# Moksha prosody

Suomalais-Ugrilaisen Seuran Toimituksia
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# Preface

This book provides an analysis of acoustic data pertaining to the prosody of the Moksha language. Central to the analysis are questions of word stress. The survey of previous research presented in this book shows that quantity and tone have not been attested as distinctive prosodic features in Moksha.

This study is a part of the Finno-Ugric Prosody Project, initiated by Ilse Lehiste (1928–2010), an outstanding researcher of suprasegmental features of Estonian and many other languages. Ilse Lehiste was the leading author of the volumes on Erzya prosody (Lehiste et al. 2003), Meadow Mari prosody (Lehiste et al. 2005), and Livonian prosody (Lehiste et al. 2008). She also participated in the starting phase of this study until her last days and therefore this book is dedicated to her memory.

This book consists of four main chapters. The first, introductory chapter gives background information concerning the Erzya- and Moksha-Mordvin languages and an overview of the segmental structure of Moksha. The second chapter focuses on the findings of previous research of word stress in Moksha. Of special interest for the analysis of literature are the unsolved problems concerning word stress; these constitute the basis for the formulation of the research questions treated in this book.

The description of the framework of the present experimental investigation and its results is given in the third chapter, where the principal research questions related to the acoustic correlates of Moksha stress are treated. In the last chapter general conclusions concerning the experimental findings are presented.

This book contains four appendices that provide a map of the Moksha dialects, a list of test words, and sets of additional data obtained in the acoustic analyses.

The principal author of the study is Dr. Niina Aasmäe, a researcher of the Mordvin languages, who has compiled all the main parts of this book and performed the acoustic and statistical analyses. Niina Aasmäe is a native speaker of Erzya, the closest cognate language of Moksha. Tatjana Zirnask, MA, who is a native speaker of Moksha, has recorded the corpus of read speech and participated in the measurement procedures. Professor Emeritus Tiit-Rein Viitso, leading expert of Finno-Ugric languages in the project, has compiled the lexical corpus and consulted on various research questions. Professor Karl Pajusalu has supervised the study and contributed to the completion of this volume. Nele Salveste, MA, and Dr. Pärtel Lippus have participated in the acoustic and statistical analyses. All the authors of this volume are working or studying at the University of Tartu.

In addition to the authors, several research fellows and students have given their contribution to the preparation of this book. The authors are grateful to Tuuli Tuisk, MA, Mihkel Pajusalu, and Sander Pajusalu, who took part in the acoustic measurements of the recordings. Words of gratitude also go to Dr. Peeter Päll who has designed the map of the Moksha dialects spoken on the territory of the Republic of Mordovia for the book. A special acknowledgement is for the informants who kindly agreed to participate in the experiment.

The authors are deeply indebted to the reviewers, Professor Kari Suomi and Professor Sirkka Saarinen whose merited suggestions helped to improve the quality of this volume.

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# Contents

# List of tables



# List of figures

# Chapter 1

# Introduction

## 1.1. Research questions and the structure of the study

The Mordvin (Erzya and Moksha) languages have been assigned an intermediate position between the north-western (Finnic, Saamic) and the other Uralic language groups (Mari, Permic, Ugric, Samoyedic) regarding the historical development and typology of these languages. The conclusions have been largely drawn on lexical evidence and etymological analyses of vocabulary based on historical phonology (Grünthal 2007). Concerning the prosodic features of many Uralic languages, including Erzya and Moksha, scarce information has been available up to now. In this respect, Hungarian, Finnish, and Estonian have been extensively studied for some time and there is general agreement about the role of stress and quantity in these languages. They share several essential features: phonological quantity contrasts, regular word-initial stress, constraints on the vowel systems depending on the prosody of a word (Lehiste, Pajusalu 2010: 225–228).

Research in the prosody of Erzya and Moksha might reveal some parallels between the Mordvin and the related languages important for establishing the tendencies of development among the language groups of the Uralic family. It has been known that Moksha and Erzya are characterised by mostly word-initial stress found in the majority of the Uralic languages and by front-back vowel harmony that functions in some of them. However, there are many features that demand detailed investigation.

It can also be argued that stress in Moksha and Erzya might display much similarity, notwithstanding the commonly accepted point of view, according to which contemporary Moksha has preserved original stress while Erzya has acquired new features (cf. Ravila 1973: 169–176). Dialect studies and some of the results of recent research (Aasmäe, Pajusalu, Zirnask 2011; Aasmäe 2012) show that in both languages stress exhibits a tendency towards alternation as far as its position within a word is concerned.

Research in word prosody has long been peripheral to the phonological studies of the two languages; methods of acoustic phonetics have been fragmentarily used until late. At the turn of the century more attention has been drawn to the prosody of the Mordvin languages, mainly the prosodic features of Erzya (Estill 2001; 2004; Lehiste et al. 2003; Aasmäe 2005; 2006).

Comparison of prosodic regularities in Erzya and Moksha is an important goal of future research. The present study addresses the issue of prosody in the Moksha language focusing primarily on the description of the acoustic features of word stress. The research plan of the study includes as the first step a survey of the main phonological features of the Moksha dialects (Chapter 1). In the overview of the segmental structure several questions relevant to the treatment of prosodic features are indicated. One of these – unstressed vowel reduction – needs to be treated in the interface of segmental and prosodic features.

The general phonological survey of the sound system is followed by an inspection of previous research done on Moksha prosody (Chapter 2). In this part, points of view expressed over time concerning word stress in Moksha are analysed.

The major part of the study (Chapter 3) involves an acoustic analysis of experimental data, which are used to solve a set of research questions. Observations are made of the productions of eight informants who speak sub-dialects of the central Moksha area, sub-dialects that are considered to be the basis of the literary language.

The principal question concerns the role of vowel duration and vowel quality in the manifestations of word stress. In the analysis of vowel duration data, possible effects of several factors (stress, intrinsic features of the segments, word structure, the prosody of an utterance) are considered. Preliminary observations are made of the possible effect of syllable structure on the duration of the syllable nuclei.

Qualitative vowel reduction observed in Moksha is put in the context of the domain of word stress and attention is drawn to the effect of the location of stress on the quality and distribution of vowels in a word. The results of the analysis are used to outline the sub-systems of vowels dependent on stress.

In the last part of Chapter 3, fundamental frequency contours of the test words are described with the view of analysing the interaction between sentence prosody and the placement of word stress(es).

In contrast to Erzya, where the question of the assignment of word stress has been considered complex, in Moksha there has been no controversy concerning this question. However, there is evidence in the literature of variation in the assignment of stress in Moksha as well. Namely, non-initial stress, allegedly dependent on the distribution of high and low vowels in a word, has been considered an alternative to the word-initial stress. Intra-speaker differences in the assignment of initial versus non-initial stress observed in various dialects imply that the assignment of stress in Moksha might not be as straightforward as it seems. The analysis of the material, therefore, includes the task of establishing possible variation in the location of word stress in the test words. The question of secondary stress, which has not received much attention in the literature, is taken into account in the study of the variation in the assignment of stress.

The experimental findings are summarised in the sub-sections of Chapter 3. The final section (Chapter 4) presents general conclusions concerning the observations of empirical data; it also outlines a range of questions that require detailed research in the future.

## 1.2. Background information on the Mordvin languages

Moksha and Erzya are in many ways typical Uralic languages. Suffixation, the use of postpositions, an elaborate system of case-marking and conjugation forms are the salient characteristics of their structure. Certain categories possessed by Erzya and Moksha, such as the definite conjugation of verbs alongside the indefinite one (see Keresztes 1999 for details) and the conjugation of non-verbal predicates (for recent treatments of the subject, see Rueter 2010; Turunen 2011; Hamari, Aasmäe [forthcoming]) are not very common in other Uralic languages. Customarily, Moksha and Erzya are referred to as the Mordvin languages, a term that has not been used by the Mokshas and Erzyas to identify themselves. The earliest evidence of the Mordvin languages extends from the scripts of single words found in the records of the 17th century travellers to glossaries and translations of ecclesiastic texts and folklore that appeared in the 18th century. The first grammars and other language sources of the 19th century, known to have been published (or stored in archives as manuscripts), were followed by the publication of fiction and linguistic literature written by native and non-native authors at the turn of the 20th century.

A considerable part of documentation pertaining to the chronology of preliterary Erzya and Moksha, as well as the major events in the development of the literary languages, have been surveyed in the works by A. P. Feoktistov (1971, 1976). Reviews of literature or commentaries on some of the historical documents or facts have been provided by many authors (some of the publications that have appeared in the last decades include: Bondarko, Polyakov 1993: 191–201; Zaicz 1998: 184–218; Bartens 1999: 9–26; Keresztes 1999: 22–26; Ivanova 2006: 9–27; Imaikina 2008: 219–229; Fournet 2010: 57–79; Rueter 2010: 3–14).

Literary Erzya and Moksha, whose standards had been developed by the 1930s, are based on dialects spoken on the territory of the present-day Republic of Mordovia, a constituent entity of the Russian Federation located in the European part of Russia (within the Volga Federal District). The Erzya and Moksha population is known to be dispersed, with an overwhelming majority living outside the national republic. The total population of the Erzyas and Mokshas in Russia is 744,237; only 333,112 of this population live in the national republic (the Russian Census of 2010). No reliable data exist as to the size of each ethnic group and the numbers of Erzyas and Mokshas living outside Russia. Taken together, the two ethnic groups rank among the most numerous Uralic peoples.

The standards of literary Moksha accord with the features of the Central dialects that are spoken in localities within several regions (districts) of the national republic. The administrative centres of these regions are the towns (and urban or rural settlements) of Atyuŕyevo, Yeľniki, Kovylkino, Krasnoslobodsk, Ruzayevka, Staroye Shaygovo, Temnikov and Torbeyevo (Feoktistov, Saarinen 2005: 47). A variety of Erzya spoken in the rural settlement of Kozlovka (present-day Atyashevo region) was used as the prototype of literary Erzya (Cygankin 1979: 15, Imaikina 2008: 229).

For both literary languages, the Russian alphabet in the Cyrillic script was adopted. Written Erzya and Moksha languages are similar in orthography and are mutually intelligible to a fairly high degree. Oral communication between speakers of Erzya and Moksha is, however, hindered owing to differences in the phonetics and phonology of the languages; there are also diverging lexical and morphological features. Differences that Moksha and Erzya display in the manifestations of prosody and the quality of segments are most salient in speech. Moksha is characterised, for example, by an inter-dependence between stress and vowel quality, which conditions an extensive reduction of vowels in unstressed syllables. In Erzya, in contrast, the quality of vowels does not crucially vary as a function of stress. Compare: Moksha *valdəftəmə* 'without light', *vəŕgas* 'a wolf' (with stress located on the initial syllable of the first word and on the non-initial syllable of the second word) and Erzya *valdovtomo*, *veŕgiz* (the location of stress alternates in a phrase; see Aasmäe 2006 for details).

Over the 20th century, the two literary languages predominantly functioned in the sphere of literature and media, having a semi-official status. The use of the native languages for public instruction was confined to schools in rural areas, where its range narrowed step by step with the decrease of the Erzya and Moksha population. On the other hand, university education provided at the departments of Mordvin linguistics and culture at the universities of the national republic, alongside research, has been continuous.

Taking into account the shortage of education and of other public uses of Erzya and Moksha for several decades, it can be presumed that the dialects spoken in scattered rural localities over a vast territory in Russia and also outside its borders, have been insignificantly influenced by the standardised languages. The Erzya and Moksha population, especially in urban areas, has become increasingly exposed to Russian; within this context, both the literary languages and the dialects have been affected to a considerable extent. In the course of being updated the literary languages have experienced radical changes. An abundance of Russian terminology has been introduced in dictionaries; grammars have been prescribing the use of concurrent forms of the native and Russian languages as a norm.

Since the 1990s, in response to the emergence of native language awareness, attempts have been made to foster the status of Erzya and Moksha. According to the Constitution of the Republic of Mordovia as of 1995 they have become co-official languages alongside with Russian; attention has been drawn to the problem of native language revitalisation and maintenance. There have been disputes over two approaches to the solution of the problem. Arguments in favour of the idea of developing a single literary Mordvin language have been opposed by the rationale that the current situation obliges the two communities to focus on the preservation and development of both Erzya and Moksha. Being highly dispersed, and with the majority living outside the Republic of Mordovia, the Erzyas and Mokshas might not be motivated to acquire a new standardised language. Yet, there is hope that the relatively large Erzya and Moksha communities will keep speaking their dialects and promoting the existing literary languages.

## 1.3. Dialects of Moksha

The varieties of both Mordvin languages have been grouped according to the core dialects spoken on the territory of the Republic of Mordovia, where the communities of the Erzyans and Mokshans are settled in the Eastern and Western areas, respectively. The taxonomy of Moksha dialects last systematised (Feoktistov 1990: LXXI–LXXXVI; Feoktistov, Saarinen 2005: 46–57; Ivanova 2006: 23–28; 2011) distinguishes four areal groups of core dialects – Central, Western, South-Eastern, and a group of transitional dialects located in an area between the territories of the Western and South-Eastern groups.

The varieties of Moksha spoken outside the national republic, largely in the Nizhniy Novgorod, Penza, and Saratov oblasts, are referred to as mixed dialects. Being similar to the sub-dialects of the core groups they also display sets of peculiar features, some of which are common to Erzya. A map showing the groups of Moksha dialects spoken in the Republic of Mordovia and a list of localities with Mokshan population is given in Appendix 1. An extended list of localities with Mordvin population in Mordovia and outside the republic has been given in Feoktistov, Saarinen (2005: 388–435). The place names available in Erzya and Moksha have been provided in Feoktistov (1990: LXXXVII–XCIX), Inzhevatov (1987) and other publications.

The dialects of Central Moksha are located in the Atyuŕyevo, Yeĺniki, Kovylkino, Krasnoslobodsk, Ruzayevka, Staroye Shaygovo, Temnikov and Torbeyevo regions. They have been divided into five sub-groups. The Western dialects are represented by two sub-groups, one of which is located to the South, the other to the North of the area comprising the Zubova-Polyana and Torbeyevo regions. The South-Eastern dialects are varieties spoken in the Insar, Kovylkino and Ruzayevka regions. In the area between the Western and South-Eastern groups (several localities of the Kovylkino and Torbeyevo regions, to the North of the Penza oblast) transitional dialects are identified. They combine features of the sub-dialects in contact.

The areal groups of Moksha dialects have also been distinguished on the basis of sets of phonological (and some morphological) features. The varieties spoken in diaspora have been described less than the core dialects (a survey of studies on the dialects of Moksha has been offered in Ivanova 2006: 9–36).

## 1.4. Segmental structure of Moksha

This section provides an account of the vowels and consonants that constitute the inventory of segments in Moksha; attention is paid to the distribution of the segments within a word and the main factors underlying the patterns of distribution. Syllable structure, which is a notion central to the analysis of prosody, has not been investigated in the research of Moksha. For the purposes of this study, syllabification will be approached in a traditional way (see Lehiste et al. 2003: 53). Namely, syllables ending in a vowel will be defined as open and those ending in one or more consonants as closed. In cases of intersyllabic consonant clusters appearing in words with more than one syllable, we will follow the general principle of syllabification, according to which the first member of the cluster closes the preceding syllable, and the second member of the cluster starts the subsequent syllable. However, the possibility that both members of the cluster in some cases might be phonetically referred to the subsequent syllable, as has been suggested, e.g. in Erzya (Aasmäe, Ross 2008), is not excluded.

### 1.4.1. Vowels

With regard to the system of vowels as an essential typological criterion for grouping the dialects of Moksha, three main types among the established groups of core dialects have been identified by G. S. Ivanova (2006: 9–36; 2011).

Type 1 in this grouping includes five sub-types of dialects referred to the Central group and the North-Western dialects of the Western group, in which there is an inventory of seven vowels: /i/, /e/, /ä/, /u/, /o/, /a/, /ə/. The dialects are located in the Northern and Central part of Mordovia (the Krasnoslobodsk, Kovylkino, Ruzayevka, Temnikov, Atyuŕyevo, Staroye Shaygovo, Torbeyevo, Zubova Polyana regions). Type 2 includes the dialects of the South-Eastern group and the South-Western dialects of the Western group, which are located in the Insar, Kadoshkino, Kovylkino, Yelńiki, Zubova Polyana, Atyuŕyevo regions. They also constitute five sub-types of dialects. Type 3 includes the borderline or transitional dialects that are dispersed (mainly located in the Ruzayevka, Insar, Torbeyevo, and Staroye Shaygovo regions). Types 2 and 3 have vowel inventories consisting of six segments; the vowel *ä* is lacking in these dialects. The two types differ with respect to the distribution of the vowels *e* and *i*.

Research in the historical aspects of the sound system of Moksha has shown that there may have been a gradual change of Proto-Mordvin **ä* and **e* into *e* and *i*, respectively, in Moksha (Paasonen, 1903: 72; Devayev 1966: 7–11). In some dialects **ä* has been lost and **e* has developed into *i*. Consequently, the vowels involved in this change are represented differently in the dialects of contemporary Moksha, as illustrated in Table 1 (see Ivanova 2006: 31–33 for more examples).

| | | | |
|---|---|---|---|
| Type 1 | *käl′* ‘tongue, language’ | *t́ev* ‘work, matter’ | *śeď i* ‘heart’ |
| Type 2 | *kel′* | *t́iv* | *śiď i* |
| Type 3 | *kel′* | *t́ev* | *śeď i* |

Table 1. Representation of /ä/, /e/ and /i/ in the varieties of Moksha.

In accordance with the patterns of vowel distributions, eleven sub-types have been differentiated across the three types of dialects (Ivanova 2006: 28–49). Only monophthongs have been distinguished in contemporary Moksha as well as Erzya (Paasonen 1903: 72–98; Devayev, Cygankin 1970: 3–5; Bondarko, Polyakov 1993: 83–94; Zaicz 1998: 187; Ivanova 2006).

Measurement data on the acoustic features of Moksha are scarce (see section 2.4. for an overview of previous experimental work); thus a precise description of the sounds is lacking. Some authors (cf. Bondarko, Polyakov 1993: 85) make a general distinction between front and non-front vowels (*i*, *e*, *ä* and *u*, *o*, *ə*, *a*, respectively). R. Bartens (1999: 28–29, 53) has identified three subsets of vowels: *u*, *o*, *a*; two allophones of the reduced vowel *ə* (that occur after a palatalised consonant versus a non-palatalised consonant); *i*, *e*, *ä*. An analogous system is shown in Koizumi (1983: 4) as an illustration of the inventory of Moksha vowels.

The position of the low vowel *a* along the horizontal axis of the articulatory space has not been clear. In some sources it is defined as a central vowel, in others as a back one. According to O. I. Chudayeva (1963: 29), *a* is a central vowel in the sub-dialect of Staroye Pshenevo (the South-Eastern dialect group); however, she considers it a back vowel as far as the literary language is concerned. S. Z. Devayev (1963: 267) has identified *a* as a back vowel in the Southern dialects of the Western group that are located along the middle course of the Vad river, noting that *a* is a phoneme with a variable place of articulation. G. S. Ivanova (2006: 28) has placed *a*, alongside with *ə*, within the category of central vowels, irrespective of dialect varieties. It has not been ascertained whether the differing descriptions of *a* are due to dialect features. It should also be noted that there is no clear definition of *ä* observed in the dialects of Type 1. Generally it has been shown to be a front counterpart of low *a* within the system of Moksha vowels (cf. Bartens 1999: 28, 53). V. Hallap (1968: 162–163) has drawn attention to the variation of the phonetic realisations of *ä* in a sub-dialect of Eastern Moksha – a certain degree of overlapping between *ä* and *a*, on the one hand, and between *ä* and *e*, on the other hand.

Vowel qualities within a word in Mordvin have been considered to be primarily subject to the influence of vowel harmony, referred to as Proto-Uralic heritage (Collinder 1965: 204–205). Either front or back vowels occur in initial and non-initial syllables, e.g. *N åL* ‘angry’, *todu* ‘a pillow’ (compare Erzya *NHåHM*, *todov*), if not interrupted by palatalised consonants, e.g. Moksha *uśkəńä* ‘wire, diminutive’. In the morphemes following the root, vowel harmony conditions the use of variants with a front and a back vowel. The low vowel *a* has no restrictions. With time, vowel harmony in Moksha has become obscured by the extensively developing feature of palatalisation in the consonant system and the influence of some other factors (see, for example Rot 1964; Itkonen 1971: 59–60; Ivanova 2006: 157–162 for details). Nevertheless, the manifestations of vowel harmony are observable in both the word stem and suffixes (Ivanova 2006: 158). The generally accepted opinion is that in Moksha, especially in the Central dialects, vowel harmony is not as well preserved as in Erzya (Bondarko, Polyakov 1993: 18–19; Ivanova 2006: 161).

Traditionally, the patterns of vowel distribution for the dialects of Moksha have been presented in terms of vowel occurrences in the initial versus non-initial syllables (cf. Devayev, Cygankin 1970: 27; Bondarko, Polyakov 1995: 89–90; Ivanova 2006: 35). Table 2 below, which reproduces (with some modifications) the sub-systems of vowels identified for the three types of dialects in Ivanova (2006: 35), also shows the distribution of vowels in the initial and subsequent syllables. In the table, symbols for vowels that have restricted occurrence are given in brackets. The vowel *o*, which in non-initial syllables only sporadically occurs in some of the sub-dialects of Central Moksha (Ivanova 2006: 26–35) is discarded. Comments following the table mainly concern the vowels of the Central dialects (Type 1).

| Type 1 | | | Types 2, 3 | | |
|---|---|---|---|---|---|
| Initial syllable | Subsequent syllables | Final open syllable | Initial syllable | Subsequent syllables | Final open syllable |
| *i* | *(ä) ə* | *(ä) (i)* | *i* | *(e) ə* | *(e) (i)* |
| *e* | *(ä) ə* | *(ä) (i)* | *e* | *(e) ə* | *(e) (i)* |
| *ä* | *(ä) ə* | *(ä) (i)* | | | |
| *u* | *a ə* | *a (u) (i)* | *u* | *a ə* | *a (u) (i)* |
| *o* | *a ə* | *a (u) (i)* | *o* | *a ə* | *a (u) (i)* |
| *a* | *a ə* | *a (u) (i)* | *a* | *a ə* | *a (u) (i)* |
| *(ə)* | *a ə* | *a (ä) (i)* | *(ə)* | *a ə* | *a (e) (i)* |

Table 2. Vowel distributions in the dialects of Moksha.

As seen from the table, the whole inventory of vowels occurs in the word-initial syllable; in non-initial syllables the occurrence of some of the vowels (*i*, *e*, *ä*, *u*, *o*) is restricted. The high vowels *i* and *u* can appear in non-initial syllables only in suffixes or endings, e.g. *kudu* '(towards) home', *äji* 'icy' (Erzya *kudov*, *ejev*); *maŕasi* 's/he hears'. In a subset of words, e.g. *kelu* 'a birch', *kulu* 'ash', *maći* 'goose', *iľi* 'rod' (Erzya *kiľej*, *kulov*, *maćej*, *iľej*), *u* and *i* seem to be associated with the stem vowel; etymologically, however, these vowels belonged to suffixes (Ivanova 2006: 137–143). The mid vowels *o* and *e* do not generally occur in unstressed non-initial syllables. As mentioned above, *o* has been observed to appear in non-initial syllables only sporadically, e.g. *oćo* 'big', *dodo* 'a pillow' for *oću*, *todu*, in some localities of Central Moksha.

The vowel *ä*, which is observed in the dialects of Central Moksha, requires special attention. In the major part of the vocabulary, the occurrence of *ä* in non-initial syllables is of a comparatively late origin. It may have developed, for instance, due to the influence of palatalised consonants on the realisation of *a* (Devayev, Cygankin 1970: 25; Ivanova 2006: 123–127; 145–147), e.g. *aťä* 'old man', *koźäś* 'the rich (person)'.

The reduced vowel *ə*, which occurs in initial and subsequent syllables, is highly frequent in Moksha; in non-initial syllables, it is the most frequent vowel (Ivanova 2006: 34, 107). Although vowel reduction is an attested phenomenon in the language, a systemic description of its phonetic and phonological aspects has been lacking. The interaction between vowel distributions and stress has received less attention than the effects of vowel harmony. This is, partly, because the quality of vowels has been considered a factor that defines the location of word stress (cf. Devayev, Cygankin 1970: 27; Ivanova 2002: 12). It has been asserted (see Chapter 2 for a survey of literature on stress), following the ideas of H. Paasonen (1903), that stress in Moksha, relatively fixed on the initial syllable, tends to be located on a subsequent syllable if it contains low *a* (or *ä*) while the initial syllable contains a high vowel (*i* or *u*).

Non-initial syllables, in case they are unstressed, principally, display the occurrences of two vowels, *a* and *ə*, as in e.g. *jakśťəŕ* 'red', *jalgat* 'friends'; the occurrence of the other vowels is restricted. It should be mentioned that the vowel *a* in unstressed non-initial syllables, e.g. *śorma* 'letter', *śormat* 'letters' is more or less reduced (Devayev, Cygankin 1970: 26).

Vowel distributions that are valid for the pattern of non-initial stress are confined to the occurrences of *a* (or *ä*) in a non-initial syllable and of *i* or *u* in the unstressed initial syllable. The high vowels in the initial syllable may be substituted by the schwa, e.g. *sťiŕńä*, *sťəŕńä* 'a girl (diminutive)', also *sťiŕ*, *sťəŕ* 'a girl'. The substitution of *i* and *u* by schwa is less frequent in the sub-dialects referred to as Type 1 than in the other dialects (Ivanova 2006: 92). It is a specific feature of Moksha that the stressed initial syllable can also contain a mid vowel symbolised as schwa, e.g. *sərməms* 'to crease', *kəŕďəms* 'to keep' (see Devayev 1963: 274; Devayev, Cygankin 1970: 23–24; Bondarko, Polyakov 1993: 87–88). The occurrence of *ə* in the initial stressed syllable has been considered to be a secondary feature of a comparatively late origin extending across the dialects (Ivanova 2007: 114).

Table 2, consequently, shows a complexity of vowel distributions conditioned by both vowel harmony and stress. Firstly, the vowels of the initial and non-initial syllables are exposed to the influence of vowel harmony – either front or back vowels occur in a word. Secondly, depending on the location of stress (either on the initial or a non-initial syllable), the schwa vowel tends to occur in unstressed position(s).

As a special condition for the distribution of vowels, the word-final open syllable is shown in Table 2. In this position (where vowels are likely to be followed by a pause), the realisations of schwa vary. Its quality is similar to that of *ä* or *e* after a palatalised consonant and to that of *a* after a non-palatalised consonant (Devajev 1963: 273–275; 281–285; Devajev 1975: 481–482; Devayev, Cygankin 1970: 26), e.g. [*piľĕ*], [*piľä̆*] 'ear' (but *piľət* 'ears') and [*tumă*] 'oak' (but *tumət* 'oaks'). Table 2 implies the occurrence of the phonetic realisations of *ə – a*, *ä* (for Type 1) and *a*, *e* (for Types 2, 3), rather than displays the occurrence of *ə*. Variation between the schwa and its allophones (*ĕ, ä̆, ă*) in the word-final open syllable is admitted in Ivanova (2006: 105–117), as well.

Although the schwa, or the reduced vowel, occupies a salient position in the subsystems of initial and non-initial syllable vowels in Moksha, the question whether it is a separate phoneme has not been solved. It has been treated as a phoneme by some authors (Bubrikh 1941: 58–59; 1953: 30, 171; Chudayeva 1958: 226; Devayev 1963: 273; 1966: 9; Hallap 1968: 162–163; Feoktistov 1990: LXXII; Bondarko, Polyakov 1993: 16–17; Zaicz 1998: 187; Bartens 1999: 29–30; Ivanova 2006: 81–93; 2011: 158–159). In some works (cf. Bartens 1999: 28–29), the system of vowels has been shown to include two allophones of the reduced vowel *ə*, which occur after a palatalised versus a non-palatalised consonant.

K. Rédei (1968: 383–386), in turn, considers *ə* to be the representation of full vowels (*i*, *u*, *e*, *o*) in unstressed syllables. Accordingly, the inventory of vowels in the dialects of Moksha could be claimed to consist of either five (*u*, *o*, *a*, *i*, *e*) or six phonemes (*u*, *o*, *a*, *i*, *e*, *ä*), with the schwa symbolising unstressed vowel reduction.

In the orthography there is no specific symbol denoting the schwa vowel; letters used to symbolise the full vowels also denote the schwa. Thus the letters *а*, *о*, *у*, *ы*, *э* stand for vowels following a non-palatalised consonant and the letters *е*, *ё*, *и*, *ю*, *я* stand for vowels following a palatalised consonant. There are some peculiarities as far as the use of the letters is concerned. A reduced vowel occurring after a non-palatalised consonant is marked with the letter *a* in word-final position, e.g. *макса* (*maksə*) 'a liver', but with the letter *o* before a word-final consonant, e.g. *максонь* (*maksəń*) 'a liver, genitive'; compare Erzya *максо* (*makso*), *максонь* (*maksoń*). Both the full vowel *a*, as in *staka* 'hard, difficult', and the variant of schwa [*ă*], as in [*maksă*] 'a liver' are symbolised with the letter *a*. The letter *я* is used for the phoneme *ä* that mainly occurs in a stressed word-initial syllable (also for *a* that follows a palatalised consonant in a subsequent syllable), while *я* and *е* (the use of which is not systematic) symbolise the variants of word-final schwa, e.g. *вяре* (*väŕä*) 'above', *гуля* (*gul′ä*) 'pigeon' (Herrala, Feoktistov 1998: 40, 43). In the word-initial unstressed syllable of words like *vəŕgas* 'a wolf', schwa is either unmarked, e.g. *врьгаз*, or symbolised as ъ: *въръгаз* (see Bondarko, Polyakov 1993: 173–190 for more details).

Word stress, which has been considered to be potentially located on the initial syllable, has not been indicated in dictionaries. Non-initial stress, allegedly conditioned by the occurrence of the low vowel *a* or *ä* in a subsequent syllable, does not appear to be regular (see Chapter 2).

### 1.4.2. Consonants

Unlike the vowel inventory, the inventory of consonants is rich, owing to the distinctive features of palatalisation and the presence versus absence of voice possessed by a number of segments. In Central Moksha as well as in the literary language, 33 consonant segments have been identified (see Table 3). Palatalisation as an inherent feature serves to distinguish the members of oppositions such as /t/–/t′/, /d/–/d′/; /s/–/ś/, /z/–/ź/, etc. Both palatalised and non-palatalised consonants can constitute pairs of voiced and voiceless members of opposition, for example /t/–/d/, /t′/–/d′/; /s/–/z/, /ś/–/ź/. In addition, palatalisation triggered by a front vowel environment or a neighbouring palatalised consonant extends to the segments that lack palatalised counterparts: /b/, /p/, /k/, /g/, /f/, /v/, /m/, /h/. It has been noticed that palatalisation in Moksha is manifested far more extensively than in Erzya (Zaicz 1998: 187).

| Consonants | Bilabial | Labio-dental | Dental-alveolar | Post-alveolar | Palatal | Velar |
|---|---|---|---|---|---|---|
| Stops | *p b* | | *t d*<br>*t′ d′* | | | *k g* |
| Affricates | | | *c*<br>*ć* | *č* | | |
| Fricatives | | *f v* | *s z*<br>*ś ź* | *ãå* | | *h* |
| Trills | | | *R̦ r*<br>*Ŕ ŕ* | | | |
| Liquids | | | *L l*<br>*L′ l′* | | | |
| Nasals | *m* | | *n*<br>*ń* | | | |
| Approximants | | | | | *J j* | |

Table 3. The inventory of consonants in literary Moksha.

There are also devoiced (or aspirated) consonants /R/, /Ŕ/, /L/, /L′/, /J/, e.g. *peJt′* 'teeth', *peJ(t′)ńə* 'the teeth' (Devayev, Cygankin 1970: 30–31), which are counterparts of /r/, /ŕ/, /l/, /l′/, /j/, respectively. The devoiced consonants are considered to be of late origin (Kabayeva 2011: 180); they generally occur before *t*, *t′* (also *k*) and constitute pairs of palatalised and non-palatalised consonants: /R/–/Ŕ/, /L/–/L′/. The fricative /v/ is also devoiced when it occurs before the consonants *t*, *t′*: e.g. *śävan* 'I take' – *śäft′ama* 'we take' (Devayev, Cygankin 1970: 30–31). On the other hand, the inventory of consonants includes /f/ and /h/, which are found in onomatopoeia, e.g. *ufams* 'to blow', *rahams* 'to laugh' and, primarily, in loans. In a number of native words an affricate /šč/ (which tends to be pronounced as *šš*) is found: e.g. *ščəńäj*, *ššəńäj* 'mother's brother', *aščəms*, *aššəms* 'to be, to stay'. It is mainly used in Russian loans (Ivanova 2002: 14; Kabayeva 2007: 124), e.g. *raščot* 'payment'.

The distribution of consonants in Moksha has been well described from the diachronic and synchronic points of view (see, for example, some of the works of contemporary authors: Devayev, Cygankin 1970: 29–45; Feoktistov 1990: XLIII, LXXII; Keresztes 1990: 25–26; Bondarko, Polyakov 1993: 95–134; Bartens 1999: 28–29; 31–64; Kabayeva 2011: 180). Herein, only points relevant to the needs of the analysis will be mentioned.

In word-initial and -final positions voiceless obstruents (*p*, *t*, *t′*, *k*, *s*, *ś*, *c*, *ć*, *š*) and sonorants (*m*, *n*, *ń*, *l*, *l′*, *r*, *ŕ*, *j*) are preferred. Combinations of consonants, which are generally avoided in the word-initial position in Finno-Ugric languages, are rare in Moksha, too. They occur in loans and onomatopoeia; in other categories of words initial combinations are possible due to vowel deletion in the first syllable, e.g. *šra*, *šira* 'table'. Words that contain a sonorant (*r*, *ŕ*, *R*, *Ŕ*) in the initial combination of consonants tend to be produced with a schwa between the consonants: e.g. *vŕgas*, *vəŕgas* 'wolf' (Erzya *veŕgiz*). At the end of monosyllabic words, combinations of consonants are also the result of vowel deletion, which is conditioned by a merge of the stem and an affix, e.g. *pil′ks* < *pil′əks* ‘ear-ring’ (Ivanova 2002: 33–35).

Consonant combinations occurring at morphological boundaries are occasionally fairly complex. Assimilation, most commonly concerning voicing, devoicing, palatalisation, affricatisation of consonants, or some other change, leads to the formation of a geminate-like combination of consonants. For example, in the verb *ańńəms* ‘to feed, frequentative’, the first intervocalic consonant belongs to the stem of the verb (compare: *andəms* ‘to feed’), the second to the suffix. Genuine geminates do not exist in Moksha and Erzya (Devayev 1963: 303; Raun 1988: 100; Kabayeva 2006: 65–69; 2007: 121). The occurrence of intervocalic combinations of consonants with two or more segments is crucial for the definition of a syllable boundary, as mentioned above.

### 1.4.3. Summary

The survey of the segmental structure of Moksha shows that the dialects have vowel inventories with either seven or six vowels whose distributions differ. Typologically, three major types of dialects have been differentiated with respect to the size of the vowel inventory and the vowel distributions in initial and non-initial syllables. The inventory of consonants in Moksha is rich, due to the distinction between palatalised/non-palatalised, voiced/voiceless, and aspirated (devoiced)/non-aspirated segments. Due to the lack of acoustic studies, the description of the characteristics of the segments has not been precise.

The sub-systems of vowels have been traditionally analysed in terms of vowel distributions in the initial versus non-initial syllables, although vowel harmony has been considered to be only partly preserved in the dialects. The occurrence of non-initial stress has been explained by the dependence of the position of stress on the quality of vowels, i.e. the distribution of high and low vowels in initial and non-initial syllables. Interaction between vowel quality and stress, considered to be mainly located on the initial syllable, has received less attention. It has been admitted, though, that there are restrictions in the occurrences of vowels in unstressed syllables.

As it emerges from the literature, low *a* which is resistant to the effects of both vowel harmony and stress can occur in any position, while the occurrences of high vowels (*i*, *u*) are restricted in non-initial syllables. The mid vowels (*e*, *o*) do not generally occur in unstressed (non-initial) syllables.

The schwa vowel which occurs in unstressed (both initial and non-initial) syllables is the most frequent vowel. The alternative occurrence of schwa and of *i* or *u* observed in the initial syllable is considered to be a comparatively late process. Dialects differ as to the frequency of schwa in relation to that of *i* and *u* in this position. In unstressed non-initial syllables schwa and *a* regularly occur. There is no clarity concerning the distribution of vowels in the word-final open syllable. Variation in the quality of vowels observed in this position has been interpreted differently. The vowels perceived to be realised as *e*, *ä*, and *a* have been considered by some authors to be the variants of schwa produced in an open syllable (before a pause). In some sources, however, the relatedness of these vowels and of the schwa has not been implied.

The schwa vowel also occurs in a specific context – a stressed syllable (or a monosyllabic word) where it has a quality similar to that of a full vowel. The segment appearing in this position has not been unequivocally included in the sub-system of stressed vowels.

From the phonological point of view, there is no unanimity concerning the question of the schwa vowel. Its role in the system has not been fully established. The question of the origin of the schwa vowel has been subject to polemics.

It should also be noted that possible influences of stress on the development of the system of consonant segments have not been taken into consideration. There is, for example, a set of aspirated (devoiced) consonants, which can only conventionally be regarded as phonemes. They might be positional variants of consonants, occurring in the neighbourhood of voiceless stops under the influence of stress.

The rules of phonotactics have been extensively described in the literature. It has been noted that voiceless consonants and sonorants are permitted in word-initial and word-final position, while the other consonants and combinations of consonants have limited distribution. These are restrictions that are also characteristic of the other Finno-Ugric languages. Syllable structure in Moksha awaits research.

# Chapter 2

# Survey of previous research on word stress in Moksha

## 2.1. Introduction

Questions pertaining to the domain of prosody, "contrastive suprasegmental features of language, basically quantity, tone, and stress" (Lehiste et al. 2003: 84), have long been peripheral in the research of the Mordvin languages. Nevertheless, different aspects of prosody have attracted the attention of researchers since the late 19th century. As far as contemporary Moksha and Erzya are concerned, no distinctive quantity or tone opposition has been attested in either language. The plausibility of an original quantity opposition has been suggested e.g. by E. Itkonen (1946: 291), according to whom distinctive quantity may have functioned at least in early Proto-Mordvin.

It can be mentioned here that the theory of opposition between long and short vowels in the hypothetical system of the Finno-Ugric protolanguage has not been unanimously accepted. One of the points against the theory is that the length opposition was claimed to exist for only a subset of vowels (see Raun 1974: 304–306 for more details).

Tone has generally received little attention in the studies of Uralic languages, as no minimal pairs differing only in tone have been found (Collinder 1965: 42, 206). The suggestion that lexical tone might have been used in a proto-system of Mordvin (Helimskiy 1977) has not gained ground. In synchronic descriptions of Moksha and Erzya, quantity and tone have been only fragmentarily mentioned within the context of stress correlates (Devayev 1975).

Concerning stress in Proto-Finno-Ugric there is an interesting point of view expressed by A. Raun (1971: 21–22): "According to the present stage of research, it looks like there was only sentence stress, but no distinctive word stress in Proto-Finno-Ugric… . Note that word stress in present-day Finno-Ugric languages is a configurational and not a distinctive feature. Such stress marks a certain (often the initial) syllable of the stem, but does not have lexical or grammatical function. In an utterance not the potential word stress but the actual sentence stress prevails."

In both diachronic and synchronic studies of Moksha, stress has received attention, though it has not been the subject of systematic research. The major part of the literature on the subject was published during the 20th century. The present review of literature on stress in Moksha includes traditional works of Finno-Ugric scholarship, phonological analyses in publications of an international community of authors, grammars, the results of local pre-experimental research on dialects, and previous empirical research in Moksha phonetics.

