	222	29	144	130	139	149
		s.d.	11	13	21	26		12	8	7	9

Table 16

The F0 of disyllabic words with stressed second syllable with falling F0 (Hz) in phrase-final and sentence-final position (PF — phrase-final, SF — sentence-final, N — number of measurements)

Female	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	4	x̄	252	260	301	283	56	230	216	212	192
		s.d.	25	45	15	20		14	15	10	12
Male	PF, N		V1beg	V1end	V2beg	V2end	SF, N	V1beg	V1end	V2beg	V2end
	13	x̄	142	133	146	128	55	209	203	158	128
		s.d.	13	6	10	7		21	19	18	8

Unlike the words with a stressed first syllable, phrase-final words with a stressed second syllable were usually produced with a rising F0 on that syllable (92% of instances). The F0 on the unstressed first syllable was falling in these cases. There were some productions with a falling F0 on the stressed phrase-final syllable: the female speaker ST had rising F0 on the first syllable and a falling F0 on the second syllable in four words, the male speaker VN had level F0 on the first syllable and rising F0 on the second syllable in seven words, and the male speaker VA had falling F0 on both syllables. However, phrase-final falling second syllables always started at a higher frequency than either rising or falling first syllables (cf. Table 16).

In sentence-final position, both rising and falling F0 curves were observed on the stressed second syllable (40% rising, 60% falling). Female speakers had falling F0 in more than half of the instances, and a rising F0 in less than half of the cases. Male speakers usually had falling F0 on the sentence-final stressed second syllable. There were some productions with a rising F0, but speakers AA and JT never had

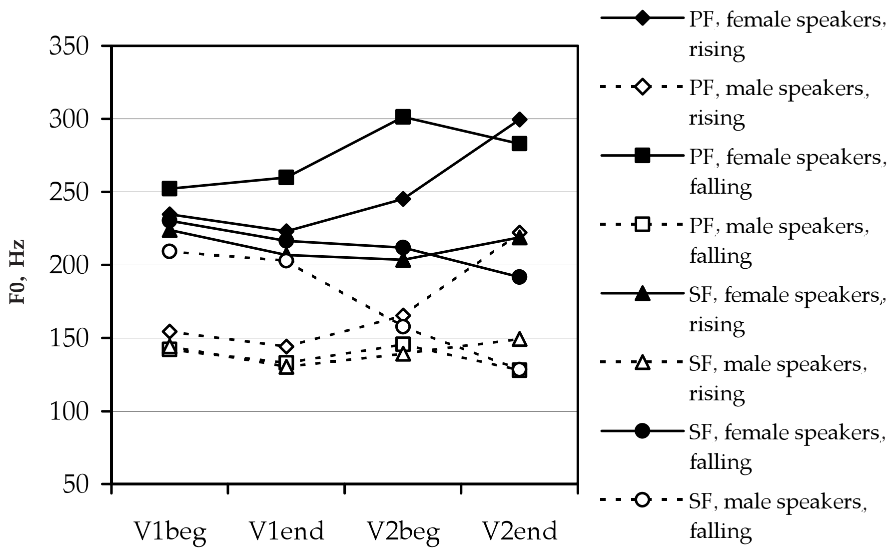

Figure 8. **The F0 of disyllabic words with a stressed second syllable (with rising and falling F0 on that syllable) produced by four female and four male speakers.**

a rising F0 on the sentence-final stressed second syllable, and speakers VN and VA had no falling F0 on the sentence-final syllable.

One difference between phrase-final and sentence-final productions by male speakers should be pointed out: in sentence-final position, the stressed syllable with falling F0 was preceded by an unstressed syllable with considerably higher pitch.

3.4.3. Trisyllabic words

The corpus included trisyllabic words with stress on the first, second, and third syllable. In what follows, words with different stress patterns are treated separately.

