

## Segment Duration in Finnish as Imitated by Russians

Riikka Ullakonoja<sup>1</sup>, Mikko Kuronen<sup>2</sup>, Pertti Hurme<sup>3</sup>, Hannele Dufva<sup>2</sup>

<sup>1</sup> Centre for Applied Language Studies, University of Jyväskylä, Finland

<sup>2</sup> Department of Languages, University of Jyväskylä, Finland

<sup>3</sup> Department of Communication, University of Jyväskylä, Finland

riikka.ullakonoja@jyu.fi, mikko.j.kuronen@jyu.fi, pertti.hurme@jyu.fi,  
hannele.dufva@jyu.fi

### Abstract

The paper reports findings of a study in which Russian speakers without any prior knowledge of Finnish imitated utterances in that language, and, in particular, how they succeeded in imitating segmental duration. The data was analysed using acoustic measurements of segment duration as well as auditory analysis by four judges. The results show that Russian speakers faced difficulties in imitating some aspects of the complicated Finnish quantity system. On the other hand, many of the imitated words were judged as comprehensible.

**Index Terms:** duration, length, Finnish, imitation, language learning

### 1. Introduction

There has been a renewed interest in investigating the role of imitation in many fields that study social, cognitive and linguistic activity [1, 2]. To our knowledge, imitation has not been much used as an elicitation method in prosodic research. In this paper, imitation will be studied using a research design in which the participants were asked to imitate sentences of varying length in a language they do not know. We report the results of a pilot study of Russians imitating Finnish utterances, with the aim of focusing on how the participants succeeded in imitating the segment durations. The durational patterns in the imitations were investigated both by acoustic measurements and perceptual analysis. We also present preliminary reflections on the role of first language (L1) in imitating an unknown language and relate our findings to second/foreign language (L2) learning research.

Inspired by Hurme [3], who investigated how native speakers of Russian without any knowledge of Finnish succeeded in mimicking Finnish utterances, the present authors conducted a pilot study [4] where also the connection of the individual's working memory to the imitation ability was investigated. The results of both studies indicated that the success of imitation depended on the length of the utterance as measured in syllables and that the initial and final parts of the utterances were imitated best. In addition, the latter study found a positive correlation between the participants' score in the working memory test and the success of imitation. In this paper we analyse the prosody of the imitated utterances focussing on segmental durations. In contrast with Russian, in Finnish quantity is distinctive which also makes the results interesting from the point of view of second/foreign language learning.

#### 1.1. Quantity in Finnish

Finnish has a complex quantity system. In two-syllable words alone there are eight possible combinations of /short/ and /long/ vowels and consonants [5]: from CVCV to CVVCCVV. Thus, *tule*, *tulle*, *tulee*, *tullee*, *tuule*, *tuulle*, *tuulee*, *tuullee* are

all Finnish words, inflections of the verbs *tulla* (come) and *tuulla* (blow). Word stress is fixed on the first syllable of the word, and the main phonetic correlate of stress is a peak in F0 [6]. All vowels can occur phonemically long and short in all stressed and unstressed syllables [7], e.g. *sika* [sika] (a pig), *siika* [si:ka] (a whitefish), *sikaa* [sika:] (a pig, partitive) and *siikaa* [si:ka:] (a whitefish, partitive). Most consonants can occur as /long/ or /short/ between vowels too, making a single-double contrast [7] e.g. *muta* [muta] (mud), *mutta* [mut:a] (but). Even words like *muuttaa* [mu:t:a:] (to change) are possible.

However, the phonetic reality of quantity in Finnish is even more complex [e.g. 8, 9, 10]. For instance, in CVVCV and CVCCV structures not only the long segments have longer duration but also the second-syllable vowel is shorter than in CVCV structures, where the second-syllable vowel can be phonetically characterized as long. Indeed, /short/ vowels can vary in duration from [very short] (CVVCV *kaato*), [short] (CVCV *kato*), [longish] (CVCCV *katto*) to [long] CVCV *kato*, depending on their position and the quantity pattern of the word [8]. Further, utterance length has an effect on segmental durations: segments tend to be shorter the more syllables the utterance consists of [11]. In recent studies also the tonal patterns in words with different quantity types and the possible role of F0 in maintaining the oppositions have been investigated [6, 12]. The possible role of F0 in perception of the quantity opposition has been shown by O'Dell [11].