## 2.2. Early views concerning word stress in Moksha

### 2.2.1. The issue of original Mordvin stress

Heikki Paasonen's work "*Mordvinische Lautlehre*" (1903), which has been pivotal for research in the phonetics of the Mordvin languages, is based on the analysis of the author's field-work materials and data from literature available at the time. Data on Moksha were collected in 4 locations – Staroye Pshenevo, Selishche, Krasnoslobodsk, and Gorodishche. According to the dialect classification by Feoktistov (1990: XXXI–XCVIII), the sub-dialect spoken in Staroye Pshenevo refers to the South-Eastern group, the varieties of Selishche and Krasnoslobodsk refer to the Western group, while Moksha spoken in Gorodishche refers to the mixed dialects of diaspora. For comparison, H. Paasonen used examples from other sources (see Paasonen 1903: XV–XVI for details), among which were examples observed in Krasnoslobodsk (Western dialects) and Temnikov and Spassk (Central dialects) by A. Ahlquist (*Versuch einer mokscha-mordwinischen Grammatik nebst Texten und Wörterverzeichniss*. St. Petersburg 1861).

In analysing the placement of word stress in the varieties of Moksha H. Paasonen noticed two tendencies: firstly, the tendency to place stress on the initial syllable; secondly, dependence of stress placement on the quality of vowels within a word. Namely, words with *i* or *u* in the first syllable had stress on a non-initial syllable that contained the vowel *a* (or *ä*, considered to be a variant of *a* which occurred under the influence of the neighbouring palatalised consonants). The vowels *i* and *u* were represented by *ə* in some words. According to H. Paasonen, the location of stress was not regular; in some word forms that contained suffixes or endings stress was located differently than in the stem. For example, *tunda* 'spring' was pronounced with stress on the final syllable in Staroye Pshenevo and with initial stress in Selishche, while in *tundaś* 'the spring' and *tundasa* 'in spring' stress was on the second syllable in the materials of both villages (Paasonen 1903: 114).

In the opening pages of the book the author defined the manifestations of stress in Moksha in this way: "In dem mokschanischen dagegen herrscht eine scharf ausgeprägte (exspiratorische) betonung. Der mokschanische accent ist frei, er kann jede silbe des wortes treffen." (Paasonen 1903: 8). The materials showed that in some words stress was on a non-initial syllable even if the same vowel occurred in both syllables: *kaftaśt́* 'twins' with stress on the second syllable in Selishche and on the first syllable in Staroye Pshenevo (Paasonen 1903: 116).

No similarity between stress in the Moksha and Erzya materials was mentioned by H. Paasonen, with the exception of patterns of stress in Staroye Pshenevo (South-Eastern dialects) and Kazhlytka (mixed Erzya dialects considerably influenced by Moksha and known as the Shoksha variety). In these dialects, H. Paasonen noticed the occurrence of vowel reduction in unstressed syllables; it was regarded as heritage of the vowel system of Mordvin (pp. 6, 83–98).

In a closing chapter (pp. 114–119), H. Paasonen suggested his idea of the original Mordvin stress. Analysing the location of stress and patterns of vowel distribution in the materials, H. Paasonen stated that stress in Mordvin might have been similar to that observed in Staroye Pshenevo, that is, located either on the initial syllable a non-initial syllable with the vowel *a* (or *ä*).

It has been repeatedly maintained that Moksha has preserved the original stress of Mordvin. P. Ravila (1929), who compared lists of parallel forms from Erzya, Moksha, and other related languages, primarily Finnish, showed that the vowel *a* in non-initial syllables in Moksha could have been preserved only due to the stressedness of the syllable in Mordvin; in unstressed syllables *a* became reduced (or deleted), e.g. Moksha *kud* 'house', Erzya *kudo*, Finnish *kota*, Saami *goatte* (Ravila 1929: 83–84).

As a reason for the stressedness of *a*, the distinctive function of stress has also been taken into account (Ravila 1929: 118–119). Attention has been drawn to pairs of words, in which the vowels *a* and *ə* in non-initial syllables occur: Moksha, Erzya *jalga* 'friend' versus Moksha *jalgə*, *jalgă*; Erzya *jalgo* 'by foot'; Moksha *kuləma*, Erzya *kuloma* 'to die; gerund, deverbal noun' versus Moksha *kuləmə*, *kuləmă*, Erzya *kulomo* 'to die, infinitive'. Lack of vowel reduction in non-initial syllables has been explained by the stressedness of *a* in Proto-Mordvin. On the other hand, the location of stress in the pairs of words has been assumed to be distinctive – it might have served to make distinction, for example between the forms of the infinitive and the gerund. According to P. Ravila, stress in Mordvin was dynamic; the features of original Mordvin stress, at least as a general principle, have been preserved in Moksha (Ravila 1929: 90–91, 109).

Subsequently, in the works of E. Itkonen (1946, 1971) an attempt was made to establish how the protosystem of vowels may have developed from early to late Mordvin. E. Itkonen's analyses of the development of the vowel system in Mordvin were largely based on the patterns of representation of original **a* by either *a* or *ə* in non-initial syllables established by P. Ravila. As far as stress is concerned, E. Itkonen suggested that due to the increasing role of *a* in non-initial syllables, dependence of stress on the quality of vowels in initial and non-initial syllables developed over the Proto-Mordvin period. Itkonen shared P. Ravila's point of view that Moksha has, in principle, inherited original Mordvin stress (Itkonen 1971: 72).

Attempts to reconsider the ideas of Paasonen and his followers have been few. The assumption that the rules of stress in contemporary Moksha may have been inherited from Proto-Mordvin is the point of departure for many authors (see, for example Normanskaya 2009). In typological literature on stress (e.g. Hulst et al. 1999), the rules thus outlined for Moksha are illustrated as a well-shaped system.

Criticism (see, for example Bubrikh 1937) mainly concerned the concrete material used for reconstruction in P. Ravila's work (1929), for example, forms diverging in Moksha and Erzya (also in other related languages), like Moksha *vəŕgas* 'wolf', *vetraš*, *vedraš* 'calf'; Erzya *veŕgiz*; *vedŕekš* (Estonian *vedis, veis*). D. Bubrikh did not find it possible to explain the occurrence of *a* in non-initial syllables from the point of view of morphological analogy, as suggested by P. Ravila. Numerous finite forms of verbs in *-(a)ms*, *-(o)ms*, *-(e)ms* that in Erzya fall together enable the formation of concurrent forms of the infinitive, e.g. *ľemďems* and *ľemďams* ‘call’. In Moksha, this type of morphological analogy is not observed. For this reason, D. Bubrikh (1937: 75) did not relate the forms to Proto-Mordvin. D. Bubrikh found numerous limitations concerning the examples that were provided in P. Ravila’s article to support the idea of the stressedness of *a* in Proto-Mordvin. The idea of the stressedness of *a* and the generalised patterns of relationship between stress and vowel quality in Proto-Mordvin were eventually supported by D. Bubrikh (1951: 83–86; 1953: 36–38).

A specific group of words with initial consonant clusters, e.g. Moksha *pŕä*, *piŕä* ‘head’; Erzya *pŕa*, *piŕa*, mentioned first by H. Paasonen (1903: 52–56) were also referred to by P. Ravila (1929: 110) as evidence of non-initial stress in the proto-forms of Mordvin. E. Itkonen (1946: 328; 1971: 49–50), however, claimed that this category of words presents, both in type and in chronology, different cases of vowel deletion.

An analysis of vowel deletion in the initial syllable that resulted in the formation of word-initial consonant clusters, generally atypical of Finno-Ugric languages, has been attempted by D. Naďkin (1988). He found that words with initial consonant clusters may have originally contained not only the vowels *i* and *u* in the first syllable and *a* (or *ä*) in a subsequent syllable. In a set of words initial consonant clusters are followed, for example, by *i*: *kši* ‘bread’, *kšńi* ‘iron’, *ksti* ‘strawberry’, *pśi* ‘hot’, etc. According to Naďkin (1988: 7–10), there might have been several reasons for the occurrence of word-initial combinations of consonants. Concerning the hypothetic Proto-Mordvin stress, D. Naďkin wrote that it might have had no fixed position.

In an earlier work (Nujanzina-Aasmäe 1980) it was shown that syncope resulting in the formation of an initial consonant cluster is observed either in loans or onomatopoeia, categories of words in which general rules may be violated. In single cases, syncope occurs in native vocabulary, like in the aforementioned example: Moksha *pŕä*, *piŕä*; Erzya *pŕa*, *piŕa* ‘head’. Both forms in such cases can be in use – one of them is either a dialect or a register variation (the full form of, for example Moksha *piŕä*, Erzya *piŕa* is used in poetic texts). It was suggested that syncope in the words of this group can have occurred sporadically over a long span of time due to the effect of several factors. Composite words have also been considered a source for the production of syncopated forms (Itkonen 1971: 43); Moksha *mźarə*, Erzya *sńaro* ‘how many, much’ can serve as an example.

The influence of rhythmic stress, phonotactics allowing certain types of word-internal consonant clusters to occur in the initial syllable of specific words, as well as the opportunity for word distinction, rather than regular stress on a non-initial syllable may have been some of the factors that conditioned vowel deletion. The fact that many of these words are used in both full and syncopated form (either as dialect or register variations or as pairs of distinctive opposition) implies that they might have developed in the conditions of alternating rhythmic stress.

It is apparent that in reconstructing the forms of Mordvin, H. Paasonen, P. Ravila, E. Itkonen and other authors were obligated to account for numerous divergences in the related word-forms of Erzya and Moksha, on the one hand, and their counterparts in Finnish (or other related languages), on the other hand. Heterogeneity in forms, e.g. Moksha *štšams*, Erzya *ortšams*, 'put on', Finnish *verhota* (Ravila 1929: 107), was primarily attributed to the effect of the location of stress which, supposedly, could vary in Mordvin (Ravila 1929: 112) or explained by the complexity of changes that took place in the development of the vowel system (Ravila 1929: 101–112). Whether there may have been an opposition between initial versus non-initial stress dependent on vowel quality and/or a morphological factor, as mentioned above, is opaque. Illustrating the influence of consonants upon vowels E. Itkonen (1946: 328–337) wrote that in the development of Mordvin and Lappish, sporadic changes were more numerous compared to the Finnic languages (Itkonen 1946: 337).

In view of the complexity of the materials presented in the literature in order to confirm the idea of the dependence of stress on the quality of vowels in Proto-Mordvin, and in view of the controversial interpretation of the data, it can be argued that the problem requires further analysis. There are numerous irregularities in the structure of the words used in reconstruction, irregularities that are liable to have several explanations – several other factors besides stress may have influenced the diachronic changes in the words. Questions arise concerning the chronology of the changes and, hence, concerning the plausibility of alternating stress dependent on *a* (or *ä*) for the system of Proto-Mordvin.

In a publication on the question of whether Kalevala metre is akin to the metres of Mordvin folk verse (Korhonen 1994), the author finds a contradiction between the commonly accepted point of view that Mordvin verse is syllabic and the assertion made by P. Ravila (1929) and E. Itkonen (1946) that the system prevailing at the final stage of Proto-Mordvin was prosodically closer to modern Moksha than to Erzya. M. Korhonen (1994: 79) writes: "The origin of the Mordvin syllabic metres is thus anything but problematic. Nothing can at this stage be said about it without detailed further research." T. Koizumi (1994: 6) maintains that while "Erzya retains an ancient stage of Proto-Mordvin accentuation, Moksha gave rise to the shifting stress..." owing to Turkic influence.

### 2.2.2. The question of unstressed vowel reduction

One of the debatable questions in the historical studies of the Uralic languages concerns the plausibility of the occurrence of the reduced vowel(s) in proto-systems (see Itkonen 1946 for details of the polemics). As concerns Proto-Mordvin, it has been maintained that the reduced vowel(s) may have belonged to the inventory of vowels, in accordance with the hypothesis that Moksha has preserved the original stress and main features of the vowel system (Paasonen 1903; Ravila 1929, 1973; Itkonen 1946, 1971).

Research into the morpho-phonemics of Moksha and Erzya has been influenced by this point of view. The occurrence of the reduced vowel(s) in Proto-Mordvin has been supported, for example, in the reconstruction of stems and suffixes (cf. Hallap 2000; Cygankin 1977, 1979: 27–66). The author of a comprehensive survey of the historical aspects of the vowel system in Moksha writes that vowel reduction might have expanded over the Proto-Mordvin period and was extensive throughout the history of Moksha (Ivanova 2006: 36–48, 81–93). Nevertheless, it has also been suggested that there might have been only full vowels in the proto-system of Mordvin (Nad́kin 1988: 4–9).

It is worth considering that in the dialects of Erzya that display the occurrence of vowel reduction (mainly the South-Eastern dialects located in the Republic of Mordovia), complex distributions of the reduced and full vowels are observed. These dialects are considered to have some features in common with Moksha due to contacts with Moksha dialects in the past (Cygankin 1979: 5–6, 47–66). In the core dialects of Erzya, which are the prototype of the literary language, full vowels are used in both stressed and unstressed syllables. The relationship between vowel duration and stress in the Erzya dialects that display vowel reduction is different from that in the core dialects of Erzya (Aasmäe, Ross 2007; Aasmäe 2009). The question arises whether vowel reduction in the Erzya dialects may have developed under the influence of Moksha dialects. Considered from this perspective, vowel reduction seems to be an innate feature of Moksha.

## 2.3. Findings on the features of Moksha stress in pre-experimental works

In synchronic descriptions of Moksha, questions pertaining to stress have been given little space (cf. Klimkina 1967: 214; Bondarko, Polyakov 1993: 142–143, in which only some of the most general features of stress were surveyed). Due to the extensive dialect documentation that began in the 1950s, publications on the spoken varieties of the Mordvin languages appeared, in which attention has been paid to a number of questions raised in the diachronic studies of the phonetics of Erzya and Moksha. One of the questions concerned the tendencies in the placement of stress, as defined by H. Paasonen – either word-initial stress, or stress located on a non-initial syllable with low *a* (or *ä*). Dialects have been found to differ as to the preference for either initial or non-initial stress in the words that had *a* (or *ä*) in a non-initial syllable. However, no empirical evidence, with the exception of examples illustrating differences in the placement of stress, has been available until now concerning the degree of regularity in the stress patterns. Commentaries made on the issue are of a general character. What emerges from the review of the literature is that in no dialect do the two tendencies exclude each other. Information available in the studies on dialects, though fragmentary and imprecise, is important evidence of variation in, chiefly, the placement of stress.

In the Central and South-Eastern dialects, stress on a non-initial syllable containing low *a* (or *ä*) seems to be more or less regular: *kərgat* 'neck, plural', *kudńat* 'house, diminutive, plural', *tundaś* 'spring, definite, singular' (Lipatov 1969: 178), while in the South-Western dialects located on the territory along the middle flow of the Vad River, stress shift is claimed to be blocked by the openness of a word-final syllable (Devajev 1963: 273–275; Devajev 1975: 481–482). Words like *kudńe* 'house, diminutive', *tunda* 'spring' have stress on the first syllable in the South-Western dialects. In the Central and the South-Eastern dialects, also in literary Moksha, stress in such words is on the second syllable. In some North-Western localities of the Central dialect group (the Temnikov, Yeľniki, and Staroye Shaygovo regions, which border localities inhabited by Erzyans) initial stress is dominant (Plaksina 2002: 6). Mixed dialects that display features of both Moksha and Erzya (as the outcome of close contacts in their history) have been found to differ considerably from the core dialects (see Ananyina 1974; Lomakina 1966; Babushkina 1966).

A word-initial syllable with a high vowel can be stressed even if a subsequent syllable contains an open vowel, e.g. *milav* 'butterfly'; in words with the same syllable structure stress, however, can be on the second syllable, e.g. *šičav* 'bug' (Babushkina 1966: 44). In some of the North-Western sub-dialects of the Central group (the Atyuŕyevo region), initial syllables with *ə* can receive stress, e.g. *məŕďə* 'husband', while in other dialects the second syllable is stressed, as in *miŕďä* (Blashkina 2005, see in Ivanova 2006: 21). Examples illustrating the dependence of the position of stress on vowel quality that can be found in the literature on Moksha dialects are, however, fragmentary and they do not unequivocally manifest such dependence.

The rationale for stress alternations – phonetic, morphological, or other – has not been defined, though it has been considered in several works. The shift of stress to a non-initial syllable with *a* (*ä*) has been considered to be a purely phonetic effect, i.e. vowels with longer intrinsic duration have the potential of attracting the word stress to a syllable (cf. Devayev, Cygankin (1970: 18–19). In other works, alternation in the location of stress has been considered to be a tendency associated with morphological distinction, as illustrated by the forms of the infinitive (with stress on the initial syllable) and the deverbal noun (with stress on a subsequent syllable), e.g. *tumə*, *tumă* 'to go' versus *tuma* 'going' (Erzya *tujeme* vs. *tujema*, respectively). Divergence in these forms has supposedly developed in the course of the transformation of deverbal nouns into the category of the infinitive; in the infinitive, the ending *-ma* became unstressed, due to which the vowel was reduced: *-mə*, *-mă* (Chudayeva 1958: 221–225; Klimkina 1967: 211).

Differentiation of these forms in the dialects is not regular; there are dialects in which stress is not used as a means for the alleged morphological distinction (Azrapkin 1966: 264–265; Lomakina 1966: 304–308). Another case of non-initial stress that has been claimed to be involved in morphological distinction is the form of the diminutive in *-ńä*, *-kä*, for example *kudńä* 'house' (Ivanova 2002: 13). Stress in forms of the diminutive is also considered to be variable (Klimkina 1967: 213); for example, in *veľeńä* 'village', *trakskä* 'cow', stress is on the first syllable while in *kudńä* 'house' and *pikskä* 'rope' it is the second syllable that receives stress. Thus, the idea of morphological distinction by means of stress needs corroboration.

No definitive interpretation has yet been provided concerning the relationship between stress and vowel quality, namely, the stressedness of either an initial syllable or of a non-initial syllable, on the one hand, and the phenomenon of unstressed vowel reduction, on the other hand. According to the literature, as it has been noticed above, there are both inter- and intra-dialect variations in the location of stress. Likewise, there is variation in the occurrence of reduced *ə*. In the Central and South-Eastern dialects *u* and *i* in an unstressed initial syllable tend to be preserved, while in the South-Western dialects they are often replaced by schwa (a syllable containing schwa can also become stressed), cp.: *śt′iŕ* versus *śt′əŕ* 'girl' (Devayev 1966: 9). Considerable variation in the occurrence of the schwa and full vowels, as well as alternations in the placement of stress have been observed in the transitional dialects located between the Central and South-Eastern dialect groups (Azrapkin 1966: 251–252, 264–265). In some works, attention has been drawn to variation in the location of stress in compound words, e.g. *kimgaftuvə* 'twelve', with stress indicated on the second syllable in one text and on the third syllable in another text (Devajev 1963: 275; see Ananyina 1967: 13; Lipatov, Alyamkin 1988: 87 for more examples).

As it appears, in publications on Moksha phonetics secondary stress in polysyllabic words has not been generally indicated. A note that compound words can have secondary stress on the first part and primary stress on the second part has been made in a recently published book on Moksha phonetics (Ivanova 2002: 13). The idea that preservation of original *a* in non-initial syllables could have been due to historical stress (if not primary then secondary) in polysyllabic words (apparently, on third and fifth syllables) expressed in the earlier literature (Ravila 1929: 116–120; Bubrikh 1937: 81; Itkonen 1971: 65) has not been further developed.

The occurrence of additional stress in polysyllabic words cannot be denied. Syllable deletion observed in numerous words that were once trisyllabic or longer, e.g. in deverbal nouns like *numa* 'ripping' (compare Erzya *nujema*), was primarily due to the stressedness of the odd-numbered syllables in the longer version of the words. Preliminary measurement data on the relationship between stress and duration (Aasmäe 2012) show longer vowel durations in the odd-numbered syllables of trisyllabic words. The occurrence of (rhythmic) stress in odd-numbered syllables of polysyllabic words seem to be typical of Finno-Ugric languages. The assignment of stresses on odd-numbered syllables is a feature attested in Finnish and Estonian (Suomi, Ylitalo 2004; Ross, Lehiste 2001: 50), which, though, differ from the Mordvin languages, for example, by the presence of distinctive quantity opposition and other segmental and prosodic features.

In the pre-experimental research of verse in Erzya and Moksha, the occurrence of additional stress in realisations of rhythm have also been accounted for. Attention to the notion of additional stress with respect to Moksha prosody has been drawn by M. Mal′kina. She writes that an underlying feature of rhythm in Moksha verses is the occurrence of two or more stressed syllables in a word; there are word stress and metrical stress(es) of different prominence that constitute the rhythm of verse in Moksha. Trochee, according to M. Maľkina, is the dominant unit of traditional verse in both Moksha and Erzya (1990: 34–42).

In view of variation in the placement of stress, which is apparent in folksongs and also occurs in speech, particularly in certain dialects, authors find it possible to define stress in Moksha as relatively free (Devayev, Cygankin 1970: 19; Klimkina 1967: 210; Devayev 1963: 275; Lomakina 1966: 308; Azrapkin 1966: 264–265; Feoktistov 1979: 148; see also Paasonen 1903: 8).

Alternation in the location of stress is also observable in loans, the major part of which in Moksha are either Russian or Turkic. H. Paasonen (1903: 116–118), in considering the possibility of Russian and Turkic influence on the development of stress in Mordvin, drew attention to the fact that both in Russian and Turkic loans, stress can occur on initial and non-initial syllables.

Variation in the location of stress in loans is also observed in contemporary dialects; stress in a word can be placed either on the initial or a subsequent syllable in Turkic loans, e.g. *dušman* ‘enemy’ (Babuškina 1966: 196–198). It can be noticed that the structure of some loans has been adapted, e.g. *kapsta* ‘cabbage’ (with stress located on the initial syllable), Russian *капуста* (with stress located on the second syllable), while in other borrowed words original structure tends to be preserved. According to some authors, though, there are dialect preferences. In some mixed dialects (Ananyina 1974: 13), stress in Russian loans is mostly placed on a non-initial syllable, while in other dialects (Lomakina 1966: 306; Azrapkin 1966: 273–274) stress is on the initial syllable. As it appears, dialect preferences in Moksha are a factor to be reckoned with.

A change in the patterns of Moksha stress over the last two centuries has been claimed by D. Estill (2001), who compared indications of stress in an 18th century document and a present-day reader of Moksha, the latter being representative of the literary norm. The comparison revealed a high percent of stress occurrences on the second syllable in the historical document and dominance of initial stress in the reader. In view of the dialect variability in the placement of stress, the question arises as to the compatibility of the sources. Input in the historical document might have originated from a dialect with relatively free stress, while the present-day literary texts may have been read dominantly with word-initial stress.

## 2.4. Empirical data available on Moksha stress

As was said in the introduction, until now synchronic description of Moksha phonetics has been based on auditory observations and empirical data available in the literature have been fragmentary. There is scarce evidence concerning acoustic correlates of stress in Moksha. The first manual of the phonetics of Erzya and Moksha introducing notions of acoustic analysis and some statistics, e.g. frequency data of phonemes (Bondarko, Polyakov 1993) contains only general notes on stress.

Concise commentaries of the auditory impression of the effect of stress (e.g. Paasonen 1903: 8, 114–116, Ravila 1929: 120; Itkonen 1946: 294–295, Bubrikh

1951: 86 and other authors) suggest that, unlike stress in Erzya (the location of which is difficult to establish because of the indistinct acoustic prominence of a stressed syllable over an unstressed one), Moksha stress is (more or less) clearly perceived.

The earliest data obtained in empirical studies derive from acoustic measurements of the formant structure of the schwa (Sovijärvi 1963) and qualitative analyses of vowel durations in stressed and unstressed syllables (Devayev, Cygankin 1970: 17; Devayev 1975: 481). The results of these measurements show that vowel duration can be an important cue of stress in Moksha.

In the work by A. Sovijärvi, the formant structure (F1, F2, and F3) of the vowel *ə* has been analysed. Measurements were made of the productions of a speaker from the area of Krasnoslobodsk (the Central group of dialects). Test words were read in short sentences, as in: *śäŕäď i pəľəts* 'his ear is aching'. Variants of *ə* measured in a stressed and unstressed syllable showed a greater stability of formant structure in the stressed position. Values of F2 for *ə* that occurred after a palatalised and a non-palatalised consonant were found to differ (on average, 1410 Hz and 1200 Hz, respectively); this difference was found to be regular.

The comparison showed a much greater difference between the values of F2 for *e* (for example in *päk eŕavi* 'badly needed') and *ə* (1200 Hz and 2200 Hz, respectively). The author noticed that this difference between the F2 values was approximately the same as the difference between the values of F2 for the German vowels *ə* and *e* (average values of F2 for *ə* in German had been reported to be higher than those found in Moksha by Sovijärvi (1963: 565–566).

In the 1970s, an attempt was made to explore the acoustic correlates of stress in Moksha (Devayev 1975). The published data include results of durational measurements – vowel durations observed in a small set of disyllabic and trisyllabic words. No information was provided on the speaker(s) and the way in which the words were produced (read or spoken). Analysis of the measurement results showed that vowels in a stressed syllable were longer than those in an unstressed one. It has been concluded that duration is an important cue of stressedness in Moksha. Below are given data on vowel durations (V1, V2, V3) in milliseconds in words with stress either on the initial or a non-initial syllable (as given in Devayev 1975: 482–483).

Vowel durations in disyllabic words with initial stress showed that vowels of the stressed syllable were longer, for example, in *kapat* 'a haystack, plural', *kasat* 'you grow': 160 ms vs. 140 ms and 180 ms vs. 128 ms, respectively. In words with stress on the second syllable, e.g. *tuftal* 'a reason', the vowel of the second syllable was significantly longer than the vowel of the unstressed syllable (48 ms vs. 220 ms). Vowel durations in trisyllabic words, in which stress was marked on the first syllable, e. g. *kelusət* 'they are in the birch', longer vowel durations were in the first and third syllables (167 ms and 117 ms vs. 29 ms in the second unstressed syllable). The question arises whether the words may have been pronounced with additional stress. The issue of secondary stress was not addressed in these analyses. Thus in the material analysed by S. Z. Devayev, duration was found to be a regular correlate of stressedness. The author concluded that duration is an important cue of stress in Moksha. As to other possible correlates of stress, an attempt was made to measure intensity. Stress in Moksha had been previously defined as dynamic. According to the author, stressedness was not regularly associated with the parameter of intensity or, rather, the measurements of intensity (in terms of loudness) did not produce clear results.

In a pilot study carried out within the framework of the present research (Zirnask 2010) a systematic analysis of vowel durations in relation to stress was made. Durational characteristics of stress were measured in the productions of two speakers from Novoye Badikovo, an administrative unit of the Zubova-Polyana region, which belongs to the South-Western dialect group previously described by S. Z. Devayev (1963). Vowel durations were measured in mono-, di-, and trisyllabic words (n = 95) embedded in the phrase- and sentence-final position of a carrier sentence (number of tokens = 380). The study showed that in the dialect of Moksha in question, stress has a significant effect on the duration of vowels – vowels in a stressed syllable had longer duration than in an unstressed syllable. This result was especially salient in words with the same vowel in both syllables. It was also found that high vowels (which are shorter than low and mid vowels measured in the same position) in a stressed syllable had almost the same duration as low and mid vowels in an unstressed syllable. Concerning trisyllabic words, in which third-syllable vowels tended to have more or less the same duration as stressed first-syllable vowels, it was noted that the words might have had additional (secondary) stress on the third syllable.

In a recent publication, data have been provided on the formant structure of Moksha vowels in the productions of several informants speaking different dialects; none of the speakers was from the Central dialect area (Fournet 2010: 245–264). Ultimately, the data have been used by the author to compare the vowel systems of the Eastern and Western dialects which, as mentioned above, lack the vowel /ä/. The question of the variability of the schwa vowel in Moksha has been addressed in an analysis of the formant structure of the allophones of the vowel (Estill 2011).

## 2.5. Summary

The early studies of the prosody of Moksha were carried out in the framework of reconstructing the prosodic features of proto-systems (Finno-Ugric, Mordvin). Later, in pre-experimental works on the dialects and standardised literary Moksha, some of the problems posed in the diachronic studies, also received the attention of authors. These approaches largely coincide in time with two periods: early (up to the 1930s, when the development of the standards for the literary language was more or less completed) and later (from the 1930s until the turn of the century, during which synchronic description dominated in the research of the Mordvin languages).

As major findings of the previous research, the following assumptions or facts should be mentioned. It has been asserted that the two Mordvin languages differ from each other in terms of the location of stress. Recent research has shown that in Erzya there is inter-dialect variation in the mobility of word stress (Aasmäe 2006). Dialects can be differentiated on the basis of the tendencies observed in the location of word stress: in some dialects stress gravitates to the initial syllable, in the other dialects initial and non-initial stress alternate to a greater or lesser extent. Alternation is presumably conditioned by the prosody of the utterance. Alternation in the location of stress has also been observed in Moksha. According to the pre-experimental studies, stress is predominantly on the initial syllable; it shifts to a subsequent syllable under the influence of the phonetic characteristics of the vowels that occur in a word (or, presumably, for the purpose of morphological distinction). Among the Finno-Ugric languages, some of the varieties of Komi have been claimed to display the dependence of the location of stress on the quality of vowels and morphological factors (see Lytkin 1952).

Different factors (syllable structure, lexical class, specific segmental or phonological similarities, etc.) can play a significant role in stress assignment in a language; see, for example, Guion et al. (2003). As far as stress location in Moksha is concerned, no empirical studies have been carried out yet to test the feasibility of the dependence of stress on the quality of vowels or morphological factors. Moreover, the regularity in the occurrence of non-initial stress and the origin of words that tend to have non-initial stress have not been established. From the analysis of publications on the dialects of Moksha it emerges that the dialects are not uniform as far as the assignment of stress is concerned. Very little attention has been paid to the issue of additional stress(es); distinction between secondary and primary stress has been made in some works only concerning compound words.

The first attempts made to define the correlates of stress in Moksha have shown that vowel durations in a word might depend on the position of stress. Data of previous research are used as valuable reference material for the analysis of the acoustic manifestations of stress addressed in this work. The next chapter, which consists of three parts, provides analyses of the duration and the quality of vowels as possible correlates of word stress; the contours of fundamental frequency on the test words are dealt with in terms of interaction between stress and sentence prosody.

# Chapter 3

# Acoustic manifestations of stress in Moksha

## 3.1. Introduction

The survey of earlier work on the prosodic features of Moksha provided in Chapter 2 shows that the attention of authors has mostly been focused on questions pertaining to stress, “produced and perceived prominence”, as defined by Ilse Lehiste (Lehiste et al. 2003: 84).

Quantity, suggested in some works as a hypothetical feature of the proto-system of Mordvin, has not been attested to be contrastive in any of the varieties of either Moksha- or Erzya-Mordvin. The length of vowels and consonants is not distinctive; hence, duration in the case of Moksha, from the typological point of view, “is available for serving as a phonetic cue to stressedness” (Lehiste et al. 2003: 85).

Furthermore, the dialects of Moksha are known to be characterised by more or less extensive vowel reduction, a phenomenon considered to be conditioned by duration-based stress (Bybee et al. 1998, Crosswhite 2004, Barnes 2006). Thus, duration in Moksha can be, *a priori*, regarded as a correlate of stress. Some empirical data available by now (see Devayev 1975, Zirnask 2010) are indicative in this respect.

In view of the present state of research on the prosody of Moksha, the experimental investigation reported below was designed to attest, first of all, to the role of duration in manifesting stress in the core variety of Moksha (the Central dialect group). Evaluation of the possible effects of other factors (the intrinsic duration of vowels, the syllable structure of a word, and the position of a word in an utterance) on the relative duration of vowels in a word was an essential part of the analysis.

The analysis of the formant structure of vowels with relation to stress constituted the second part of the investigation. Reduction of vowels was expected to be systematically displayed in the unstressed syllables of the test words. The question of possible effects of position in an utterance on the quality of vowels in the test words was also considered.

Additionally, as the third part, the pitch curves of the test words were observed to gain insights into the interaction between word stress and the intonation of the utterances, in which the words were produced.

## 3.2. Materials and method

Taking into account the scarcity of acoustic data for Moksha, measurements were made of controlled speech. As input, a corpus of 104 target words consisting of one to six syllables was selected to represent the major types of word structure (see the list of the test words in Appendix 2). Monosyllabic words were of the (C)V(C), (C)VCC type; some of the disyllabic (and longer) words contained combinations of consonants in the word-internal or word-final position (or in both positions), due to the occurrence of suffixes, e.g. *makśśəms* ‘to give (frequentative)’.

The methodology involved acoustic analyses of the test words that occured in two (the phrase- and sentence-final) positions of the carrier sentences. The phrase-final position can also be referred to as sentence-internal (cf. Lehiste 1982: 12). The sentences read by the informants were written in literary Moksha (see the example below).

Example:
a) *Мярголень макса, аф сия.* ‘I would say liver, not silver.’
b) *Мярголень сия, аф макса.* ‘I would say silver, not liver.’

The carrier sentences permitted consideration of the possible effects of sentence prosody on the acoustic characteristics of the test words. The material was recorded in 2008 under fieldwork conditions (using an M-Audio MicroTrack 24/96 digital recorder and an Audio-Technica ATM33a microphone) by Tatiana Zirnask. The sentences were read by speakers of the Central Moksha dialects who were residents of different localities.

Prior to the acoustic measurements, the location of stress in the test-words was assessed, through repeated listening, by T. Zirnask, a native Moksha speaker, and N. Aasmäe, a native Erzya speaker. Observations were made of the productions of 14 informants (2457 tokens in all), which were also analysed from the point of view of segmental structure.

For the acoustic analysis, the productions of eight informants from the localities listed below were selected (the initials of the informants’ names are indicated in the list).

- Mordovskaya Kozlovka of the Atyuŕyevo region:
  JM, a female aged 50
  NN, a female aged 39
  IS, a male aged 56
  NM, a male aged 54
- Poĺskoye Tsybayevo of the Temnikov region:
  JS, a female aged 53
- Mordovskiye Parki of the Krasnoslobodsk region:
  ST, a female aged 41
- Zaytsevo of the Kovylkino region:
  TR, a female aged 40
  VT, a female aged 34

In selecting the materials for the acoustic analysis, the criterion of uniformity in the style of pronunciation was followed – preference was given to neutral, i.e. not emphatic, reading. For measurements, the PRAAT software (Boersma and Weenik 2010) was used. The total number of tokens observed in the acoustic analysis amounted to 1664. Measurements were made of the duration of each segmental sound, of formant frequencies of the vowels, and of fundamental frequency, which was measured at the beginning and the end of the vowel (no obvious fundamental frequency peak within the vowel was observed).

In the present research, which was based on the analysis of read (or controlled) speech, stress was perceived to be predominantly located on the initial syllable of the test words in 89 percent of all tokens. Cases of stress on a subsequent syllable included words like *śijä* 'silver', *kundasamak* 'you will catch me', i.e. words having a high vowel *i*, *u* in the first syllable and low *a* (also *ä*) in a subsequent syllable. There was, however, some variation in the placement of stress in such words. The same speaker could pronounce them with initial stress in one utterance and with non-initial stress in the utterance that followed. As mentioned in the survey of literature (see Chapter 2), some authors find it possible to define stress in Moksha, particularly in certain dialects, as relatively free. Accordingly, an analysis of spontaneous speech is required to find out the extent of variability in the assignment of stress.

Words with more than two syllables, e.g. *ajďamaJt́* 'you chased me', *ajďasajńə* 'I chase them', *kundańď́äŕasamak* 'if you catch me', tended to have additional stress(es) that were located on either odd- or even-numbered syllables. The phenomenon of additional stress, which has been mentioned by some authors in connection with the analysis of the structure of compound words, is another unstudied issue of Moksha prosody. In the following sub-chapters, the results of the acoustic analysis of duration, formant structure, and fundamental frequency of the vowels in the test-words is provided.

## 3.3. Data analysis

### 3.3.1. Duration

To evaluate the role of duration in manifesting stress, the analysis was centred on data pertaining to the syllable nuclei of the test words, i.e. vowels. Factors that may condition variation in the duration of a segment generally include, in addition to stress, "...the phonetic nature of the segment itself (intrinsic duration), preceding and following sounds, other suprasegmental features, and position of the segment within a higher-level phonological unit" (Lehiste 1976: 226–229).

In the present work, the input was selected to be representative of the major types of word structure; as a consequence, the effect of several factors conditioning duration variability was to be tested. First and foremost, mean vowel duration in stressed vs. unstressed syllables in the test words was examined. In evaluating the data, the location of stress (on the initial or non-initial syllable) and the occurrence of additional stresses was considered. The effect of the intrinsic duration of the syllable nuclei as well as of the number and types of syllables constituting the words was also taken into account. The conditioning role of consonant environment was envisaged; to avoid measurement bias, the effects of environment were controlled by selecting words with various types of phonotactic structure.

The influence of utterance prosody was observed by comparing data for test words placed in the phrase- and sentence-final positions of the carrier sentence. Concerning the possible effect of pre-boundary lengthening in an utterance, I. Lehiste (1982: 12) maintains that there is "a general tendency for words to be somewhat longer before a sentence boundary than before a sentence-internal pause..."

The analysis of vowel duration was based on words containing from one to six syllables. The mean duration of vowels pooled over the data of the eight speakers are presented in Tables 4–6 and Figures 1–3 (additional data are given in Appendix 3-I). The statistical significance of certain differences in the data has been established by the analysis of variance (ANOVA).

### 3.3.1.1. Duration of vowels in stressed vs. unstressed syllables

Table 4 shows the results for the disyllabic and trisyllabic words with stress on the initial syllable (with additional stress on the third syllable). With respect to the relative durations of V1 and V2, the two word groups exhibited different results. The disyllabic words exhibited a highly significant durational difference in favour of V1 over V2, but only phrase-finally [$F(1, 902) = 99.15$, $p < 0.001$]. In the sentence-final position, however, where pre-boundary vowel lengthening is likely to occur, V1 and V2 durations did not differ.

In trisyllabic words, asymmetry between the vowel durations of the stressed and unstressed syllables (V1 and V2) was salient in both phrase- and sentence-final positions: [$F(1, 219) = 122.2$, $p < 0.001$] for the phrase-final position; and [$F(1, 232) = 64.76$, $p < 0.001$] for the sentence-final position. The mean durational ratio between the stressed and unstressed syllable nuclei (V1/V2) in trisyllabic words was much higher than in disyllabic words both in the phrase- and sentence-final positions: [$F(1, 561) = 38.71$, $p < 0.001$] and [$F(1, 562) = 67.94$, $p < 0.001$], respectively.

As seen from Table 4, stress is clearly signalled by additional duration. In trisyllabic words, the vowels of the third syllable were longer than those of the preceding syllable in both the phrase- and sentence-final position. This observation supports the suggestion that trisyllabic words had additional stress (in this analysis the task of defining the location of primary and secondary stress was not set). Consequently, syllables in such words may have constituted trochaic feet. The first two syllables constituted "a prosodic foot, followed by a third syllable that is a prosodic foot in its own right" (Ross, Lehiste 2001: 52). The one-syllable, degenerate, foot has the potential of developing into a disyllabic foot; compare: *ajďamaJť* 'you chased me' and *ajďasajńə* 'I chase them'.

In sentence-final position, presumably due to the effect of pre-boundary lengthening, the duration of third-syllable vowels was similar to that of first-syllable vowels, while in phrase-final position the duration of third-syllable vowels was, on the average, somewhat shorter than that of first-syllable vowels.