3.4.3.1. Trisyllabic words, first syllable stressed

The F0 of trisyllabic words with stress on the first syllable is given in Table 17 and Figure 9 (for data of individual speakers, cf. Appendix 4, Table 17A).

In phrase-final trisyllabic words with a stressed first syllable, seven out of eight speakers had a rising F0 on the stressed syllable, followed by falling F0 on the rest of the word. The exception was the male speaker JT, who had the first syllable with rising F0, the second syllable with falling F0, and the final syllable with rising F0. His results (11 words) were not taken into account for calculating averages (cf. Appendix 4, Table 17A).

Table 17

The F0 of trisyllabic words with a stressed first syllable (Hz) in phrase-final and sentence-final position (PF — phrase-final, 4 female and 3 male speakers; SF — sentence-final, 4 female and 4 male speakers; N — number of measurements)

Female		N	V1beg	V1end	V2beg	V2end	V3beg	V3end
PF	$\bar{x}$	47	265	302	290	249	226	208
	s.d.		25	22	38	26	15	12
SF	$\bar{x}$	46	221	209	215	202	207	200
	s.d.		22	8	11	10	12	11
Male		**N**	**V1beg**	**V1end**	**V2beg**	**V2end**	**V3beg**	**V3end**
PF	$\bar{x}$	34	198	217	184	154	146	132
	s.d.		35	39	31	26	28	30
SF	$\bar{x}$	46	174	156	149	138	142	133
	s.d.		17	14	10	11	12	13

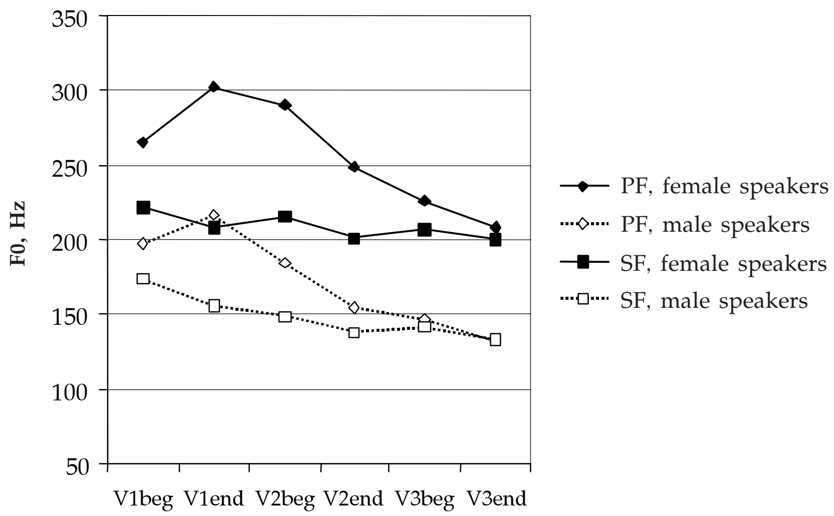

Figure 9. **F0 contours of trisyllabic words with a stressed first syllable (4 female and 3 male speakers — phrase-final occurrences; 4 female and 4 male speakers — sentence-final occurrences).**

In sentence-final position, F0 is falling on the stressed syllable as well. There were minor fluctuations — the female speaker LV had a slight rise (9 Hz) in the vowel of the first syllable, the female speaker ST had level F0 on the last syllable, and the male speaker VN had a level first syllable, followed by falling F0 on the unstressed syllables. All speakers had lower F0 values in sentence-final position.

3.4.3.2. Trisyllabic words, second syllable stressed

The F0 of trisyllabic words with stress on the second syllable is given in Table 18 and Figure 10 (for data of individual speakers, cf. Appendix 4, Table 18A).

