

Whereas most of the early learners (21 out of 30) perceive category boundaries within the range of native-speaker categorization for all three places of articulation this applies to only two of the ten late learners (AO 13 and 16). In the group of early learners nine subjects show category boundaries within the range of native-speaker categorization for either one or two of the Swedish minimal pairs. At the same time no early learner was found who exhibits non-nativelike category crossover points for all three places of stop articulation. Finally, the analysis of the group of late L2 learners shows that seven individuals change phoneme category within the range of native-speaker categorization for either one or two of the three places of articulation. In contrast, only one subject (AO 14) does not exhibit category boundaries within the range of native-speaker categorization for any of the stops.

#### 4 Summary and conclusions

The present study has shown that age of onset has an effect on apparently nativelike L2 speakers' categorical perception of the voicing contrast in Swedish word initial stops. In addition to negative correlations between AO and perceived category boundaries, significant group differences were found. The late L2 learners change phoneme category at the shortest crossover points, thereby deviating the most from the Swedish controls. In short, the data confirm that there is a general age effect on categorical perception even among L2 speakers who seem to have attained a nativelike L2-proficiency (Research Question 1).

Among the late L2 learners only two subjects (AO 13 and 16) change stop category within the range of native-speaker categorization regarding all three places of articulation. Thus, only a small minority of late, apparently nativelike L2 speakers show actual nativelike behavior concerning the categorical perception of the voicing contrast (Research Question 2).

Most of the early L2 learners change category for the three stop continua at VOTs within the range of native-speaker categorization. On the contrary, no subject with an early AO was identified who showed non-nativelike category boundaries for all three stop continua. Thus, most, but far from all, early learners show nativelike behavior when their perception of the L2 is analyzed in detail (Research Question 3).

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## Stress, Accent and Vowel Durations in Finnish

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#### Abstract

*The paper summarises recent research on the interaction of prominence and vowel durations in Finnish, a language with fixed initial stress and a quantity opposition in both vowels and consonants; to be more accurate, the research has been conducted on Northern Finnish. It is shown that, in one-foot words, there are four statistically distinct, non-contrastive duration degrees for phonologically single vowels, and three such degrees for phonologically double vowels. It is shown that the distributions of these duration degrees are crucially determined by moraic structure. Also sentence accent has a moraic alignment, with a tonal rise occurring on the word's first mora and a fall on the second mora. It is argued that the durational alternations are motivated by the particular way in which accent is realised.*

#### 1 Introduction

In Finnish word stress is invariably associated with the initial syllable, and there is a binary quantity opposition in both vowels and consonants, independent of stress, effectively signalled by only durational differences. There are very good grounds for interpreting the quantity oppositions syntagmatically, as distinctions between a single phoneme and a double phoneme, i.e. a sequence of two identical phonemes (Karlsson, 1969). This interpretation is also reflected in the orthography, and thus there are written words like *taka*, *taaka*, *takka*, *taakka*, *takaa*, *taakaa*, *takkaa*, *taakkaa*. However, the orthography only indicates the contrastive, phonemic quantity distinctions and, beyond this, it does not in any way reflect the actual durations of phonetic segments. Thus, for example, the orthography or a phonemic transcription do not in any way express the fact that, in e.g. the dialect discussed in this paper, the second-syllable single vowel in *taka* has a duration that is almost twice as long as that in *taaka*, *takka* and *taakka*. This paper summarises recent research on such non-contrastive vowel duration alternations, and suggests their motivations. The paper only looks at vowel durations, and only in words that consist of just one, primary-stressed foot, and thus the effect of secondary stress on vowel durations, which has not been systematically examined, is excluded.

As will be seen below, the mora is an important unit in Finnish prosody. The morae of a syllable are counted as follows: the first vowel phoneme – the syllable nucleus – is the first mora, and every phoneme segment following in the same syllable counts as an additional mora. Below, reference will be made to a word's morae, and e.g. the words *taka*, *taaka* and *taakka* have the moraic structures  $CM_1.CM_2$ ,  $CM_1M_2.CM_3$  and  $CM_1M_2M_3.CM_4$ , respectively (where  $M_n$  refers to the word's  $n^{\text{th}}$  mora, and C is a non-moraic consonant).