In words with stress on even-numbered syllables, e.g. *kundal′iJť* 'you would catch it/him/her', the relation between the duration of vowels in the second and third syllables was found out to be analogous to that observed in words with

| disyllabic words | | V1(ms) | V2(ms) | V1/V2 | V3(ms) |
|---|---|---|---|---|---|
| phrase-final | mean | 116.0*** | 97.5*** | 1.2 | |
| n = 451 | s.d. | 28.7 | 24.3 | 0.4 | |
| sentence-final | mean | 114.2 | 112.5 | 1.1 | |
| n = 433 | s.d. | 27.6 | 25.6 | 0.3 | |
| trisyllabic words | | | | | |
| phrase-final | mean | 106.1*** | 74.7*** | 1.5 | 85.9 |
| n = 110 | s.d. | 22.4 | 19.6 | 0.5 | 25.1 |
| sentence-final | mean | 105.8*** | 80.38*** | 1.4 | 104.6 |
| n = 117 | s.d. | 25.5 | 22.8 | 0.4 | 24.8 |

Table 4. Mean vowel durations, in ms (V1 = first vowel, V2 = second vowel, V3 = third vowel), and mean durational ratios between stressed and unstressed syllable nuclei (V1/V2) with standard deviations (s.d.): di- and trisyllabic words in phrase- and sentence-final position (stress located on odd-numbered syllables). Statistically significant differences between the values are starred: *($p$ = 0.05), **($p$ = 0.01), ***($p$ = 0.001).

stress on odd-numbered syllables (see Table 5). The length difference between V2 and V3 was highly significant in both phrase- and sentence-final positions: [$F(1, 48) = 97.94$, $p < 0.001$] and [$F(1, 50) = 104.93$, $p < 0.001$], respectively). Mean duration ratios were much higher (1.9 in phrase- and 1.7 in sentence-final position) than in the case of stress on odd-numbered syllables. As to the initial unstressed syllable in *kundal′iJt′*, it may have constituted a foot with the final syllable of the preceding word that was part of the carrier sentence, namely: *märgəl′iń kundal′iJt′* ‘I would say you would catch it/him/her’.

The effect of additional stress on the relationship between vowel durations within a word was further examined in a subset of words with 4 to 6 syllables (the total number of observations was 35 for the phrase-final and 29 for the sentence-final position), in which the odd-numbered syllables were perceived as stressed. For the phrase-final position, statistically significant differences were found between vowel durations of first and second syllables: [$F(1, 58) = 4.82$, $p < 0.001$], as well as of the third and fourth syllables [$F(1, 58) = 4.82$, $p < 0.05$]. As polysyllabic words were, firstly, under-represented in the corpus and, secondly, they contained vowels of different qualities, this issue will have to be revisited in the future in the light of broader material.

The assignment of additional stress in words that consist of three or more syllables is a salient tendency supported by the durational data presented above. Trisyllabic words either constituted a trisyllabic foot, e.g. *vet′əćə* ‘fifth’, or were realised as a disyllabic foot followed by a one-syllable foot, e.g. *vet′əće*. In a part of the speakers’ productions words consisting of three syllables changed into disyllabic words, due to the deletion of the unstressed second syllable, e.g. *vet′ćə*. Additional (presumably, secondary) stress on the third syllable was not always perceivable.

| Trisyllabic words | | V1(ms) | V2(ms) | V3(ms) | V2/V3 |
|---|---|---|---|---|---|
| phrase-final | mean | 50.7 | 138.3*** | 77.0*** | 1.9 |
| n = 25 | s.d. | 11.5 | 21.7 | 15.6 | 0.6 |
| sentence-final | mean | 50.4 | 143.3*** | 86.0*** | 1.7 |
| n = 27 | s.d. | 10.7 | 22.5 | 16.8 | 0.4 |

Table 5. Mean vowel durations, in ms (V1 = first vowel, V2 = second vowel, V3 = third vowel), and mean durational ratios between stressed and unstressed syllable nuclei (V2/V3), with standard deviations (s.d.): trisyllabic words in phrase- and sentence-final position (stress located on the second syllable). Statistically significant differences between the values are starred: *($p$ = 0.05), **($p$ = 0.01), ***($p$ = 0.001).

Likewise, in some words with more than three syllables either two disyllabic feet were produced, e.g. *lomańeńd́i* 'to person(s)', or the first three syllables constituted one foot followed by a one-syllable foot: *lomańənd́i* 'to person(s)'. Variation in the placement of stresses in tri- and polysyllabic words requires a detailed study in which analyses of the morphological structure of the test material would be involved, to define the potential location of the primary and secondary stresses. At this stage of research, distinction between the primary and secondary stresses was not in the focus of analysis.

The results considered above show that the duration of vowels significantly depended on the position of stress. Stressed syllable vowels had longer duration than the vowels of unstressed syllables. Relative vowel durations in a word also displayed dependence on the number of syllables constituting a word and the position of a word in an utterance.

### 3.3.1.2. Other factors conditioning vowel durations

To determine the possible effect of the intrinsic characteristics of the segments on the relationship between vowel durations, mean vowel durations in subsets of mono-, di-, and trisyllabic words with high and low vowels, *i* and *u* versus *a* (also *ä*), were compared. Mean durations of *a* and *i* in monosyllabic words (*ši* 'a day', *šit́* 'in the day-time', number of observations = 35 and *va* 'you see', *vaj* 'butter', number of observations = 38) are shown in Figure 1.

Low *a* had longer duration than high *i* in both the phrase- and sentence-final positions, the mean durations of *a* being 156.8 ms and 165.9 ms, while those of *i* were 124.1 ms and 135.7 ms, respectively. The difference between the values of duration for *a* and *i* was statistically significant: [$F(1, 33) = 12.45$, p = 0.001] for the phrase-final position and [$F(1, 36) = 11.64$, p = 0.002] for the sentence-final position.

Such a difference implies that a high vowel occurring in a stressed syllable might not have a longer duration than a low vowel in an unstressed syllable. The vowel durations in the disyllabic word *śijä* 'silver', in which stress was alternatively assigned to the first syllable in some utterances (number of observations = 4) and to the second syllable in other utterances (number of observations = 9),

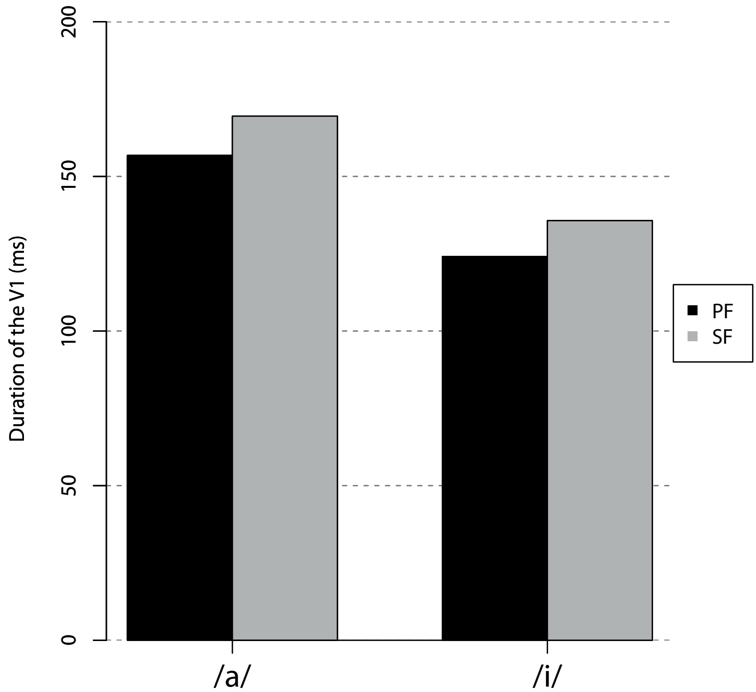


Figure 1. Vowel durations, in ms: low /a/ and high /i/ in monosyllabic words (PF = phrase-final position, SF = sentence-final position).

are well in accordance with this assumption. The high vowel *i* of the stressed syllable in *śijä* was found to be shorter than *ä* of the unstressed syllable (mean durations for the phrase-final position: 114.5 ms vs. 120.5 ms). The duration of *ä* in the stressed syllable of *śijä* exceeded that of *i* (mean durations for phrase-final position: 101.4 ms vs. 172.0 ms). Analogous to this, in the trisyllabic word *kundal′iJt′* 'you wanted to catch it/him/her', high *u* of the stressed syllable (1 observation) was shorter than low *a* of the unstressed syllable (71.0 ms vs. 82.0 ms). The duration of *i* (99.0 ms) in the third syllable receiving additional stress and constituting a degenerate foot slightly exceeded that of the low *a* in the preceding unstressed syllable. In cases with stress on the second syllable in *kundal′iJt′* (number of observations = 7), the durations of *u*, *a*, and *i* were, respectively: 57.6 ms, 132.7 ms, 84.7 ms; the *a* in the stressed syllable was considerably longer than *u* and *i* in the unstressed syllables.

Thus, the intrinsic duration of vowels that occur in the stressed and unstressed syllables of a word is a crucial factor for the temporal relationship between the vowels. It implies that distinction between the quality of vowels (full versus reduced) might also serve for the differentiation between stressed and unstressed syllables. This assumption is dealt with in detail in 3.3.2.

The effect of syllable structure was not displayed as explicitly. The occurrence of two or more intervocalic consonants at morpheme boundaries (and combinations of consonants in word-initial and -final positions) is a characteristic feature of Moksha (see Chapter 1). The analysis of the segments in the productions of the target words revealed occurrences of an epenthetic vowel between consonants in words like *eŕgə* > *eŕigə* ‘a bead’, *śeľmə* > *śeľəmə* ‘an eye’, *käďga* > *käďiga* ‘from hand to hand’; as a result, an extra syllable was produced. However, in many cases the occurrence of the epenthetic vowel was not obvious. Though the intricate question of the location of syllable boundary remains to be solved, it was important for the purposes of the present analyses to have a certain cue as to the openness or closedness of syllables within the tokens. The solution was to compare vowel durations, primarily, in monosyllabic words of the CV and CVC(C) types, i.e. ending in a vowel and in a consonant or a combination of consonants. Further, vowel durations were compared in subsets of disyllabic words that contained analogous sequences of segments. The results of comparison are shown below.

As seen in Figure 2, vowels had longer duration in the CV series (number of observations = 57) compared to those in the CVC(C) series (number of observations = 156), the mean durations being 154.0 ms vs. 141.5 ms in the phrase-final position and 161.0 ms vs. 149.5 ms in the sentence-final position, respectively. The difference in the two series of words was statistically significant in the phrase-final position [$F(1, 78) = 4.29$, $p = 0.04$].

The subsets of disyllabic tokens selected to investigate the effects of syllable structure on vowel durations included the CVCV, CVCVC, CVCCVC, CVCCV, and CVCCCV types. In Table 6, the mean durations of vowels observed in these

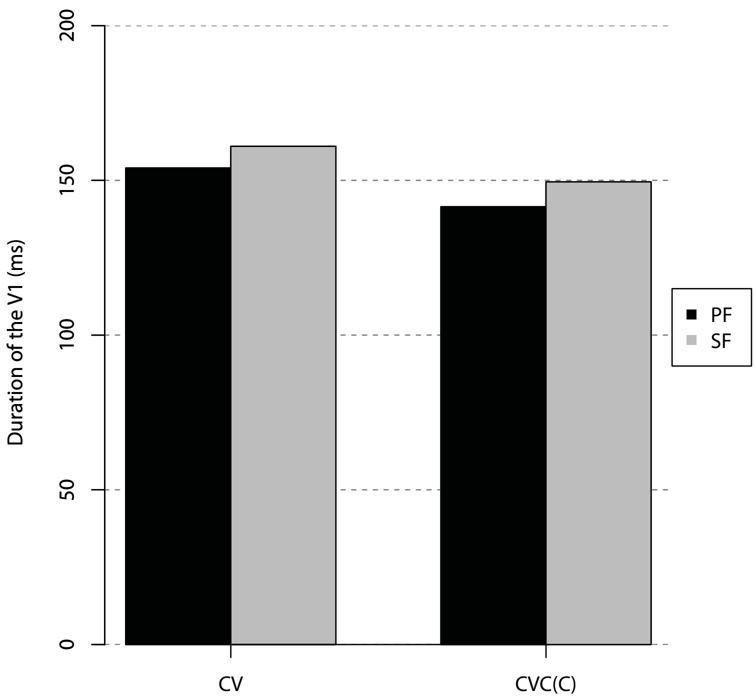


Figure 2. Vowel durations, in ms: monosyllabic words ending in a vowel, CV, or a consonant, CVC(C) (PF = phrase-final position, SF = sentence-final position).

subsets of words are presented on the background of the durational data obtained on the set of disyllabic tokens that included more types of structure.

In the CVCV series, the vowel durations (V1, V2) and the durational ratios (V1/V2) were greater compared to the overall results on the disyllabic words, while in the other series they were somewhat smaller or differed very little. In each series of words, the difference between V1 and V2 was greater in phrase-final position than in sentence-final position. In sentence-final position, durational ratios in each series were smaller than in phrase-final position; it is very likely that pre-boundary vowel lengthening affected the vowel durations of the second syllable more than those of the first syllable. In the series with internal combinations of consonants and ending with vowels, the durational ratios were below 1.0.

In phrase-final words, the differences in the mean durations of V1 were statistically significant between the CVCV type of words, on the one hand, and each of the the CVCVC, CVCCV, CVCCVC, CVCCCV types, on the other hand: [$F(1, 178) = 11.09$, $p = 0.001$]; [$F(1, 101) = 21.25$, $p < 0.001$]; [$F(1, 292) = 42.53$, $p < 0.001$]; [$F(1, 90) = 15.43$, $p < 0.001$], respectively.

The differences in V1 mean durations between the CVCV and the CVCCV, CVCCVC, CVCCCV might imply that the initial (stressed) syllables in CVCV and the other series were produced as open vs. closed, respectively. The difference in the V1 values between the CVCV and CVCVC types is surprising; though, it can not be excluded that syllable boundary in the CVCVC words (e.g. *nupəń* 'moss', *nokan* 'I want', *säťav* 'quiet') was within the second consonant. As is known from the literature, single voiceless consonants in the intervocalic position are perceived to be relatively long (cf. e.g. Paasonen 1903: VII; Kabayeva 2006: 66–67). The length of the consonants *p*, *t*, *k* measured in word-initial and

| Series of words | | Phrase-final position V1(ms) | V2(ms) | V1/V2 | Sentence-final position V1(ms) | V2(ms) | V1/V2 |
|---|---|---|---|---|---|---|---|
| all (disyllabic): | mean | 116.0 | 97.5 | 1.2 | 114.2 | 112.5 | 1.1 |
| n = 451 / 433 | s.d. | 28.7 | 24.3 | 0.4 | 27.6 | 25.6 | 0.3 |
| CVCV | mean | 132.3 | 103.3 | 1.3 | 128.6 | 117.2 | 1.1 |
| n = 76/78 | s.d. | 27.3 | 24.0 | 0.4 | 24.2 | 23.7 | 0.3 |
| CVCVC | mean | 117.1 | 94.1 | 1.3 | 116.2 | 104.9 | 1.1 |
| n = 102/102 | s.d. | 30.3 | 22.7 | 0.3 | 28.4 | 24.0 | 0.3 |
| CVCCVC | mean | 105.3 | 89.5 | 1.3 | 98.3 | 91.1 | 1.1 |
| n = 28/28 | s.d. | 22.9 | 27.0 | 0.4 | 20.9 | 22.6 | 0.3 |
| CVCCV | mean | 110.0 | 99.3 | 1.2 | 109.6 | 118.6 | 0.9 |
| n = 197/197 | s.d. | 25.1 | 23.9 | 0.3 | 25.5 | 23.6 | 0.2 |
| CVCCCV | mean | 112.2 | 97.0 | 1.2 | 100.7 | 114.6 | 0.9 |
| n = 15/15 | s.d. | 29.1 | 23.0 | 0.4 | 28.2 | 25.9 | 0.2 |

Table 6. Mean vowel durations, in ms (V1 = first vowel, V2 = second vowel), and duration ratios (V1/V2) with standard deviations (s.d.) in series of disyllabic words (stress located on the first syllable).

intervocalic position (Kabayeva 2007: 122–124) has been found to differ. In the intervocalic position these consonants were significantly longer than in the word-initial position. It has also been noted by V. Hallap (1968: 165) that the syllable-boundary in words having an intervocalic voiceless stop might be in the midst of the stop and not before it. The assumption that the initial syllable in the CVCVC words with an intervocalic voiceless stop might be produced as a closed one, however, needs further verification on a larger set of test words.

In the CVCV and CVCVC series as well as in the CVCCCV and CVCCVC series V2 mean durations differed: [$F(1, 178) = 6.372$, $p < 0.01$]; [$F(1, 41) = 3.94$, $p < 0.05$], respectively. The durational difference in the values of V2 between the CVCV and CVCVC series as well as between CVCCCV and CVCCVC implies that the second syllables in both pairs of series were produced as open vs. closed, respectively.

Further, statistically significant differences were found in the mean durational ratios (V1/V2) between the CVCV and CVCCV subsets of words (see Figure 3): [$F(1, 292) = 15.43$, $p < 0.001$]. These differences might also be explained by the openness vs. closedness of the first syllable in the two subsets. The V1/V2 ratios between the CVCV and CVCCCV series showed no difference. Intervocalic consonant sequences in the CVCCCV words (*kandt́ə*, *kantt́ə* ‘I carry you’, *kudtńə*, *kuttńə* ‘the houses’) were more complex than in the CVCCV words (*maksə* ‘liver’, *šit́ńə* ‘the days’, *kudcə*, *kutcə* ‘in the house’, etc); hence, syllable composition was different in the two series. The number of consonants and,

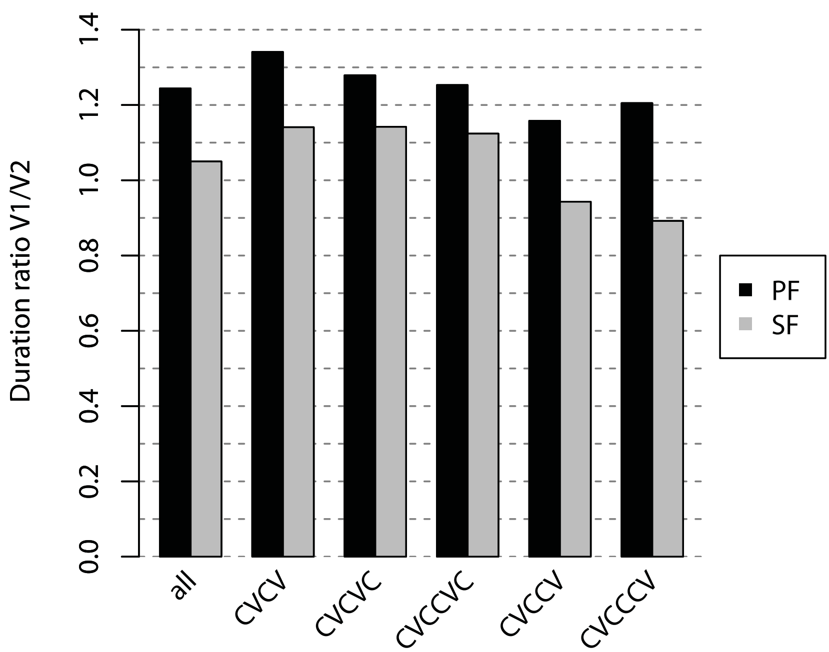


Figure 3. Durational ratios (V1/V2): series of disyllabic words produced in phrase-final (PF) and sentence-final (SF) position.

supposedly, consonant types might cause variation in the V1/V2 durational ratios in Moksha; this is a supposition that also requires a detailed study.

The analysis of vowel durations in disyllabic words showed that the closedness or openness of the syllables constituting the words conditions a certain amount of variation in the V1 and V2 mean vowel durations and in the durational ratios V1/V2. The results also imply that there might be dependence of the syllable boundary on the types of consonants which occur in the position between two syllables. The realisation of a consonant as a coda or an onset might depend on the occurrence of intervocalic single voiceless stops and of certain combinations of consonants. The realisation of an epenthetic vowel, in this context, seems to be an alternative to the production of complicated sequences of consonants.

#### 3.3.1.3. Summary

The acoustic analysis of vowel durations in the test words clearly showed that the position of stress influenced the relative duration of the vowels – in stressed syllables vowels were longer than in unstressed syllables. The durational ratios between the vowels of stressed and unstressed syllables were found to display dependence on the intrinsic duration of the vowels occurring within a word. The mean durations of high and low vowels that occurred in stressed and unstressed syllables, respectively, tended to be equalised. In some words, the relationship between the vowel durations was reversed – the low vowels of the unstressed syllable turned out to be longer than the high vowels of the stressed syllable. Similarly, the mean vowel durations in the stressed and unstressed syllables were equalised or the durational ratios between the vowels were reversed, due to the influence of sentence-final position, where the pre-boundary pause is expected to be longer than in phrase-final position.

The present analysis also showed a certain amount of variation in the vowel durations conditioned by the openness and closedness of a syllable. The mean duration of vowels in closed syllables was smaller than in open syllables. There was variation in the durational ratios between the vowels observed in several subsets of words that differed by structure (e.g. CVCV, CVCVC, CVCCV). This result indicates that there might have been effects of certain types of consonants on the location of the syllable boundary. In a subset of tokens containing a single voiceless stop in the intervocalic position, the syllable boundary might have been realised within the consonant that presumably was relatively long in the position between two vowels. The question of the location of syllable boundary needs to be explored by using larger subsets of words, selected to represent different types of intervocalic consonants and combinations of consonants.

Observations of mean vowel durations in trisyllabic words support the assumption that words of more than two syllables receive, more or less regularly, additional stress. In trisyllabic words with initial stress, first- and third-syllable vowels were longer than the vowels in the unstressed second syllable. In the words with non-initial stress, second-syllable vowels were the longest.

The analysis of the locations of stress(es) and of the vowel durations also showed that within the carrier utterances, the test words were predominantly realised as sequences of disyllabic feet. Mean durational ratios between the stressed first and unstressed second syllables, which constituted disyllabic feet, were found to be higher in trisyllabic words than in disyllabic words. Questions pertaining to the issues of additional stress(es) and the tendency towards the realisation of words as sequences of disyllabic feet appear to be most relevant to the further research of the prosodic features of Moksha.

### 3.3.2. Vowel quality

An analysis of the formant structure of the vowels in the test words was carried out to estimate, primarily, the effects of stress on the quality of the syllable nuclei. The formant values of vowels that occurred in the subsets of phrase- and sentence-final words were also compared, to make a judgement about the possible effects of sentence position.

Vowel reduction, by which the phonetic and phonological systems of Moksha and Erzya differ, was one of the target issues of the analysis. Research in the phonetics-phonology interface of the phenomenon of vowel reduction (cf. Lindblom 1963; Bybee et al. 1998; Flemming 2001; Aguilar et al. 2003; Crosswhite 2004; Barnes 2006; Amir et al. 2007) has been focused on the effects of segmental, prosodic and morphological context. Vowels are typically shorter in certain segmental environments (for example, before voiceless stops or geminates), in unstressed syllables, and in affixes. Phonological vowel reduction has been defined as a phenomenon whereby in the vowel inventory of a language, neutralisations of contrast take place; as a result, only a subset of the inventory is realised. Cross-linguistic surveys demonstrate that phonological vowel reduction is generally restricted to languages with a duration-based stress. The results obtained from the analyses of the durational data (see 3.3.1.) imply that vowel reduction in Moksha is likely to be related to stress.

The scope of the acoustic analysis of vowel qualities consisted in establishing the phonetic manifestations of vowel reduction and the relevance of stress to the phenomena observed. Analysis was based on subsets of test words, in which stress was perceived to be located on the first syllable, therefore the first and the second syllables counted as the stressed and unstressed conditions, respectively. The test words had different structure, to avoid measurement bias. Seven types of words were included: (C)VCV, (C)VCVC, (C)VCCV, CVCCCV, (C)VCCVC, CVCCVCC, (C)VCVCC; the consonant segments in the words varied.

The overall number of tokens used in this analysis was 877. The vowel segments that occurred in the words – /a/, /o/, /u/, /i/, /e/, /ä/, /ə/ – were representative of the inventory of vowels identified for the majority of the Central dialects. In the stressed first syllable, all the vowels, with the exception of /ə/, occurred. The occurrencies of *ä* in the stressed initial syllable were more or less regular in the productions of all the speakers; however, in some productions of the informants *ä* tended to be substituted with *e*, as in *śäťav*, *śeťav* ‘quiet’.

The vowels of unstressed second syllables that regularly occurred in the productions of all the speakers were *a*, *i*, *u*, and *ə*, e.g. *lomań* 'person', *nupəń* 'moss', *śed′iJt′* 'hearts', *kuću* 'spoon'. However, the schwa vowel alternated with [*ĕ*], [*ă̈* ], and [*ă*]: e.g. [*pil′ə*], [*pil′ĕ*], [*pil′ă̈* ] 'ear'; [*maksə*], [*maksă*] 'liver', while unstressed *a*, as in *ked′ga* 'along the hand', was perceived as a vowel similar to a variant of schwa, [*ă* ].

As word-final [*ĕ*] and [*ă* ] were realised in the productions of all the informants, the variants of words with [*ĕ*] and [*ă* ] were included in the list of the test words (see Appendix 2), which basically provides the phonemic transcription of the words. In the acoustic diagrams, they were represented as /e/ and /a/ among the vowels of unstressed syllables; details of such variation were secondary to this analysis but they present interest for further research.

In the unstressed second syllable, only some speakers' productions contained *ä*; generally, *ä* alternated with *a*, as in *śät′äv*, *śät′av* 'quiet', or with *ə*, as in *šäjäŕ*, *šäjəŕ* 'hair'. In the acoustic diagrams, which display data for eight informants, the formant values for the unstressed *ä*, for this reason, were not included. Variation in the productions of the vowels accounts for a considerable amount of inter- and intra-speaker differences in the results of the acoustic analyses, hence, in the statistics.

The measurement results are shown as the mean values of the formants (F1, F2) in the acoustic vowel diagrams (see Figures 4–11), separately for the female and male speakers' productions. The mean values of F1 and F2 are given in Hertz; the ellipses for the vowels in the diagrams are based on the standard deviations. The formant values (F1, F2 and F3) in Hertz and Barks, with standard deviations, are given in Tables 1–4 of Appendix 3-II (regarding convertion of Hz to Barks cf. Traunmüller 1990). The analysis of the formant structure of the vowels was done with the R programme (R Development Core Team 2010).

### 3.3.2.1. Vowels in the productions of female informants

The measurement results on the productions of six female informants (JM, JS, NN, ST, TR, VT) are presented in Figures 4–7. The relative positions of vowels in the vowel space are shown for the stressed and unstressed syllable vowels (Figures 4a, 4b and 5a, 5b, respectively). The formant values of the vowels were measured in subsets of phrase- and sentence-final words, to estimate the possible effect of sentence position, alongside with the effects of stress. The combined results on the mean values of the formants are presented in Figure 6. Figure 7 includes standard deviations for the F1 and F2 values measured for the stressed and unstressed positions.

The vowels of stressed syllables produced in the phrase-final words (Figure 4a) were found to display fairly well differentiated positions within the vowel space. The diagram allows distinguishing three front vowels – /i/, /e/, /ä/; two back vowels – /u/, /o/; and a central vowel – /a/. The positions of the front vowel /i/ produced by the six informants were very close. The positions of /e/, distinctly lower than those of /i/, were relatively diffuse; both /i/ and /e/ were higher in the productions of VT, compared to the other informants' results. The positions of /ä/ were also diffuse; in the productions of TR and ST the vowel tended to occupy positions close to those of /e/. The positions of /u/ and /o/ were well differentiated.

Low /a/ (defined either as a central or a back vowel in the pre-experimental research, see Chapter 2) was realised as a central vowel in the productions of all the female informants. The positions of /a/ were diffuse along the vertical axis of the vowel space. In the productions of TR and VT, the positions of /a/ were higher than in the other speakers' productions.

Comparison of the positions of stressed syllable vowels observed in phrase- and sentence-final words (Figures 4a and 4b) showed that the formant values of the vowels were, to some extent, influenced by the sentence-final position. Namely, the positions of /i/ were diffused and there was some overlap between the positions of /i/ and /e/; they were relatively close in the productions of TR, JM, and JS. The positions of /e/ and /ä/ tended to rise; in the productions of VT /ä/ was very close to /e/. There was also overlap between the positions of the back vowels in the sentence-final words – /o/ tended to rise and move towards /u/.

In the productions of VT /u/ was centralised. There was also a slight rise in the positions of /a/; alongside with this, /a/, /u/, and /o/ were somewhat retracted, in relation to the variants that occurred in phrase-final words.

The rise in the positions of almost all the vowels (/e/, /ä/, /o/ and /a/) can be regarded as a general effect of sentence-final position on the quality of vowels. Alongside with the effect of rising, more retracted positions of /a/, /o/, and /u/ in the sentence-final words than in the phrase-final ones can be taken into account in evaluating the effects of sentence-final position on the quality of vowels. Despite overlap between the position of some vowels (see Figure 4b), the vowel qualities observed in the sentence-final words were relatively well distinguished in the vowel space.

The analysis of the F1 and F2 values in the vowels of unstressed syllables (see Figures 5a and 5b) clearly showed that the positions of vowels tended to shift towards the centre of the vowel space occupied by the schwa vowel. The acoustic diagrams demonstrate the expected centralisation in the positions of unstressed vowels; overlap between the positions of schwa and of the other vowels (with the exception of /i/) can be seen. In the unstressed syllables no productions of /o/ were observed; /ä/, which in unstressed syllables occurred only in few tokens produced by some informants, was not included in the diagrams.

Figure 5a shows that the unstressed syllable vowels of phrase-final words tended to move towards the centre of the vowel space. Unstressed /i/, compared to the stressed variant, was lowered. Front /e/ and back /u/ moved towards the centre while /a/ was raised and fronted. Unstressed /e/ (which, in fact, was a realisation of schwa in an open word-final syllable, as noted above) appeared to be moving towards the centre of the vowel space. The positions of central /a/ and /ə/ overlapped to a considerable extent. This is in accordance with the preliminary observations of the segmental composition of the test material: the schwa vowel

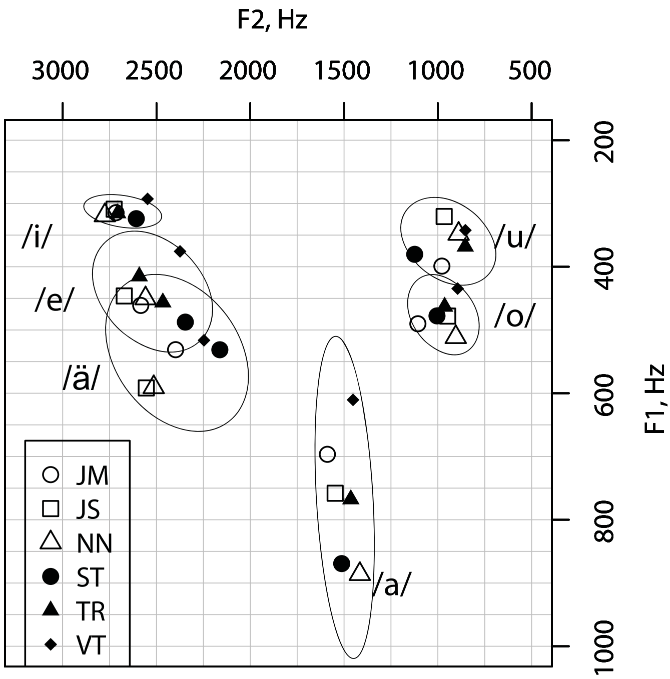


Figure 4a. Acoustic vowel diagram (values in Hz): vowels of the stressed first syllable in phrase-final words produced by the female speakers (JM, JS, NN, ST, TR, VT).

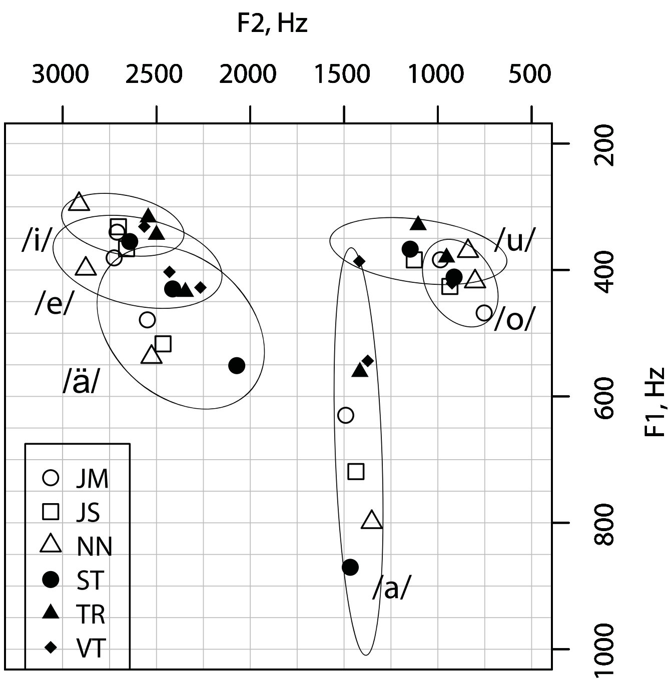


Figure 4b. Acoustic vowel diagram (values in Hz): vowels of the stressed first syllable in sentence-final words produced by the female speakers (JM, JS, NN, ST, TR, VT).

in word-final syllables was realised as a vowel similar to /a/. On the other hand, unstressed /a/ in some instances was heard as a reduced vowel.

The positions of unstressed vowels for the sentence- and phrase-final words were comparable in that centralisation was displayed as the major tendency in both sentence positions. The sentence-final position in its turn produced the effect of rising. As seen from Figure 5b, there was a slight rise in the positions of /ə/, /a/, and /u/, in relation to the positions of these vowels in the phrase-final words (Figure 5a). A narrower vowel space can be observed in the diagram for the sentence-final words than for the phrase-final ones.

The combined results on the vowel qualities observed in relation to the factors of stress and sentence position are illustrated in Figure 6. The stressed and unstressed vowels (marked in the diagram by filled and unfilled symbols, respectively) occupied different positions. The unstressed /e/, /u/, and especially /a/ moved towards the centre of the vowel space, while the stressed vowels were peripheral in relation to the unstressed vowels. Centralisation was displayed as the major effect produced by the unstressed position on the quality of vowels.

The effects produced by sentence position on the vowel qualities were not as uniform as the effects of unstressed position. In the vowel space (Figure 6), the vowels of sentence-final words were higher than those of the phrase-final ones (compare the positions of stressed /ä/, /a/, /o/ as well as those of unstressed /e/, /ə/, /a/, /u/). The stressed /a/, /o/, and /u/ in sentence-final words were also slightly retracted in relation to the variants observed in phrase-final words.

Focusing on the effects of stress on the vowel qualities, variation in the F1 and F2 values of the vowels was considered. Figure 7 shows the averaged F1 and F2 values, with standard deviations, of vowels produced in stressed and unstressed syllables (indicated with filled and unfilled symbols, respectively). Among the vowels of stressed syllables, the formant values for /i/ and /o/ varied least of all. The F2 values for /i/ varied in the unstressed syllables more than in the stressed ones. A considerable amount of variation was observed in the formant values of unstressed /e/, a vowel produced in open word-final syllables. It occupied a position closer to the stressed /e/ than to the schwa but tended to centralise and exhibit large variation in both F1 and F2 values. Stressed /ä/ was more variable than stressed /e/ but it varied less than the unstressed /e/.

A considerable amount of variation, especially in the F1 values, was displayed by the stressed /a/. The unstressed /a/, which also varied, was more advanced and higher than the stressed variant. It moved to the space occupied by schwa. As mentioned above, the realisations of the variants of schwa and of unstressed /a/ in open word-final syllables were perceived to be similar; details concerning the variants of these (and other) vowel segments require a thorough analysis in further research. Both stressed and unstressed /u/ showed greater variation in the F2 than in the F1 values; unstressed /u/ tended to be centralised. Expectedly, the centre of the F1-F2 space was occupied by the schwa, which displayed equally large variation in the F1 and F2 values.

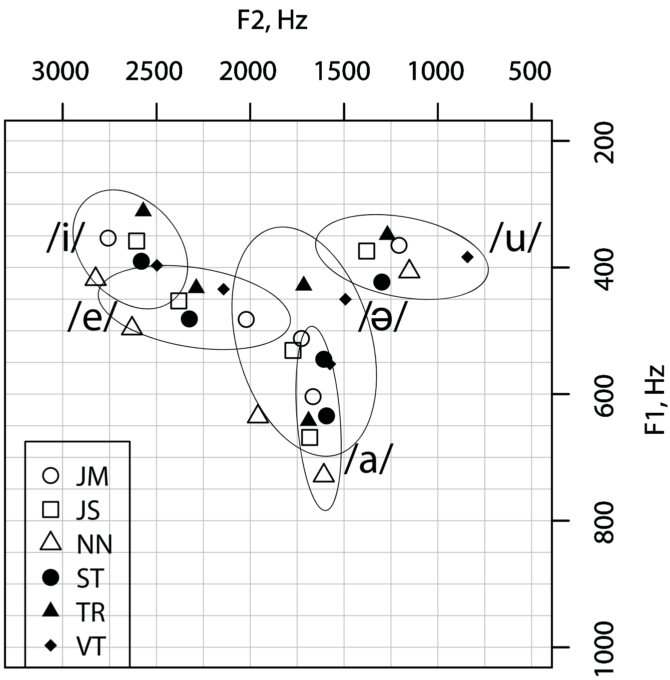


Figure 5a. Acoustic vowel diagram (values in Hz): vowels of the unstressed second syllable in phrase-final words produced by the female speakers (JM, JS, NN, ST, TR, VT).

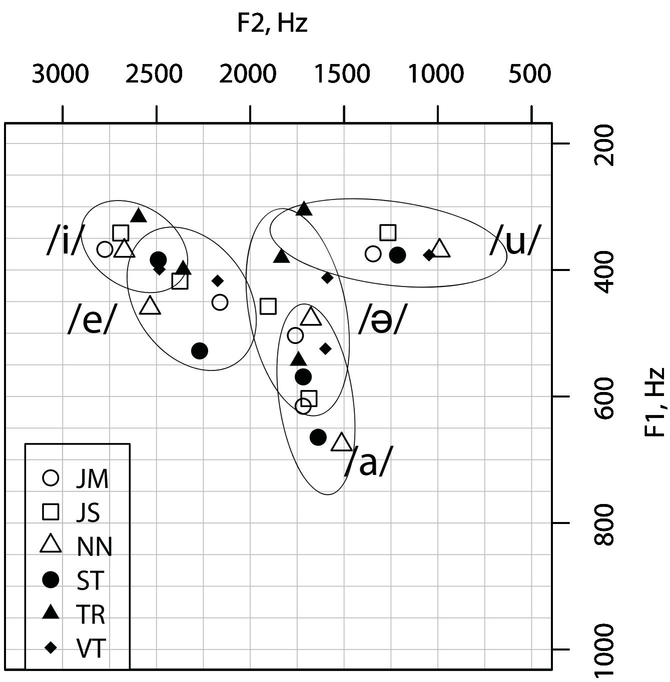


Figure 5b. Acoustic vowel diagram (values in Hz): vowels of the unstressed second syllable in sentence-final words produced by the female speakers (JM, JS, NN, ST, TR, VT).