Table 18

The F0 of trisyllabic words with a stressed second syllable (Hz) in phrase-final and sentence-final position (PF — phrase-final, 4 female and 3 male speakers; SF — sentence-final, 2 female and 2 male speakers; N — number of measurements)

Female		N	V1beg	V1end	V2beg	V2end	V3beg	V3end
PF	x̄	9	230	220	245	314	250	217
	s.d.		9	10	20	18	15	10
SF	x̄	5	273	266	207	190	210	192
	s.d.		19	12	10	8	14	2
Male		N	V1beg	V1end	V2beg	V2end	V3beg	V3end
PF	x̄	7	159	149	156	205	172	148
	s.d.		9	7	10	14	39	44
SF	x̄	6	189	172	142	132	140	131
	s.d.		43	29	7	12	13	10

In phrase-final position, words with stress on the second syllable had a falling F0 on the unstressed initial syllable, rising F0 on the stressed second syllable, and falling F0 on the unstressed third syllable. Speakers ST, JT, and VN had a level F0 on the unstressed first syllable. Speaker JT differed from the others in having a level F0 on the first syllable, falling F0 on the second syllable, and rising F0 on the third syllable; his results were not taken into account in calculating the averages (cf. Appendix 4, Table 18A).

In sentence-final position, the F0 was falling throughout the whole word in the speech of two female speakers (EI and NK) and two male speakers (AA, VA); the averaged values in Table 18 are based on productions by these speakers. The female speaker ST had a falling F0 on the first two syllables, but a rising F0 at the end of the word. The female speaker LV and the male speaker VN produced the sentence-final words in the same way as phrase-final words — with a rising F0 on the stressed second syllable. The male speaker JT had rising F0 on the first syllable and falling F0 on the second and third syllables.

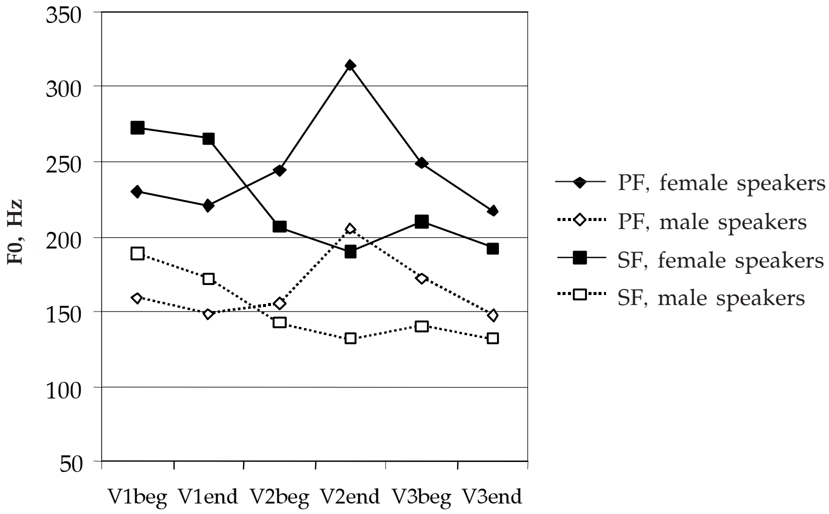

Figure 10. **The F0 contours of trisyllabic words with a stressed second syllable (4 female and 3 male speakers — phrase-final occurrences; 2 female and 2 male speakers — sentence-final occurrences).**

3.4.3.3. Trisyllabic words, third syllable stressed

The F0 of trisyllabic words with a stressed third syllable is given in Table 19 and Figure 11 (for data by individual speakers, cf. Appendix 4, Table 19A).