#### 1.2. Quantity in Finnish for learners

As quantity is a distinctive feature in Finnish, it is also often mentioned as one of the foremost difficulties of Finnish for L2 learners. However, the complexity and intricacy of the quantity system manifests also in native speakers' slower acquisition. It has been shown that while Finnish children learn to make the difference in the consonantal durations between CVCV/CVCCV patterns at an early age, they do not fully master those differences in the second-syllable vowels that are sub-phonemic but systematic even at the age of six [13].

As studies focussing on learners of Finnish as a foreign language have shown, quantity distinctions are notoriously difficult. Vihanta's [14] study of French learners of Finnish reading Finnish sentences containing minimal pairs showed that they often lengthened the final vowel (as in French) and failed to make the sub-phonemic durational difference in the second-syllable vowel in CVCV vs. CVVCV/CVCCV words. On the whole they tended to exaggerate the distinction between /short/ and /long/, leading to problems in understanding. Toivola [15] who studied the prosodic features and foreign accent in L2 Finnish spoken by Russian learners found out that they often produced either too short or too long segments in word-medial position, and segments that were too long in word-final position. The perception of Finnish quantity

by L2 speakers has been studied by Ylinen and colleagues [16, 17] who learned that the vowel quantity distinction was difficult to perceive even for Russians who had lived in Finland for several years.

In all, while the first extensive experimental acoustic analyses of Finnish quantity in native speakers' speech as well as tests of perception of the quantity distinction were conducted as early as in the 1970s [9], up till now there are few studies that have investigated the topic in L2 Finnish speech. Thus, the current study adds to the understanding of the Finnish quantity system as perceived and produced by non-speakers of Finnish.

### 1.3. Duration in Russian

In Russian, phoneme length is not distinctive (with the exception of some rare consonantal minimal pairs such as *strany* – *stranny*). However, the vowel duration is used for another function, to signal the location of word stress, as stressed vowels are longer than unstressed ones vowels. Being distinctive, word stress can fall on any syllable and its position can differ in various forms of the same word. Proportionately, the durational difference between Finnish stressed long and short vowels is similar as between Russian stressed and unstressed vowels (about 2:1) [18]. However, in Russian the duration of the unstressed vowel depends also on its position relative to the stressed vowel, as there are two degrees of vowel reduction in unstressed vowels. The weak degree occurs in the syllable immediately preceding the stressed syllable, but can also occur in some other positions (e.g. word initial and phrase final positions) and has the duration of 1.25–1.4 times the duration of the other unstressed vowels (with the strong degree of reduction) [19]. The fact that in Russian the duration is one of three cues of word stress (the others being intensity and pitch) whereas in Finnish it mainly signals phonological length offers interesting possibilities for research.

## 2. Material and Methods

### 2.1. Material

Data was collected in an imitation task, following the design of [3]. Russian subjects were asked to orally imitate 30 auditory stimuli, each of which they heard only once, in a language they did not know. The stimuli were three-word Finnish utterances (with 4–11 syllables) previously recorded from a female speaker, a native Finnish speaker with a standard Finnish pronunciation. The stimuli aimed at echoing spontaneous utterances in spoken Finnish with a naturalistic prosody in mind. *Tili tuli tänään* (paycheck arrived today) and *yöllä saattaa tuulla* (at night it may rain) are examples. The stimuli were presented to the subjects in two different randomized orders in order to avoid fatigue and learning effects. The responses were recorded with an Edirol by Roland 4-bit Wave/MP3 R-09 digital recorder and a high quality Koss headset (sample rate 44.1 kHz, 16 bit resolution). A practice stimulus was presented before the experiment. Six native speakers of Russian (further R11, R12, R13, R14, R15, R16) were asked to imitate the stimuli. They were all female, aged 20–26, university students from St. Petersburg. Five of them were students of linguistics, and thus, had some phonetic training.