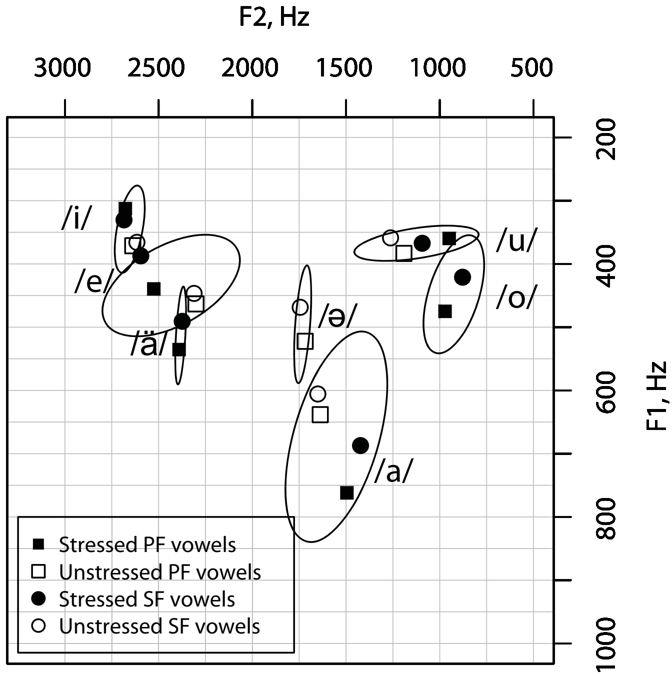


Figure 6. Acoustic vowel diagram, combined data (values in Hz): vowels of the stressed first and unstressed second syllables in phrase- and sentence-final (PF, SF) words produced by the female speakers (JM, JS, NN, ST, TR, VT).

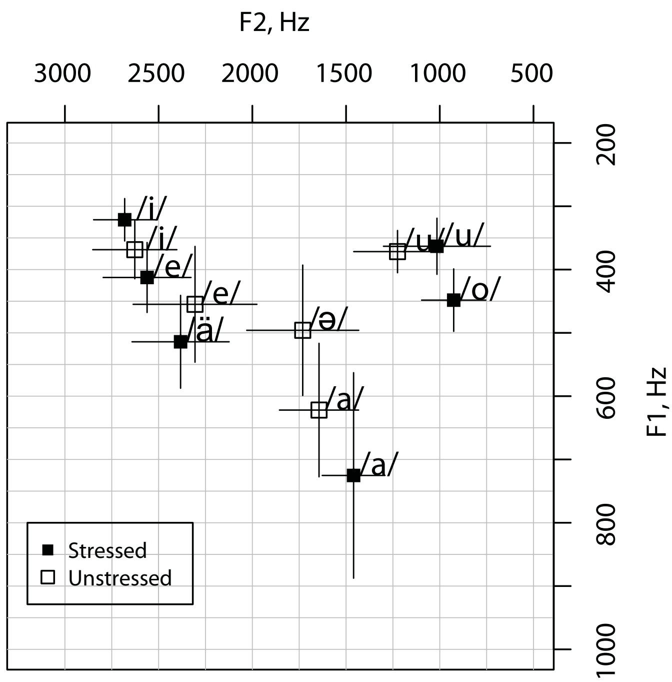


Figure 7. Average formant values of vowels in stressed and unstressed syllables, with standard deviations (values in Hz): productions of the female speakers (JM, JS, NN, ST, TR, VT).

### 3.3.2.2. Vowels in the productions of male informants

The mean F1 and F2 values for the vowels observed in the productions of the male speakers (IS and NM) are shown in Figures 8–11. Analogous to the previous part of the analysis, the quality of vowels was evaluated in relation to the factors of stress and sentence position. The acoustic diagrams in Figures 8–9 show the mean F1 and F2 values in the two speakers' productions of stressed and unstressed syllable vowels observed in phrase- and sentence-final words. Figure 10 illustrates the combined results on the formant values of the vowels in relation to the factors of stress and sentence position. In Figure 11, the formant values in the stressed and unstressed vowels, with the standard deviations, are shown.

The positions of the stressed vowels produced in phrase-final words (Figure 8a) were well differentiated in the diagram. The vowel space for the productions of NM was narrower than for the productions of IS; accordingly, the front and central vowels in the productions of NM were retracted in relation to the vowels produced by IS. In the productions of NM, /ä/ was central and significantly lower than in the productions of IS (and of the female speakers). It moved towards the position of /a/, which in the male informants' productions was realised as a back vowel (IS, though, had a more advanced /a/ than NM). As shown above, /a/ was realised as a central vowel by the female speakers. The positions of /u/ and /o/ in the productions of the two speakers differed least of all: the vowels had somewhat higher positions in the productions of NM than in those of IS.

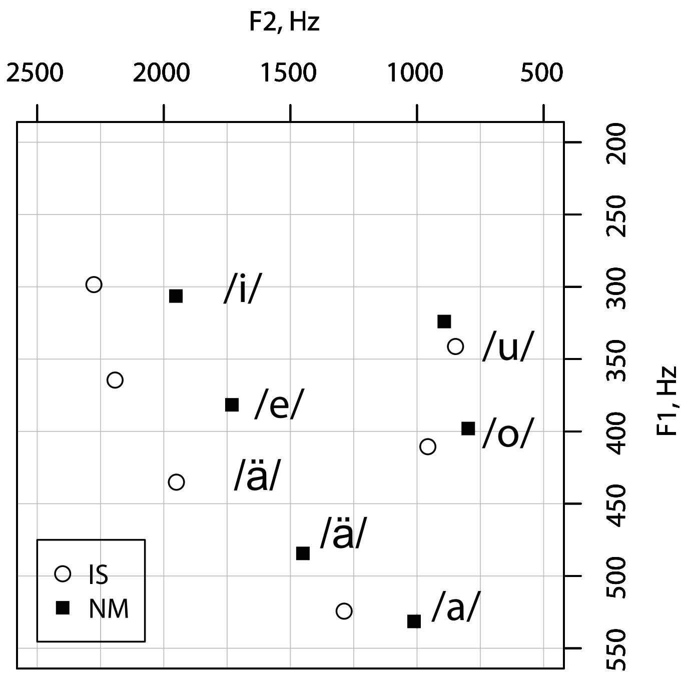


Figure 8a. Acoustic vowel diagram (values in Hz): vowels of the stressed first syllable in phrase-final words produced by the male speakers (IS, NM).

The sentence-final position (Figure 8b) produced the same effect as was observed in the results for the female speakers – the vowels were somewhat higher than in the phrase-final words. There was a rise in the positions of /i/ and /e/, especially noticeable in the results of NM. The positions of /ä/ in the productions of both male speakers were also higher in the sentence-final words than in the phrase-final ones. In the productions of IS, /ä/ and /e/ had close positions but in the productions of NM the positions of the two vowels were clearly apart. A rise was observed in the positions of /a/; moreover, /a/ produced by IS was more retracted than in phrase-final words and moved close to the position of NM's /a/. The formant values of the back vowels, especially those of /u/, were influenced by sentence-final position least of all.

The formant values of vowels produced in unstressed syllables (Figures 9a and 9b) displayed a tendency towards centralisation; the vowel space occupied by the unstressed vowels was narrower than that occupied by the stressed vowels. The acoustic diagrams show that the central part of the vowel space was occupied by the schwa vowel and the positions of the other vowels moved towards the centre.

Unstressed /i/ in the productions of NM moved towards the centre but in the productions of IS it was lower compared to the stressed variant. Unstressed /e/ occupied a central position in both phrase- and sentence-final words produced by NM but it moved towards the centre and was lowered in the productions of IS.

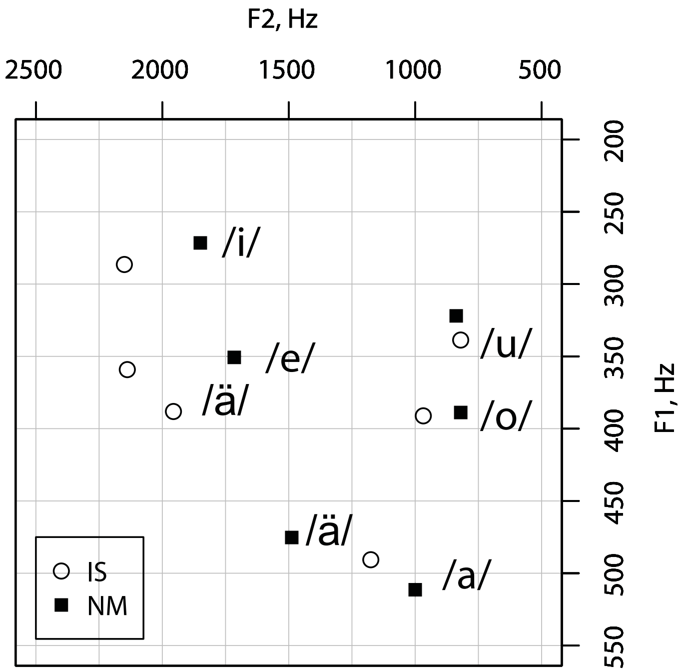


Figure 8b. Acoustic vowel diagram (values in Hz): vowels of the stressed first syllable in sentence-final words produced by the male speakers (IS, NM).

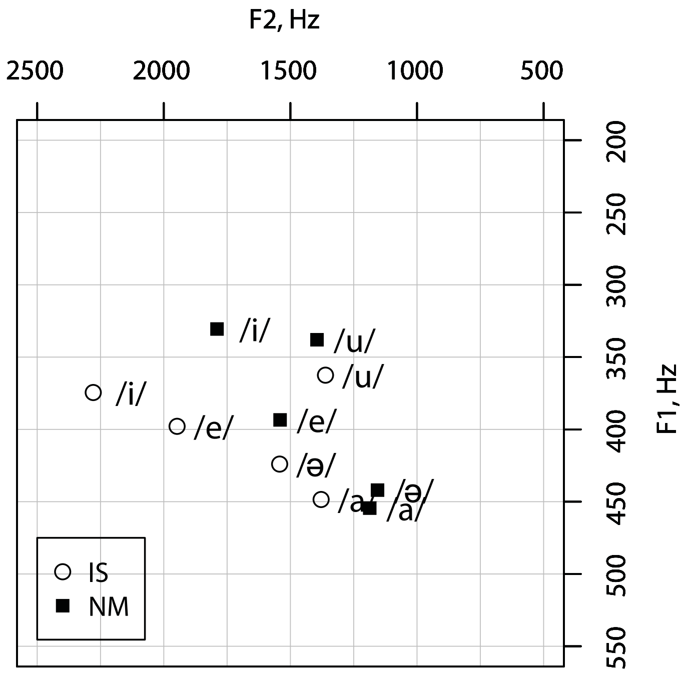


Figure 9a. Acoustic vowel diagram (values in Hz): vowels of the unstressed second syllable in phrase-final words produced by the male speakers (IS, NM).

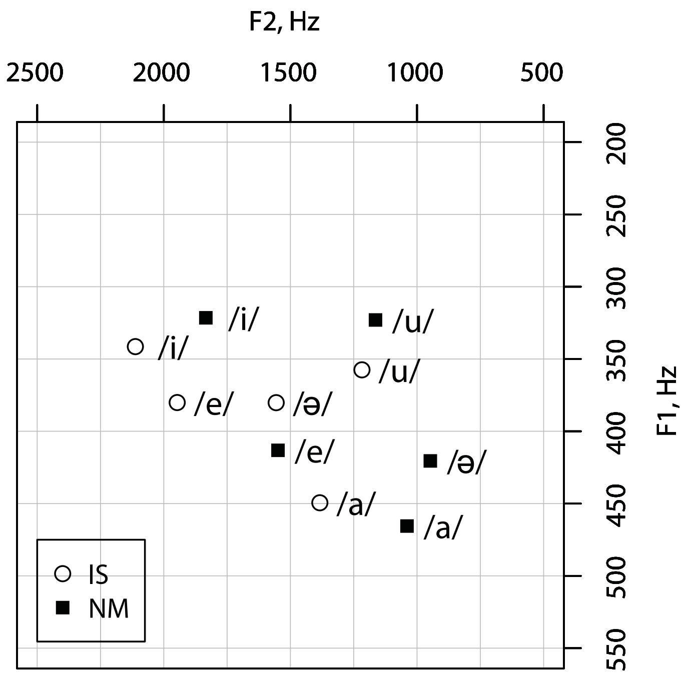


Figure 9b. Acoustic vowel diagram (values in Hz): vowels of the unstressed second syllable in sentence-final words produced by the male speakers (IS, NM).

Unstressed /a/ was centralised: in the phrase-final words it was higher and advanced in relation to the variant produced in stressed syllables. In sentence-final words, unstressed /a/ produced by speaker NM was retracted in relation to the position of the stressed /a/. In the productions of speaker IS a more advanced /a/ was observed than in the productions of NM.

A salient difference was found between the quality of the schwa in the productions of the two speakers. IS produced /ə/ as a central vowel in both phrase- and sentence-final words, while the positions of /ə/ were close to those of /a/ in the productions of NM. In the productions of NM, /ə/ was higher in the sentence-final words than in the phrase-final words.

The back vowel /u/ in the productions of both speakers exhibited a greater extent of centralisation in the unstressed syllable of the phrase-final words; in the sentence-final position /u/ was retracted and slightly raised.

The combined results on the mean F1 and F2 values of vowels observed in the stressed and unstressed syllables of phrase- and sentence-final words are illustrated in Figure 10. In the acoustic diagram, the positions of unstressed /e/, /u/, /a/ are shifted towards the centre of the vowel space (unstressed /i/ was also lowered and /a/ was raised), while the vowels of stressed syllables occupied peripheral positions in relation to the unstressed syllable vowels. The effect of sentence position was mainly manifested by a rise: the vowels produced in the sentence-final words had higher positions than the vowels of phrase-final words.

The rise in the positions of vowels was observed in both stressed and unstressed vowels; /u/ and /a/ in the sentence-final words also tended to be retracted in relation to the variants observed in phrase-final words.

The mean F1 and F2 values for the vowels, with standard deviations, pooled across the male speakers' results (Figure 11) show variation observed in the productions of stressed and unstressed vowels (filled and unfilled symbols, respectively, in the diagram). Among the vowels of stressed syllables, /u/ and /o/ varied least of all. The vowel /a/ displayed considerable variation in the F1 values, while variation of the F2 values was more salient in /ä/. The vowels of unstressed syllables, /e/, /u/, and especially schwa, showed considerable variation in the F2 values.

The combined results on the F1 and F2 values for the vowels showed that the quality of *i* and *o* observed in the stressed position varied less than the quality of the other vowels in both the male and female speakers' productions. The quality of *u* in stressed syllables was more variable in the female speakers' productions, while unstressed *u* tended to be centralised in the productions of both groups of speakers. The F2 values of *u* varied more than the F1 values (supposedly due to the effects of the neighbouring palatalised and non-palatalised consonants). The front vowel *e* in the male and female speakers' productions displayed considerable variation in the F1 and F2 values for both stressed and unstressed positions; unstressed *e* was centralised. The front vowel *ä*, which also displayed variable F1 and F2 values, in the productions of the male speakers was retracted in relation to the positions of *ä* in the female speakers' productions. There were noticeable differences between the quality of *ə* and *a* observed in

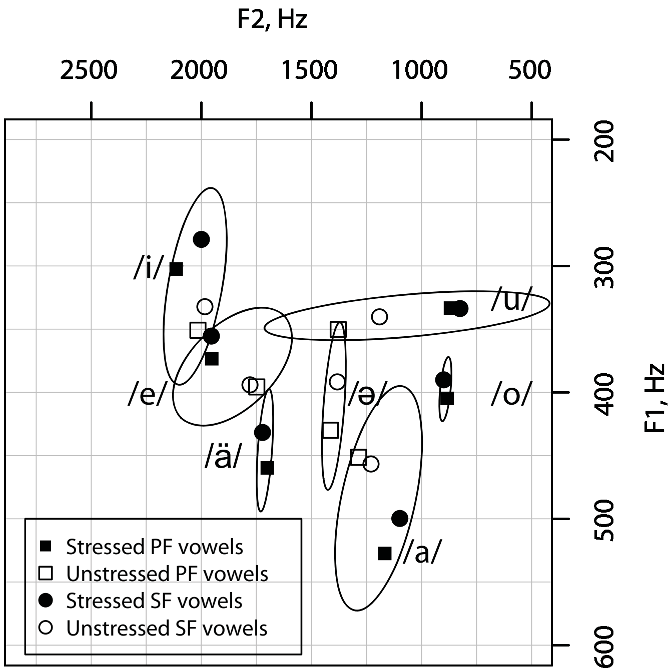


Figure 10. Acoustic vowel diagram, combined data (values in Hz): vowels of the stressed first and unstressed second syllables in phrase- and sentence-final (PF, SF) words produced by the male speakers (IS, NM).

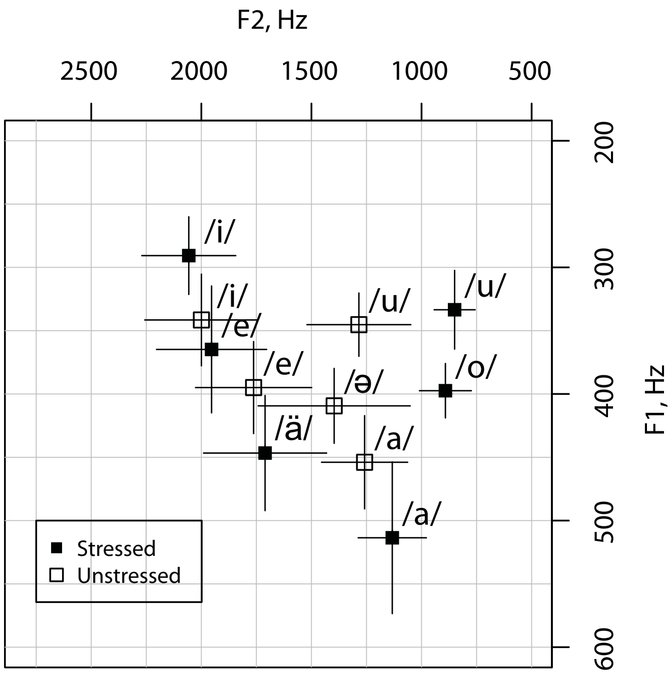


Figure 11. Average formant values of vowels in stressed and unstressed syllables, with standard deviations (values in Hz): productions of the male speakers (IS, NM).

the male and female speakers' productions. The positions of the two vowels in the vowel space for the male speakers' productions were retracted in relation to those for the female speakers' productions.

With the specific characteristics mentioned above, the pooled results observed for the productions of the female speakers and those of the male speakers (as illustrated in Figures 6–7 and Figures 10–11, respectively) can be considered to be analogous. The quality of vowels in the subsets of disyllabic words produced in phrase- and sentence-final positions displayed differences that can be attributed to the influence of stress, on the one hand, and the influence of sentence position, on the other hand.

In unstressed syllables, the occurrence of the schwa vowel and a tendency towards centralisation in the position of the other vowels within the F1–F2 space were systematically observed. As expected, the schwa occupied the central location in the F1–F2 space.

The effects of sentence position on the quality of vowels were not uniform and less salient than those of stress. The phenomenon of rising in the position of the vowels of sentence-final words was steadily manifested in the results; it can also be mentioned that the central and back vowels of sentence-final words in the vowel space had retracted positions in relation to the vowels of phrase-final words.

### 3.3.2.3. Summary

The analysis of vowel qualities in the female and male speakers' productions had the primary aim of establishing the phonetic manifestations of the effects of stress in the formant values of vowels. Observations were made of disyllabic words produced with word-initial stress.

The results showed that there were considerable differences between the quality of the vowels that occurred in the stressed and unstressed syllables. The vowels of stressed syllables were well differentiated in the vowel space. The positions of the unstressed syllable vowels tended to be centralised, with the centre of the vowel space occupied by the schwa vowel. The phenomenon of centralisation was clearly observable across the results on all the speakers' productions. It is highly probable that the reduction of vowels, exhibited as the centralisation of the formant values of the vowels in unstressed position, alongside with vowel duration differences (described in 3.3.1.), serves to distinguish a stressed syllable from an unstressed one.

The quality of vowels also showed a certain amount of variation that can be attributed to the influence of sentence position. Both stressed and unstressed vowels of sentence-final words, in relation to the vowels of phrase-final words, displayed a rise in the positions within the vowel space. The central and back vowels of sentence-final words, in relation to the vowels of phrase-final words, were also slightly retracted. The effects of sentence position, contrary to those of stress, were not manifested in a uniform way.

No comparison of vowel qualities for open and closed syllables was included in the analysis; however, observations of the formant values in some vowels may suggest that open syllables caused expected variation. As mentioned above, in word-final open syllables the schwa alternated with *e* and *a*, while *a* tended to be reduced. According to the results of the acoustic analysis, *e* and *a* that occurred in unstressed syllables, also *ə*, showed large variation, which is feasible to be related to the effects of word-final open syllable.

Variation in the F2 values of the vowels observed in both stressed and unstressed positions might be explained by the effects of the neighbouring palatalised and non-palatalised consonants. Considerable variation was displayed, for example, by the schwa vowel. The variability of F2 in the schwa has been emphasised by Estill (2011) in a publication that presented measurement results on the formant structure of this vowel. Observations were made of the allophones of schwa that occurred after palatalised and non-palatalised consonants. Previously, the mean F2 values for the allophones of schwa observed after a palatalised and a non-palatalised consonant (in the speech of a male speaker from the Central dialect area) were shown to be 1410 Hz and 1200 Hz, respectively (Sovijärvi 1963: 564–565). These results are comparable to the findings of the analysis presented above.

Taking into account the observations of the disyllabic words produced with word-initial stress, it is possible to outline the general characteristics of the sub-systems of vowels that occurred in the stressed and unstressed syllables. The vowels of the initial stressed syllable included /i/, /e/, /ä/, /u/, /o/, /a/. Among the six segments, /ä/ was found to be unstable – it tended to be substituted by /e/. As to quality, overlap was observed between the formant values of /ä/ and /e/ in the inter- and intra-speaker productions.

The number of full vowels that occurred in the unstressed second syllable was reduced: *i*, *u*, and *a*; the occurrence of *ä* in this position may have been due to the change *a* > *ä* under the influence of neighbouring palatalised consonants. The sub-system of vowels of the unstressed syllable includes the schwa, the occurrences of which were regular in the material observed. Moreover, the vowels *a* and *u* (to some extent, also *i*) displayed the tendency towards centralisation.

An assumption can be made that vowel reduction in Moksha might also be morphologically conditioned, as the vowels of unstressed second syllables belong either to the stem or a morpheme beyond the stem. In some of the varieties of Erzya that display, similarly to Moksha, patterns of unstressed vowel reduction, vowels in the unstressed second syllable were found to be shorter in suffixes than in the stem (Aasmäe, Ross 2007). Concerning Moksha, this aspect of vowel reduction awaits analysis. Considering the fact that *i* and *u* occur in syllables beyond the stem, the sub-system of unstressed vowels is conceivably reduced to two principal segments, *ə* and *a*: e.g. *śiśəm* 'seven', *pil′ə* 'ear', *jalga* 'friend'. The realisations of *ə* and *a* in word-final open syllables tended to be realised as reduced *a*: *jalgə*, *jalgă* 'by foot'; *jalga*, *jalgă* 'friend'. The vowel *a* in a closed unstressed syllable, e.g. *maksat* 'you give', was also heard as more or less reduced. A detailed analysis of the quality of *i*, *u*, and especially *a*, from this perspective, might yield interesting results for the description of vowel reduction in Moksha.

Of the two mid vowels, *o* and *e*, the first did not occur in the unstressed second syllable. As to *e*, characteristics similar to those of the full vowel were displayed by the schwa, due to the effect of the word-final open syllable, e.g. *pil′ə*, *pil′ĕ* 'ear'. In the vowel space, the unstressed *e* was clearly centralised. Concerning trisyllabic words (which were not included in the analysis of vowel qualities), it can be assumed that word-final *e*, as in *kotəće* 'the sixth', would exhibit the quality of a full vowel if secondary stress is located on the third syllable.

In longer words, vowel distributions might be subject to the effect of additional stresses, as in [*kundăńd′äŕăsamăk*] 'if you catch me' (with stresses on odd-numbered syllables) and [*kundańd′əŕasămak*] (with stresses on even-numbered syllables); both versions were observed in the test material. The factor of additional stress has not been hitherto taken into account in the examination of the vowel distributions in Moksha.

There seem to be reasons to differentiate between two subsets of vowels for the unstressed non-initial syllables – one constituted by the schwa and /a/, the other including the cardinal vowels /i/, /u/, and /a/. The latter subset is presumably valid for contexts beyond the stem: *pit′ńi* 'expensive' (Erzya *pit′ńej*), *vät′i* 'leads', *ved′u* 'watery' (Erzya *ved′ev*), *maksat* 'you give', while the former functions within the stem: *pit′ńə* 'price' (Erzya *pit′ńe*), *lomań* 'person'. The subsystems of vowels thus defined can be expected to function within the disyllabic foot rather than the word – historically, the stem in Finno-Ugric languages was predominantly disyllabic. The high vowels /i/ and /u/, as noted before, are not permitted in a non-initial syllable of the stem in Erzya and Moksha; however, they may follow a monosyllabic stem (which, originally, may have been disyllabic). Low /a/ has no restrictions in non-initial syllables; it appears in both subsets.

A comment is required concerning inter-speaker variation, especially with respect to the realisations of the vowels /ä/ and /a/. The two vowels have been considered to be involved in vowel harmony as the members of opposition between the front and back vowels. In the acoustic analysis, the formant values of /a/ were found to differ in the male and female speakers' productions: /a/ turned out to be central in the pronunciation of the female speakers while the male speakers tended to produce it as a back vowel. In a recent publication on Moksha, the acoustic diagrams of vowels show that /a/ in the male informants' productions was retracted in relation to the positions of the female informants' /a/ (Fournet 2010: 262–263). Inter-speaker differences between the positions of /a/ in the vowel space have been also mentioned in the observations of Erzya (see Lehiste et al. 2003: 62–67). The positions of /ä/, as seen in the acoustic diagrams, showed overlap with those of /e/ in a part of the material; nevertheless, in the major part of the observations /ä/ was clearly lower than /e/. In the productions of a male informant (NM), /ä/ had F1 values nearer to those of /a/ than /e/. Sources of variation in the quality of the two vowels might be complex, including second language influence.

The system of vowels, according to the present observations can be characterised as unstable. Among the front vowels, /ä/ displayed irregular distributions and considerable overlap with /e/; the back vowel /o/ was available only in stressed syllables, /i/ and /u/ only in suffixes. The presence of schwa and the centralisation of /a/ (also of /u/ and /i/) in the unstressed syllable can be considered the most salient features of the system.

### 3.3.3. Fundamental frequency

Contrastive fundamental frequency, as noted above, does not function at word level in the Mordvin languages. In view of the results of acoustic analyses which showed the potential role of vowel durations and quality in distinguishing a stressed syllable from an unstressed one, fundamental frequency cannot be expected to be important as a correlate of stress in Moksha, either. Furthermore, analyses of the fundamental frequency as a cue of stressedness have been contradicted in the theory of prosody (cf. Sluijter and van Heuven 1996). The main argument against this approach has been that pitch movement is "the correlate of accent, rather than lexical stress" (Sluijter and van Heuven 1996: 2471; see also Gussenhoven 2005: 17–25). In an article by K. Suomi and R. Ylitalo (2004) this argument has been supported by an analysis of word stress in Finnish.

In this investigation of Moksha, a language that has been described in terms of acoustic phonetics only fragmentarily, the primary task of eliciting the pitch curves for the test words was to define the values of fundamental frequency (F0), the frequency of vocal fold vibration, on the stressed and unstressed syllables of the words. (According to the definition given in Lehiste 1976: 229–230, the terms *fundamental frequency* and *pitch* refer to "the acoustic correlate of vocal fold vibration" and "the perceptual correlate of frequency", respectively.) Data of fundamental frequency were also expected to yield evidence of the realisations of the test words as rhythmic feet.

Observations were made of phrase-final and sentence-final words. Consequently, the results on the fundamental frequency contours were expected to differ, primarily, due to the difference in the intonation within the two parts of the carrier sentences. The rising contour for the phrase-final words and the falling contour for the sentence-final words were expected to be realised as the general tendencies of sentence intonation.

Observations of the F0 contours were based on subsets of words consisting of 2 to 6 syllables produced alternatively with initial and non-initial stress. Fundamental frequency was measured in the beginning and at the end of every syllable rhyme. The results, which were based on the productions of six female and two male informants, are demonstrated in Figures 12–23; the F0 values for each speaker's productions are given in Tables 1–6 (Appendix 3-III).

To illustrate variation in the inter-speaker results, first, the F0 contours observed in the productions of disyllabic words by each of the eight informants are shown (Figures 12–13). Further, the tendencies of F0 movement on the test words are demonstrated as results pooled across the productions of the male and female speakers (Figures 14–23). In each figure, F0 contours are shown for the subsets of words produced with initial versus non-initial stress. The symbols $V_n$b and $V_n$e in the figures refer to the F0 values measured in the beginning (b) and the end (e) of each vowel ($V_n$) in a syllable (the number of syllables in a word was 2 to 6).

### 3.3.3.1. Disyllabic words

The F0 contours for the productions of disyllabic words, e.g. *lomań* ‘person’, *śeľme* ‘eye’ (Figures 12–13), displayed a salient difference, firstly, between the male and female informants’ results. The male informants’ productions of the words in both sentence positions mostly showed level or nearly level contours. In the productions of the female informants, distinct rising and falling contours were also observed. The female speakers produced the phrase-final words with a rise on the stressed first syllable and a fall on the unstressed second syllable (Figure 12, left panel). In the subset of words with non-initial stress (Figure 12, right panel), the unstressed first syllable had a falling or almost level contour in both male and female speakers’ productions, while there was considerable variation of contours on the stressed second syllable. Some of the female speakers produced the words with a salient rising F0 contour on the stressed second syllable. The other informants’ productions showed a falling or a level contour. The results for the sentence-final position (Figure 13) displayed less variation in the inter-speaker F0 contours. With some exceptions, the movement of the F0 curves was uniform: on both the stressed and unstressed syllables there were falling or nearly level curves.

It can be noted that inter-speaker variation in the F0 contours mostly concerned the female speakers’ productions of the phrase-final words, in which stress was located on the second syllable. The stressed syllable in these words tended to be realised mostly with a rise, but some female (and all the male) informants had a fall.

As far as the male speakers’ results are concerned, it can be mentioned that there was little variation in the F0 contours for the phrase- and sentence-final words. In both speakers’ productions, falling contours were observed on the phrase-final words (Figure 12). The productions of sentence-final words by NM (Figure 13, left and right panels) showed a rising contour. In the words produced by IS (Figure 12), the F0 values on the unstressed first syllable, right panel) were somewhat higher than on the stressed first syllable (left panel).

In figures 14–23, the pooled F0 results on the male and female speakers’ productions are illustrated. Figures 14 –15 show the averaged results obtained on the disyllabic words. The male speakers’ productions had level or nearly level F0 contours on the stressed and unstressed syllables of the words in both sentence positions. The unstressed first syllable of the phrase-final words (Figure 14, right panel) showed higher F0 values compared to those of the sentence-final words. In the female speakers’ productions of the phrase-final words, a rising contour was observed on the stressed (first and second) syllables (Figure 14, left and right panels).

In the sentence-final words (Figure 15), the female informants had falling or level contours on both the stressed and unstressed syllables. The F0 values on the unstressed first syllable (right panel) were somewhat higher than on the stressed first syllable (left panel) in the female spearkers’ productions. The male speakers’ productions did not show noticeable rising or falling contours.

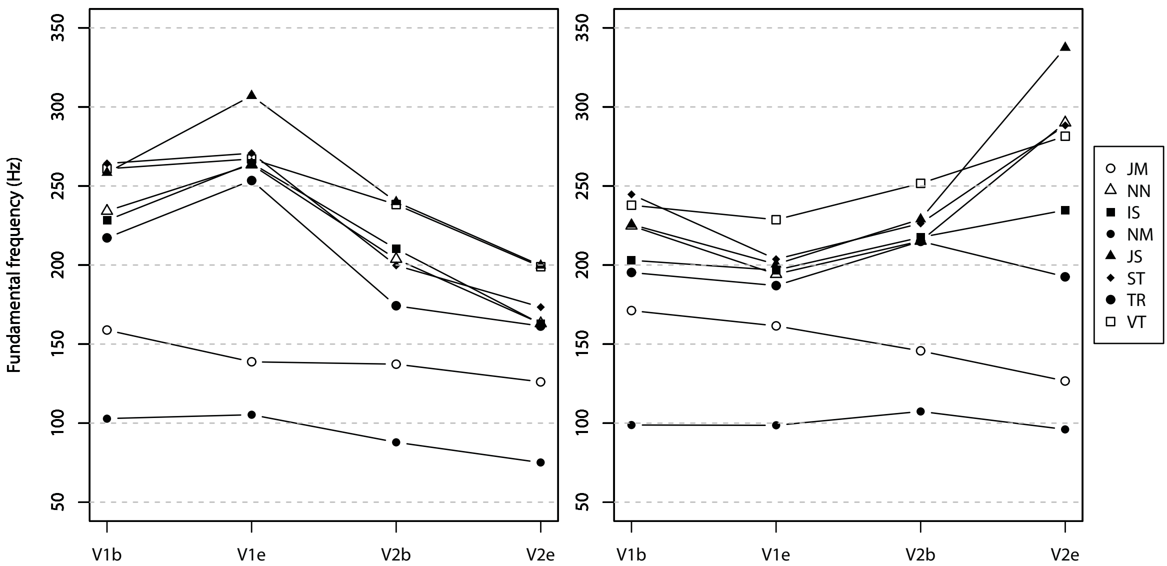


Figure 12. Inter-speaker Fo contours: disyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in phrase-final position.

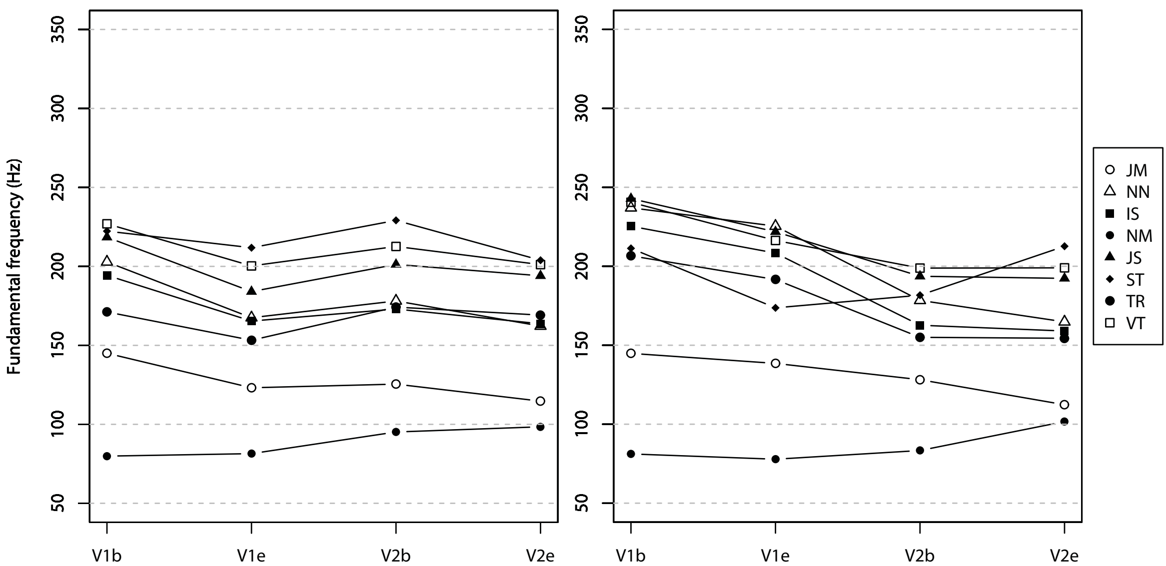


Figure 13. Inter-speaker Fo contours: disyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in sentence-final position.

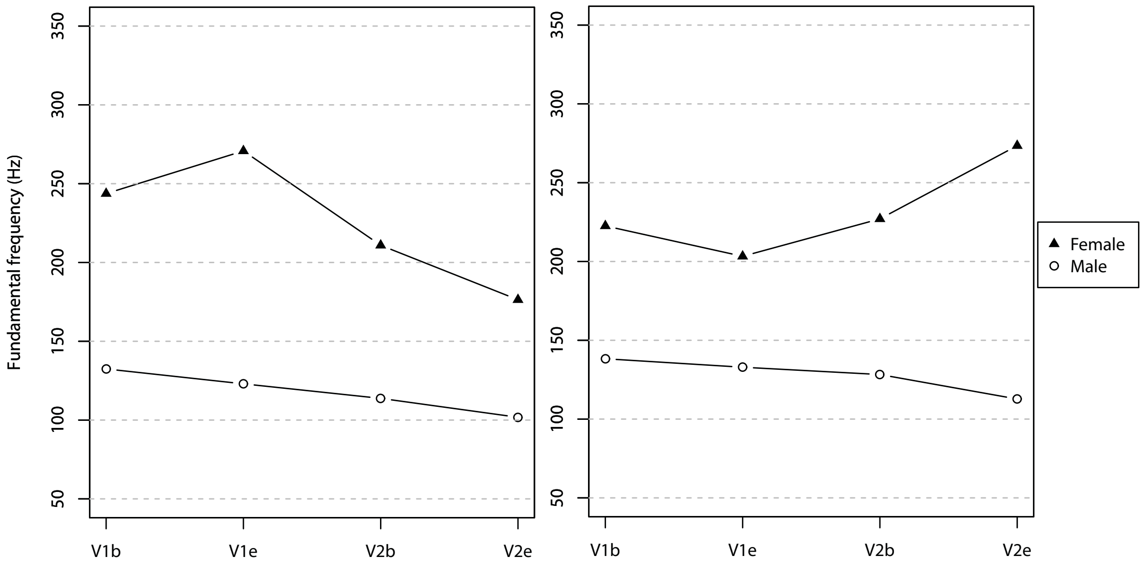


Figure 14. Fo contours, combined data: disyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in phrase-final position.

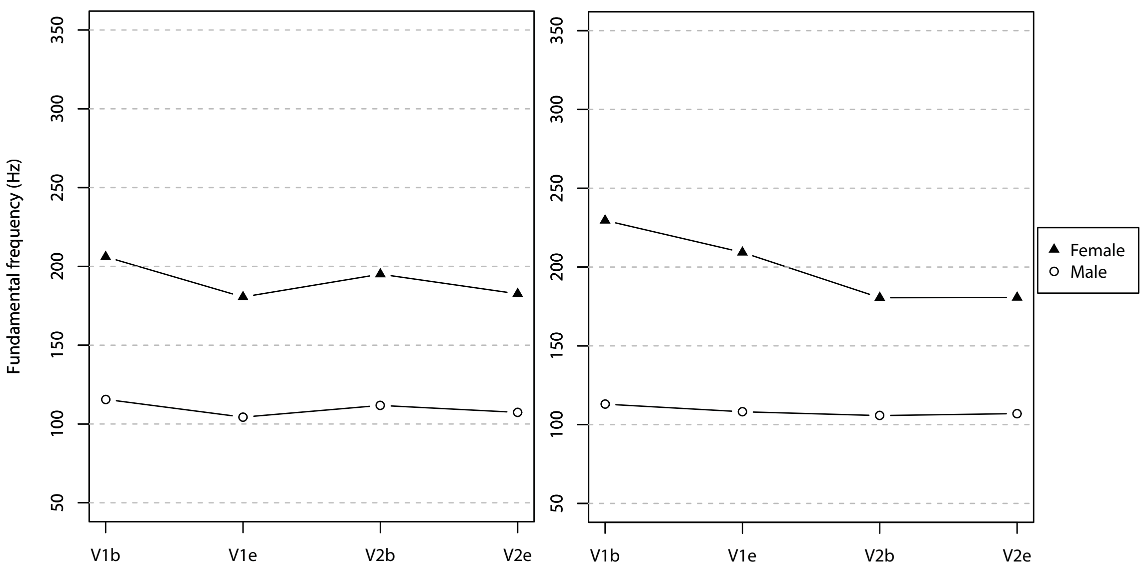


Figure 15. Fo contours, combined data: disyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in sentence-final position.