#### 2 Vowel duration patterns

Suomi & Ylitalo (2004) investigated segment durations in unaccented, trisyllabic nonsense words that consist of one foot each. The segmental composition of the nonsense words was

fully counterbalanced. The word structures investigated were CV.CV.CV, CV.CVC.CV, CV.CVV.CV, CV.CVV.CVV, CVC.CV.CV, CVC.CVC.CV, CVV.CV.CVV and CVV.CVV.CVV, each represented by 18 different words. The words were spoken in the frame sentence *xyz, MINUN mielestäni xyz kirjoitetaan NÄIN (xyz, in MY opinion xyz is written like THIS)*, where *xyz* represents the target word, the second occurrence of which was measured. The five speakers were instructed to emphasise the capitalised words. Suomi & Ylitalo only compared segment durations within the domain of the word's first two morae with those outside the domain, but the data have now been reanalysed in more detail. It turned out that there are four statistically distinct, non-contrastive and complementary duration degrees for single vowels, denoted as  $V_{(1)} - V_{(4)}$  in Table 1. The Table also shows the results for three classes of double vowels (VV) with different moraic affiliations. The duration labels given to the duration degrees are *ad hoc*.

**Table 1.** The mean durations (in ms) of the four duration degrees (DD) of phonologically single vowels (V) and of three types of double vowels (VV) as observed in Suomi & Ylitalo (2004) and in Suomi (in preparation); columns S & Y and S, respectively. In the column Moraic status " $M_{3+}$ " means that the V is the word's third or later mora, " $M_1$ " that the V is  $M_1$  that is followed by a syllable boundary, " $M_1C$ " that the V is  $M_1$  that is followed by a consonant in the same syllable, " $CM_2$ " that the V is  $M_2$  preceded by a consonant in the same syllable, " $M_1M_2$ " that the VV constitutes the sequence  $M_1M_2$ , " $M_2M_3$ " that the VV constitutes the sequence  $M_2M_3$ , and " $M_{3+}M$ " that the first segment in the VV sequence is  $M_{3+}$  or a later mora. For further explanations see the text.

DD	Duration label	S & Y	S	Moraic status	Example structures
$V_{(1)}$	"extra short"	48	75	$M_{3+}$	CV.CV.CY, CVC.CV
$V_{(2)}$	"short"	58	104	$M_1$	CV.CV(X)
$V_{(3)}$	"longish"	73	126	$M_1C$	CVC.CV(X)
$V_{(4)}$	"long"	84	158	$CM_2$	CV.CV(C)
$VV_{(1)}$	"longish" + "longish"	149	-	$M_1M_2$	CVV(X)
$VV_{(2)}$	"long" + "extra short"	142	-	$M_2M_3$	CV.CVV
$VV_{(3)}$	"very long"	135	-	$M_{3+}M$	CVC.CVV, CVV.CVV

Suomi (in preparation) measured durations in segmentally fully controlled, accented CV.CV and CVC.CV nonsense words embedded in the frame sentence *Sanonko \_\_\_ uudelleen? (Shall I say \_\_\_ again?)* and spoken by seven speakers. Suomi found the same four statistically distinct duration degrees for phonologically single vowels, as reported in Table 1. Three of the four single vowel duration degrees have been well documented earlier, e.g. by Lehtonen (1970), but the existence of degree  $V_{(3)}$  ("longish") has not been previously reported.

Below are the distributional rules of the observed duration degrees. The rules are to be applied in the following manner: if a word contains a VV sequence, then an attempt to apply the rule for VV duration should be made first. If this rule is not applicable, then the rule for V should be applied to both members of the VV sequence (and of course to singleton V's).