For the present analysis, we chose the stressed vs. non-stressed, short vs. long vowels (and long vs. short consonants) in the following disyllabic words: *päättää*<sup>2</sup> (to decide) –

*päättää*<sup>2</sup> (decide, imperative form); *sata*<sup>2</sup> (hundred) – *saattaa*<sup>2</sup> (may); *tuulla*<sup>3</sup> (to blow) – *tulla*<sup>2</sup> (to come); *teetä*<sup>3</sup> (tea, partitive) – *teettää*<sup>3</sup> (to have made), *tili*<sup>1</sup> (pay check) – *tilli*<sup>1</sup> (dill); *tuli*<sup>2</sup> (fire) – *tulli*<sup>2</sup> (customs); *kisaa*<sup>3</sup> (competition, partitive) – *kissaa*<sup>3</sup> (cat, partitive). The numbers refer to the position of the word in the utterance (1=first word, 2=second word, i.e. middle, 3=last word). These words occurred in different utterance positions: the pairs listed above mostly (except for *tulla* – *tuulla*) occurred in the same sentential position, which makes their comparison possible.

### 2.2. Methods

First, the imitated utterances were submitted to auditory evaluation by the four authors, all native speakers of Finnish and experts in phonetics. Here, the judges listened to the model utterance and each imitation three times (each judge in a different randomized order) and rated the success of the imitation. The comprehensibility of both the whole utterance and each word were rated on a 1–5 Likert-type scale (0=missing, 1=completely against the model, 2=not completely comprehensible, 3=comprehensible, 4=rather good, 5=near-native). In addition, the judges were asked to submit verbal comments on the segmental and prosodic features that they found particularly disturbing or successful. The judges' numeric ratings ('c' in Figures 2–3) were highly consistent and reliable (Cronbach's alpha .91 at the utterance level, between .86–.92 at the word level).

Second, the acoustic analysis of segment durations were carried out in Praat [20]. First, the comprehensibly imitated words were annotated in the segmental level. The segment onsets and offsets were determined both visually in the spectrogram (as well as in the intensity and F0 curves) and auditorily, and marked manually. Words that were not comprehensibly imitated were discarded. In word-initial plosives the occlusion phase was excluded, but included in the position between the vowels. The durations and auditory ratings were analysed in different word types. The relative segment durations were calculated and expressed as the ratio between segment duration and the mean duration of the [very short vowel], second vowels in CVCCV and CVVCV structures, for each speaker. Due to the small sample size the data is not analysed using statistical tests at this point.

## 3. Results

### 3.1. Acoustic analysis of segment duration

First, we present the results of the acoustic analysis of segment duration in a) the first (stressed) syllable and b) the second (unstressed) syllable, further divided into three subgroups (Table 1). Four words were left out of the analysis either because they were not imitated by Russian speakers (*teetä*) or because they were the only occurrence of the particular word type *tuulla* (CVVCCV), *kisaa* (CVCVV), *kissaa* (CVCCVV).

Table 1. Three categories of second syllable vowel duration following [10]

Vowel duration	Words	Word type
very short	tulla, tilli, tulli päättää	CVCCV CVVCV
long	sata, tili, tuli	CVCV
very long	päättää, saattaa, teettää	CVVCCVV

Figure 1 shows the mean relative segment durations of the selected words as the proportion of the duration of the mean of the [very short] vowel duration produced by each speaker (see Table 1 for examples). Both Russian speakers and the Finnish native speaker make a distinction between short and long in the first-syllable vowel. However, there are differences in how the Russian subjects and the Finn produce duration in the second syllables, especially in case of the [very long] final vowel, imitated similarly as the [long] final vowel. As for consonants, the difference between /short/ and /long/ consonants is clearer in the speech of the Finnish speaker. The relative segment durations in the speech of the Finnish speaker are similar to those of other Finnish speakers as reported in [10].