The averaged F0 contours for the two sentence positions displayed variation – rising, falling, and level contours were observed on the male and female speakers' productions of both phrase- and sentence-final words. Higher F0 values on the stressed syllable was observable as a general tendency, mainly displayed in the female speakers' productions.

#### 3.3.3.2. Trisyllabic words

The F0 contours on stressed and unstressed syllables in trisyllabic words, e.g. *kundal'iJt'* 'you would like to catch it', *ardəma* 'ride' (Figures 16–17), in which stress(es) were located either on the first and third syllables or on the second syllable, did not principally differ from those in disyllabic words. In the productions of the male speakers, a level or nearly level contour dominated; a falling contour was observed on the productions of the words with non-initial stress (Figure 17, right panel).

In the female speakers' productions, the realisation of fairly distinct rising and falling contours was observed on the phrase-final words (Figure 16). The stressed (first or second) syllable had a rising contour and higher F0 values than the unstressed syllable that followed. In the sentence-final position falling contours on both stressed and unstressed syllables dominated in the male and female speakers' productions. It can be noticed that, similarly to the results for disyllabic words, the unstressed first syllable of trisyllabic words (Figure 17, right panel) tended to have higher F0 values than the stressed first syllable (Figure 17,

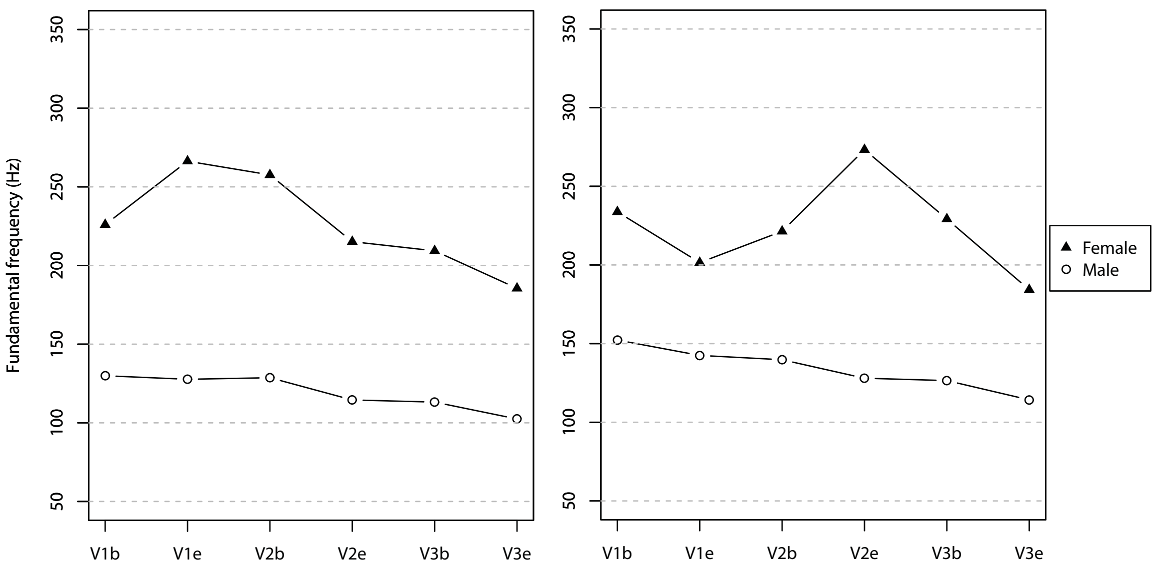


Figure 16. F0 contours, combined data: trisyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in phrase-final position.

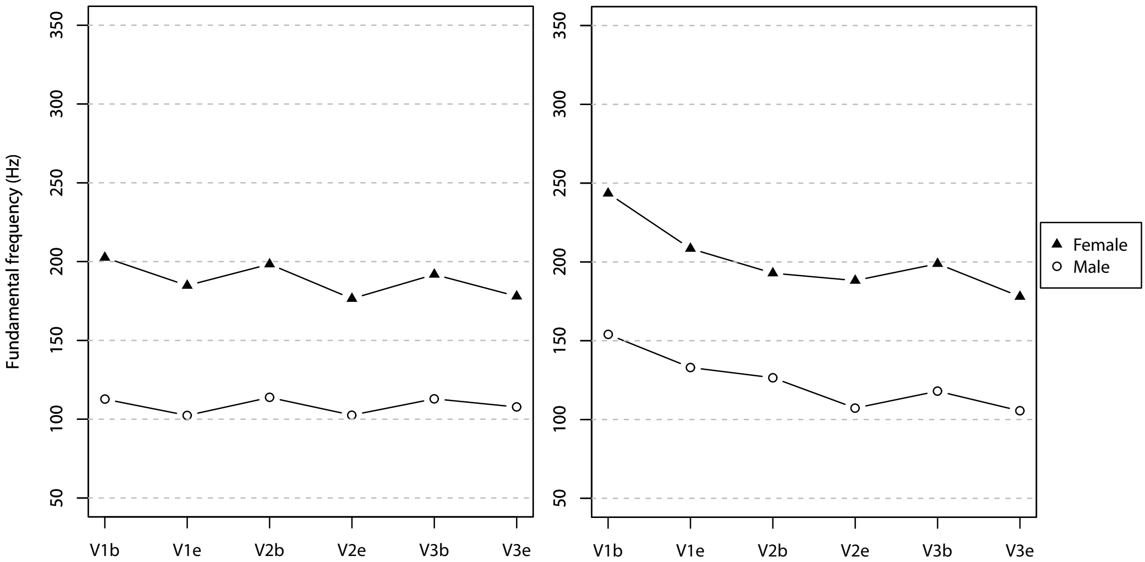


Figure 17. Fo contours, combined data: trisyllabic words with stress on the first syllable (left panel) and on the second syllable (right panel) in sentence-final position.

left panel). The F0 contours revealed the realisations of the prosodic feet – a disyllabic foot followed by a one-syllable foot (left panel) and a disyllabic foot preceded by a one-syllable foot (right panel). There are outlines of the disyllabic feet discernible in the curves.

### 3.3.3.3. Polysyllabic words

The F0 contours on polysyllabic words are illustrated in Figures 18–23. There were subsets of four-syllable words, e.g. *kundasamak* ‘you (will) catch me’ (Figures 18 and 19), that had stresses on odd-numbered syllables (left panel) and even-numbered syllables (right panel). The F0 curves were indicative of the realisations of the rhythmic feet. Higher F0 values and a rising F0 contour distinct in the female speakers’ productions of the phrase-final words (Figure 18) were, to all appearances, displayed by the syllable that had primary stress (the first syllable in the left panel and the second syllable in the right panel). The male speakers’ productions showed almost level contours, however, the outlines of the disyllabic feet were discernible in the curves. There were differences in the F0 values on the subsets of words produced with initial and non-initial stress in phrase- and sentence-final position. The words that had stresses on even-numbered syllables showed higher F0 values than the words with stresses on odd-numbered syllables. This difference was observed on the male speakers’ productions of the phrase-final words (Figure 18) and on the female speakers’ productions of the sentence-final words (Figure 19). The observed manifestations of fundamental

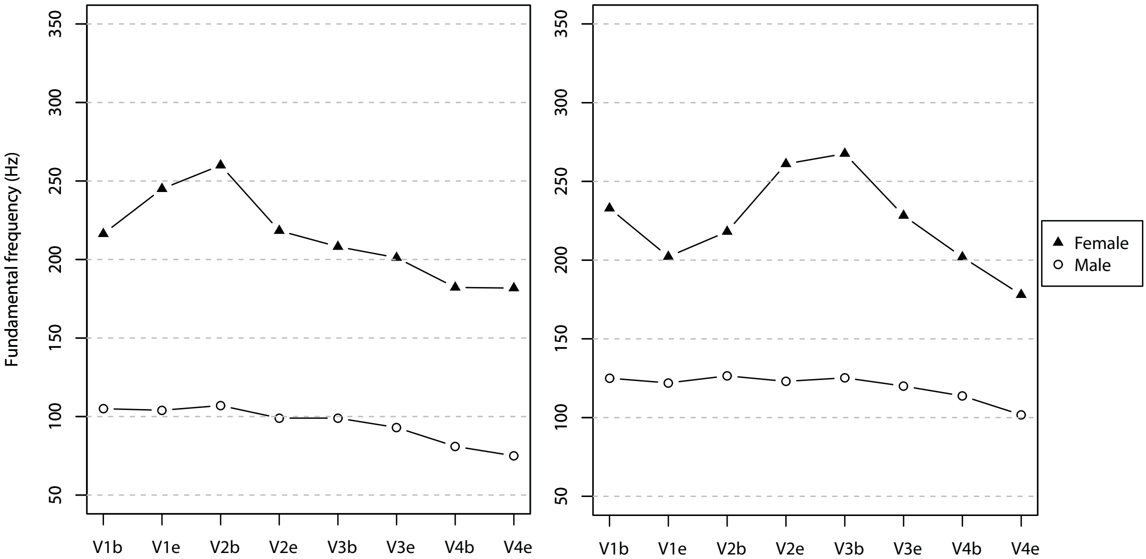


Figure 18. Fo contours, combined data: four-syllable words with stress on the first syllable (left panel) and on the second syllable (right panel) in phrase-final position.

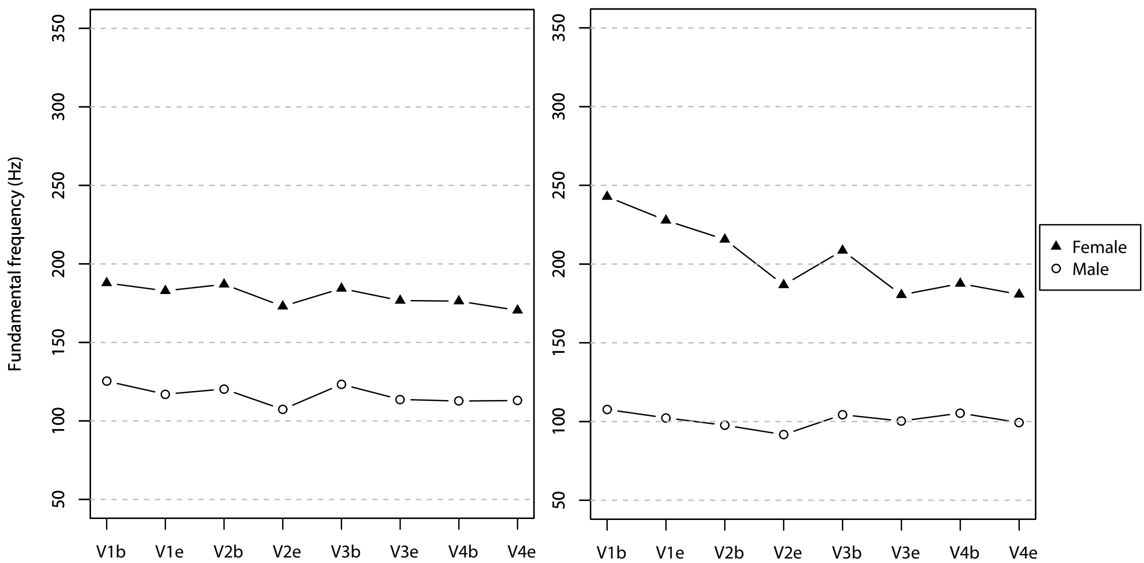


Figure 19. Fo contours, combined data: four-syllable words with stress on the first syllable (left panel) and on the second syllable (right panel) in sentence-final position.

frequency in the male and female speakers' productions of phrase- and sentence-final words might be attributable to the intonation of the utterances.

In five-syllable words, as in *oćulgədəmə* 'grow', no alternation in the positions of stresses was perceived; results were available on subsets of words produced with initial stress (Figures 20 and 21). The F0 contours for the five-syllable words also exhibited the tendency towards the realisation of feet, namely a trisyllabic foot followed by a disyllabic foot. The head syllable of the first foot, which might have had primary stress, showed higher F0 values than the head syllable of the second foot.

The salience of the F0 contour on the stressed syllables of phrase-final words (Figure 20) was observable in the productions of the female, rather than male, speakers. However, the F0 contours illustrating the male speakers' results were, in principle, similar to the contours observed on the female speakers' productions. The sentence-final words showed nearly level F0 contours in the results for the male and female speakers' productions (Figure 21). The F0 curve tended to be slightly falling on the female spekers' productions and slightly rising on the male speakers' productions.

The six-syllable words, e.g. *kundańd'äŕasamak* 'if you catch me', were produced with stresses located alternatively on odd-numbered and even-numbered syllables. According to the F0 contours for the two subsets of words (Figures 22 and 23), primary stress may have been located in the second foot of the words that had stresses on odd-numbered syllables (left panels). In the words with non-initial stress, or stress on even-numbered syllables (right panels), the disyllabic foot preceded by the unstressed first syllable may have had primary stress.

Relatively higher F0 values on the stressed syllables than on the unstressed syllables were mainly observed on the productions of phrase-final words. However, in some of the subsets of words that had stresses on even-numbered syllables, the unstressed first syllable systematically displayed higher F0 values than the stressed first syllable of the words with stresses on odd-numbered syllables (see Figures 15, 16, 17, 19, 23).

Higher F0 values on the stressed syllable than on the unstressed syllable(s) of a foot, in the context of this analysis, can not be considered a correlate of word stress. The results demonstrated the highest F0 values on the unstressed syllables in several subsets of words. Neither can a rise or a fall in the F0 curve be attributed to the manifestations of word stress: in the F0 contours analysed here, both the rising and the falling (also level) contour on the stressed syllables were observed. The differences in the manifestations of fundamental frequency might suggest sentence intonation which predetermines the prosody of the word.

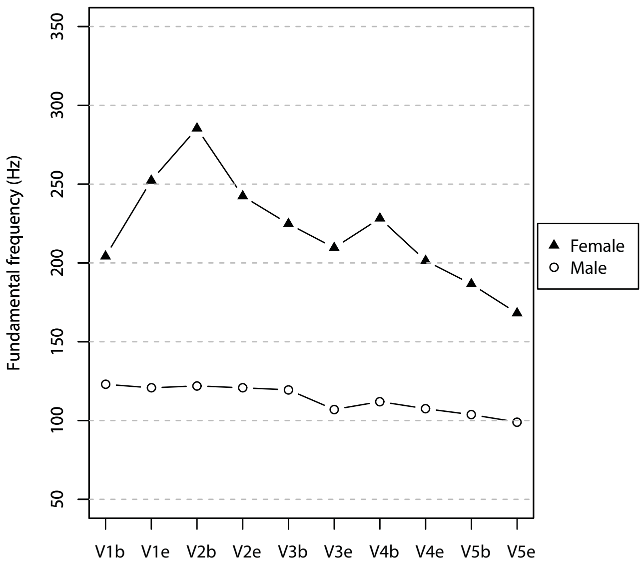


Figure 20. Fo contours, combined data: five-syllable words with stress on the first syllable in phrase-final position.

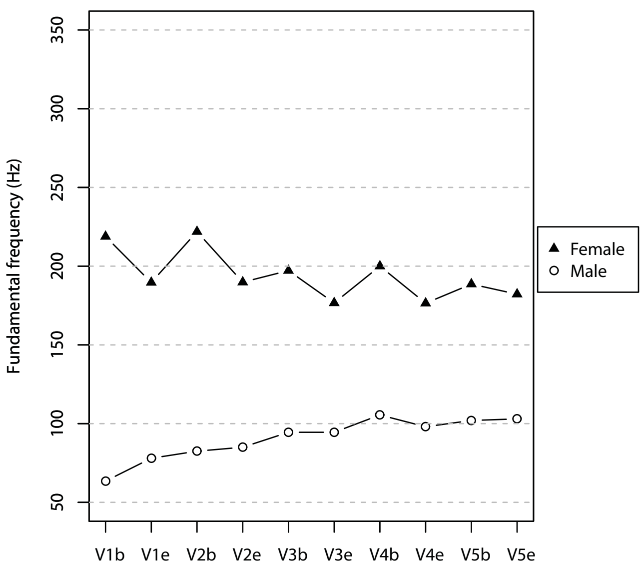


Figure 21. Fo contours, combined data: five-syllable words with stress on the first syllable in sentence-final position.


Figure 22. Fo contours, combined data: six-syllable words with stress on the first syllable (left panel) and on the second syllable (right panel) in phrase-final position.


Figure 23. Fo contours, combined data: six-syllable words with stress on the first syllable (left panel) and on the second syllable (right panel) in sentence-final position.

### 3.3.3.4. Summary

Two subsets of words (phrase- and sentence-final) were used for the analysis of fundamental frequency. The words occurred in a declarative sentence, where they were contrasted, as in 'I would say A, not B'. The location of stress(es) varied in the words. There were variants of words with initial and non-initial stress available for making comparison between the F0 contours observed in the material. The sentences were produced, as expected, with a rising F0 contour on the phrase-final words and a falling F0 contour on the sentence-final words, which alternated with level or nearly level F0 contours. The falling contour was used in the phrase-final position of some utterances, apparently, to reinforce the word; the rising contour that was observed on some of the sentence-final words may have been due to the reading format – the sentences were read as a list.

The F0 contours, as seen from the analysis, mainly differed with respect to the position of the test words in the utterances. The productions of phrase-final words generally displayed higher F0 values than those of sentence-final words. The F0 curves on both phrase- and sentence-final words were either rising or falling, to all appearances, according to the variation of intonation in the utterances produced by different speakers. Level or nearly level contours prevailed in the male speakers' productions.

The F0 movement on words consisting of more than two syllables revealed relatively salient sequences of di- and trisyllabic feet within the F0 curve. The units were constituted by a stressed syllable and one or two unstressed syllables; it can be assumed that higher F0 values were displayed by the foot with primary stress. The analysis of the F0 contours in the observed material, however, did not allow identifying fundamental frequency as a cue for stressedness because the stressed and unstressed syllables could not be discriminated either on the basis of the F0 movement or the values of F0. On both stressed and unstressed syllables, rising, falling and level contours and comparable F0 values were observed. In some of the subsets of words that had non-initial stress, the unstressed first syllable showed higher values of F0 than the stressed first syllable of the words with initial stress.

The manifestations of fundamental frequency in the material are attributable first and foremost to the domain of sentence prosody, namely, intonation. Moreover, the realisation of the words as di- or trisyllabic feet might have been conditioned by the prosody of the utterances.

As shown in 3.3.1.1., the location of word stress might have alternated under the influence of the utterance in the following way. In the carrier sentence, the test words were preceded by a trisyllabic word (*märgəl′əń, märgəl′iń* 'I would say') in the first part of the sentence and a monosyllabic word (*af* 'not') in the second part of the sentence. The first syllable of some of the test words might have constituted a disyllabic foot with the last syllable of *märgəl′iń* or with the monosyllabic word *af*, which can be assumed to have had additional (secondary) stress. The first syllable of the test word, consequently, may have had no stress: e.g. *märgəl′iń śijä* 'I would say silver', or *af śijä* 'not silver'. Alternatively, the word *märgəľəń* in some of the utterances may have been realised as a trisyllabic foot; it is feasible that there would be word-initial stress in the test word: *märgəľəń śijə*. Thus, non-initial stress in a test word might have been an adjustment to the rhythmic pattern set within the whole utterance. An analogous observation has been made concerning Erzya: "...the higher-level rhythmical stress can disregard word boundaries causing movement of word stress to the second, fourth etc. syllables..." (Lehiste et al. 2003: 86; see also Aasmäe 2006: 38–39).

To clarify questions concerning the realisations of primary and secondary stresses and of the numbers of syllables possible in a foot, it is necessary to elicit the intricacies of interaction between prosody and the morpho-phonological structure of the word. Hitherto, the question of secondary stress has been taken into account only in the treatment of compound words.

# Chapter 4

# Conclusions

The aim of the investigation reported in this book was to produce empirical findings that would be useful for the description of the prosodic features of contemporary Moksha. Observations were made of the Central dialects that constitute the basis of the literary language. The scope of the study was confined to the analysis of the manifestations of stress; phonologically distinctive quantity and tone, the other potential properties of word prosody, have not been attested in synchronic studies of Moksha.

The main part of the book (Chapter 3) concentrated on the analysis of the duration and quality of vowels in relation to word stress. The effects of sentence position were taken into account in evaluating the variability of the duration and of the quality of vowels in the test material. An analysis of the fundamental frequency contours on the vowels was carried out to observe interaction between word stress and sentence prosody.

The preceding parts of the book (Chapter 1 and Chapter 2) contained a review of the segmental structure and of the prosody of Moksha as described in the earlier literature; this information served as a basis for planning the acoustic analyses.

The findings of the analyses were summarised in the sub-sections of Chapter 3. In this chapter, general conclusions mainly concerning the observations of empirical data are presented and a range of questions that require detailed research in the future is outlined.

The properties of vowels in the varieties of the Central dialect group, essential for the purposes of the acoustic study, were given more space than those of the consonants. Information concerning the features of consonants was important for the verification of acoustic data obtained for the vowels and for making assumptions as to the intricate question of syllabification. The survey of the inventories of vowels and consonants (Chapter 1) showed that a comprehensive description of the segments based on acoustic data is missing. The description of the segmental structure of Moksha in the previous research has been centred on establishing the inventories of segments in the dialects and on the elicitation of the historical aspects of the sound system. The analysis of the literature allowed distinguishing the sub-systems of vowels that function in relation to vowel harmony and stress. The relationship between stress and vowel qualities that has received little attention in earlier studies constituted one of the central research questions in the present investigation.

The survey of the literature on word prosody in Moksha and the related Erzya language (Chapter 2) had the aim of establishing previous findings and issues that have entailed polemics in the past. Although the present approach was synchronic, the results of some diachronic studies were also considered. Such a perspective enabled putting the theme in a wider context and planning the present research.

It has been established earlier that stress in the dialects of Moksha is mainly located on the word-initial syllable. Alternation in the position of stress has been considered to be associated with the distribution of the high and low vowels: stress is located on a non-initial syllable that contains *a* (or *ä*) if there is a high vowel (*i*, *u*) in the initial syllable. No reliable explanation of the variation has been offered, except for the assumption that the location of word stress might depend on the relative intrinsic duration of the syllable nuclei. This implies that word stress is potentially located on a syllable with a vowel that has a longer intrinsic duration than the other vowels in the word (Devayev, Cygankin 1970: 18–19). Data from the dialects have shown, however, that the position of stress in words that contain high and low vowels in initial and non-initial syllables, respectively, varies; for this reason, stress in Moksha, particularly in certain dialects, has been considered to be relatively free.

In the survey of literature, attention has also been drawn to the phenomenon of vowel reduction which is considered to be one of the most salient features of the vowel system of Moksha. The historical aspects of vowel reduction in Moksha have been extensively discussed in the literature. In some of the later publications, attention has been paid to the acoustic features of the schwa vowel observed in relation to the palatalised and non-palatalised consonants.

The question of the assignment of stress in Moksha has not been studied in detail – an analysis of the position of stress in the test material was, therefore, carried out in the first stage of the present investigation. The present work allowed conclusions to be made of read speech (see section 3.2.). Observations made of the assignment of stress in a set of test words read by 14 informants (2457 tokens in all) showed variation as mentioned in the literature: there was alternation of initial and non-initial stress. Word-initial stress was observed in the majority of tokens (89%). In words that contained a high vowel (/i/ or /u/) in the first syllable and a low vowel (/a/ or /ä/) in a subsequent syllable, initial and non-initial stress alternated. Considering the results on controlled speech it can be expected that stress in spontaneous speech would display greater variability in location (as mentioned in the studies of dialects). An analysis of spontaneous speech in future research might also elicit the factor(s) underlying the assignment of stress.

On the basis of the present findings it can be suggested that sentence prosody plays a significant role in the realisations of stress within a word. In the analysis, attention was paid to the occurrence of additional stress(es) in words containing more than two syllables and the realisation of the words as di- or trisyllabic prosodic feet. The question of the degrees of word stress concerning Moksha has not been hitherto addressed (what is more, the phonetic and phonological bases of the phenomena have not been fully established in the theory of prosody). At the present stage of the research it can only be supposed that the occurrence of additional stresses might be associated with the morphological structure of the word, in addition to the influence of sentence prosody.

Two tendencies in the assignment of stress(es) were observed in the analysis of the material – either odd-numbered or even-numbered syllables were generally stressed. In trisyllabic and longer words, the occurrence of stresses on either odd- or even-numbered syllables was observed as a fairly persistent tendency, making it possible to detect disyllabic feet in the rhythmic patterns of the words. The realisations of trisyllabic feet were not as frequent as those of disyllabic feet. On the production level, the occurrence of additional stresses was supported by the measurement results, which are viewed below.

**Firstly**, regarding vowel durations (see section 3.3.1.), the results of acoustic analyses were significantly in favour of the working hypothesis: vowel durations displayed dependence on the location of stress. Vowels were observed to be longer in stressed syllables than in unstressed ones. In view of the occurrence of unstressed vowel reduction in the language, the duration of vowels can be considered an essential correlate of stress in Moksha.

The vowels of first and third syllables in trisyllabic words that were perceived to have stress were significantly longer than the vowel of the unstressed second syllable. Preliminary results on a subset of polysyllabic (from four to six syllables) words showed that the vowels of stressed, either even- or odd-numbered syllables, were longer than the vowels of the unstressed syllables. This means that the words may have been realised as disyllabic feet followed or preceded by a one-syllable foot. Durational ratios between the vowels in the disyllabic foot turned out to be higher in trisyllabic words than in disyllabic ones, which might show greater integrity between the syllables of a foot in longer words.

The present analyses also revealed the effects of other factors (sentence position, syllable structure, and the intrinsic duration of vowels) on the relative vowel durations in a word. The mean durational ratios were lower in sentence-final words, due to a greater pre-boundary lengthening in this position, compared to those in phrase-final words. The vowel durations in stressed and unstressed syllables of sentence-final words tended to equalise.

A certain amount of variation was conditioned by the openness and closedness of the syllables. The vowels of closed syllables, (C)CVC(C), turned out to be shorter than the vowels of open syllables, (C)CV. The effect of different types of consonants (or consonant combinations) that occurred at syllable boundary and the issue of syllabification were not studied in detail but some of the results indicate that they are an important factor to be reckoned with in the further research of Moksha prosody.

The difference in the intrinsic duration of the vowels within a word is another factor that produced an effect upon the durational ratios between the vowels. Vowel durations tended to be equal, if a high and a low vowel occurred in the stressed initial and the unstressed subsequent syllable, respectively. In some words, the stressed high vowel was even shorter than the unstressed low vowel. Nevertheless, stress was perceived to occur on the syllable with a high vowel. This might imply that the quality of the vowels is used to make the distinction between stressed and unstressed syllables in such words – the unstressed low vowel might have been perceived to lack the qualities of the full high vowel that occurs under stress.

**Secondly**, the analysis of vowel quality (acoustically, F1 and F2 frequencies) showed that the quality of vowels in unstressed syllables differed systematically from that of the vowels occurring in stressed syllables (see section 3.3.2.).

Centralisation of the positions of unstressed vowels in the vowel space was observed as one of the most salient effects of the unstressed position. The regular occurrence of the reduced vowel (schwa) in unstressed syllables is a characteristic feature of the vowel system of the language. Consequently, vowel quality is, alongside duration, a correlate of stress. The distribution of vowel qualities in Moksha is considerably influenced by the position of stress.

Since the positions of the syllables referred to as stressed vs. unstressed do not fully coincide with the initial and non-initial syllables, words display a complexity of vowel qualities that occur under the influence of stress and vowel harmony. In the analysis of the test material, attention was focused on the relationship between the phenomenon of vowel reduction and stress. The findings of previous research and the results of this work show that the subsystem of vowels in unstressed non-initial syllables is significantly reduced under the influence of stress. Two vowels, /ə/ and /a/, generally occur in these positions. The occurrence of the high vowels, /i/ and /u/, is restricted to suffixes, while the mid vowels, /e/ and /o/, almost exclusively occur in the stressed initial syllable.

The vowels that occur in word-final open syllables required special attention. In the description of the vowel distributions in the literature, there has been no clarity about the vowel qualities allowed in this position. The effect of word-final position (pre-pausal lengthening) on the vowels of open syllables (namely, the realisations of schwa as *e*, *ä*, and *a*) has been mentioned by some authors. The vowels of open word-final syllables can be considered to be potentially affected by phenomena like the openness of the syllable, pre-pausal lengthening, and, as the present findings show, the likely occurrence of rhythmic stress. It can not be excluded that the distribution of vowel qualities functions within a disyllabic and trisyllabic foot. Hence, in the word-final syllable that has secondary stress, the vowels tend to be realised as full vowels; in trisyllabic words that are realised as trisyllabic feet, the schwa vowel tends to appear in the third syllable. The complexity of the vowel distributions in non-initial syllables, which is caused by the effects of vowel harmony and stress functioning concurrently in a word, requires further research.

The analysis of vowel qualities revealed inter-speaker variation, which might be related to the differences between the sub-dialects of Central Moksha (see Ivanova 2006: 28–36), the informants' age, and other factors, for example, second language effects. The vowel /ä/ considered to be common to the dialects of Central Moksha did not consistently occur in the speakers' productions, especially in non-initial unstressed syllables. In the productions of some speakers, /ä/ alternated with /e/ in the stressed first syllable; in unstressed non-initial syllables /ä/ was observed in single tokens produced by some of the informants. The characteristics of the low vowel /a/ also differed; /a/ turned out to be central mainly in the pronunciation of the female speakers, while the male speakers tended to produce it as a back vowel. In the review of literature, attention was drawn to the divergence in the definition of this vowel given by different authors. To explain the differences in the quality of vowels observed in the speakers' productions, results of an extensive study of the segments are required.

**Thirdly**, the results on the fundamental frequency contours on the test words (see section 3.3.3.) were congruent with the other results in that the contours were indicative of the realisations of the prosodic feet. The F0 curve on words containing more than two syllables showed the salience of parts corresponding to the recurrent disyllabic (also trisyllabic) units. As expected, the F0 values displayed the effects of sentence position: differences were observed in the F0 values for the phrase- and sentence-final words. It can be suggested that the realisations of prosodic feet in the test words depended on sentence prosody and, in this context, stress(es) were realised within the domain of the utterances rather than as the features of lexical words. Hence, alternation in the positions of stress might have been largely conditioned by the sentence prosody.

With respect to the results of this study on stress in Moksha, the opinion of A. Raun (1971: 21–22) concerning the hypothetic features of Proto-Finno-Ugric prosody seems to be valid. Namely: "In an utterance not the potential word stress but the actual sentence stress prevails." The results of research on stress in Erzya (Lehiste et al. 2003; Aasmäe 2006) and the present findings on stress in Moksha exhibit similarity – in both languages word stress appears to be subordinated to sentence prosody. On the other hand, the relationship between the vowel system and stress, despite this similarity, differs to a considerable extent. An attempt can be made in further research to give a more categorical answer to the question of how the interaction between word and sentence stress is realised in the two languages by investigating, for example, the information structure (cf. Arnhold 2013) of Moksha and Erzya.

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# Appendix 1

# Geographical distribution of Moksha dialects

by Peeter Päll (PhD)


Map of Moksha localities in the Republic of Mordovia

## *List of Moksha localities*

(Abbreviations of administrative names: *Atyu = Atyuŕyevo, Insa = Insar, Kado = Kadoshkino, Kovy = Kovylkino, Kras = Krasnoslobodsk, Ruza = Ruzayevka, Star = Staroye Shaygovo, Zubo = Zubova Polyana, Temn = Temnikov, Torb = Torbeyevo, Yeĺn = Yeĺniki*).

### 1. Central dialect group

*Northern dialects:*

1 Krasnovka *Star*
2 Krasnyy *Star*
3 Kuldym *Star*
4 Podgornoye Konakovo *Temn*
5 Poĺskoye Tsibayevo *Temn*
6 Staryy Shukstilim *Temn*
7 Temyashevo *Star*
8 Vertelim *Star*

*Temnikov-Atyuŕyevo dialects:*

9 Barashevo *Atyu*
10 Gremyachevo *Atyu*
11 Kolopinka *Atyu*
12 Lesnoy Bor *Atyu*
13 Lesnoye Ardashevo *Temn*
14 Lesnoye Kichatovo *Temn*
15 Lesnoye Pluksovo *Temn*
16 Lesnoye Siyaly *Temn*
17 Lipovka *Atyu*
18 Mordovskaya Kozlovka *Atyu*
19 Novoye Avkimanovo *Temn*
20 Pesochnoye Kanakovo *Temn*
21 Poťma *Atyu*
22 Staraya Kyaŕga *Atyu*
23 Staroye Avkimanovo *Temn*
24 Baranovka *Atyu*

*Rybkino-Mamolayevo dialects:*

25 Keretino *Kovy*
26 Kichatovo *Kovy*
27 Mamolayevo *Kovy*
28 Novaya Derganovka *Kovy*
29 Novaya Samayevka *Kovy*
30 Novaya Tolkovka *Kovy*
31 Novoye Lep′yevo *Kovy*
32 Novoye Mamongino *Kovy*
33 Ponikedovka *Kovy*
34 Rybkino *Kovy*
35 Samozleika *Kovy*
36 Staraya Derganovka *Kovy*
37 Staraya Samayevka *Kovy*
38 Staraya Tolkovka *Kovy*
39 Staroye Lep′yevo *Kras*
40 Staroye Mamongino *Kovy*
41 Zaytsevo *Kras*
42 Volgapino *Kovy*

*Krasnoslobodsk-Sindrovo-Shaygovo-Levzha dialects:*

43 Akshov *Star*
44 Kolopino *Kras*
45 Lemdyay *Star*
46 Lepchenki *Yeĺn*
47 Levzha *Ruza*
48 Mordovskiye Parki *Kras*
49 Mordovskiye Polyanki *Kras*
50 Mordovskoye Maskino *Kras*
51 Novaya Terizmorga *Star*
52 Perkhlyay *Ruza*
53 Porub *Star*
54 Privoĺye *Kras*
55 Staroye Sindrovo *Kras*
56 Staroye Shaygovo *Star*
57 Zaberyozovo *Kras*
58 Tustatovo *Kras*

## 2. South-Eastern dialect group

59 Adashevo *Kado*
60 Boldovo *Ruza*
61 Glushkovo *Kado*
62 Kochetovka *Insa*
63 Kulikovka *Ruza*
64 Mordovskaya Avgura *Kovy*
65 Mordovskaya Payovka *Insa*
66 Mordovskaya Pishlya *Ruza*
67 Mordovskoye Baymakovo *Ruza*
68 Mordovskoye Kolomasovo *Kovy*
69 Novaya Muravyovka *Ruza*
70 Novley *Insa*
71 Novoye Drakino *Kovy*
72 Novoye Pshenevo *Kovy*
73 Novyy Usad *Ruza*
74 Novyye Verkhisy *Insa*
75 Payovo *Kado*
76 Palayevka *Ruza*
77 Podgornoye Alyoksovo *Kovy*
78 Pushkino *Ruza*
79 Singileyka *Insa*
80 Staraya Muravyovka *Ruza*
81 Staroye Drakino *Kovy*
82 Staroye Pshenevo *Kovy*
83 Staryye Verkhisy *Insa*
84 Shadym *Kovy*
85 Shadymo-Ryskino *Insa*
86 Zarya *Insa*
87 Verkhnyaya Lukhma *Insa*

## 3. Western dialect group

*Northern dialects:*

88 Anayevo *Zubo*
89 Kargashino *Zubo*
90 Kryukovka *Zubo*
91 Pichalovka *Zubo*
92 Pichovka *Zubo*
93 Promzino *Zubo*
94 Zhuravkino *Zubo*
95 Vadovskiye Selishchi *Zubo*

*South-Western dialects:*

96 Achadovo *Zubo*
97 Buldygino *Zubo*
98 Lopatino *Torb*
99 Mordovskaya Polyana *Zubo*
100 Novaya Poťma *Zubo*
101 Novoye Badikovo *Zubo*
102 Novyye Vyselki *Zubo*
103 Pichpanda *Zubo*
104 Pokrovskiye Selishchi *Zubo*
105 Staraya Poťma *Zubo*
106 Staroye Badikovo *Zubo*
107 Staryye Pichury *Torb*
108 Zarubkino *Zubo*
109 Zhukovka *Zubo*
110 Tarkhanskaya Poťma *Zubo*

## 4. Transitional dialects

*Group 1*

111 Aľkino *Kovy*
112 Mazylug *Torb*
113 Mordovskoye Vechkinino *Kovy*
114 Novaya Pichimorga *Torb*
115 Parapino *Kovy*
116 Salazgoŕ *Torb*
117 Varzhelyay *Torb*

*Sub-group 1*

118 Nosakino *Torb*
119 Staraya Terizmorga *Star*
120 Suzgaŕye *Ruza*

*Sub-group 2*

121 Atyuŕyevo *Atyu*
122 Dukhońkino *Atyu*
123 Yezhovka *Kovy*
124 Kishaly *Atyu*
125 Pereveśye *Atyu*
126 Pichepolonga *Atyu*
127 Streľnikovo *Atyu*
128 Trusklyay *Ruza*

*Sub-group 3*

129 Novyye Rzhavtsy *Kovy*
130 Roďkino *Kovy*

*Group 2*

Dialects in the Belinskiy region of the Penza oblast:
131 Korsayevka
132 Kozlovka
133 Novaya Kashtanovka
134 Pichevka

## Mixed dialect groups

*Gorodishche dialect*

Sub-dialects in the Gorodishche and Sosnovoborsk regions of the Penza oblast:
135 Digilyovka
136 Nizhniy Katmis
137 Pichileyka
138 Verkhniy Katmis
139 Vadaley

*Verkhniy-Alatyr dialects*

Sub-dialects in the Lukoyanov region of the Nizhegorodskaya oblast
(the names of localities are not identified)

