THE PHONETICS OF CHUVASH STRESS: IMPLICATIONS FOR PHONOLOGY

Michael Dobrovolsky
University of Calgary, Canada

ABSTRACT

Chuvash is alleged to be a "default-stress" language of the type in which the last marked vowel or syllable is singled out for stress at one edge of a phonological word, while, in the event the word does not contain one of the marked vowels or syllables, stress defaults to the first vowel or syllable at the opposite of the phonological word. This paper provides phonetic evidence and statistical analysis of Chuvash disyllabic words that suggest that there is no default stress in Chuvash. Rather, the alleged default stress is the intonation downturn that in Chuvash typically occurs on the first vowel or sonorant consonant following the first vowel of the examined forms. In phonological terms, there is only last-full-vowel stress assignment in the stress component of the grammar, and a falling intonation that is assigned in the intonational component of the grammar.

1. INTRODUCTION

This study attempts to establish the phonetic correlates of Chuvash stress with reference to the framework used by Beckman 1986 [1] to distinguish between stress and pitch accent languages. Chuvash [tʃăvaʃ], is an aberrant Turkic language spoken in the Chuvash Republic, Russia, some 1000 kilometers east of Moscow. Chuvash is alleged to be a "default-stress" language, one in which a certain marked vowel or syllable is singled out for stress at one edge of the phonological word, while, in the event the word does not contain one of the marked vowels or syllables, stress defaults to the opposite (or same edge) of the phonological word.

In the case of Chuvash, vowels are divided into two types, "full" /i y e ɨ u a/ and "reduced," /ĕ ă/ (which correspond phonologically to Turkish / œ o/; the stress rule as commonly cited in Chuvash grammars and western linguistic sources is as follows: stress the last full vowel of a word; if there are no full vowels, stress the first vowel of the word [2].

As early as Ashmarin 1898 [3], questions concerning the phonetic nature of Chuvash stress arose. Ashmarin notes that the default stresses are "difficult to hear." Kotleev, cited in Jakovlev [4] claims that there are no clear-cut phonetic correlates for the default stresses. Jakovlev himself claims that vowel quality itself may be viewed as a stress correlate.

I hypothesize in this paper that there is no default stress in Chuvash, and that all reduced vowels are stressless; what is perceived as a default stress is a falling intonation that is assigned formally at a higher suprasegmental level than stress assignment.

The paper is organized as follows: section 2 describes the data used in the study; section 3 gives the results of observational and statistical analysis of this data; discussion and conclusions are presented in section 4, and implications for phonology in section 5.

2. DATA

2.1 Data collection.

Data was collected in the Chuvash republic in the summer of 1994. A Sony Professional Walkman was used to tape two male and two female consultants in their homes or in a university residence. Citation forms were elicited in Russian and repeated twice in Chuvash (see [5] for details). Each of four speakers recorded showed a slightly different dialect profile. Initial observation of raw data and statistics suggested that one speaker's stress pattern did not conform to that of the standard dialect that was the object of this study (she was originally from South Chuvashia, where the default stress is right-edge, not left-edge). Her tokens were therefore discarded. All tokens examined were two-syllable words; each possible combination of full and reduced vowels was analyzed.

To limit this study, only items with falling intonation (F0 of vowel two lower than the F0 of vowel one) were used for all tests except those reported in Table 5. Since all speakers showed an incorrigible predilection for rising intonation (even though elicitations were done by asking for two repetitions of each word), the number of tokens empoyed was reduced to 40 total for all word classes. Token types, total number of items for each type, and total number of items with falling intonation used in this study by speaker are given in Table 1. It should be noted that the same words were elicited from each speaker — the data collection is not heterogeneous. Due to other dialect variation, a few matching forms were not found; speaker vn uses /o/ where other speakers have /u/, and two speakers have /măkăr/ 'bull' while the other two have / văkăr/. Due to the selection of items with only falling intonation, not every match-up of two syllable words could be made across the board. Since the number of tokens is low, the usual precautions in interpreting the data apply.