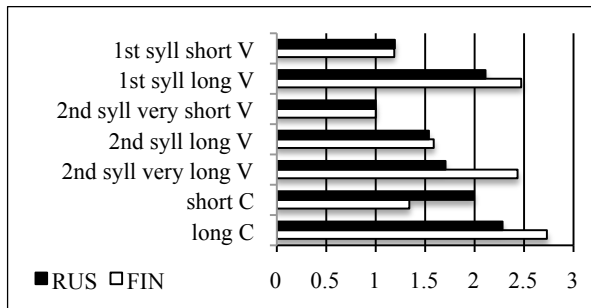


Figure 1: Relative segment duration

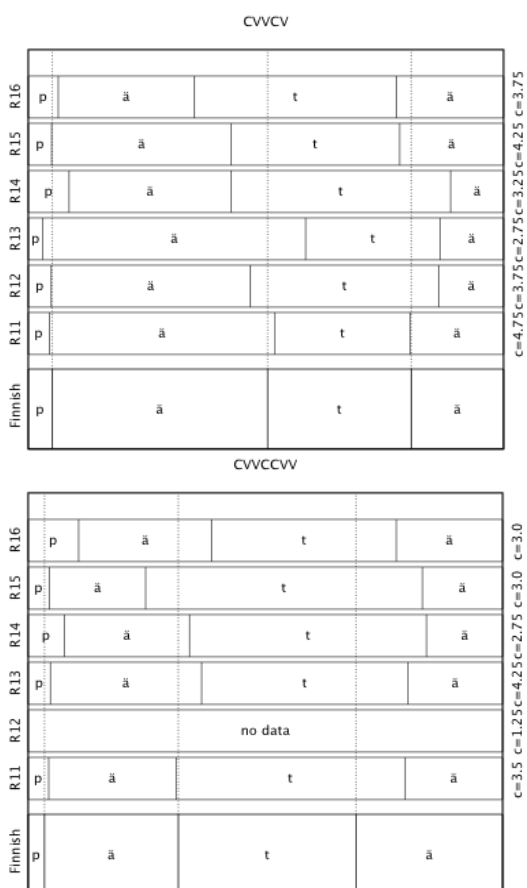


Figure 2: Relative segment durations of the word päättä (above) and päättää (below)

Figure 2 shows the relative segment durations of the words *päättä* and *päättää* in the Finnish model utterance and its Russian imitations, with time on the x-axis, speakers and comprehensibility ratings (c) on the y-axis. One of the Russian speakers (R11) matches the original durations very closely in her imitation of the word *päättä*. The other productions are less close to the target for all segments in both words, and the word *päättää* is more difficult to imitate. As Figure 2 shows, the second syllable vowel in *päättää* is too short in all imitations. However, often the preceding consonant is much longer than in the model. The word *päättää*, consisting of three consecutive long segments, is structurally foreign to the Russian speakers, but interestingly, the subjects may aim at imitating the length they possibly hear by transferring the feature to the preceding consonant. Thus, Figure 2 confirms the finding illustrated in Figure 1 showing that a [very long] second syllable vowel is difficult to imitate.

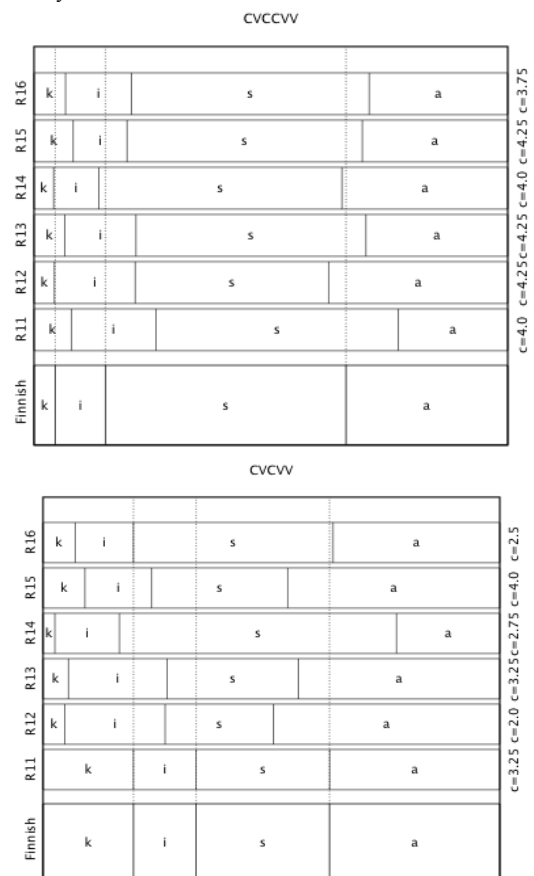


Figure 3: Relative segment durations of the word kissaa (above) and kisaa (below)

