Perception of vowel length in native speakers and second-language users of a quantity language

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ABSTRACT

In the Finnish language, there is a phonological opposition between short and long sounds. Second-language (L2) users of Finnish, whose native language does not include this distinction, often find it difficult to acquire. We compared the categorization of short and long speech sounds in school-aged L2 users and native speakers of Finnish. Two pseudoword continua with vowel durations varying from short to long either in the word-initial or word-final position were used as stimuli. The results showed that the categorization was similar in both groups in the first-syllable position, but, in the word-final position, the category boundary was crossed with shorter durations in the L2 users. In both conditions, the reaction times were shorter in the native speakers than in the L2 users. We suggest that phonological categories for short and long sounds are established in L2 users, but the categorization is still faster in native speakers, as indicated by the reaction times.

1. INTRODUCTION

In the Finnish language, quantity, the opposition between short and long speech sounds, is linguistically significant: two words with different meanings can be separated by the quantity degrees only (e.g., /tuli/ 'fire' vs. /tu:li/ 'wind') (see [1] for review). At the acoustical level, quantity degrees are primarily separated by sound duration, even though some spectral differences between Finnish short and long vowels have been discovered (short vowels are on average somewhat more centrally placed than the long ones [2–3]). In Finnish, the role of quantity is quite extensive: all vowels can be either short or long in all positions of the word, and the two quantity degrees concern also consonants[1]. The second-language (L2) users of Finnish, however, often have difficulties in correctly perceiving and producing the quantity distinction if their native language (L1) is not a quantity language. The first aim of the present study was to determine whether the accuracy or speed of vowel-length categorization to short and long quantity degrees differs between school-aged native speakers of Finnish and advanced second-language users of Finnish whose L1 does not include the phonological quantity distinction.

In many languages, e.g., in Russian, duration is a cue for stress instead of length. While, in Finnish, stress is always located on the first syllable of the word, in Russian, stress is non-fixed (it can fall on any syllable of a word) and it has a phonologically distinctive role. The acoustic parameters of Russian word stress are duration, F0, intensity and vowel quality, but, according to Bondarko [4], the most important cue is the duration. Russians who do not speak any Finnish may even perceive Finnish unstressed long vowels as

[1] In Finnish, consonants (excluding /d/, /h/, /j/, and /v/) can appear as long in all positions of the word except in word-initial and word-final.

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stressed based on the vowel duration, as demonstrated by de Silva [5]. Therefore, in Russian L2 users of Finnish, the accuracy of quantity categorization that is cued by duration may be possibly affected by the position of the vowel in the word (stressed first-syllable vs. unstressed position). Due to this, the second aim of the study was to determine whether the position of the opposition affects the quantity categorization in Russian L2 users.

2. METHODS

Two subject groups were employed. The L2 group consisted of eleven advanced L2 learners of Finnish, speaking Russian as L1 (7 boys, mean age 12;7 years;months, mean time spent in Finland 5;2 y;mo). All Russian subjects spoke Finnish fluently and studied at school in a Finnish-speaking class. The criteria for being included in a group of second-language users were as follows: the child reported that his/her mother tongue was Russian, s/he had moved to Finland later than at the age of 4 years and s/he had been living in Finland for not less than 3 years. In the native-speaker group there were 14 monolingual native speakers of Finnish (9 boys, mean age 11;5 y;mo). All subjects reported having no language or hearing impairments.

The subjects participated in two-alternative forced-choice categorization tasks that took place in a sound-attenuated room. The stimuli were presented via headphones. The stimuli that were used in the study were pseudowords where the duration of one vowel was manipulated so that the stimuli formed a continuum with ca 20-ms duration steps from a word with a short vowel to that with a long vowel (see Fig. 1). The duration was manipulated by concatenating fundamental cycles to the end of the vowel. Two conditions were tested: in the first-syllable condition, the varying vowel was located in the first (i.e., stressed) syllable of the pseudoword (CVCV vs. CVVCV), whereas in the word-final condition in the word-final (unstressed) position (CVCV vs. CVCVV). In both conditions, 7 stimuli with variable vowel durations were presented 10 times each in a random order with a 2-s interstimulus interval (ISI, offset to onset). The 70 stimuli of each condition were divided into two blocks. The subjects indicated their perception of vowel length by pressing the keys of a response pad. In order to ensure that the subjects understood the task, the test sequences were preceded by examples of the sounds the subjects were about to hear (stimuli 1, 4 and 7). After this, they were presented with a rehearsal sequence where each of the 7 stimuli occurred once in a random order. The subjects were instructed to react by pressing the response keys during the rehearsal. The rehearsal sequence was run twice, but if the subject considered the rehearsal insufficient, the rehearsal was run for a third time.