	FF	FR	RF	RR
rv	06/03	07/03	07/03	06/03
sl	08/04	07/03	07/01	07/03
vn	08/05	07/04	06/03	06/05
total/falls	22/12	21/10	20/7	19/11

Table 1. Total items by type/ falling intonation, and speaker

2.2 Analysis.

Analysis was carried out on Kay CSL model 4300, version 5.17. Tokens were digitized from original cassette tapes at 44000 Hz. After examining the results spectrographically, each token was filtered using a 200th order Blackman low pass window and then downsampled to 22000 Hz. These token were then analyzed for the following values, which were transferred to data sheets and, ultimately, to SPSS for statistical analysis. (see acknowledgements):

- F0 1st vowel (V1)
- dB peak V1

• F0 2nd vowel (V2)
• dB average V1
• dB average V2
• time in ms V1
• dB peak V2l
• Total amplitude V1
• Total amplitude V2
• time in ms V1

From these figures were computed the ratios adapted from [1].

• F0 Ratio = 17.31 ln (Hz vowel 2 / Hz vowel 1)
• dB Peak Ratio = (dB peak vowel 2 - dB peak vowel 1)
• dB Average Ratio = (dB average vowel 2 - db average vowel 1
• Total Amplitude Ratio = (total amplitude vowel 2 - total amplitude vowel 1).
• Duration Ratio = ln (ms vowel 2 / ms vowel 1)

Total Amplitude Ratio is arrived at by adding amplitude values at all data points for a given vowel across its duration. It is claimed in [1] that this ratio is the most significant correlate for the presence of "true" stress in English, while it is not significantly correlated with the presence of accent in Japanese, the pitch langauge examined in the comparative study.

To these ratios were added a measure termed Duration Difference (ms V2 - ms V1) for purposes of statistical testing within word groups.

3. RESULTS

3.1 General.

This section reports on the resuts of statistical analyses carried out on the measures found to be significant distinguishers of word classes with different stress.

3.2 Statistics.

3.2.1 Anova and dependent variables. A one way ANOVA comparing the four word-stress groups — FF, FR, RF, RR — was significant for all ratios except the F0 Ratio, this latter not surprising since all tokens had falling intonation. From here on, F0 ratio will not be reported on; "all ratios" refers to all remaining ratios.

For all significant measures, post-hoc Scheffe pairwise tests were performed. These tests produced the results given in Table 2 (stressed vowels are bolded; shaded areas indicate no statistically significant differences between measures).

Word-stress class	Duration Ratio	Pk Amp. Ratio	Avg Ampl Ratio	Tot Amp Ratio
F**F** - **F**R	.000	.011	.014	.000
F**F** - R**F**	.005	1.000	1.000	.177
F**F** - **R**R	.003	.667	.395	.009
FR - R**F**	.000	.043	.040	.000
FR - **R**R	.328	.172	.404	.284
R**F** - **R**R	.000	.807	.516	.000

Table 2. Statistical significance of measures by word-stress group

These tests show that words belonging to different stress classes are distinguished most consistently by Duration Ratio. This may not be surprising; since the words are citation forms, second vowels are frequently longer due to the terminal intonations. Total Amplitude Ratio, determined in [1] to be the most significant distinguishing measure of word-stress differences in English, is the next most effective distinguisher, followed by Peak Amplitude Ratio and Average Amplitude Ratio.

In classes of words that have differing stress placement (F**F**-**F**R, F**F**-**R**R, **F**R-F**F**, and R**F**-**R**R), only F**F**-**F**R and **F**R-R**F** are significantly distinguished by more than one variable. Two groups (F**F**-R**F** and **F**R-**R**R) have the same stress placement. The former is distinguished only by Duration Ratio and the latter by none of the variables examined here.

3.2.2 Groupings. Results of statistically homogenous groupings are provided in Table 3.

Duration Ra	Pk. Ampl. Ra	Avg. Ampl. Ra	Total Ampl.Ra
FR **R**R	**F**R	**F**R	**F**R **R**R
	RR	**R**R	
F**F**	R**F**	F**F**	F**F**
R**F**	F**F**	R**F**	R**F**

Table 3. Homogeneous grouping: results

The classes are not neatly grouped into initially and finally stressed words. The placement of two cases of RR class words in a row by themselves reflects the fact that for these measures, the RR class is ambiguous, "belonging" to both the initially stressed and finally stressed grouping. RR words are thus not clearly distinguished from other word types by all measures.

3.2.2 One-sample T-Test. A one-sample t-test provides information about the significance of difference in the measures within each word-stress class rather than across classes. Thus, we are examining the difference in means for vowel one against vowel two. Results are given in Table 4.