# Appendix 2

# List of test words

| Test words | Pronunciation |
|---|---|
| *ва* ‘look (imperative)’ | *va* |
| *ве* ‘night’ | *ve* |
| *вий* ‘force’ | *vij* |
| *вии* ‘strong’ | *viji* |
| *вай* ‘butter’ | *vaj* |
| *ваи* ‘greasy’ | *vaji* |
| *эй* ‘ice’ | *äj, ej* |
| *эи* ‘icy’ | *äji, eji* |
| *ши* ‘day’ | *ši* |
| *шит* ‘days’ | *šit* |
| *ведь* ‘water’ | *ved′* |
| *веть* ‘waters’ | *ved′t′, vet′t′* |
| *кядь* ‘hand’ | *käd′, ked′* |
| *кятть* ‘hands’ | *käd′t′, kät′t′, ked′t′, ket′t′* |
| *веть* ‘at night’ | *vet′* |
| *шить* ‘at day time’ | *šit′* |
| *тись* ‘did’ | *t′iś, t′iJś* |
| *лийсь* ‘flew’ | *l′iśś, l′iJś* |
| *ирдез* ‘rib’ | *iŕd′əs* |
| *рдаз* ‘mud’ | *ərdas, rdas* |
| *крга* ‘neck’ | *kərga* |
| *курга* ‘mouth’ | *kurgə, kurgă* |
| *трва* ‘lip’ | *tərva, trva* |
| *торба* ‘bag, sack’ | *torba* |
| *кие* ‘who’ | *kijə, kijě* |
| *сия* ‘silver’ | *śijä, śijě* |
| *сяда* ‘hundred’ | *śadə, śadă* |
| *сятяв* ‘quiet’ | *śät′äv, śät′av, śet′av* |
| *ватте* ‘I look at you’ | *vatt′ə, vatt′ě* |
| *кантте* ‘I carry you’ | *kand′t′ə, kand′t′ě, kant′t′ə, kant′t′ě* |
| *тонне* ‘yours (singular)’ | *tońńə, tońńě* |
| *тинне* ‘yours (plural)’ | *t′ińńə, t′ińńě* |
| *кяпе* ‘barefooted’ | *käpə, käpě, kepə, kepě* |
| *пеке* ‘stomach’ | *pekə, pekě* |
| *пиле* ‘ear’ | *pil′ə, pil′ě* |
| *пильге* ‘foot’ | *pil′gə, pil′gě* |
| *кедьга* ‘along the hand’ | *ked′ga* |
| *кедьге* ‘vessel’ | *ked′gə, ked′gě* |
| *ведьта* ‘water (ablative)’ | *ved′tə, ved′tă, vet′tə, vet′tă* |
| *кядьта* ‘hand (ablative)’ | *käd′tə, käd′tă, kät′tə, kät′tă* |
| *кельме* ‘cold’ | *kel′mə, kel′mě* |
| *сельме* ‘eye’ | *śel′mə, śel′mě* |
| *инжи* ‘visitor’ | *LQåL Lńdži* |
| *кенже* ‘nail’ | *NHQåəN HQåě, keńdžə, keńdžě* |
| *толга* ‘feather’ | *tolga* |
| *ялга* ‘friend | *jalga* |
| *врьгаз* ‘wolf’ | *vəŕgas* |
| *вирьге* ‘in a/the forest’ | *viŕgä, viŕgě* |
| *эрьгя* ‘bead’ | *eŕgə, eŕgě, äŕgě* |
| *эрьхкя* ‘lake’ | *eRkə, eRkě, äRkə* |
| *максат* ‘you give’ | *maksat* |
| *макса* ‘liver’ | *maksə, maksă* |

| | |
|---|---|
| *максомс* 'give' | *maksəms* |
| *максcемс* 'give (frequentative)' | *maksśəms* |
| *шеер* 'mouse' | *šejər* |
| *шяярь* 'hair' | *šäjəŕ, šäjäŕ* |
| *кемонь* 'ten' | *keməń* |
| *ломань* 'person' | *lomań* |
| *пизел* 'rowan' | *piźəl* |
| *сисем* 'seven' | *śiśəm* |
| *ведю* 'watery' | *veďu* |
| *вяти* 'leads' | *väťi, veťi* |
| *куцю* 'spoon' | *kuću* |
| *кудце* 'your house' | *kudćə, kudćĕ,k utćə, kutćĕ* |
| *кудса* 'in the house' | *kudcə, kudcă, kutcə, kutcă, kudsă* |
| *кядьса* 'in hand(s), in place' | *käďcə, käďcă, käťcə, keťcə, keďsə* |
| *одар* 'uterus' | *odar* |
| *одархт* 'uteruses' | *odaRt* |
| *седи* 'heart' | *śeďi* |
| *седихть* 'hearts' | *śeďiJť* |
| *нокан* 'I want' | *nokan* |
| *нупонь* 'moss' | *nupəń* |
| *питне* 'price' | *piťńə, piťńĕ* |
| *питни* 'expensive' | *piťńi* |
| *шитне* 'the days' | *šiťńə, šiťńĕ* |
| *куттне* 'the houses' | *kudťńə, kudťńĕ, kutťńə, kutťńĕ* |
| *палама* 'a kiss, kissing' | *palamə, palamă* |
| *палома* 'fire, burning' | *paləmə, paləmă* |
| *ветеце* 'fifth' | *veťəćə, veťəćĕ, veťćə* |
| *котоце* 'sixth' | *kotəćə, kotəćĕ* |
| *ардома* 'a ride, riding' | *ardəmə, ardəmă* |
| *архтома* 'a painting, painting' | *aRtəmə, aRtəmă* |
| *ваттада* 'you look (plural)' | *vattadə, vattadă* |
| *канттада* 'you carry (plural)' | *kandtadə, kanttadă* |
| *тоннеса* 'in yours (singular)' | *tońńəsə, tońńəsă* |
| *тиннеса* 'in yours (plural)' | *ťińńəsə, ťińńəsă* |
| *куднясот* 'in your small house' | *kudńasət* |
| *кяднясот* 'in your small hand' | *käďńasət* |
| *кудтот* 'about your house' | *kudtət, kuttət* |
| *куднядот* 'about your small house' | *kudńadət* |
| *айдямайхть* 'you chased me' | *ajďamaJť* |
| *айдясайне* 'I chased them' | *ajďasajńə, ajďasajńĕ* |
| *пинем* 'oat' | *pińəm* |
| *ломанень* 'person's' | *lomańəń* |
| *ломаненьди* 'to person(s)' | *lomańəńďi* |
| *кундасамак* 'you (will) catch me' | *kundasamak* |
| *кундалить* 'you would catch it' | *kundaľiJť* |
| *кундалемайть* 'you would catch me' | *kundaľəmaJť* |
| *оцюлгодома* 'grow' | *oćulgədəmə, oćulgədəmă* |
| *оцюлгофтома* 'raise, magnify' | *oćulgəftəmə, oćulgəftəmă* |
| *кунданьдярясамак* 'if you catch me' | *kundańďäŕasamak, kundańďeŕasamak* |
| *кунданьдярясайне* 'if I catch them' | *kundańďäŕasajńə, kundańďeŕasajńĕ* |
| *кафксоце* 'eighth' | *kafksəćə, kafksəćĕ* |
| *вейхксоце* 'ninth' | *veJksəćə, veJksəćĕ* |

# Appendix 3

# Additional data obtained in the course of acoustic analysis

## I. Data of vowel durations

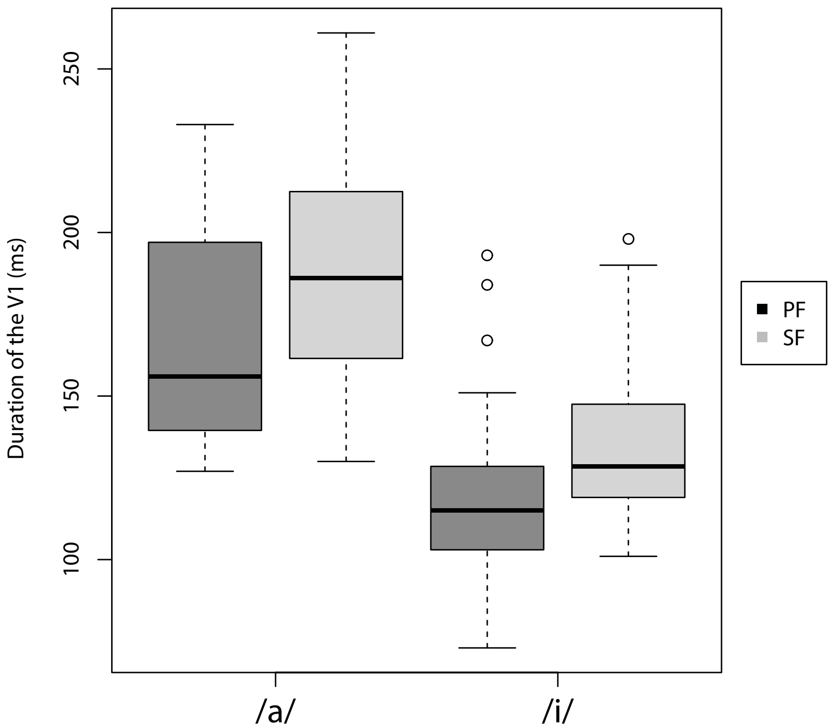



Figure 1. Boxplots of vowel durations (in ms) for monosyllabic words: the vowels /a/ and /i/ (PF = phrase-final position, SF = sentence-final position).

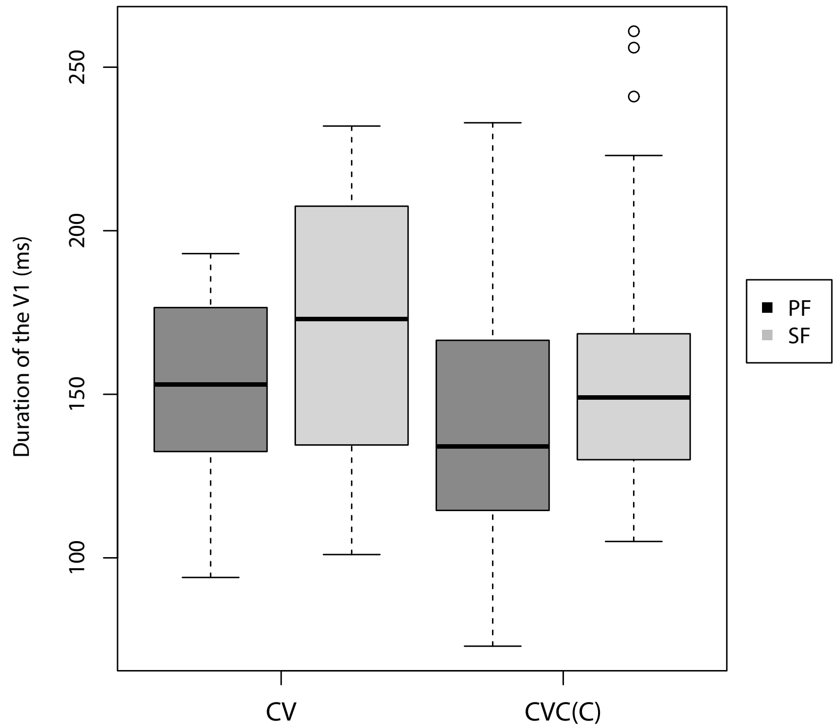



Figure 2. Boxplots of vowel durations (in ms) for monosyllabic words ending in a vowel and a consonant (or a combination of consonants): CV vs CVC(C) (PF = phrase-final position, SF = sentence-final position).

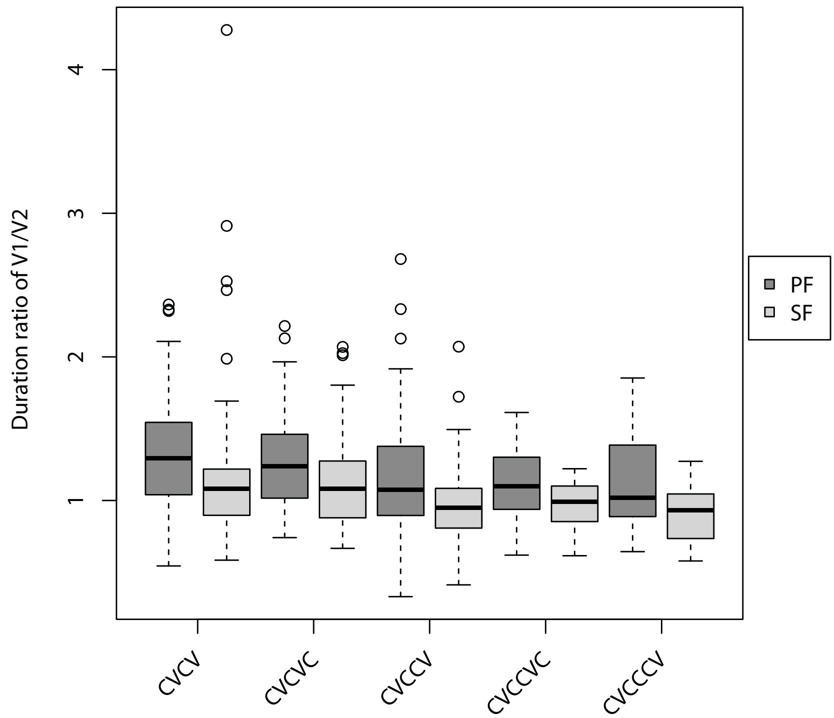



Figure 3. Boxplots of vowel duration ratios (V1/V2) in series of CVCV, CVCVC, CVCCV, CVCCVC and CVCCCV words produced in the phrase-final (PF) and sentence-final (SF) position.

## II. Data of vowel quality

Table 1. Average formant values (in Hz and Bark) with standard deviations (s.d.) of vowels in phrase-final words produced by 6 female speakers.

| | Stressed first syllable | | | | Unstressed second syllable | | | |
|---|---|---|---|---|---|---|---|---|
| Speaker | Vowel | F1 | F2 | F3 | Vowel | F1 | F2 | F3 |
| JM | /a/ | 697 | 1589 | 2576 | /a/ | 604 | 1665 | 2864 |
| | s.d. | 42 | 129 | 179 | s.d. | 59 | 141 | 237 |
| | Bark | 6.5 | 11.46 | 14.68 | Bark | 5.78 | 11.77 | 15.36 |
| | /ä/ | 531 | 2398 | 3102 | /ä/ | — | — | — |
| | s.d. | 52 | 112 | 234 | s.d. | — | — | — |
| | Bark | 5.18 | 14.22 | 15.88 | Bark | — | — | — |
| | /e/ | 461 | 2584 | 3280 | /e/ | 482 | 2022 | 2990 |
| | s.d. | 14 | 115 | 143 | s.d. | 58 | 377 | 207 |
| | Bark | 4.58 | 14.71 | 16.24 | Bark | 4.75 | 12.96 | 15.65 |
| | /i/ | 315 | 2716 | 3413 | /i/ | 354 | 2758 | 3336 |
| | s.d. | 42 | 119 | 264 | s.d. | 8 | 237 | 274 |
| | Bark | 3.17 | 15.04 | 16.48 | Bark | 3.57 | 15.12 | 16.34 |
| | /o/ | 490 | 1106 | 2962 | /ə/ | 512 | 1727 | 2990 |
| | s.d. | 35 | 203 | 215 | s.d. | 25 | 160 | 252 |
| | Bark | 4.83 | 9.08 | 15.59 | Bark | 5.02 | 12.01 | 15.64 |
| | /u/ | 399 | 978 | 2872 | /u/ | 365 | 1207 | 3051 |
| | s.d. | 55 | 142 | 474 | s.d. | 37 | 109 | 42 |
| | Bark | 3.99 | 8.36 | 15.3 | Bark | 3.68 | 9.68 | 15.79 |
| NN | /a/ | 886 | 1416 | 2743 | /a/ | 729 | 1608 | 2759 |
| | s.d. | 49 | 110 | 64 | s.d. | 89 | 213 | 246 |
| | Bark | 7.81 | 10.7 | 15.11 | Bark | 6.72 | 11.5 | 15.11 |
| | /ä/ | 591 | 2515 | 2966 | /ä/ | — | — | — |
| | s.d. | 65 | 121 | 375 | s.d. | — | — | — |
| | Bark | 5.67 | 14.53 | 15.56 | Bark | — | — | — |
| | /e/ | 450 | 2558 | 3258 | /e/ | 497 | 2630 | 3265 |
| | s.d. | 77 | 300 | 249 | s.d. | 89 | 222 | 260 |
| | Bark | 4.46 | 14.6 | 16.19 | Bark | 4.86 | 14.8 | 16.2 |
| | /i/ | 319 | 2775 | 3418 | /i/ | 418 | 2824 | 3407 |
| | s.d. | 20 | 283 | 383 | s.d. | 97 | 93 | 214 |
| | Bark | 3.22 | 15.14 | 16.46 | Bark | 4.16 | 15.29 | 16.48 |
| | /o/ | 511 | 904 | 2927 | /ə/ | 636 | 1959 | 3041 |
| | s.d. | 35 | 64 | 96 | s.d. | 175 | 427 | 196 |
| | Bark | 5.01 | 7.93 | 15.52 | Bark | 5.96 | 12.76 | 15.76 |
| | /u/ | 348 | 889 | 2867 | /u/ | 406 | 1152 | 2944 |
| | s.d. | 24 | 226 | 137 | s.d. | 16 | 47 | 62 |
| | Bark | 3.51 | 7.72 | 15.39 | Bark | 4.07 | 9.39 | 15.56 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ST | /a/ | 869 | 1513 | 2785 | /a/ | 634 | 1593 | 2742 |
| | s.d. | 234 | 112 | 91 | s.d. | 58 | 111 | 87 |
| | Bark | 7.59 | 11.13 | 15.2 | Bark | 6.02 | 11.48 | 15.1 |
| | /ä/ | 531 | 2162 | 2862 | /ä/ | — | — | — |
| | s.d. | 35 | 273 | 260 | s.d. | — | — | — |
| | Bark | 5.18 | 13.48 | 15.36 | Bark | — | — | — |
| | /e/ | 488 | 2346 | 3010 | /e/ | 481 | 2325 | 3013 |
| | s.d. | 54 | 166 | 216 | s.d. | 86 | 275 | 221 |
| | Bark | 4.8 | 14.06 | 15.69 | Bark | 4.73 | 13.96 | 15.69 |
| | /i/ | 324 | 2608 | 3164 | /i/ | 390 | 2581 | 3380 |
| | s.d. | 36 | 96 | 259 | s.d. | 60 | 168 | 220 |
| | Bark | 3.27 | 14.77 | 16 | Bark | 3.91 | 14.69 | 16.43 |
| | /o/ | 478 | 1005 | 2784 | /ə/ | 545 | 1608 | 2788 |
| | s.d. | 49 | 181 | 104 | s.d. | 27 | 150 | 92 |
| | Bark | 4.72 | 8.5 | 15.2 | Bark | 5.3 | 11.53 | 15.21 |
| | /u/ | 380 | 1124 | 2944 | /u/ | 423 | 1298 | 2684 |
| | s.d. | 59 | 222 | 116 | s.d. | 33 | 165 | 20 |
| | Bark | 3.82 | 9.16 | 15.56 | Bark | 4.23 | 10.13 | 14.96 |
| TR | /a/ | 768 | 1464 | 2654 | /a/ | 642 | 1689 | 2792 |
| | s.d. | 81 | 140 | 86 | s.d. | 113 | 114 | 166 |
| | Bark | 7 | 10.91 | 14.89 | Bark | 6.05 | 11.87 | 15.21 |
| | /ä/ | 456 | 2466 | 3091 | /ä/ | — | — | — |
| | s.d. | 29 | 160 | 381 | s.d. | — | — | — |
| | Bark | 4.53 | 14.39 | 15.83 | Bark | — | — | — |
| | /e/ | 415 | 2592 | 3294 | /e/ | 433 | 2288 | 3104 |
| | s.d. | 33 | 171 | 321 | s.d. | 87 | 358 | 348 |
| | Bark | 4.15 | 14.72 | 16.24 | Bark | 4.29 | 13.81 | 15.86 |
| | /i/ | 315 | 2707 | 3348 | /i/ | 311 | 2570 | 3309 |
| | s.d. | 26 | 84 | 324 | s.d. | 16 | 237 | 369 |
| | Bark | 3.18 | 15.02 | 16.34 | Bark | 3.14 | 14.65 | 16.26 |
| | /o/ | 463 | 964 | 2727 | /ə/ | 428 | 1715 | 2873 |
| | s.d. | 42 | 130 | 266 | s.d. | 60 | 126 | 126 |
| | Bark | 4.59 | 8.28 | 15.04 | Bark | 4.27 | 11.97 | 15.4 |
| | /u/ | 368 | 854 | 2788 | /u/ | 348 | 1269 | 2843 |
| | s.d. | 31 | 267 | 213 | s.d. | 15 | 151 | 216 |
| | Bark | 3.71 | 7.46 | 15.19 | Bark | 3.52 | 9.99 | 15.33 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| VT | /a/ | 610 | 1452 | 2583 | /a/ | 553 | 1576 | 2822 |
| | s.d. | 44 | 175 | 222 | s.d. | 38 | 209 | 259 |
| | Bark | 5.83 | 10.84 | 14.69 | Bark | 5.36 | 11.37 | 15.26 |
| | /ä/ | 516 | 2247 | 2848 | /ä/ | — | — | — |
| | s.d. | 31 | 139 | 293 | s.d. | — | — | — |
| | Bark | 5.06 | 13.78 | 15.32 | Bark | — | — | — |
| | /e/ | 376 | 2374 | 3066 | /e/ | 434 | 2142 | 2860 |
| | s.d. | 56 | 161 | 226 | s.d. | 39 | 198 | 294 |
| | Bark | 3.77 | 14.14 | 15.81 | Bark | 4.33 | 13.44 | 15.34 |
| | /i/ | 293 | 2547 | 3071 | /i/ | 397 | 2497 | 3088 |
| | s.d. | 12 | 161 | 220 | s.d. | 16 | 186 | 224 |
| | Bark | 2.95 | 14.61 | 15.82 | Bark | 3.98 | 14.47 | 15.85 |
| | /o/ | 435 | 895 | 2911 | /ə/ | 450 | 1492 | 2588 |
| | s.d. | 42 | 146 | 213 | s.d. | 20 | 238 | 144 |
| | Bark | 4.33 | 7.83 | 15.48 | Bark | 4.48 | 11.01 | 14.72 |
| | /u/ | 342 | 853 | 2787 | /u/ | 384 | 842 | 2726 |
| | s.d. | 47 | 136 | 174 | s.d. | 15 | 7 | 37 |
| | Bark | 3.45 | 7.56 | 15.2 | Bark | 3.86 | 7.53 | 15.07 |

Table 2. Average formant values (in Hz and Bark) with standard deviations (s.d.) of vowels in sentence-final words produced by 6 female speakers.

| | Stressed first syllable | | | | Unstressed second syllable | | | |
|---|---|---|---|---|---|---|---|---|
| Speaker | Vowel | F1 | F2 | F3 | Vowel | F1 | F2 | F3 |
| JM | /a/ | 630 | 1491 | 2511 | /a/ | 615 | 1718 | 2790 |
| | s.d. | 43 | 158 | 157 | s.d. | 86 | 175 | 253 |
| | Bark | 5.99 | 11.03 | 14.52 | Bark | 5.86 | 11.96 | 15.19 |
| | /ä/ | 479 | 2549 | 3192 | /ä/ | — | — | — |
| | s.d. | 32 | 146 | 222 | s.d. | — | — | — |
| | Bark | 4.73 | 14.61 | 16.06 | Bark | — | — | — |
| | /e/ | 381 | 2726 | 3372 | /e/ | 451 | 2162 | 3072 |
| | s.d. | 20 | 132 | 100 | s.d. | 61 | 293 | 184 |
| | Bark | 3.83 | 15.06 | 16.42 | Bark | 4.47 | 13.46 | 15.82 |
| | /i/ | 340 | 2710 | 3437 | /i/ | 367 | 2775 | 3284 |
| | s.d. | 14 | 116 | 211 | s.d. | 11 | 197 | 102 |
| | Bark | 3.43 | 15.02 | 16.53 | Bark | 3.7 | 15.17 | 16.26 |
| | /o/ | 468 | 753 | 3014 | /ə/ | 504 | 1759 | 2885 |
| | s.d. | 38 | 225 | 231 | s.d. | 75 | 228 | 199 |
| | Bark | 4.63 | 6.8 | 15.7 | Bark | 4.93 | 12.11 | 15.42 |
| | /u/ | 384 | 986 | 3143 | /u/ | 374 | 1345 | 3122 |
| | s.d. | 14 | 115 | 60 | s.d. | 30 | 23 | 90 |
| | Bark | 3.86 | 8.42 | 15.98 | Bark | 3.77 | 10.38 | 15.94 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| JS | /a/ | 719 | 1437 | 2912 | /a/ | 603 | 1687 | 2953 |
| | s.d. | 44 | 134 | 59 | s.d. | 74 | 212 | 255 |
| | Bark | 6.66 | 10.79 | 15.49 | Bark | 5.76 | 11.83 | 15.56 |
| | /ä/ | 517 | 2465 | 2996 | /ä/ | — | — | — |
| | s.d. | 50 | 125 | 247 | s.d. | — | — | — |
| | Bark | 5.06 | 14.4 | 15.66 | Bark | — | — | — |
| | /e/ | 366 | 2660 | 3194 | /e/ | 418 | 2375 | 3152 |
| | s.d. | 22 | 114 | 155 | s.d. | 65 | 220 | 155 |
| | Bark | 3.69 | 14.9 | 16.08 | Bark | 4.16 | 14.13 | 15.99 |
| | /i/ | 332 | 2703 | 3268 | /i/ | 342 | 2691 | 3310 |
| | s.d. | 21 | 80 | 294 | s.d. | 20 | 155 | 316 |
| | Bark | 3.35 | 15.01 | 16.2 | Bark | 3.45 | 14.97 | 16.28 |
| | /o/ | 426 | 936 | 3131 | /ə/ | 458 | 1905 | 3053 |
| | s.d. | 40 | 136 | 125 | s.d. | 90 | 473 | 252 |
| | Bark | 4.25 | 8.1 | 15.95 | Bark | 4.52 | 12.53 | 15.78 |
| | /u/ | 384 | 1126 | 2933 | /u/ | 341 | 1266 | 2845 |
| | s.d. | 42 | 205 | 142 | s.d. | — | — | — |
| | Bark | 3.86 | 9.19 | 15.53 | Bark | 3.44 | 9.99 | 15.34 |
| NN | /a/ | 799 | 1352 | 2686 | /a/ | 676 | 1513 | 2571 |
| | s.d. | 78 | 199 | 40 | s.d. | 99 | 308 | 261 |
| | Bark | 7.22 | 10.37 | 14.97 | Bark | 6.32 | 11.03 | 14.64 |
| | /ä/ | 538 | 2527 | 3167 | /ä/ | — | — | — |
| | s.d. | 51 | 357 | 426 | s.d. | — | — | — |
| | Bark | 5.23 | 14.5 | 15.96 | Bark | — | — | — |
| | /e/ | 398 | 2877 | 3526 | /e/ | 460 | 2535 | 3263 |
| | s.d. | 33 | 119 | 197 | s.d. | 50 | 405 | 248 |
| | Bark | 3.99 | 15.41 | 16.69 | Bark | 4.56 | 14.45 | 16.19 |
| | /i/ | 296 | 2913 | 3508 | /i/ | 370 | 2672 | 3412 |
| | s.d. | 46 | 91 | 326 | s.d. | 41 | 302 | 270 |
| | Bark | 2.98 | 15.49 | 16.64 | Bark | 3.72 | 14.89 | 16.48 |
| | /o/ | 418 | 802 | 2890 | /ə/ | 477 | 1677 | 2894 |
| | s.d. | 18 | 50 | 107 | s.d. | 77 | 579 | 218 |
| | Bark | 4.18 | 7.25 | 15.44 | Bark | 4.7 | 11.56 | 15.44 |
| | /u/ | 370 | 839 | 2793 | /u/ | 370 | 991 | 2767 |
| | s.d. | 17 | 47 | 87 | s.d. | 33 | 41 | 44 |
| | Bark | 3.73 | 7.5 | 15.22 | Bark | 3.72 | 8.47 | 15.16 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ST | /a/ | 870 | 1467 | 2712 | /a/ | 665 | 1638 | 2799 |
| | s.d. | 274 | 99 | 85 | s.d. | 152 | 217 | 97 |
| | Bark | 7.56 | 10.94 | 15.03 | Bark | 6.2 | 11.63 | 15.23 |
| | /ä/ | 551 | 2072 | 2840 | /ä/ | — | — | — |
| | s.d. | 93 | 243 | 181 | s.d. | — | — | — |
| | Bark | 5.33 | 13.21 | 15.32 | Bark | — | — | — |
| | /e/ | 430 | 2414 | 2898 | /e/ | 528 | 2270 | 3041 |
| | s.d. | 40 | 192 | 202 | s.d. | 193 | 324 | 181 |
| | Bark | 4.29 | 14.24 | 15.45 | Bark | 5.05 | 13.78 | 15.76 |
| | /i/ | 355 | 2643 | 3292 | /i/ | 384 | 2490 | 3248 |
| | s.d. | 23 | 102 | 273 | s.d. | 29 | 287 | 365 |
| | Bark | 3.58 | 14.86 | 16.25 | Bark | 3.86 | 14.43 | 16.14 |
| | /o/ | 411 | 913 | 2708 | /ə/ | 569 | 1718 | 2836 |
| | s.d. | 12 | 173 | 122 | s.d. | 141 | 150 | 97 |
| | Bark | 4.12 | 7.93 | 15.02 | Bark | 5.46 | 11.97 | 15.32 |
| | /u/ | 367 | 1148 | 2930 | /u/ | 376 | 1215 | 2792 |
| | s.d. | 66 | 391 | 95 | s.d. | 12 | 139 | 156 |
| | Bark | 3.68 | 9.12 | 15.53 | Bark | 3.79 | 9.71 | 15.22 |
| TR | /a/ | 561 | 1416 | 2599 | /a/ | 544 | 1743 | 2815 |
| | s.d. | 142 | 212 | 74 | s.d. | 136 | 200 | 173 |
| | Bark | 5.38 | 10.66 | 14.75 | Bark | 5.23 | 12.05 | 15.26 |
| | /ä/ | 435 | 2346 | 3120 | /ä/ | — | — | — |
| | s.d. | 19 | 410 | 339 | s.d. | — | — | — |
| | Bark | 4.33 | 13.96 | 15.89 | Bark | — | — | — |
| | /e/ | 344 | 2500 | 3175 | /e/ | 400 | 2358 | 3223 |
| | s.d. | 20 | 307 | 393 | s.d. | 65 | 317 | 290 |
| | Bark | 3.47 | 14.44 | 15.99 | Bark | 3.99 | 14.04 | 16.11 |
| | /i/ | 317 | 2544 | 3254 | /i/ | 317 | 2596 | 3538 |
| | s.d. | 9 | 212 | 289 | s.d. | 12 | 182 | 137 |
| | Bark | 3.2 | 14.59 | 16.17 | Bark | 3.2 | 14.73 | 16.72 |
| | /o/ | 380 | 954 | 2817 | /ə/ | 381 | 1834 | 2928 |
| | s.d. | 26 | 130 | 280 | s.d. | 36 | 178 | 61 |
| | Bark | 3.82 | 8.21 | 15.25 | Bark | 3.83 | 12.41 | 15.53 |
| | /u/ | 329 | 1105 | 2841 | /u/ | 306 | 1714 | 2580 |
| | s.d. | 17 | 294 | 119 | s.d. | 6 | 196 | 131 |
| | Bark | 3.32 | 9.02 | 15.33 | Bark | 3.09 | 11.96 | 14.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| VT | /a/ | 544 | 1374 | 2530 | /a/ | 524 | 1599 | 2773 |
| | s.d. | 46 | 270 | 183 | s.d. | 51 | 289 | 260 |
| | Bark | 5.29 | 10.43 | 14.56 | Bark | 5.12 | 11.43 | 15.15 |
| | /ä/ | 428 | 2266 | 2908 | /ä/ | — | — | — |
| | s.d. | 24 | 123 | 316 | s.d. | — | — | — |
| | Bark | 4.27 | 13.84 | 15.45 | Bark | — | — | — |
| | /e/ | 403 | 2431 | 3172 | /e/ | 417 | 2174 | 2967 |
| | s.d. | 16 | 185 | 234 | s.d. | 35 | 243 | 263 |
| | Bark | 4.04 | 14.29 | 16.02 | Bark | 4.17 | 13.52 | 15.59 |
| | /i/ | 331 | 2565 | 3281 | /i/ | 399 | 2485 | 3324 |
| | s.d. | 48 | 139 | 281 | s.d. | 5 | 215 | 167 |
| | Bark | 3.34 | 14.66 | 16.23 | Bark | 4 | 14.43 | 16.33 |
| | /o/ | 421 | 924 | 2884 | /ə/ | 412 | 1589 | 2632 |
| | s.d. | 20 | 192 | 182 | s.d. | 7 | 178 | 175 |
| | Bark | 4.21 | 7.99 | 15.42 | Bark | 4.13 | 11.45 | 14.82 |
| | /u/ | 386 | 1419 | 2877 | /u/ | 376 | 1047 | 2872 |
| | s.d. | 25 | 645 | 398 | s.d. | 15 | 164 | 181 |
| | Bark | 3.88 | 10.27 | 15.36 | Bark | 3.79 | 8.78 | 15.4 |

Table 3. Average formant values (in Hz and Bark) with standard deviations (s.d.) of vowels in phrase-final words produced by 2 male speakers.

| | Stressed first syllable | | | | Unstressed second syllable | | | |
|---|---|---|---|---|---|---|---|---|
| Speaker | Vowel | F1 | F2 | F3 | Vowel | F1 | F2 | F3 |
| IS | /a/ | 524 | 1288 | 2158 | /a/ | 448 | 1379 | 2137 |
| | s.d. | 88 | 122 | 139 | s.d. | 47 | 132 | 109 |
| | Bark | 5.1 | 10.08 | 13.51 | Bark | 4.45 | 10.52 | 13.44 |
| | /ä/ | 435 | 1950 | 2457 | /ä/ | — | — | — |
| | s.d. | 44 | 91 | 117 | s.d. | — | — | — |
| | Bark | 4.33 | 12.84 | 14.38 | Bark | — | — | — |
| | /e/ | 364 | 2193 | 3018 | /e/ | 398 | 1948 | 2571 |
| | s.d. | 58 | 104 | 361 | s.d. | 33 | 195 | 245 |
| | Bark | 3.66 | 13.62 | 15.68 | Bark | 3.99 | 12.8 | 14.65 |
| | /i/ | 298 | 2276 | 3211 | /i/ | 374 | 2279 | 3130 |
| | s.d. | 44 | 50 | 197 | s.d. | 24 | 160 | 505 |
| | Bark | 3.01 | 13.87 | 16.1 | Bark | 3.77 | 13.87 | 15.87 |
| | /o/ | 411 | 957 | 2336 | /ə/ | 424 | 1542 | 2315 |
| | s.d. | 18 | 96 | 122 | s.d. | 20 | 373 | 186 |
| | Bark | 4.11 | 8.25 | 14.04 | Bark | 4.24 | 11.16 | 13.97 |
| | /u/ | 341 | 848 | 2294 | /u/ | 362 | 1362 | 2439 |
| | s.d. | 37 | 133 | 68 | s.d. | 12 | 411 | 351 |
| | Bark | 3.44 | 7.53 | 13.92 | Bark | 3.65 | 10.34 | 14.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM | /a/ | 531 | 1012 | 2042 | /a/ | 454 | 1187 | 2174 |
| | s.d. | 17 | 68 | 140 | s.d. | 24 | 128 | 156 |
| | Bark | 5.19 | 8.59 | 13.13 | Bark | 4.51 | 9.55 | 13.55 |
| | /ä/ | 484 | 1451 | 2433 | /ä/ | — | — | — |
| | s.d. | 12 | 192 | 108 | s.d. | — | — | — |
| | Bark | 4.78 | 10.83 | 14.31 | Bark | — | — | — |
| | /e/ | 382 | 1731 | 2488 | /e/ | 393 | 1541 | 2350 |
| | s.d. | 63 | 99 | 166 | s.d. | 33 | 145 | 227 |
| | Bark | 3.82 | 12.03 | 14.45 | Bark | 3.95 | 11.25 | 14.06 |
| | /i/ | 306 | 1952 | 3085 | /i/ | 331 | 1790 | 2589 |
| | s.d. | 14 | 168 | 345 | s.d. | 18 | 110 | 220 |
| | Bark | 3.09 | 12.83 | 15.82 | Bark | 3.34 | 12.26 | 14.71 |
| | /o/ | 398 | 798 | 2113 | /ə/ | 442 | 1156 | 2023 |
| | s.d. | 27 | 111 | 56 | s.d. | 11 | 132 | 25 |
| | Bark | 3.99 | 7.2 | 13.38 | Bark | 4.4 | 9.4 | 13.09 |
| | /u/ | 324 | 892 | 2329 | /u/ | 338 | 1395 | 2050 |
| | s.d. | 21 | 73 | 59 | s.d. | 31 | 249 | 242 |
| | Bark | 3.27 | 7.85 | 14.03 | Bark | 3.41 | 10.57 | 13.15 |

Table 4. Average formant values (in Hz and Bark) with standard deviations (s.d.) of vowels in sentence-final words produced by 2 male speakers.

| | Stressed first syllable | | | | Unstressed second syllable | | | |
|---|---|---|---|---|---|---|---|---|
| Speaker | Vowel | F1 | F2 | F3 | Vowel | F1 | F2 | F3 |
| IS | /a/ | 491 | 1175 | 2114 | /a/ | 449 | 1384 | 2169 |
| | s.d. | 66 | 117 | 91 | s.d. | 37 | 156 | 136 |
| | Bark | 4.82 | 9.5 | 13.38 | Bark | 4.47 | 10.53 | 13.54 |
| | /ä/ | 388 | 1956 | 2409 | /ä/ | — | — | — |
| | s.d. | 18 | 113 | 138 | s.d. | — | — | — |
| | Bark | 3.9 | 12.85 | 14.24 | Bark | — | — | — |
| | /e/ | 359 | 2138 | 2961 | /e/ | 380 | 1947 | 2562 |
| | s.d. | 23 | 152 | 385 | s.d. | 36 | 205 | 261 |
| | Bark | 3.62 | 13.44 | 15.54 | Bark | 3.82 | 12.79 | 14.62 |
| | /i/ | 286 | 2150 | 3121 | /i/ | 341 | 2112 | 2720 |
| | s.d. | 31 | 176 | 252 | s.d. | 50 | 245 | 336 |
| | Bark | 2.88 | 13.47 | 15.91 | Bark | 3.44 | 13.34 | 15 |
| | /o/ | 391 | 968 | 2268 | /ə/ | 380 | 1556 | 2215 |
| | s.d. | 23 | 68 | 90 | s.d. | 17 | 249 | 214 |
| | Bark | 3.93 | 8.32 | 13.85 | Bark | 3.82 | 11.28 | 13.67 |
| | /u/ | 339 | 820 | 2248 | /u/ | 358 | 1218 | 2234 |
| | s.d. | 39 | 73 | 74 | s.d. | 30 | 166 | 92 |
| | Bark | 3.41 | 7.37 | 13.79 | Bark | 3.6 | 9.72 | 13.75 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NM | /a/ | 511 | 1000 | 2063 | /a/ | 466 | 1040 | 2123 |
| | s.d. | 29 | 68 | 71 | s.d. | 36 | 134 | 129 |
| | Bark | 5.02 | 8.52 | 13.21 | Bark | 4.61 | 8.73 | 13.4 |
| | /ä/ | 475 | 1488 | 2326 | /ä/ | — | — | — |
| | s.d. | 15 | 130 | 191 | s.d. | — | — | — |
| | Bark | 4.7 | 11.02 | 14 | Bark | — | — | — |
| | /e/ | 351 | 1716 | 2517 | /e/ | 413 | 1549 | 2311 |
| | s.d. | 47 | 96 | 259 | s.d. | 40 | 112 | 131 |
| | Bark | 3.53 | 11.97 | 14.51 | Bark | 4.13 | 11.29 | 13.97 |
| | /i/ | 272 | 1850 | 2910 | /i/ | 322 | 1834 | 2745 |
| | s.d. | 14 | 109 | 251 | s.d. | 25 | 112 | 214 |
| | Bark | 2.73 | 12.48 | 15.46 | Bark | 3.25 | 12.42 | 15.09 |
| | /o/ | 389 | 820 | 2254 | /ə/ | 420 | 948 | 2101 |
| | s.d. | 12 | 98 | 166 | s.d. | 22 | 122 | 68 |
| | Bark | 3.91 | 7.36 | 13.79 | Bark | 4.2 | 8.19 | 13.34 |
| | /u/ | 322 | 838 | 2314 | /u/ | 323 | 1164 | 2156 |
| | s.d. | 12 | 63 | 39 | s.d. | 18 | 238 | 91 |
| | Bark | 3.25 | 7.49 | 13.99 | Bark | 3.26 | 9.41 | 13.51 |