Table 19

The F0 of trisyllabic words with a stressed third syllable (Hz) in phrase-final and sentence-final position (PF — phrase-final, 4 female and 4 male speakers; SF — sentence-final, 3 female and 3 male speakers; N — number of measurements)

Female		N	V1beg	V1end	V2beg	V2end	V3beg	V3end
PF	x̄	40	234	221	228	220	241	306
	s.d.		16	13	15	17	17	17
SF	x̄	29	245	225	238	224	206	202
	s.d.		20	15	24	18	10	11
Male		N	V1beg	V1end	V2beg	V2end	V3beg	V3end
PF	x̄	41	158	144	150	142	158	213
	s.d.		11	12	10	11	18	28
SF	x̄	30	183	172	188	183	155	130
	s.d.		15	11	16	15	11	11

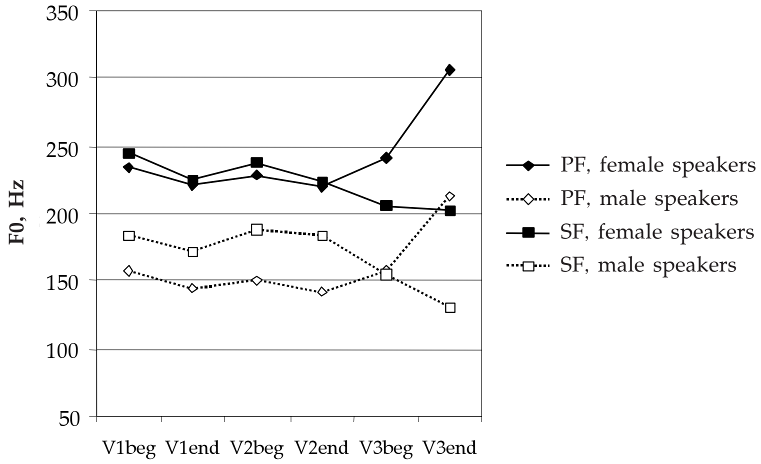

Figure 11. **The F0 contours of trisyllabic words with a stressed third syllable (4 female and 4 male speakers — phrase-final occurrences; 3 female and 3 male speakers — sentence-final occurrences).**

The phrase-final words with a stressed third syllable were always pronounced with a rising F0 on the word-final stressed syllable. The first two syllables had falling F0.

In sentence-final position, however, the F0 was usually falling also on the stressed third syllable. There were two exceptions: the female speaker LV and the male speaker VN produced the words in sentence-final position with the same F0 contour as in phrase-final position (cf. Appendix 4, Table 19A). Therefore their results were excluded when the F0 averages were calculated.

3.4.4. Four-syllable words

There were six four-syllable words in the corpus, with stress on the first (2 words), third (1 word), and fourth (3 words) syllable.

3.4.4.1. Four-syllable words; first syllable stressed

The data on the F0 of two four-syllable words (*nələnəštəm* 'these/those four (acc. sg.)', *vitədəme* 'waterproof') with a stressed first syllable are given in Table 20 and Figure 12 (data by individual speakers cf. Appendix 4, Table 20A). The male speakers JT and VN also pronounced the word *nələtənat* 'foursome' with primary stress on first syllable in sentence-final position.

Table 20

The F0 of four-syllable words with primary stress on the first syllable and a secondary stress on the fourth syllable (Hz) (PF — phrase-final, 4 female and 3 male speakers; SF — sentence-final, 2 female and 2 male speakers; N — number of measurements)

Female	N		V1beg	V1end	V2beg	V2end	V3beg	V3end	V4beg	V4end
PF	8	x̄	251	312	331	275	249	230	218	208
		s.d.	18	20	27	30	8	7	11	7
SF	4	x̄	222	240	257	231	234	227	231	221
		s.d.	8	20	25	23	23	17	12	19
Male	N		V1beg	V1end	V2beg	V2end	V3beg	V3end	V4beg	V4end
PF	6	x̄	162	201	205	170	149	131	131	121
		s.d.	16	22	40	53	12	5	9	3
SF	6	x̄	153	156	158	146	147	139	143	133
		s.d.	8	16	10	6	9	1	7	12