Word-stress class	Measure	Sig. (2-tailed)
FF	Duration Diff.	.000
	Total Ampl. Ratio	.002
	Avg. Ampl. Ratio	.978
	Peak Ampl. Ratio	.359
FR	Duration Diff.	.036
	Total Ampl. Ratio	.002
	Avg. Ampl. Ratio	.001
	Peak Ampl. Ratio	.000
RF	Duration Diff.	.001
	Total Ampl. Ratio	.000
	Avg. Ampl. Ratio	.973
	Peak Ampl. Ratio	.547
RR	Duration Diff.	.371
	Total Ampl. Ratio	.246
	Avg. Ampl. Ratio	.071
	Peak Ampl. Ratio	.519

Table 4. One-sample T-test: results.

Reference to these results is made in section 4.1.2.

4. DISCUSSION, CONCLUSIONS

4.1 Discussion.

The statistical results bear on a number of issues in stress analysis. I will focus here on the issue of the special status of reduced vowels, and especially on RR words in this data. Do the statistical results bear out the hypothesis that reduced vowels are always unstressed, even in words that allegedly carry default-left stress?

4.1.1. Words with differing stress placement. R vowels that precede or follow a stressed F are in general extremely short and non-prominent. This subjective impression is confirmed by the nearly across-the-board statistically significant differences between the pairs F**F** - **F**R and **F**R - R**F**, which are separated by all four measures in Table 2. The other two pairs with differing stress, F**F**-**R**R and R**F**- **R**R, both show significant differences in Duration Ratio and Total Amplitude Ratio. These pairs underscore the fact that when a full vowel is in final position, it carries a longer terminal intonation in these citation forms.

4.1.2. Words with the same stress placement. For the pairs F**F**-R**F** and **F**R-**R**R, only F**F**-R**F** are distinguished by Duration Ratio. But **F**R-**R**R are not distinguished by any measure. Does this mean that they are both stressed? Not necessarily, as the one sample T-tests have shown. Recall that word internal statistics in Table 4 demonstrate that F**F** vowels are distinguished significantly by Duration Difference as well as difference in Total Amplitude — in other words, they are "stressed," in Beckman's sense. The vowels of RR words, however, are not significantly distinguished by either Duration Difference, Total Amplitude Ratio, or Peak Amplitude Ratio — they are not "stressed." Only Average Amplitude Ratio differences separate the **R**R vowels; this may follow from the drop in amplitude that accompanies the falling intonation of the word across two short vowels.

4.1.3. First conclusions. These measures and statistical analysis appear to support the hypothesis that reduced vowels in Chuvash are unstressed, even in RR words. We must then ask what it is that is perceived as RR stress.

4.2. What is RR stress?

I hypothesize that RR words in Chuvash are unstressed. What phonetic measure or measures may give the impression of some "difficult to hear" stress in these words? Chuvash disyllabic words examined in this study are characterized by an intonation drop across the first vowel early in the word. I suggest that this is what is interpreted as "stress," given a lack of other robust stress measures on the word.

To confirm the early intonation downturn, the pitch traces of all available tokens from all speakers were examined. In particular, I looked for an intonation downturn that began well within the confines of the first vowel (away from the pitch depressing influence of a following consonant), or at least, in the case of words that had a sonorant consonant after the first vowel, within this sonorant. Results are given in Table 5. It should be noted that these results for F**F** and **F**R data include words with falling-rising and rising terminal intonations. The rise-falls were particularly interesting in that they still showed very frequent F0 drops on the first vowel. In other words, true rise-rise F0s were very rare.

Stress class	Fall on V1	Fall later	per cent
F**F**	24	13	64.86
FR	31	10	75.60
R**F**	13	5	72.22
RR	12	5	70.58

Table 5. Percentage falling intonation in first vowel or sonorant C following first vowel

These results are as expected for three categories, with one surprise. The highest percentages of falling F0 are on stressed vowels in intital postion, where the F0 falls across a relatively long vowel that is lengthened by stress. Hence, there is plenty of time for the intonation drop to begin early. The next highest percentage is found on reduced vowels that precede a stressed full vowel. Here, we might expect the stressed full vowel to pull the F0 towards it, but we do not see this, which is confirmation of the early falling F0 pattern of Chuvash intonation on these words. RR forms show the next highest percentage of falling F0 early in the word. These are the key forms that suggest that it is this early falling F0 that is picked up as the RR word's "stress." Finally, F**F** forms show the lowest percentage of early falling F0, though it is still well above chance. It is of course possible that a larger sample for R**F** and RR forms would show a lower percentage of early fall, one that is more in line with the F**F** data.