## III. Data of fundamental frequency

Table 1. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in monosyllabic words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

| Position | Speaker | N | V1 beg. | V1 end |
|---|---|---|---|---|
| | female | | | |
| PF | JM | 14 | 217 | 266 |
| | | s.d. | 31.3 | 30.4 |
| | NN | 15 | 233 | 320 |
| | | s.d. | 38.1 | 28.4 |
| | JS | 15 | 213 | 240 |
| | | s.d. | 23.1 | 16.5 |
| | ST | 15 | 251 | 279 |
| | | s.d. | 35.1 | 18.2 |
| | TR | 15 | 219 | 215 |
| | | s.d. | 28.9 | 27.3 |
| | VT | 15 | 258 | 280 |
| | | s.d. | 14.1 | 22.2 |
| SF | JM | 16 | 189 | 166 |
| | | s.d. | 15.4 | 8.9 |
| | NN | 16 | 204 | 190 |
| | | s.d. | 35.5 | 14.4 |
| | JS | 15 | 179 | 155 |
| | | s.d. | 23.1 | 2.9 |
| | ST | 16 | 205 | 210 |
| | | s.d. | 32 | 13.5 |
| | TR | 16 | 168 | 170 |
| | | s.d. | 38.1 | 50.3 |
| | VT | 16 | 216 | 198 |
| | | s.d. | 15.9 | 10.4 |
| | male | | | |
| PF | IS | 15 | 147 | 136 |
| | | s.d. | 12.7 | 20.4 |
| | NM | 14 | 109 | 103 |
| | | s.d. | 6.2 | 7 |
| SF | IS | 15 | 134 | 116 |
| | | s.d. | 14.3 | 6.1 |
| | NM | 16 | 84 | 88 |
| | | s.d. | 8.5 | 11.7 |

Table 2. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in disyllabic words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

| Position | Speaker | N | V1 stressed | | | | N | V2 stressed | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | | V1 | | V2 | |
| | | | beg. | end | beg. | end | | beg. | end | beg. | end |
| | female | | | | | | | | | | |
| PF | JM | 58 | 234 | 263 | 204 | 163 | 6 | 225 | 194 | 215 | 290 |
| | | s.d. | 27.3 | 26.8 | 21.1 | 10.9 | s.d. | 22.1 | 6.4 | 7.4 | 19.7 |
| | NN | 57 | 258 | 307 | 240 | 200 | 9 | 226 | 200 | 229 | 338 |
| | | s.d. | 34.1 | 18.7 | 30.2 | 40.1 | s.d. | 27.8 | 14.6 | 25.1 | 24.7 |
| | JS | 59 | 228 | 264 | 210 | 163 | 6 | 203 | 197 | 218 | 235 |
| | | s.d. | 31 | 23.5 | 25.9 | 17.3 | s.d. | 11.7 | 3.1 | 9.7 | 27.8 |
| | ST | 61 | 264 | 271 | 200 | 173 | 5 | 245 | 204 | 226 | 288 |
| | | s.d. | 36 | 15.9 | 26.5 | 24.6 | s.d. | 48.2 | 12.3 | 15.3 | 17.2 |
| | TR | 58 | 217 | 254 | 174 | 161 | 6 | 195 | 187 | 215 | 193 |
| | | s.d. | 25 | 20.6 | 25.7 | 35.9 | s.d. | 27.9 | 25.4 | 19.8 | 27.7 |
| | VT | 55 | 261 | 267 | 238 | 199 | 7 | 238 | 229 | 252 | 282 |
| | | s.d. | 14.9 | 15.5 | 16.9 | 11.6 | s.d. | 7.4 | 14.8 | 5.1 | 15.4 |
| SF | JM | 57 | 203 | 168 | 178 | 162 | 6 | 237 | 225 | 178 | 165 |
| | | s.d. | 20.6 | 12.5 | 11.1 | 7.5 | s.d. | 22.4 | 8.3 | 6.4 | 6.1 |
| | NN | 56 | 218 | 184 | 201 | 194 | 6 | 243 | 222 | 194 | 192 |
| | | s.d. | 28.2 | 12.6 | 16.9 | 12.9 | s.d. | 30.1 | 8.2 | 12.5 | 5.7 |
| | JS | 55 | 194 | 165 | 173 | 164 | 5 | 225 | 208 | 163 | 159 |
| | | s.d. | 21.8 | 8.8 | 13 | 7 | s.d. | 28.5 | 7.4 | 1.5 | 1.7 |
| | ST | 59 | 222 | 212 | 229 | 204 | 4 | 211 | 174 | 182 | 213 |
| | | s.d. | 28.8 | 9.5 | 24.7 | 5.4 | s.d. | 15.3 | 4.2 | 9 | 3.1 |
| | TR | 57 | 171 | 153 | 174 | 169 | 6 | 207 | 192 | 155 | 154 |
| | | s.d. | 27.2 | 18.3 | 48.2 | 45.4 | s.d. | 25.1 | 14.4 | 4.6 | 4.7 |
| | VT | 56 | 227 | 200 | 213 | 201 | 8 | 240 | 216 | 199 | 199 |
| | | s.d. | 17.8 | 7.3 | 14.5 | 6.3 | s.d. | 5.5 | 7.6 | 6.8 | 5.5 |
| | male | | | | | | | | | | |
| PF | IS | 57 | 159 | 139 | 137 | 126 | 7 | 171 | 162 | 146 | 127 |
| | | s.d. | 12.7 | 17.8 | 6.6 | 7.1 | s.d. | 13.6 | 13.9 | 6.1 | 6.9 |
| | NM | 54 | 103 | 105 | 88 | 75 | 9 | 99 | 99 | 107 | 96 |
| | | s.d. | 9.3 | 6.1 | 9 | 10.3 | s.d. | 4.4 | 0.5 | 3.2 | 7.5 |
| SF | IS | 56 | 145 | 123 | 125 | 115 | 6 | 145 | 138 | 128 | 112 |
| | | s.d. | 11.9 | 8.3 | 7.4 | 6.1 | s.d. | 10.2 | 5.9 | 9.9 | 6.3 |
| | NM | 50 | 80 | 81 | 95 | 98 | 10 | 81 | 78 | 83 | 102 |
| | | s.d. | 8.2 | 5.5 | 7.6 | 6.7 | s.d. | 6.1 | 5.2 | 4.9 | 5.1 |

Table 3. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in trisyllabic words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

| Posi-tion | Speaker | N | V1 and V3 stressed | | | | | | N | V2 and V4 stressed | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | | V1 | | V2 | | V3 | |
| | | | beg. | end | beg. | end | beg. | end | | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | | | | | | |
| PF | JM | 16 | 219 | 251 | 241 | 198 | 187 | 163 | 3 | 216 | 179 | 196 | 225 | 208 | 198 |
| | | s.d. | 25.2 | 18.8 | 26.5 | 19.4 | 16.5 | 14.5 | s.d. | 9.9 | 7.1 | 23.7 | 63.1 | 31.2 | 82 |
| | NN | 15 | 248 | 309 | 306 | 255 | 242 | 210 | 3 | 266 | 231 | 250 | 312 | 276 | 224 |
| | | s.d. | 29.6 | 24.3 | 11.8 | 24 | 45.2 | 54.3 | s.d. | 40.3 | 20 | 25.7 | 18.2 | 19.1 | 74.3 |
| | JS | 14 | 208 | 274 | 273 | 225 | 211 | 167 | 4 | 202 | 194 | 210 | 295 | 248 | 185 |
| | | s.d. | 13.8 | 13.3 | 11.6 | 16.2 | 28.3 | 28.4 | s.d. | 9.5 | 14 | 8.7 | 16.2 | 21.9 | 26.5 |
| | ST | 17 | 238 | 267 | 232 | 187 | 200 | 199 | 6 | 272 | 202 | 219 | 286 | 222 | 165 |
| | | s.d. | 39.6 | 24.3 | 32.3 | 17 | 35.2 | 42 | s.d. | 9.5 | 7.9 | 18 | 19.7 | 18.7 | 7.8 |
| | TR | 17 | 201 | 246 | 240 | 205 | 170 | 161 | 3 | 190 | 185 | 208 | 258 | 185 | 154 |
| | | s.d. | 23 | 17.8 | 16.6 | 11.8 | 23.8 | 22.8 | s.d. | 15.4 | 19.2 | 10 | 9.5 | 17.9 | 3 |
| | VT | 13 | 244 | 254 | 259 | 226 | 228 | 196 | 3 | 232 | 217 | 247 | 256 | 241 | 192 |
| | | s.d. | 10 | 9.5 | 12.1 | 10.8 | 11.8 | 9.8 | s.d. | 11.6 | 20.6 | 5.7 | 9.5 | 18.6 | 12.2 |
| SF | JM | 15 | 194 | 169 | 185 | 161 | 171 | 160 | 3 | 251 | 226 | 189 | 160 | 165 | 152 |
| | | s.d. | 15.6 | 12.4 | 16.3 | 8.4 | 12.4 | 9.6 | s.d. | 9.7 | 18.7 | 7.8 | 5.1 | 17.1 | 11.5 |
| | NN | 14 | 212 | 188 | 206 | 185 | 205 | 197 | 3 | 298 | 253 | 220 | 185 | 203 | 175 |
| | | s.d. | 24.5 | 12.4 | 17.8 | 12.6 | 15.8 | 8.9 | s.d. | 15.9 | 24 | 21 | 20.2 | 34 | 10.6 |
| | JS | 15 | 194 | 175 | 186 | 166 | 180 | 164 | 3 | 252 | 226 | 190 | 158 | 172 | 157 |
| | | s.d. | 17.9 | 26.8 | 27.5 | 20.8 | 17 | 7.2 | s.d. | 15.7 | 7.6 | 6.1 | 6.7 | 4.6 | 4.5 |
| | ST | 18 | 220 | 215 | 233 | 196 | 227 | 197 | 7 | 232 | 175 | 185 | 226 | 240 | 204 |
| | | s.d. | 36.4 | 27.6 | 25.7 | 14 | 32.8 | 18.2 | s.d. | 22.7 | 15.3 | 7.6 | 7.5 | 29.8 | 8.4 |
| | TR | 14 | 162 | 152 | 157 | 151 | 158 | 150 | 3 | 201 | 194 | 163 | 151 | 154 | 149 |
| | | s.d. | 14.1 | 6.7 | 9.2 | 4.6 | 9.9 | 3.7 | s.d. | 15.6 | 20.4 | 8.5 | 0.6 | 10.4 | 4 |
| | VT | 13 | 230 | 204 | 217 | 197 | 203 | 198 | 3 | 242 | 220 | 221 | 200 | 203 | 197 |
| | | s.d. | 8.9 | 7.9 | 10.9 | 2.5 | 7.7 | 5.2 | s.d. | 12.9 | 13.9 | 3.5 | 9 | 13.7 | 2.1 |
| | male | | | | | | | | | | | | | | |
| PF | IS | 14 | 159 | 149 | 154 | 133 | 138 | 126 | 3 | 170 | 158 | 151 | 137 | 143 | 127 |
| | | s.d. | 12.9 | 19.4 | 14.2 | 8.4 | 7.3 | 8.3 | s.d. | 17.7 | 21.1 | 7.8 | 5.7 | 7.1 | 2.3 |
| | NM | 15 | 101 | 106 | 103 | 96 | 87 | 77 | 2 | 98 | 96 | 106 | 100 | 76 | 75 |
| | | s.d. | 9.6 | 5.4 | 7.7 | 6.5 | 10.3 | 8 | s.d. | — | — | — | — | — | — |
| SF | IS | 16 | 137 | 119 | 130 | 114 | 125 | 116 | 3 | 181 | 153 | 139 | 116 | 129 | 112 |
| | | s.d. | 21.4 | 17.7 | 8.6 | 9 | 7.4 | 6.8 | s.d. | 10.3 | 9 | 4.6 | 13.7 | 11.2 | 4.2 |
| | NM | 13 | 83 | 82 | 94 | 88 | 98 | 97 | 1 | 74 | 72 | 89 | 82 | 84 | 85 |
| | | s.d. | 6.8 | 4.7 | 7.5 | 3.7 | 4.4 | 4.6 | s.d. | — | — | — | — | — | — |

Table 4. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in four-syllable words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

| Position | Speaker | N | V1 and V3 stressed | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | V4 | |
| | | | beg. | end | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | |
| PF | JM | 2 | 220 | 246 | 284 | 236 | 208 | 195 | 188 | 192 |
| | | s.d. | 2.8 | 0 | 36.1 | 4.9 | 15.6 | 14.1 | 18.4 | 15.6 |
| | NN | 1 | 245 | 278 | 304 | 251 | 245 | 244 | 196 | 189 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | JS | 2 | 183 | 174 | 179 | 166 | 178 | 176 | 169 | 170 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | ST | 1 | 221 | 287 | 267 | 187 | 186 | 181 | 170 | 166 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | TR | 1 | 209 | 239 | 241 | 233 | 224 | 216 | — | — |
| | | s.d. | — | — | — | — | — | — | — | — |
| | VT | 0 | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — |
| SF | JM | 2 | 194 | 176 | 184 | 154 | 169 | 158 | 168 | 153 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | NN | 1 | 201 | 182 | 191 | 182 | 185 | 183 | 199 | 192 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | JS | 1 | 167 | 175 | 169 | 159 | 181 | 165 | 170 | 156 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | ST | 1 | 193 | 214 | 225 | 207 | 207 | 202 | 199 | 202 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | TR | 2 | 166 | 158 | 164 | 152 | 157 | 156 | 150 | 148 |
| | | s.d. | 10.6 | 6.4 | 6.4 | 1.4 | — | — | 9.2 | 3.5 |
| | VT | 1 | 227 | 218 | 213 | 205 | 207 | 196 | 197 | 195 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | male | | | | | | | | | |
| PF | IS | 0 | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — |
| | NM | 1 | 105 | 104 | 107 | 99 | 99 | 93 | 81 | 75 |
| | | s.d. | — | — | — | — | — | — | — | — |
| SF | IS | 3 | 150 | 134 | 135 | 116 | 138 | 124 | 120 | 121 |
| | | s.d. | 6.4 | 4.2 | 1.4 | 24 | 9.2 | 0.7 | 2.1 | 4.2 |
| | NM | 1 | 77 | 83 | 91 | 90 | 95 | 92 | 99 | 97 |
| | | s.d. | — | — | — | — | — | — | — | — |

| Position | Speaker | N | V2 and V4 stressed | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | V4 | |
| | | | beg. | end | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | |
| PF | JM | 2 | 226 | 198 | 205 | 242 | 260 | 226 | 196 | 155 |
| | | s.d. | 4.9 | 5.7 | 18.4 | 19.1 | 9.9 | 26.2 | 0.7 | 1.4 |
| | NN | 2 | 268 | 226 | 246 | 300 | 322 | 259 | 222 | 180 |
| | | s.d. | 8.5 | 0.7 | 2.1 | 14.8 | 31.1 | 11.3 | 2.1 | 10.6 |
| | JS | 2 | 200 | 186 | 190 | 255 | 281 | 256 | 250 | 245 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | ST | 2 | 263 | 196 | 238 | 279 | 255 | 191 | 168 | 161 |
| | | s.d. | 2.8 | 7.1 | 5.7 | 1.4 | 7.1 | 12.7 | 0.7 | 7.1 |
| | TR | 2 | 190 | 178 | 179 | 230 | 230 | 211 | 174 | 165 |
| | | s.d. | 2.1 | 2.1 | 12.7 | 26.2 | 31.8 | 32.5 | 38.9 | 42.4 |
| | VT | 2 | 233 | 221 | 236 | 258 | 265 | 240 | 224 | 195 |
| | | s.d. | 2.8 | 1.4 | 1.4 | 8.5 | 11.3 | 5.7 | 7.8 | 1.4 |
| SF | JM | 3 | 234 | 223 | 204 | 162 | 190 | 161 | 178 | 162 |
| | | s.d. | 6.4 | 12.7 | 9.9 | 2.8 | 19.1 | 1.4 | 6.4 | 1.4 |
| | NN | 2 | 292 | 275 | 246 | 198 | 218 | 186 | 196 | 188 |
| | | s.d. | 7.8 | 4.2 | 3.5 | 0.7 | 24.7 | 6.4 | 4.2 | 3.5 |
| | JS | 1 | 209 | 241 | 205 | 155 | 187 | 162 | 171 | 162 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | ST | 2 | 228 | 178 | 213 | 224 | 255 | 208 | 210 | 206 |
| | | s.d. | 4.9 | 7.8 | 45.3 | 2.8 | 36.8 | 2.1 | 2.8 | 3.5 |
| | TR | 2 | 216 | 208 | 182 | 153 | 166 | 154 | 160 | 156 |
| | | s.d. | 9.2 | 7.8 | 5.7 | 1.4 | 6.4 | 4.2 | 0.7 | 3.5 |
| | VT | 2 | 262 | 248 | 239 | 212 | 226 | 202 | 202 | 202 |
| | | s.d. | 24 | 2.8 | 2.8 | 1.4 | 9.2 | 12 | 12 | 6.4 |
| | male | | | | | | | | | |
| PF | IS | 2 | 162 | 157 | 155 | 144 | 149 | 142 | 140 | 129 |
| | | s.d. | 9.2 | 11.3 | 4.2 | 4.9 | 1.4 | 4.2 | 4.9 | 5.7 |
| | NM | 2 | 88 | 87 | 98 | 102 | 102 | 98 | 88 | 74 |
| | | s.d. | 3.5 | 11.3 | 5.7 | 2.1 | 10.6 | 4.2 | 2.8 | 0.7 |
| SF | IS | 2 | 176 | 150 | 135 | 120 | 141 | 123 | 126 | 106 |
| | | s.d. | — | — | — | — | — | — | — | — |
| | NM | 2 | 74 | 78 | 79 | 78 | 86 | 89 | 95 | 96 |
| | | s.d. | 17.7 | 0.7 | 1.4 | 0.7 | 0 | 0 | 1.4 | 2.8 |

Table 5. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in five-syllable words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

| Position | Speaker | N | V1 and V3 stressed | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | V4 | | V5 | |
| | | | beg. | end | beg. | end | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | | | |
| PF | JM | 1 | 205 | 234 | 268 | 233 | 195 | 186 | 193 | 185 | 162 | 151 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — |
| | NN | 2 | 204 | 289 | 347 | 276 | 236 | 238 | 266 | 237 | 212 | 180 |
| | | s.d. | 13.4 | 8.5 | 2.8 | 12 | 12.7 | 0.7 | 17.7 | 8.5 | 12 | 0.7 |
| | JS | 1 | 170 | 277 | 288 | 255 | 237 | 227 | 242 | 199 | 193 | 155 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — |
| | ST | 2 | 214 | 245 | 278 | 206 | 206 | 188 | 214 | 172 | 174 | 160 |
| | | s.d. | 9.2 | 5.7 | 1.4 | 5.7 | 20.5 | 6.4 | 41.7 | 6.4 | 0.7 | 7.8 |
| | TR | 2 | 170 | 227 | 247 | 228 | 228 | 193 | 202 | 184 | 156 | 153 |
| | | s.d. | 12 | 14.1 | 0 | 2.1 | 19.1 | 11.3 | 9.2 | 0 | 2.8 | 4.2 |
| | VT | 2 | 246 | 245 | 277 | 259 | 239 | 222 | 242 | 222 | 214 | 196 |
| | | s.d. | 11.3 | 4.2 | 5.7 | 0 | 12.7 | 7.8 | 2.1 | 13.4 | 0.7 | 7.8 |
| SF | JM | 2 | 188 | 160 | 202 | 169 | 184 | 164 | 186 | 157 | 174 | 160 |
| | | s.d. | 9.9 | 0 | 18.4 | 1.4 | 14.1 | 13.4 | 13.4 | 2.8 | 7.8 | 4.2 |
| | NN | 2 | 248 | 212 | 260 | 206 | 239 | 165 | 206 | 180 | 194 | 184 |
| | | s.d. | 47.4 | 5.7 | 7.8 | 10.6 | 29.7 | 5.7 | 12.7 | 0.7 | 2.8 | 0.7 |
| | JS | 1 | 184 | 192 | 185 | 194 | 178 | 179 | 196 | 179 | 184 | 184 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — |
| | ST | 2 | 296 | 210 | 269 | 206 | 207 | 198 | 234 | 199 | 209 | 202 |
| | | s.d. | 93.3 | 0.7 | 8.5 | 7.8 | 0 | 0.7 | 36.8 | 4.2 | 5.7 | 0.7 |
| | TR | 2 | 156 | 158 | 166 | 154 | 158 | 156 | 174 | 152 | 152 | 157 |
| | | s.d. | 2.8 | 0.7 | 19.1 | 4.9 | 5.7 | 3.5 | 17.7 | 1.4 | — | — |
| | VT | 2 | 223 | 206 | 231 | 212 | 208 | 198 | 203 | 192 | 198 | 196 |
| | | s.d. | 26.9 | 1.4 | 4.2 | 9.2 | 9.2 | 16.3 | 7.1 | 7.8 | 2.1 | 2.1 |
| | male | | | | | | | | | | | |
| PF | IS | 2 | 158 | 139 | 152 | 149 | 142 | 128 | 144 | 135 | 136 | 128 |
| | | s.d. | 6.4 | 1.4 | 4.9 | 1.4 | 0 | 14.8 | 2.1 | 1.4 | 2.1 | 0 |
| | NM | 2 | 88 | 102 | 92 | 92 | 97 | 86 | 80 | 80 | 72 | 70 |
| | | s.d. | 30.4 | 2.1 | 0.7 | 2.1 | 5.7 | 0.7 | 10.6 | 0 | 5.7 | 5.7 |
| SF | IS | 0 | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — |
| | NM | 2 | 64 | 78 | 82 | 85 | 94 | 94 | 106 | 98 | 102 | 103 |
| | | s.d. | 2.1 | 2.8 | 4.9 | 4.2 | 0.7 | 4.9 | 14.8 | 2.8 | 1.4 | 5.7 |

Table 6. Average fundamental frequencies (in Hz) with standard deviations (s.d.) of vowels in six-syllable words (N = number of tokens, PF = phrase-final position, SF = sentence-final position).

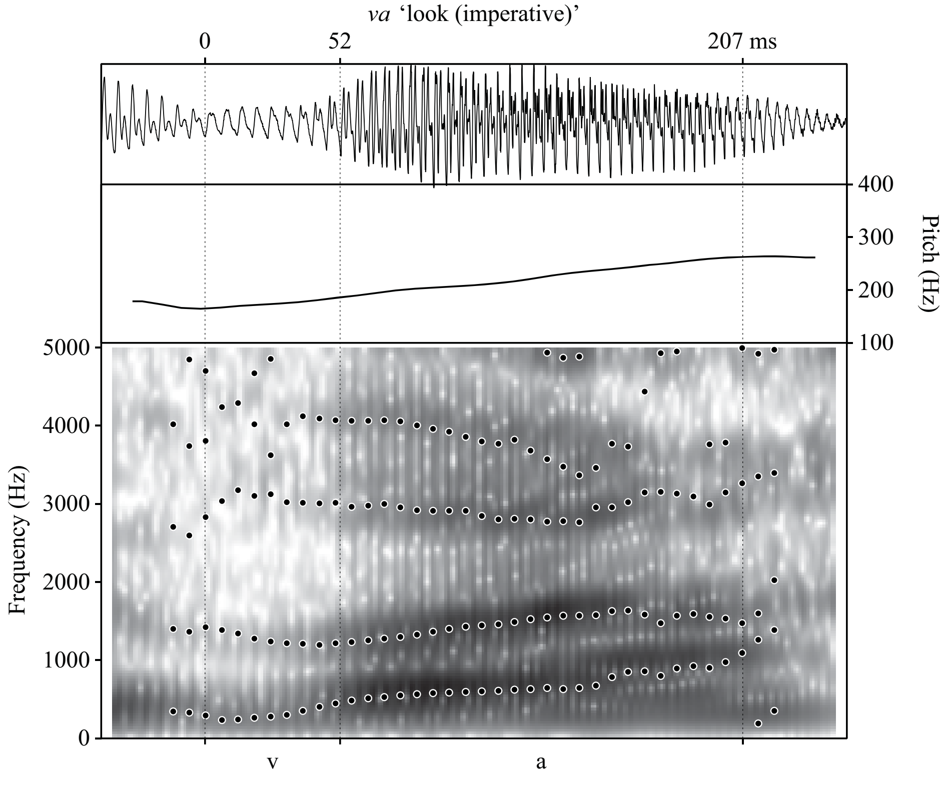
| Position | Speaker | N | V1 and V3 stressed | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | V4 | | V5 | | V6 | |
| | | | beg. | end | beg. | end | beg. | end | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | | | | | |
| PF | JM | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | NN | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | JS | 1 | 196 | 200 | 186 | 180 | 197 | 274 | 282 | 257 | 252 | 218 | 189 | 161 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | ST | 1 | 211 | 204 | 206 | 191 | 208 | 275 | 270 | 210 | 185 | 179 | 169 | 164 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | TR | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | VT | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| SF | JM | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | NN | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | JS | 1 | 184 | 225 | 211 | 238 | 173 | 172 | 171 | 175 | 175 | 174 | 177 | 174 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | ST | 2 | 244 | 182 | 182 | 164 | 242 | 222 | 228 | 211 | 244 | 208 | 209 | 209 |
| | | s.d. | 15.6 | 0.7 | 4.2 | 0.7 | 17 | 6.4 | 3.5 | 7.1 | 53 | 2.1 | 7.1 | 1.4 |
| | TR | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | VT | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | male | | | | | | | | | | | | | |
| PF | IS | 3 | 155 | 142 | 144 | 142 | 139 | 156 | 160 | 132 | 155 | 136 | 124 | 106 |
| | | s.d. | 7.1 | 11.3 | 7.1 | 2.8 | 1.4 | 4.9 | 9.9 | 23.3 | 17 | 19.1 | 9.2 | 4.9 |
| | NM | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| SF | IS | 2 | 163 | 148 | 142 | 138 | 129 | 125 | 126 | 112 | 125 | 119 | 117 | 110 |
| | | s.d. | 14.1 | 14.8 | 11.3 | 9.2 | 8.5 | 7.1 | 7.1 | 16.3 | 1.4 | 5.7 | 7.1 | 7.8 |
| | NM | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |

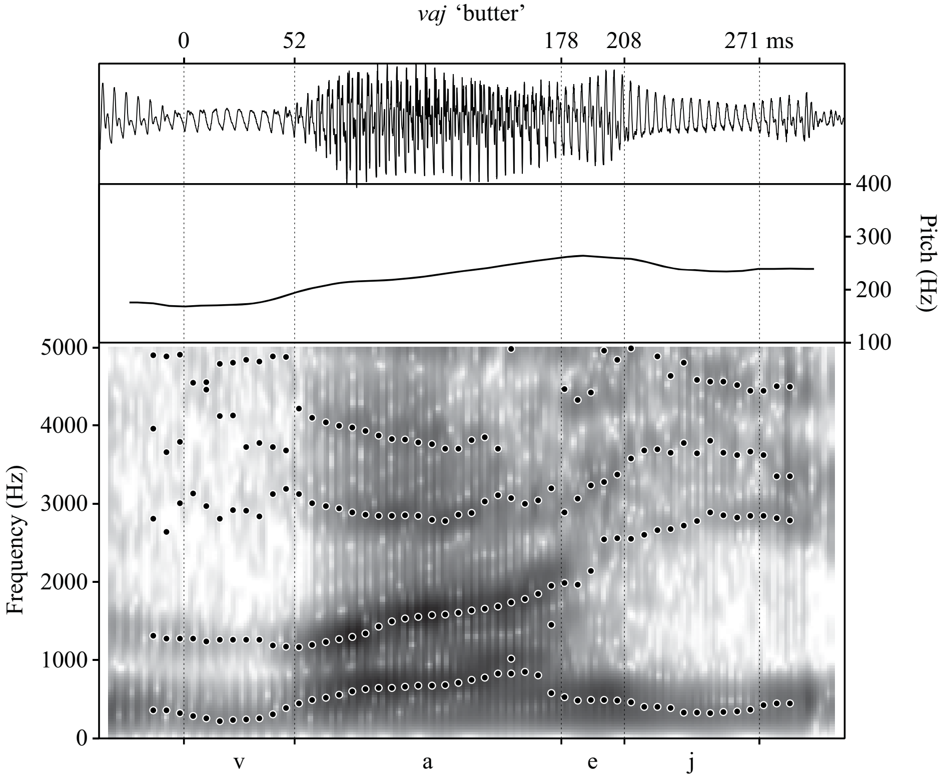
| Posi-tion | Speaker | N | V2 and V4 stressed | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | V1 | | V2 | | V3 | | V4 | | V5 | | V6 | |
| | | | beg. | end | beg. | end | beg. | end | beg. | end | beg. | end | beg. | end |
| | female | | | | | | | | | | | | | |
| PF | JM | 2 | 222 | 196 | 199 | 244 | 264 | 230 | 235 | 214 | 222 | 192 | 158 | 154 |
| | | s.d. | 6.4 | 10.6 | 0 | 6.4 | 16.3 | 19.1 | 0 | 3.5 | 9.2 | 3.5 | 5.7 | 2.8 |
| | NN | 2 | 238 | 231 | 265 | 314 | 280 | 253 | 258 | 234 | 260 | 241 | 201 | 184 |
| | | s.d. | 29.7 | 1.4 | 28.3 | 7.1 | 33.2 | 15.6 | 4.9 | 5.7 | 12.7 | 1.4 | 14.1 | 2.1 |
| | JS | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | ST | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | TR | 1 | 196 | 196 | 208 | 243 | 235 | 223 | 239 | 196 | 219 | 176 | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | VT | 1 | 244 | 230 | 235 | 254 | 257 | 251 | 252 | 230 | 259 | 227 | 213 | 185 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| SF | JM | 2 | 252 | 240 | 195 | 168 | 181 | 170 | 184 | 177 | 194 | 174 | 184 | 168 |
| | | s.d. | 6.4 | 1.4 | 9.9 | 12 | 8.5 | 7.8 | 3.5 | 12.7 | 12 | 10.6 | 9.9 | 19.1 |
| | NN | 2 | 278 | 288 | 218 | 202 | 209 | 202 | 202 | 200 | 206 | 202 | 200 | 194 |
| | | s.d. | 34.6 | 15.6 | 7.8 | 9.2 | 1.4 | 1.4 | 2.8 | 9.2 | 0.7 | 2.1 | 6.4 | 12.7 |
| | JS | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | ST | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | TR | 2 | 201 | 198 | 184 | 162 | 158 | 154 | 158 | 154 | 155 | 154 | 154 | 148 |
| | | s.d. | 25.5 | 3.5 | 9.2 | 12 | 3.5 | 4.9 | 5.7 | 3.5 | 2.8 | 4.9 | 9.2 | 9.2 |
| | VT | 2 | 254 | 242 | 229 | 220 | 220 | 205 | 210 | 206 | 212 | 198 | 196 | 198 |
| | | s.d. | 3.5 | 2.1 | 0 | 4.2 | 2.1 | 5.7 | 0 | 4.9 | 4.9 | 9.2 | 1.4 | 4.9 |
| | male | | | | | | | | | | | | | |
| PF | IS | 1 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | NM | 1 | 98 | 99 | 101 | 113 | 104 | 104 | 108 | 90 | 97 | 94 | 83 | 76 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| SF | IS | 0 | — | — | — | — | — | — | — | — | — | — | — | — |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |
| | NM | 1 | 88 | 84 | 80 | 81 | 86 | 86 | 86 | 76 | 80 | 85 | 92 | 80 |
| | | s.d. | — | — | — | — | — | — | — | — | — | — | — | — |

# Appendix 4

# Spectrograms of 1–6 syllable words produced in phrase-final position (speaker JM)

Position of stress:
S1 = stress on first syllable (also on odd-numbered syllables)
S2 = stress on second syllable (also on even-numbered syllables)





*vaj* ‘butter’
0
52
178
208
271 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
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a
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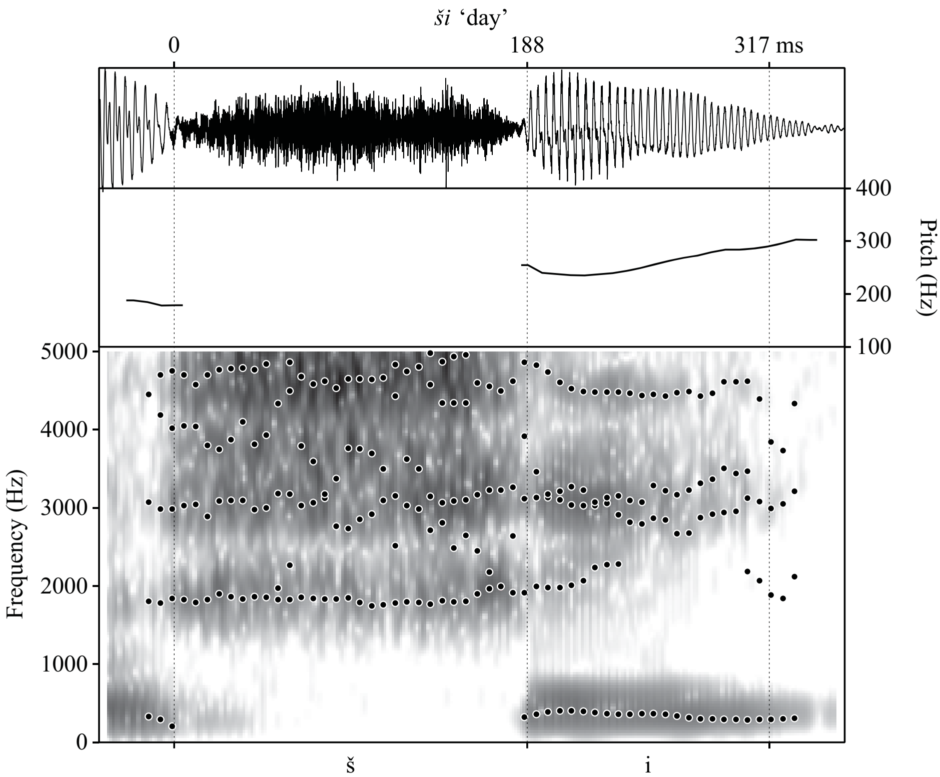

*ši* ‘day’
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188
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300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
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Frequency (Hz)
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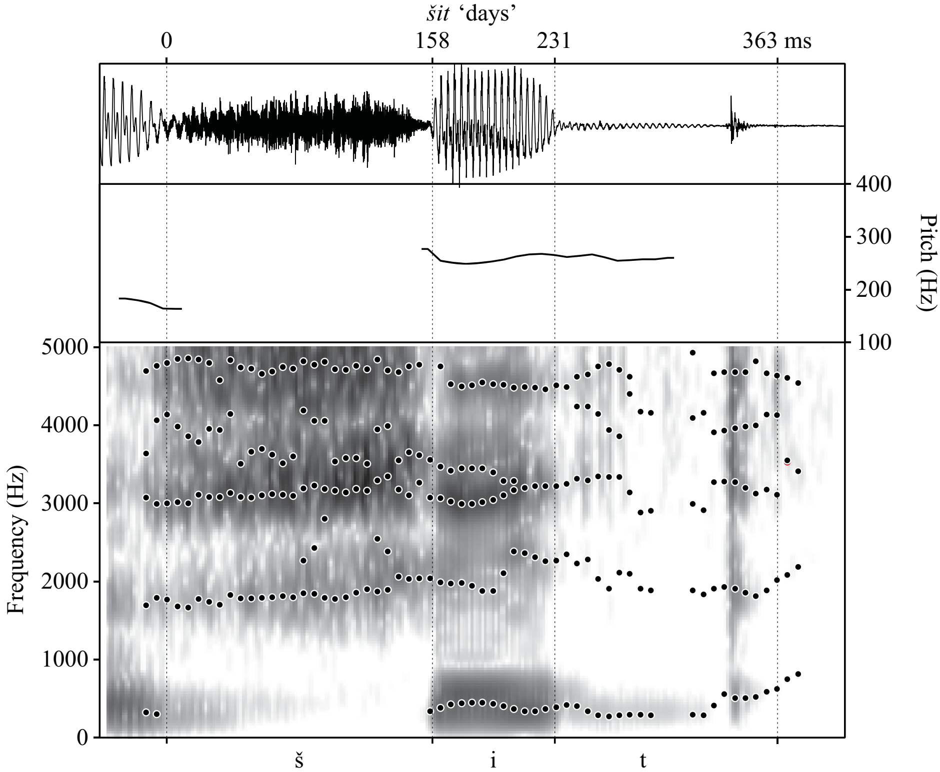
i



*šit* 'days'
0
158
231
363 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
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Frequency (Hz)
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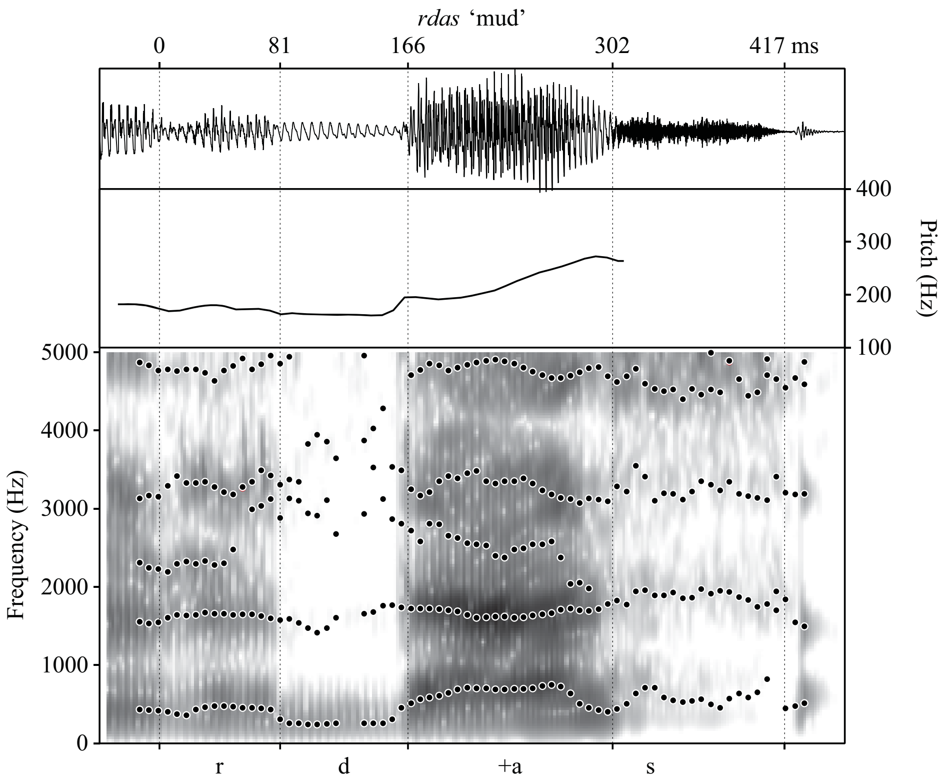