Next, we will investigate two words that were the only occurrences in their category, *kisaa* and *kissaa* (both in sentence accent position) and thus not included in the previous analysis. Figure 3 shows that some speakers clearly manage to imitate the durational patterns better than others. Speaker R14 matches all segment durations present in the Finnish model in the word *kissaa* and speaker R11 in the word *kisaa*. However, most Russian speakers fail to imitate the duration of the unstressed vowel in the second syllable for both words. This seems to interfere with the relative duration of the other segments in both words, similarly as in the word *päättää* in

Figure 2. However, one possibility is that vowel duration is more difficult to imitate than that of consonants. In *kisaa* the speakers differ in their imitations: some (R14, R16) exaggerate the duration of the sibilant, others (R12, R13, R15) that of the word final long vowel. Also the duration of the first vowel can be exaggerated (R12, R13). Overall the durational pattern of the word *kissaa* was easier to imitate than *kisaa*, *päätä* or *päättää*, probably because it was pronounced slowly, with a strong sentence accent and some emotionality in the Finnish model. Furthermore, both *kisaa* and *kissaa* were in utterance final position, and thus easier to imitate than *päätä* and *päättää*, which were in utterance medial position, see [4]. Also, it can be speculated that the long fricative in the word *kissaa* may be easier for Russians to perceive and then imitate than the short plosive in *päätä*.

### 3.2. Perceptual evaluation of the segment duration

Next, we will discuss the perceptual evaluations of the imitations by the four judges. The verbal comments in the perceptual analysis suggest that whenever the judges perceived the participants' productions as recognizable on the whole, also the durational patterns of the model had been closely followed. Although there was some variation – and some poor imitations – the durational patterns in the subjects' productions quite consistently matched the native speakers' intuition of the boundary between /short/ or /long/ quantity. In line with the acoustic analysis, the word-final /long/ vowels were frequently, particularly after a long vowel in the first syllable, perceived as “too short”.

Figure 4 shows the comprehensibility ratings (1–5) of the judges in different word types. Overall, most word types got a mean comprehensibility rating of over or near three (3=comprehensible). This means that despite the potential difficulties in the durational patterns discussed above, the speakers' imitations were generally comprehensible. Figure 4 includes all seven word types (see 2.1), although in some of them there is only one word as an example. In line with what was said above concerning Figure 3, the word *kissaa* (CVCCVV) was the easiest to imitate. Other successfully imitated word type was CVVCCVV (e.g. *päättää*). The least successful type CVVCCV was the word *tuulla*, the segmental content of which might be difficult for perception.

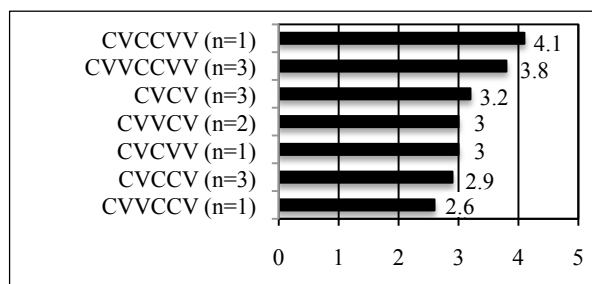


Figure 4: Mean comprehensibility ratings (1–5) of the imitations according to the word type

Obviously, the comprehensibility ratings are not based exclusively on successful imitations of durational patterns. Other factors, such as the position of the word within the utterance (see 2.1), the nature of the segments, and sentence stress are likely to influence as well. Nevertheless, it is obvious that a clear violation of the durational pattern is likely to result in low comprehensibility ratings especially when it

concerns the first, stressed syllable of the imitated word. This can be seen in Figure 3, in the word *kisaa* where the violation in duration of the first vowel or sibilant appears to be associated with low comprehensibility ratings.