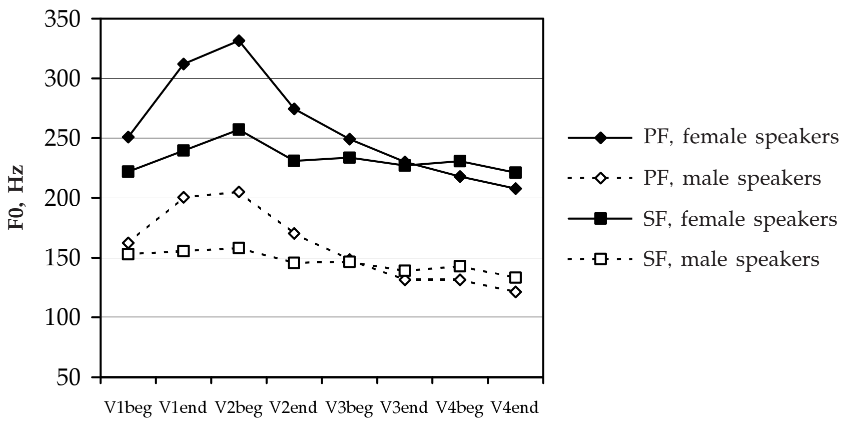

Figure 12. **The F0 of four-syllable words with primary stress on the first and the secondary stress on the fourth syllable (Hz) in phrase-final and sentence-final position (4 female and 3 male speakers — phrase-final; 2 female and 2 male speakers — sentence-final).**

In phrase-final position, the F0 is rising during the stressed first syllable. The F0 rise continues to the beginning of the second syllable, and falls continuously from that point; the pitch may also be level at the end of the word. As was the case of trisyllabic words with a stressed first syllable, here too the male speaker JT constitutes an exception: in his speech, the words had falling F0 in the first syllable and rising F0 in the final syllable (cf. Appendix 4, Table 20A). His values are not included in the averages.

In sentence-final position, the speakers differed more among themselves. Table 20 contains values averaged from productions by two female speakers (ST and LV) and two male speakers (JT and VN). The two female speakers produced sentence-final words with the same F0 contours as phrase-final words. The female speaker EI had a falling F0 in the first two syllables, a rising F0 in the third syllable, and a falling or rising F0 in the fourth syllable (which averaged to a level contour). The female speaker NK had a falling F0 throughout the whole word. The male speakers JT and VN had a level F0 in the first syllable, followed by a falling F0. The F0 of Speaker AA was falling during the first and third syllables, but rising at the end of the word. Speaker VA had a rising F0 in the first syllable, as in phrase-final words, and falling F0 in the following syllables.

3.4.4.2. Four-syllable words with stress on the third or fourth syllable

The F0 data for four-syllable words with a stressed third syllable are given in Table 21 and Figure 13 (for data by individual speakers, cf. Appendix 4, Table 21A). There was only one such word in the corpus: *kučəneže* 'she/he wants to catch'.

Table 21

The F0 of the four-syllable word *kučəneže* 'she/he wants to catch' with a stressed third syllable (Hz) (PF — phrase-final, 4 female and 4 male speakers; SF — sentence-final, 3 female and 4 male speakers; N — number of measurements)

Female	N		V1beg	V1end	V2beg	V2end	V3beg	V3end	V4beg	V4end
PF	4	x̄	229	206	244	227	248	311	240	219
		s.d.	18	24	26	28	34	33	40	51
SF	3	x̄	236	221	245	232	186	173	191	179
		s.d.	27	15	18	23	18	4	6	9
Male	N		V1beg	V1end	V2beg	V2end	V3beg	V3end	V4beg	V4end
PF	4	x̄	165	145	167	154	176	217	145	120
		s.d.	28	16	14	15	17	44	10	10
SF	4	x̄	174	152	173	152	135	120	129	121
		s.d.	33	32	47	36	14	10	14	10

In phrase-final position, the word was produced with rising F0 on the stressed third syllable and falling F0 on the other syllables. The F0 of the beginning of the second syllable was higher than the F0 at the end of the first syllable.

In sentence-final position, the female speakers had falling F0 on the whole word, some of the syllables being level. The male speakers usu-