- VV → [very long] if the first V in the sequence constitutes  $M_{3+}$   
 V → [extra short] if it constitutes  $M_{3+}$   
 → [short] if it constitutes  $M_1$  that is not next to  $M_2$   
 → [longish] if it occurs in the sequence  $M_1M_2$   
 → [long] if it constitutes  $M_2$  that is not next to  $M_1$

As the rule for VV duration is formulated, it is only applicable to  $VV_{(3)}$  but not to  $VV_{(1)}$  nor to  $VV_{(2)}$ . In these latter two cases, then, the rule for V duration has to be separately applied to both segments in the sequence, and the correct durations are assigned. Thus VV is "very long" in e.g. CVV.CVV.CVV and CVC.CVV, V is "extra short" in e.g. CVV.CV, CVC.CV and CV.CV.CV, "short" in CV.CV(X), "longish" in CVC.CV and CVV.CV (both segments in VV are "longish"), and "long" in CV.CV. In the structure CV.CVV, the first segment in the second-syllable VV sequence ( $M_2$ ) is analysable as "long" and the second one ( $M_3$ ) as "extra short"; the sum of these duration degrees is (84 ms + 48 ms =) 132 ms which is 10 ms less than the observed duration for  $VV_{(2)}$  (142 ms), but the difference was not significant. The durational alternations under discussion of course entail complications to the realisation of the phonemic quantity opposition, and in particular the durational difference in the second-syllable vocalic segments in CV.CV and CV.CVV word structures is less than optimal.

Notice that the above rules explicitly refer to moraic structure only, and not e.g. to the syllable. Notice further that  $M_{3+}$  is only referred to when the vowel is either "very long" or "extra short". These degrees represent the durations of double and single vowels in those unstressed syllables in which nothing interferes with the realisation of the quantity opposition; in these positions, the mean duration of double vowels is (135/48 =) 2.8 times that of single vowels. But when a vowel constitutes  $M_1$ , it can be either "short" or "longish", and when it constitutes  $M_2$ , it can be either "longish" or "long". This is because the durations of these segments also signal prominence.

### 3 On the phonetic realisation of prominence

The distinction drawn by Ladd (1996, and elsewhere) between the association and the alignment of prominence is very useful in Finnish. Primary word stress is unquestionably phonologically associated with the word's initial syllable, but its phonetic alignment with the segmental material is more variable. Stress is signalled by greater segment duration, but not necessarily on the stressed syllable only. Broadly speaking, stress is manifested as greater duration of the segments that constitute  $M_1$  and  $M_2$ , but exactly how the greater duration is distributed depends on the structure of the initial syllable. If the initial syllable is light, i.e. in (C)V.CV(C) words, the first-syllable vowel is "short" and the second-syllable vowel ( $M_2$ ) is "long" (but both are longer than the third-syllable "extra short" vowel in (C)V.CV.CV(C) words). But if the initial syllable is heavy, i.e. contains both  $M_1$  and  $M_2$ , then both of these segments are "longish" as in CVV.CV(C) words (and the second-syllable V is "extra short").

As concerns sentence accent, it is normally realised as a tonal rise-fall that is also moraicly aligned: the rise is realised during the first mora, and (most of) the fall during the second mora. Thus in (C)V.CV(C) words, the rise is realised during the first syllable and the fall during the second one, whereas in words with a heavy initial syllable both the rise and the fall are realised during the initial syllable. Strong (e.g. contrastive) accent involves a wider  $f_0$  movement than moderate accent, and it is also realised durationally, as an increase in the durations of especially  $M_1$  and  $M_2$ . But moderate accent is not realised durationally, i.e. the unaccented and moderately accented versions of a word have equal durations.

In many languages, details of the tonal realisation of accent depend on the structure of the accented syllable. Thus e.g. Arvaniti, Ladd & Mennen (1998) report that, in Greek, the slope and duration of the (prenuclear) accentual tonal movement vary as a function of the structure of the accented syllable. This is not so in Finnish. Instead, what has been observed repeatedly is that, given a constant speech tempo and a given degree of accentuation, the rise-fall tune is temporally and tonally uniform across different word and syllable structures (Suomi, Toivanen & Ylitalo, 2003; Suomi, 2005; in press).