4.3. IMPLICATIONS FOR PHONOLOGY

From the mid 1970's on, it has been speculated that great many stress systems in the world's languages fall out of the "marked/default" stress application, of which Chuvash has been cited as an example. If it turns out that the phonetic data for Chuvash does not support this contention, then the primary implication for phonology is straightforward: some languages at least may not show this pattern, but, more interestingly, may only appear to show it. If this is the case, then it will be worthwhile examining other systems alleged to be of this type to see if they also show some different phonetic modality in stress manifestation.

A second implication of this study is that the formal representation of Chuvash stress will no longer rely on the marked vs. default pattern on a single level of representation (that of the stress application procedures, which themselves may involve several layers of application). The burden of capturing the "default" now moves upward to a higher level of suprasegmental representation, one that will not be implemented until the intonation component of the grammar kicks in. Stress marking will then be accomplished by (phonological) word-level stress assignment while "default stress" becomes a function of the intonation. Figure 1 shows how this might be represented for two disyllabic Chuvash words, one with only full vowels and one with only reduced vowels (the extended dots represent spreading of the intonational L pitch.

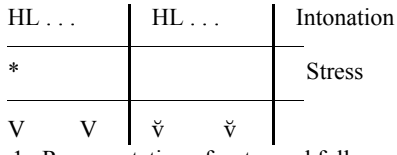

Figure 1. Representation of a stressed full vowel word and "default stressed" reduced vowel word with falling intonation in Chuvash

I conclude that impressionistic reports that there is something different about stress on reduced vowel words in Chuvash are supported by the phonetic and statistical evidence examined here. This diference reflects the nature of the langauge's single stress assignment rule (stress the last full vowel of a word) and its intonation profile (pitch drops early in the word, at least in citation forms). As is to be expected, Chuvash stress is more comple than this paper has had space to show. For example, Chuvash displays a layer of rhythmic stresses that serve to complicate any analysis. This is worth a study of its own. For the purposes of this paper, it's a good enough start to show that the aural perceptions of a number of phoneticians over the last century appear to have been correct.

ACKNOWLEDGMENTS

Many people made it possible for me to go to Chuvashia. In Chuvashia, I must single out N. I. Egorov and P. J. Jakovlev for the time and personal insights on Chuvash that they shared. My guide, S. B. Lastochkin, gave a lot of his time to arrangements. Craig Dickson of Speech Technology Research Ltd. in Victoria, B. C. provided much helpful advice on pitch analysis with CSL. Gisela Engles of the University of Calgary Academic Computing Service was a great help in organizing the spreadsheet. The statistical analuysis and interpretation could not have been done without the help and patience of Eugene Deen of the University of Victoria's SDH Student Computing Service, though I bear responsibility for the ultimate linguistic interpretation. I also thank John Esling, Jocelyn Clayards, and the Linguistics Department at the University of Victoria for their hospitality and lots of help getting used to their machines.

REFERENCES

[1] Beckman, M. E. 1986. *Stress and Non-Stress Accent.* Dordrecht-Holland/Riverton-USA: Foris.

[2] Hayes, B. 1995. *Metrical Stress Theory*. Chicago: University of Chicago Press.

[3] Ashmarin, N. I. 1898. *Materialy dlja izsledovanija Chuvashskogo jazyka* [*Material for the analysis of Chuvash*] (microfilm). Moskva: Gos. Izd. Inostrannyx i Nacional'nyx slovarej.

[4] Jakovlev, P. J. 1987. Slovensnoe udarenie v Chuvashskom jazyke [Word stress in Chuvash]. In Pavlov, I. P, Gorshkov, A. E., and Fedotov, M. R. (eds.) *Voprosy Fonetiki, Grammatiki i Onomastiki Chuvashskogo Jazyka*, pp. 48-53. Cheboksary: Nauchno-issledovatel'skij Institut jazyka, literatury, i èkonomiki pri Sovete Ministrov Chuvahkoj ASSR

[5] Dobrovolsky, M. 1995. The phonetics of reduced vowels in Chuvash: implications for the phonology of Turkic. In Elenius, K. and Branderud, P. (eds), *Proceedings of the XIIIth International Congress of Phonetic Sciences*. Stockholm: KTH and Stockholm University.