## 4. Discussion

The paper examined segment duration in imitated Finnish speech by Russians. The results seem to indicate that some features of the Finnish quantity system are indeed difficult to imitate. First, there are large individual differences. Second, there are differences caused by the word type and the position of the word in the utterance. In more particular, our results show that speakers of Russian were not successful in imitating the [very long] vowel in the (unstressed) second syllable, but produced a shorter vowel while prolonging the duration of the preceding consonant (Figures 2 and 3). As such a long vowel does not exist in Russian in similar positions, this is also an example of possible L1 influence. Length patterns in L1 have been shown to have influence on conveying quantity in L2 [21, 22]. Also, previous studies [14, 15] have shown that L2 learners of Finnish tend to produce word-final vowel durations as too long, suggesting that learning can lead to exaggerating the learned category, a phenomenon which is well-known from both L1 and L2 learning of different linguistic skills. Exaggeration of quantity categories in L2 Swedish is reported in [21]. Indeed, the word-final position may be particularly vulnerable for non-nativelike durations as even native speakers do not fully master the durational system by the age of six [13].

The findings indicate that closer examination is needed to study the role of such factors as, e.g., sentence stress, segmental content, tonal patterns [6, 12] and utterance type in the imitation of segment durations. Further, the imitation experiment with its interplay between articulation and perception – and between two languages, Finnish and Russian – offers new insights into cross-language phonetics and learning of L2 pronunciation, e.g. the effect of segments and prosodic features of L1 on L2 and possible differences in the acquisition of segmental and prosodic features.

## 5. Conclusions

The preliminary results suggest that more research is needed on the interplay between general and language-specific aspects in the ways prosodic features are perceived and articulated. In this experiment, data was elicited that aimed at mapping how subjects cope with the articulation of utterances in a language that is unfamiliar to them, using their auditory perception only. To see how prior knowledge about the language or its writing system exerts influence, new studies will be designed. Further studies will be conducted to examine the presence of L1 transfer in imitated utterances vs. second/foreign language learners' speech. In conclusion, we believe imitation experiments of an unknown language offer an interesting new tool for the study of the role of imitation in language learning and development.

## 6. Acknowledgements

We thank the students and staff at St. Petersburg State University for participating in and organizing the experiment, especially Dr. Nina Volskaya. We also wish to express our gratitude to the Academy of Finland for a travel grant (n:o 260539) to the first author, which enabled data collection.