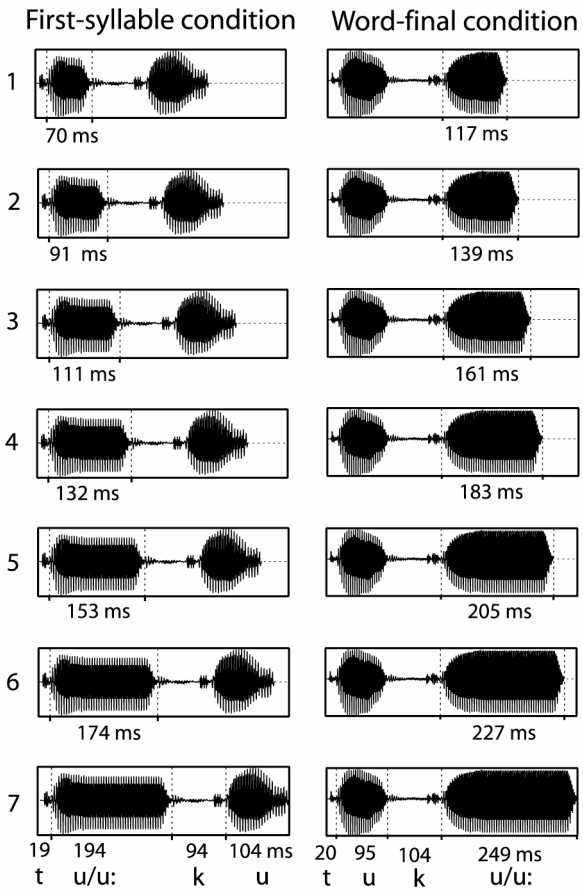

Figure 1: The oscillograms of the stimuli used in the study, and the durations (rounded to the nearest millisecond) of the sounds in the pseudowords. Left: first-syllable condition (CVCV vs. CVVCV). Right: word-final condition (CVCV vs. CVCVV).

From the categorization functions, the location of the category boundary and the function steepness were determined as follows: a difference curve was calculated on the basis of adjacent data points and the normal distribution was fitted to these data. The average represents the location

of category boundary, and the standard deviation (SD) represents the steepness. These data, the overall categorization data and the reaction times (RTs) were submitted to the analysis of variance (ANOVA).

3. RESULTS AND DISCUSSION

The results showed that the categorization functions were significantly different ($F(1, 23)=4.4$, $p<.05$) between the groups in the word-final position. In comparison with the native speakers, in the L2 users the 50% crossover point between the categories for short and long vowel occurred earlier, i.e., closer to the beginning of the continuum consisting of stimuli with shorter durations (see Fig. 2). In the first-syllable position, however, the categorization functions did not reveal any significant differences between the groups (see Fig. 3).

When the location of the category boundary was tested with fitted data, the difference between the groups did not reach significance in either position, even though, in the word-final position, the results approached significance ($F(1, 23)=3.66$, $p<.07$). There were no significant differences in the steepness of the functions.

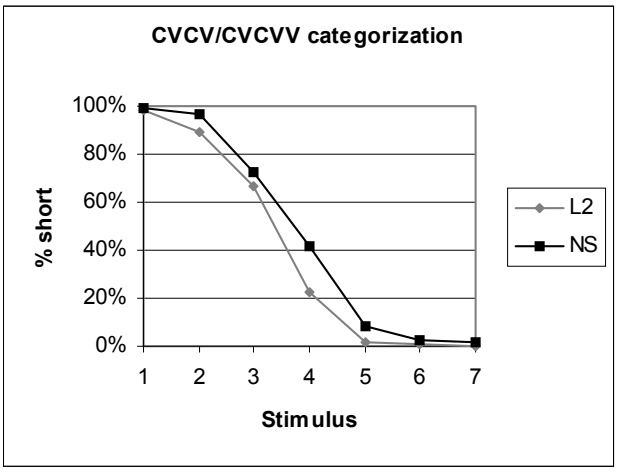

Figure 2: The categorization functions (the percentage of "short" reactions to each stimulus) of the word-final condition in the second-language users (L2) and the native speakers (NS).