#### 4 Motivating the durational alternations

Why are there so many non-contrastive vowel duration degrees in Finnish, alternations that partly interfere with the optimal realisation of the quantity opposition? The answer seems to be provided by the particular combination of prosodic properties in the language. Given the uniformity of the accentual tune across different word structures, and given the moraic alignment of the accentual tune, the durational alternations discussed above are necessary. If the durational alternations did not exist but accent nevertheless had the moraic alignment that it has, the uniformity of the accentual tune would not be possible. Why the tonal uniformity exists is not clear, but there it is. It is somewhat paradoxical that, in a full-fledged quantity language in which segment durations signal phonemic distinctions, segment durations nevertheless also vary extensively to serve tonal purposes, while in non-quantity languages like Greek the segmental composition of the accented syllable determines the tonal realisation.

The durational alternations are also observable in unaccented words. But this does not undermine the motivation just suggested, because unaccented and moderately accented words do not differ from each other durationally, and the alternations are directly motivated in moderately accented words. Thus unaccented words are as if prepared for being accented. A conceivable alternative would be that unaccented words would lack the alternations present in accented words, but this state of affairs would further complicate the durational system.

To summarise, beyond the loci in which stress and accent are realised, i.e. when vowels do not constitute  $M_1$  or  $M_2$ , single vowels are "extra short" and double vowels "very long", which results in their clear separation. In (C)V.CV(X) words, the tonal rise is realised during the initial syllable and it is sufficient that the vowel is "short". The long fall is realised during the second syllable, and therefore the vowel must be "long". In (C)V.CV(X) words, both the rise and most of the fall is realised during the initial syllable, and therefore both segments in the VV sequence must be "longish". This paper is not about consonant durations but in (C)VC.CV(X) words, in which  $M_2$  is a consonant, it too has to be "longish"; if the consonant has relatively short intrinsic duration elsewhere, it is lengthened in this position. As a consequence of these alternations, the accentual rise-fall can be uniform across different word structures, and at the same time, the quantity oppositions are not jeopardised.

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## Phonological Demands vs. System Constraints in an L2 Setting

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#### Abstract

*How can system constraints and phonological output demands influence articulation in a L2-speaker? When measuring durations and articulator movements for some Swedish /V:C/ and /VC:/ words, pronounced by a Swedish and a Polish speaker, it appeared that phonological vowel length was realized very similarly by both speakers, while complementary consonant length was applied only by the native Swedish speaker. Furthermore, the tendency for increased openness in short (lax) vowel allophones was manifested in analogous jaw and lip movements in the Swedish speaker, but followed a different pattern in the Polish speaker.*

#### 1 Introduction

How is articulation influenced by system-based constraints and output-based constraints, when a person uses a second language? According to the Hyper & Hypo speech theory (Linblom 1990) the degree of articulatory effort in human speech is determined by mainly two factors: 1) The limitations that inertia in the articulators poses upon speech, including the tendency for economy in effort. 2) The demands of the listener, e.g. sufficient phonological contrast. The former is assumed to result in unclear speech, or "under shoot", and the latter to "over shoot" or "perfect shoot" (clear speech). According to the H&H-theory, the output demands vary depending on e.g. contextual predictability and the acoustic channel being used, the presence of noise etc.

From a cross-linguistic point of view, the demands of a listener are to a high degree determined by the phonologic system of the language in question. These demands are supposed to be intuitively inherent in the native speaker of the language, i.e. the speaker has a clear but probably unconscious picture of the articulatory goal. What happens to a L2-speaker in this perspective? We can assume that the L2-speaker is influenced both by L1 and L2 demands on the output, as well as by system-based constraints.

Swedish has a quantity distinction in stressed syllables, manifested in most varieties as either /V:(C)/, or /VC:/. Elert (1964) has shown that the Swedish long-short phonological distinction is accompanied by analogous differences in duration for the segments involved. His study also shows that the differences in duration between long and short Swedish vowel allophones are significantly greater (mean 35%) than durational differences between closed and open vowels (5-15%). This predicts that output constraints for Swedish segment durations would override the system constraints, i.e. the inherent differences in duration between open and closed vowels.

Polish on the other hand, is a language without phonological quantity, and is not expected to involve any output constraints on the duration of segments. Duration differences in Polish are assumed to result mainly from vowel openness, in accordance with the "Extent of Movement Hypothesis" (Fischer-Jørgensen, 1964). A native Polish speaker, who speaks