## 7. References

- [1] Yoshida, H., "Imitating and Repeating Foreign Language: Implications for Language Teaching", University of Kyoiko, 2009. Online: [ir.lib.osaka-kyoiku.ac.jp/dspace/bitstream/.../3/ok\\_eibun\\_54\\_083.pdf](http://ir.lib.osaka-kyoiku.ac.jp/dspace/bitstream/.../3/ok_eibun_54_083.pdf), accessed on 21 Feb 2014.
- [2] Reiterer S.M., Xiaochen, H., Sumathi T.A., Singh, N. C. "Are you a good mimic? Neuro-acoustic signatures for speech imitation ability". *Frontiers in Psychology*, 4:782, 1–13, 2013.
- [3] Hurme, P. "Oudon kielen matkimisesta: Ihmisen kyvyistä ja rajoituksista imitoida oudon kielen lauseita", in *Fonetiikan paperit - Helsinki 1975*, 19–35, 1975.
- [4] Ullakonoja, R., Dufva, H., Hurme, P. and Kuronen M., (submitted) "How to imitate an unknown language? Russians imitating Finnish", *Proceedings of the Finnish Phonetics symposium, Turku, 25-26<sup>th</sup> Oct 2013*.
- [5] Lehiste, I., "The function of quantity in Finnish and Estonian", *Language* 41:3, 447–456, 1965.
- [6] Suomi K., Toivanen J. and Ylitalo, R., "Durational and tonal correlates of accent in Finnish", *Journal of Phonetics* 31, 113–138, 2003.
- [7] Iivonen, A., "Major features of standard Finnish phonetics", in V. de Silva and R. Ullakonoja [Eds] *Phonetics of Russian and Finnish, general description of phonetic systems, experimental studies on spontaneous and read-aloud speech*, 47–65, Peter Lang, 2009.
- [8] Wiik, K. and Lehiste, I., "Vowel quantity in Finnish disyllabic words", *Second International Congress of Fenno-Ugrists, Helsinki 1965*, 569–574, 1968.
- [9] Lehtonen, J., "Aspects of Quantity in Standard Finnish", *Studia Philologica Jyväskyläensia* 6, Jyväskylä, 1970.
- [10] Suomi, K., Toivanen, J. and Ylitalo, R., "Finnish sound structure. Phonetics, phonology, phonotactics and prosody", *Studia Humaniora Ouluensia* 9, Oulu, 2008. Online: <http://herkules oulu.fi/isbn9789514289842/isbn9789514289842.pdf>, accessed on 14 Dec 2013.
- [11] O'Dell, M., "Intrinsic Timing and Quantity in Finnish", *Acta Universitatis Tamperensis* 979, University of Tampere, Tampere, 2003. Online: <http://tampub.uta.fi/bitstream/handle/10024/67344/951-44-5838-9.pdf?sequence=1>, accessed on 14 Dec 2013.
- [12] Vainio, M., Aalto, D., Järvikivi, J. and Suni, A., "Quantity and tone in Finnish lexically stressed syllables", *Proceedings of the Second International Symposium on Tonal Aspects of Languages*, 121–124, 2006. Online: <https://helda.helsinki.fi/handle/10138/24708>, accessed on 15 Dec 2013.
- [13] Hurme, P. and Sonninen, A., "Development of durational patterns in Finnish CVCV and CVCCV words", in Hurme, P. [Ed] *Papers in Speech Research* 6, 1–14, Jyväskylä, 1985.
- [14] Vihanta, V., "Suomen äännekestit ranskalaisen suomenoppijan kannalta", in Hurme, P. and Dufva, H. [Eds] *Papers from the 14th Meeting of Finnish Phoneticians, Papers in Speech Research* 7, Jyväskylä, 101–122, 1987.
- [15] Toivola, M., "Vieraan aksentin arvioiminen ja mittaaminen Suomessa", *Unigrafia*, Helsinki, 2011. Online: <https://helda.helsinki.fi/bitstream/handle/10138/27888/vieraan.pdf?sequence=1>, accessed on 14 Dec 2013.
- [16] Ylinen, S., Shestakova, A., Alku, P. and Huutilainen, M. "The perception of phonological quantity based on durational cues by native speakers, second-language users and nonspeakers of Finnish", *Language and Speech* 48:3, 313–338, 2005.
- [17] Ylinen, S., Shestakova, A., Huutilainen, M., Alku, P. and Näätänen, R. "Mismatch negativity (MMN) elicited by changes in phoneme length: A cross-linguistic study", *Brain Research* 1072:1, 175–185, 2006.
- [18] de Silva, V. "Quantity and quality as universal and specific features of sound systems: Experimental phonetic research on interaction of Russian and Finnish sound systems", *Studia Philologica Jyväskyläensia*, Jyväskylä, 1999.
- [19] Jones, D. and Ward D. "The Phonetics of Russian", University Press, Cambridge, 1969.
- [20] Boersma, P. and Weenink, D., "PRAAT: Doing phonetics by computer", Version 5.3, [Computer program], 2013. Online: <http://www.praat.org/> (University of Amsterdam, Amsterdam), accessed on 14 Nov 2013.
- [21] Thorén, B. "The priority of temporal aspects in L2-Swedish prosody: Studies in perception and production." *Stockholms universitet*, 2008.
- [22] Thorén, B. "Durations of phonologically long segments in native and foreign accented Swedish." *Fonetik 2010, Lunds universitet*, 2-4 juni 2010, 2010. Online: [http://www.bossethoren.se/bosse\\_b\\_thoren\\_fon2010.pdf](http://www.bossethoren.se/bosse_b_thoren_fon2010.pdf), accessed on 21 Feb 2013.