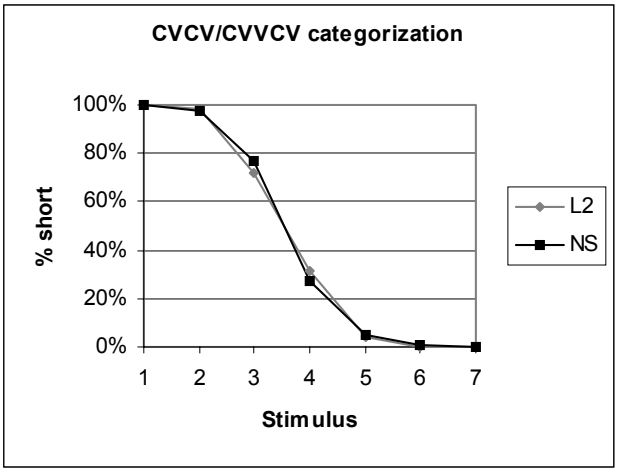

Figure 3: The categorization functions (the percentage of "short" reactions to each stimulus) of the first-syllable condition in the second-language users (L2) and the native speakers (NS).

For the RTs, significant differences were observed between the groups in both conditions (for the first-syllable position ($F(1, 23)=8.0$, $p<.01$), and for the word-final position ($F(1, 23)=8.4$, $p<.01$)). The native speakers of Finnish categorized the vowel length faster than the L2 users (see Fig. 4 and 5).

Due to the very similar categorization functions between the groups in the first-syllable position and the lack of significant differences in the steepness and fitted boundary locations, it seems likely that the L2 users have established phonological categories for Finnish quantity degrees. However, the groups' responses differed in the word-final position, the L2 users showing category boundary earlier than the native speakers. As there was no difference between the groups in the stressed first-syllable position, the difference in the word-final position may be related to the fact that the vowel is unstressed. However, the difference may have also been caused by the peculiarity of duration relations in CVCV structure: in standard Finnish, the final short vowel of CVCV words is typically longer in duration than in the other word structures [1]. This "irregularity" may not be salient enough for all the L2 users to acquire, because it is not linguistically relevant, even though this structure is very frequent in Finnish.

Even though the quantity categories have apparently been established for L2 users as well as for the native speakers,

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the RTs showed that the native speakers were able to perform the categorization faster. This implies that the categories may be more strongly established in native speakers or that native speakers may have a higher sensitivity to duration at the early stages of auditory processing (see [6]). This may facilitate categorization based on duration processing.

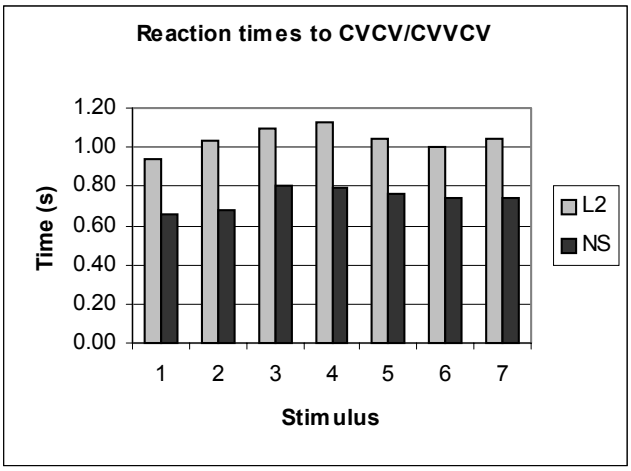

Figure 4: The reaction times in the first-syllable condition in the second-language users (L2) and the native speakers (NS).

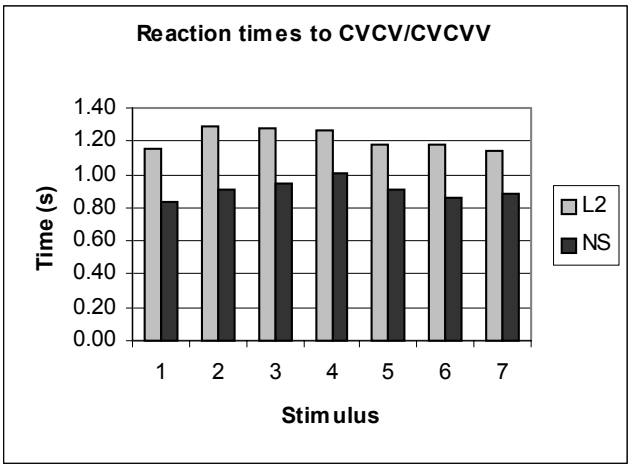

Figure 5: The reaction times in the word-final condition in the second-language users (L2) and the native speakers (NS).

4. CONCLUSIONS

The categorization of quantity degrees was compared between native speakers and second-language (L2) users of Finnish in first-syllable and word-final positions. A difference between the groups in categorization functions was observed in the word-final but not in the first-syllable position. This may be due to the stress pattern or the peculiarity of duration in the word-final vowel of CVCV words that has not been acquired by all L2 users. The reaction times differed in both conditions: the native speakers performed faster in the categorization task than the L2 users, suggesting facilitated processing in native speakers.

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