*rdas* 'mud'
0
81
166
302
417 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
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Frequency (Hz)
r
d
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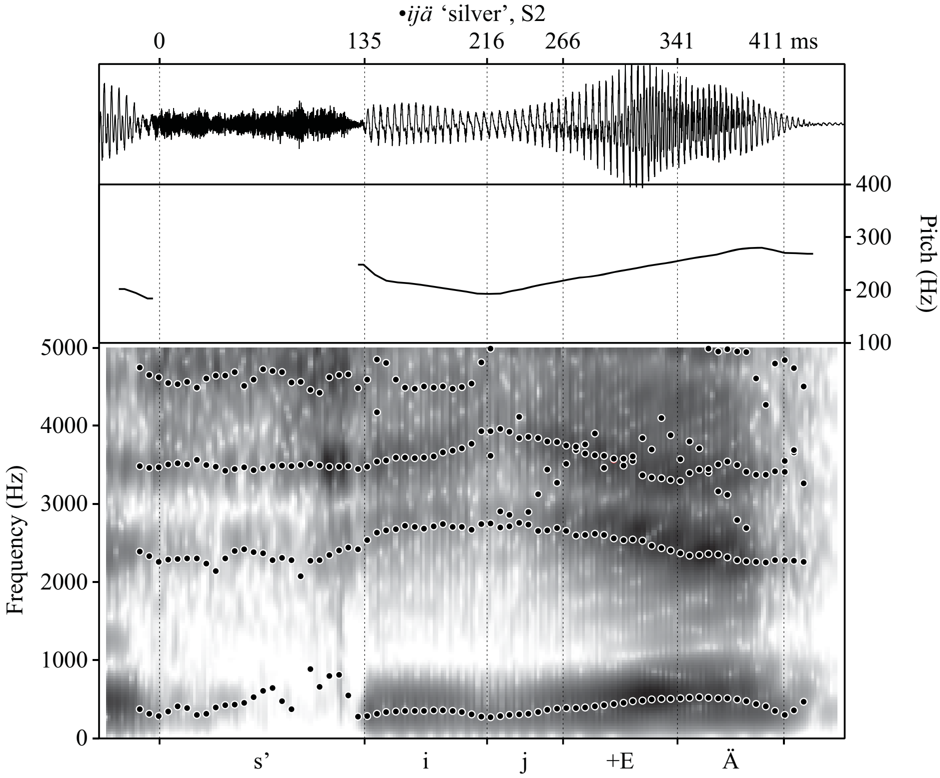
•ijä 'silver', S2
0
135
216
266
341
411 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
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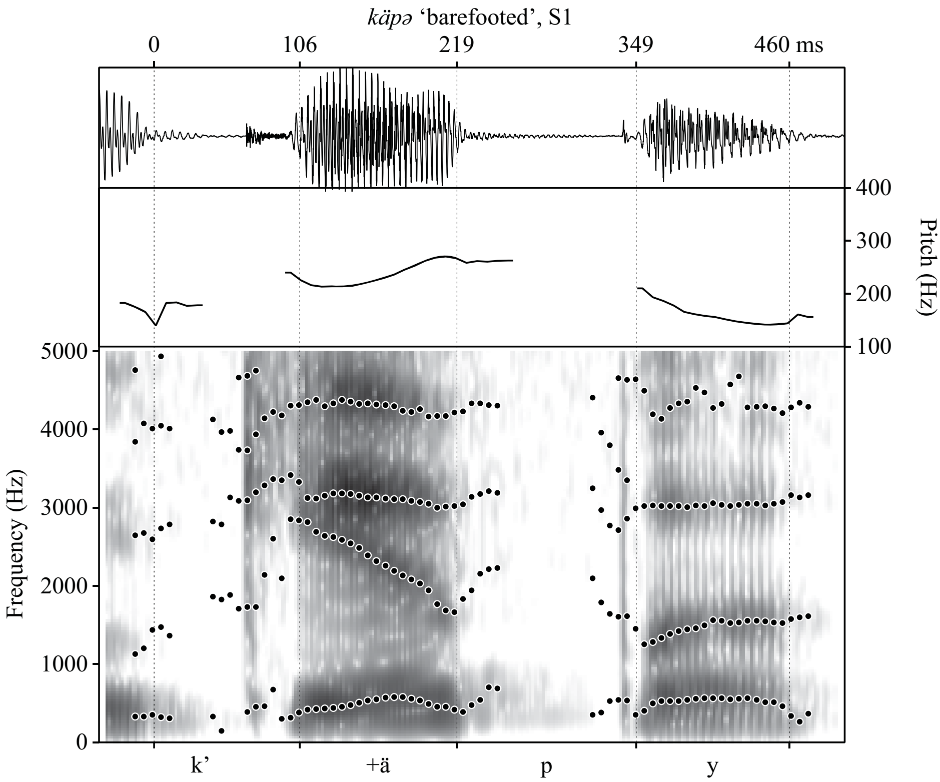
käpə 'barefooted', S1
0
106
219
349
460 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
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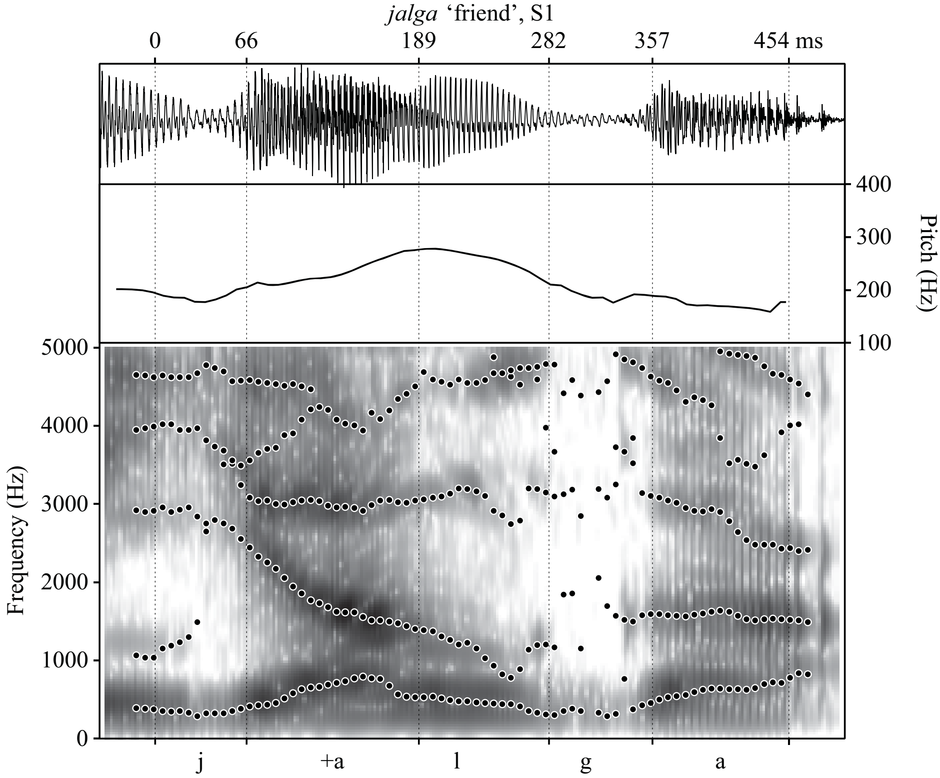
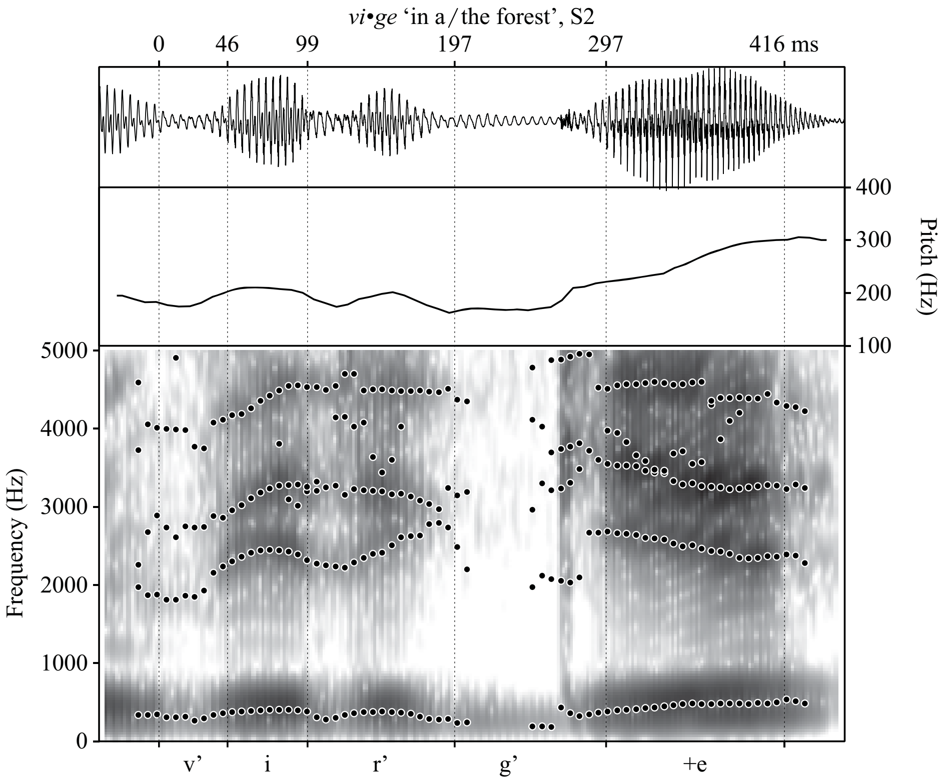
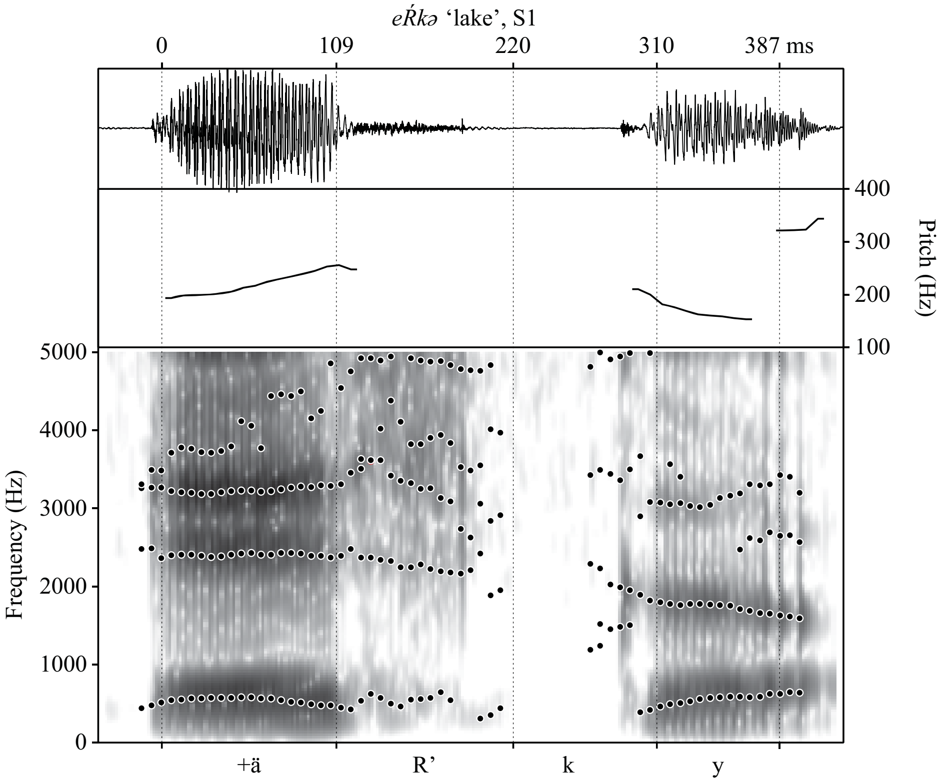
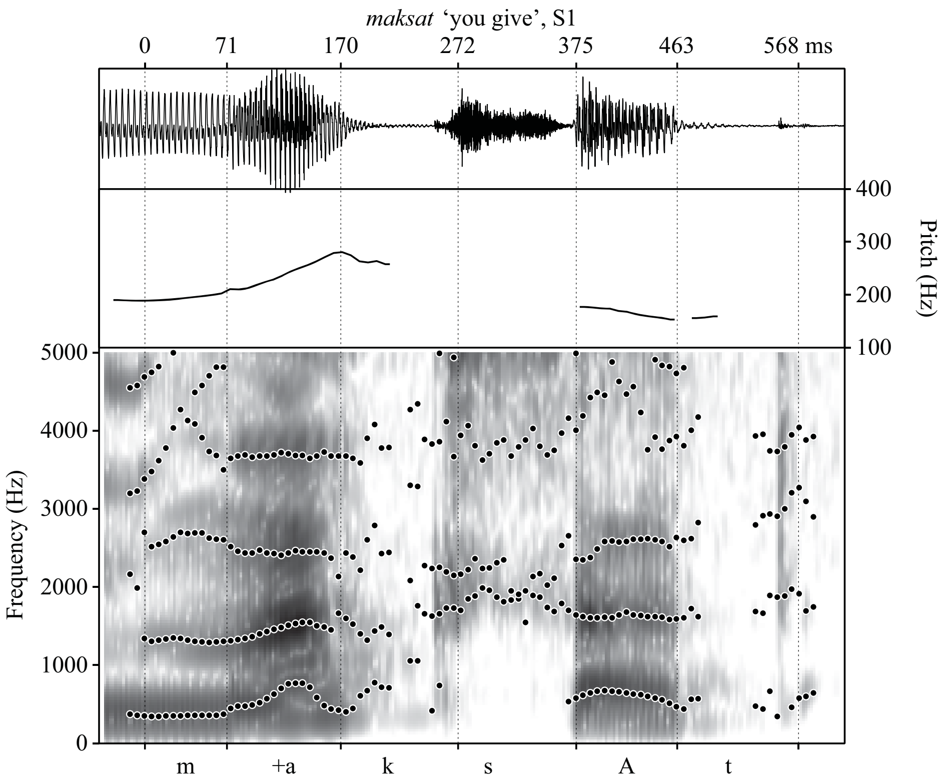
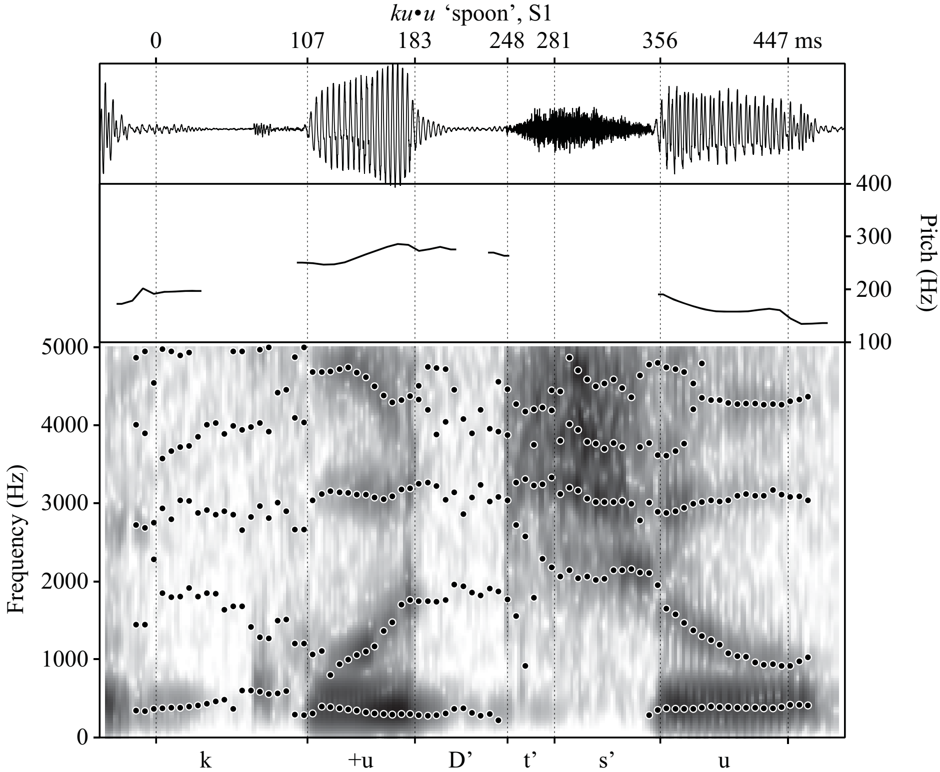
p
y

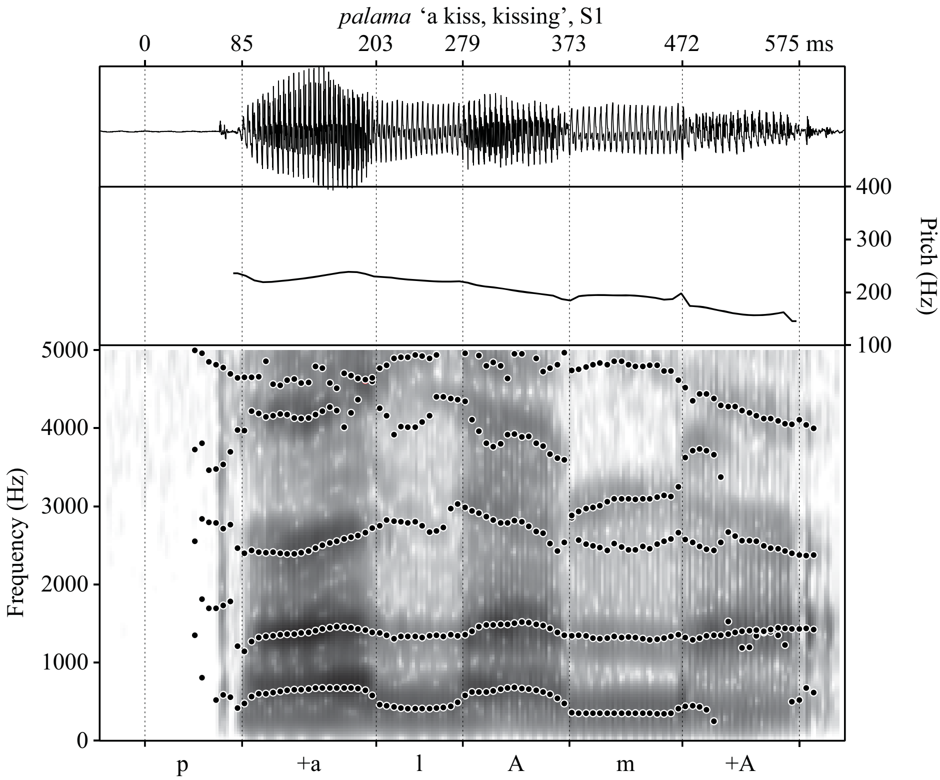

*jalga* 'friend', S1
0
66
189
282
357
454 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
j
+a
l
g
a


*vi•ge* 'in a / the forest', S2
0
46
99
197
297
416 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
v'
i
r'
g'
+e

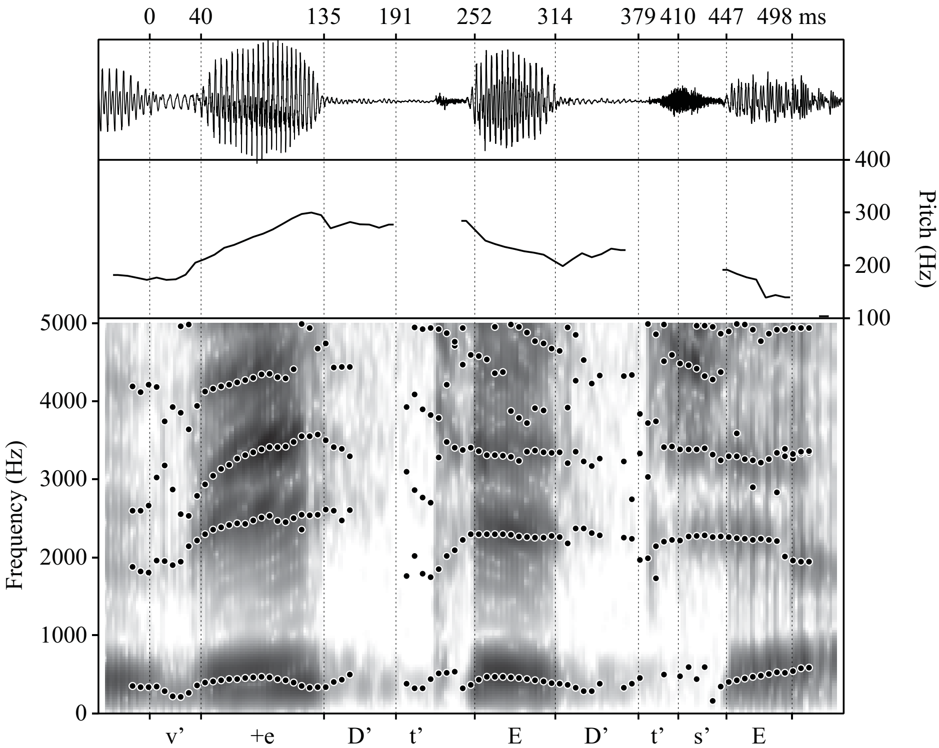

*eŔkə* 'lake', S1
0
109
220
310
387 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
+ä
R'
k
y


*maksat* 'you give', S1
0
71
170
272
375
463
568 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
m
+a
k
s
A
t

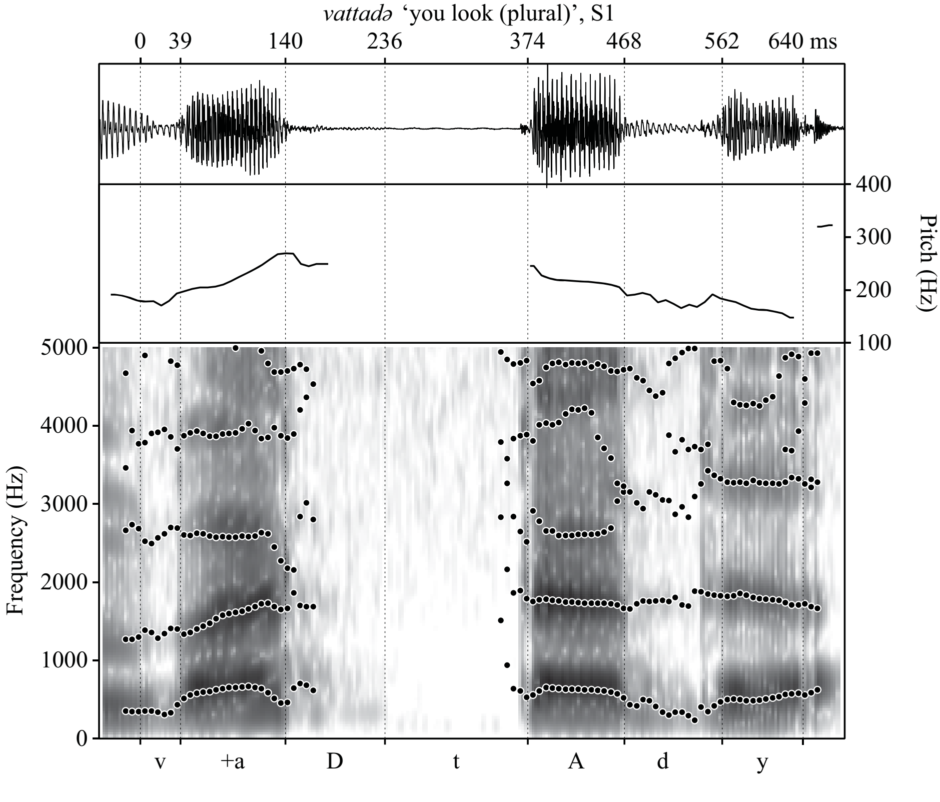

*ku•u* 'spoon', S1
0
107
183
248
281
356
447 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
k
+u
D'
t'
s'
u


*palama* 'a kiss, kissing', S1
0
85
203
279
373
472
575 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
p
+a
l
A
m
+A

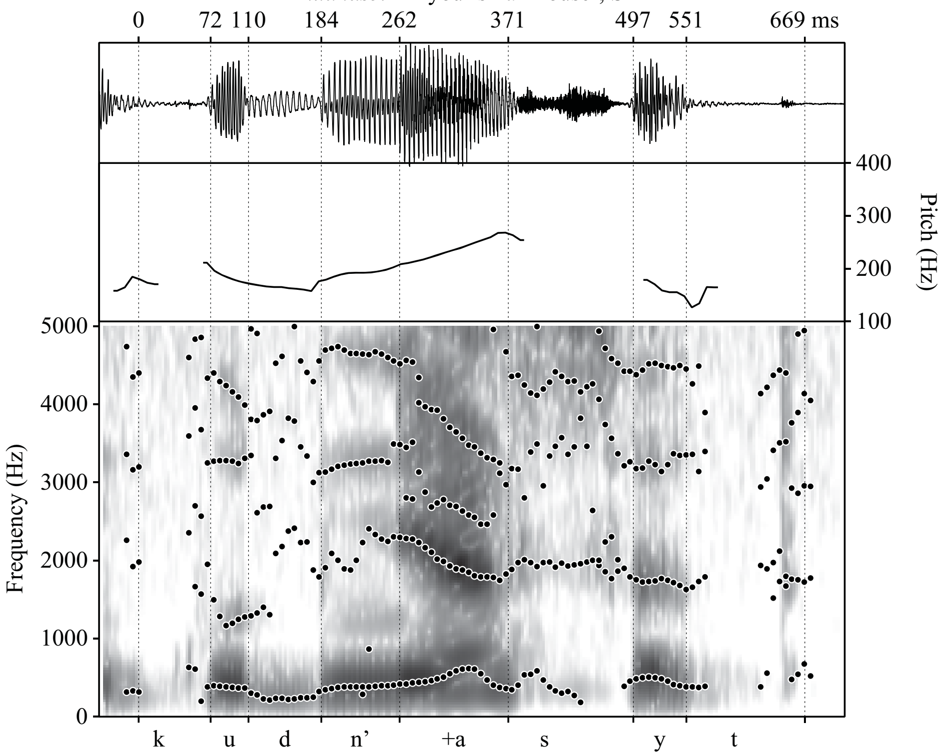
*veťeće* ‘fifth’, S1



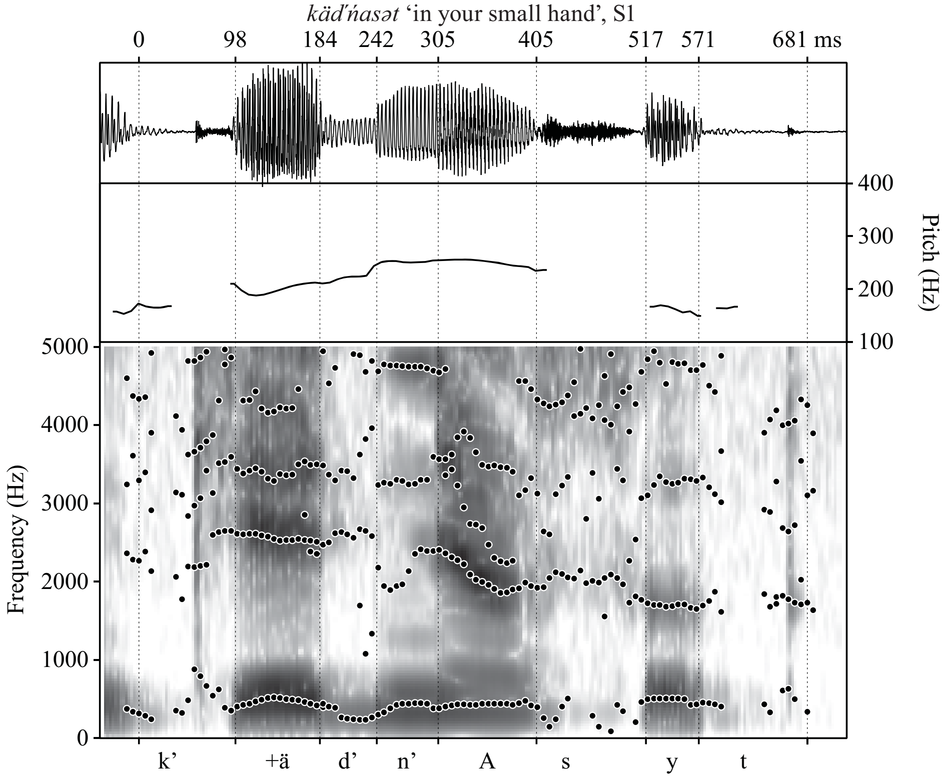

*vattadə* ‘you look (plural)’, S1

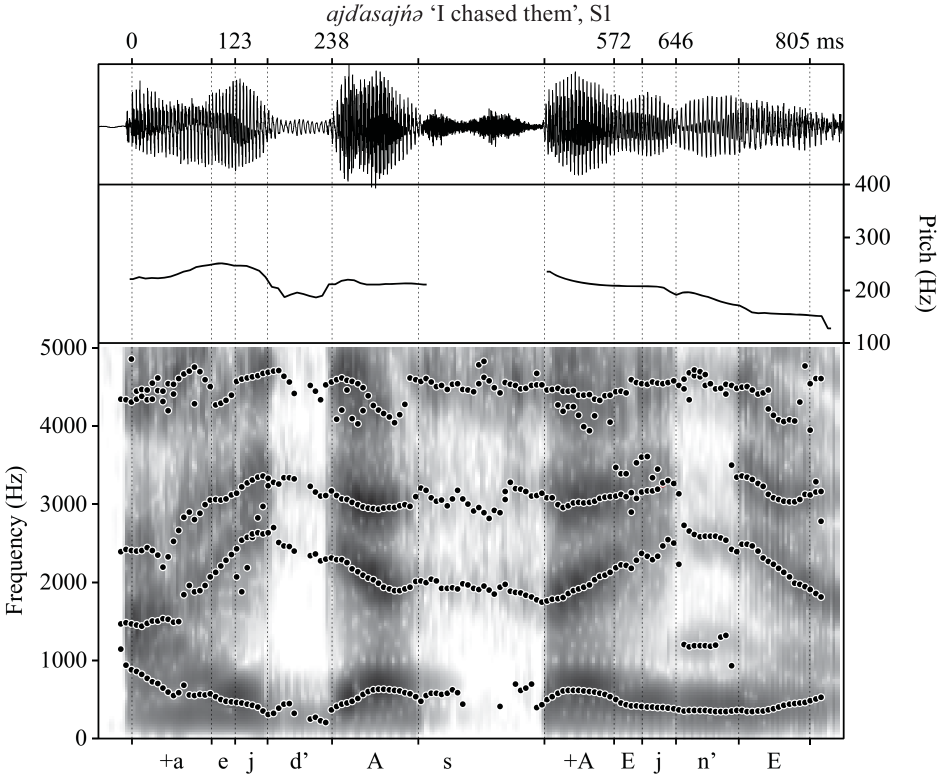


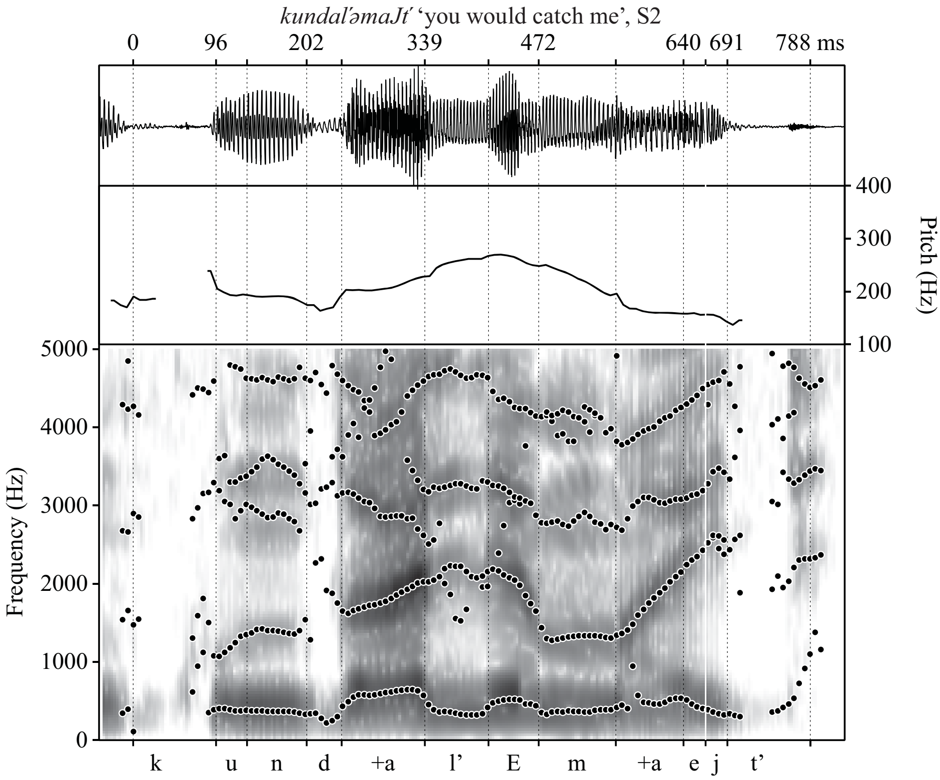
*kudńasət* ‘in your small house’, S2

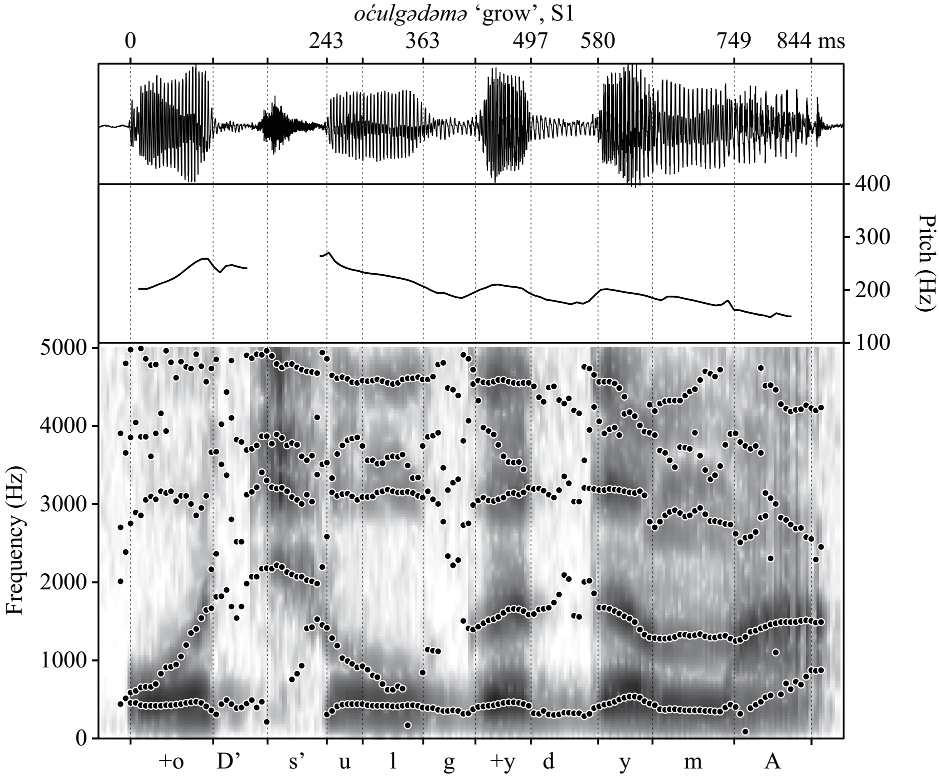


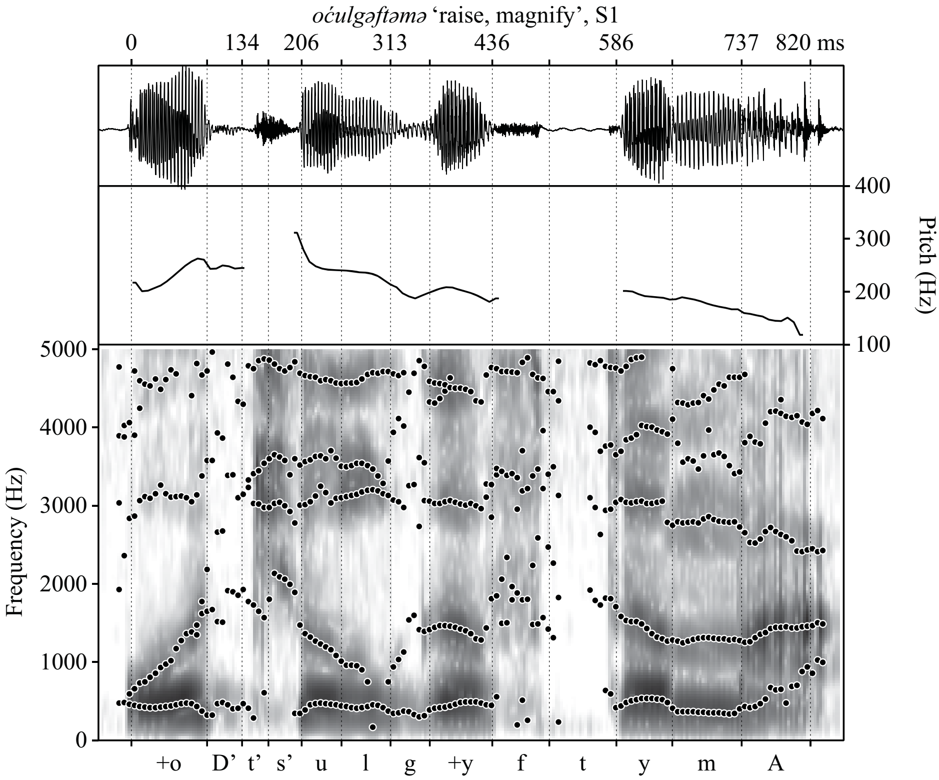

*käd'ńasət* ‘in your small hand’, S1

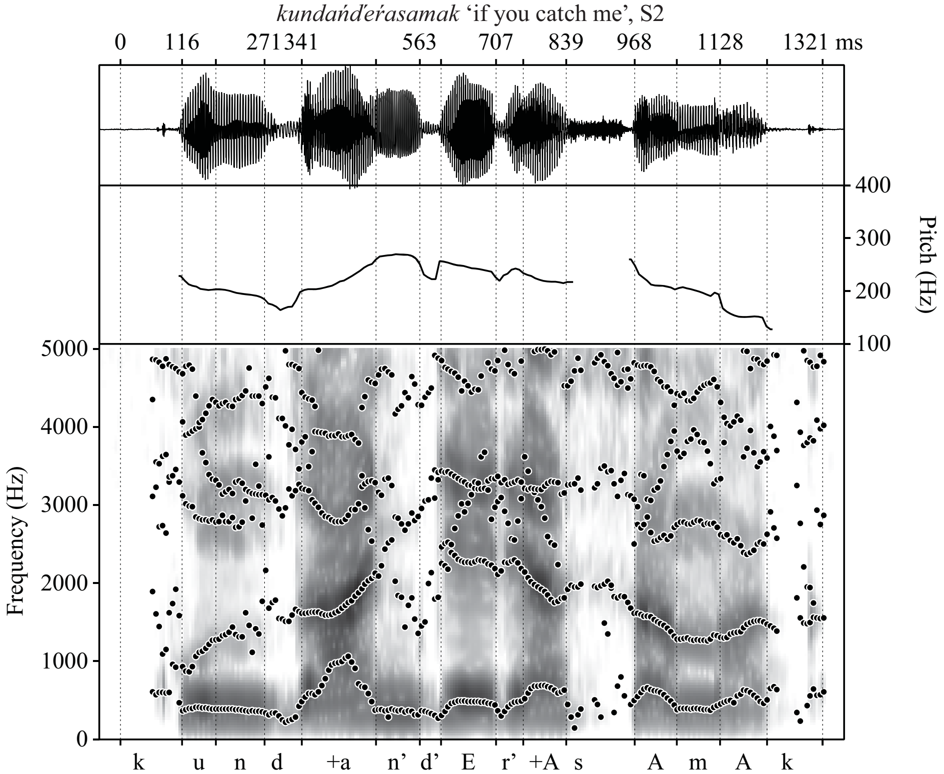



*ajďasajńə* 'I chased them', S1
0 123 238 572 646 805 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
+a e j d' A s +A E j n' E


*kundaľəmaJt'* 'you would catch me', S2
0 96 202 339 472 640 691 788 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
k u n d +a l' E m +a e j t'


*oćulgədəmə* ‘grow’, S1
0
243
363
497
580
749
844 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
+o D’ s’ u l g +y d y m A


*oćulgəftəmə* ‘raise, magnify’, S1
0
134
206
313
436
586
737
820 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
+o D’ t’ s’ u l g +y f t y m A


*kundańďeŕasamak* ‘if you catch me’, S2
0 116 271 341 563 707 839 968 1128 1321 ms
400
300
200
100
Pitch (Hz)
5000
4000
3000
2000
1000
0
Frequency (Hz)
k u n d +a n’ d’ E r’ +A s A m A k