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Suomi, K.

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Word stress and duration in Finnish

Kari Suomi & Riikka Ylitalo
Department of Finnish and Saami and Logopedics, Oulu University, Finland
kari.suomi@oulu.fi

Abstract
The paper summarises results of an investigation of the durational correlates of word stress in Finnish, to be reported in more detail elsewhere. It was observed that segments and syllables have a reliably longer duration when they occur within the domain of the word’s first two morae than when they occur outside this domain. The most conspicuous concomitant of primary stress is the durational variation of the second-syllable single vowel: if this vowel constitutes the word’s second mora, its duration is very much longer than otherwise. It was further observed that when a consonant constitutes the word’s second mora, the consonant is lengthened, but only if it is voiced. We wish to argue that the motivation for the second-mora lengthening is to provide room for the phonetic realisation of accentuation.

Primary stress
Finnish has fixed stress: primary stress always falls on the word-initial syllable, and secondary stresses (usually) on following odd syllables, but not on the word-final one (but a long word-final syllable may receive secondary stress if the preceding syllable is short and unstressed). This much is uncontroversial, but it has remained unclear what the phonetic correlates of Finnish stress are like, and whether such correlates exist at all, independently of (sentence) accents; that is, whether a stressed syllable is anything more than the default docking site of an accent. Previously, in most studies of Finnish stress has been equated with accentuation, and the results have accordingly been interpreted to show that stress is realised tonally, and the results provide no positive information on the eventual phonetic correlates of stress.

It has been reported for numerous languages that a given syllable has a longer duration in stressed than in unstressed positions. In Finnish, superficially at least, this does not seem to be the case. This is because, other things equal, a CV syllable is much longer when constituting the second, unstressed syllable of a CV.CV word, than when constituting the first, stressed one (whereas in CVV.CV and CVC.CV words the similarly unstressed second-syllable CV is very short). The V₂ in (C)V₁.CV₂(X) words is traditionally called the ‘half-long’ vowel (whose duration relative to V₁ is subject to dialectal variation). The V₂ in such words constitutes the word’s second mora, and its duration is roughly twice the duration of the V in the second-syllable CV in CVV.CV and CVC.CV words (while in both cases the second-syllable V is in opposition to VV). The situation in CV.CV words (longer syllable duration in unstressed than in stressed position) looks strange in a cross-linguistic perspective, and at the same time perceptually inexplicable, and probably for this reason it has not, to our knowledge, been previously suggested that duration could signal stress in Finnish. But this is precisely what we wish to propose.

The results of Suomi et al. (submitted) show that the domain of the phonetic alignment (in the sense suggested by Ladd, 1996) of accentuation in Finnish is the accented word’s first two morae (while accents are phonologically associated with the stressed, word-initial syllable, except for contrastive accents that may highlight syllables in any position for pragmatic reasons). Our findings on accent, together with Ladd’s distinction between alignment and association, suggested to us that the domain of stress alignment might be similar to that of accent alignment, and we consequently formulated the following working hypothesis:

A phonological unit (segment, syllable) has a longer duration when it constitutes, or is contained within, the sequence of a word’s first two morae, than when the unit occurs outside such a sequence.
We first tested the hypothesis by running an experiment with trisyllabic nonsense items with fully balanced segmental materials across the three syllables. Eight structures were included, viz. CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV, CV.CV.CV; each structure constitutes a left-headed metrical foot, and some of the structures were included merely to (hopefully) rule out alternative explanations of results seemingly consistent with the working hypothesis. There were 18 items representing each structure. The items were embedded in a constant frame sentence in which they were designed to receive no or at most minimal accentuation (which they actually did in the productions by 5 speakers of a northern variety of Finnish). Concerning syllables with balanced segmental structure, it was observed that they had on average and reliably 20 % longer duration when occurring in the domain of the word’s first two morae than when occurring elsewhere. For example, the first syllable in CV.CV.CV (in which the second-syllable V constitutes the word’s second mora) was 28 % longer than the third syllable, and the first syllable in CV.CV.CV, CV.CV.CV (in which the first syllable contains the word’s first two morae) was 10 % longer than the second syllable, and 12 % longer than the third syllable.

We secondly tested the working hypothesis against the extensive (10 speakers) earlier data in Lehtonen (1970), a study of the durational realisation of the quantity opposition involving real words that did not explicitly compare durations of segments or syllables in stressed positions against unstressed positions in a given word structure. Here too, to put it briefly, segments and their carrier syllables had longer duration when occurring in the domain of the word’s first two morae than when occurring outside the domain, and the differences were approximately of the same magnitude as those mentioned above.

The results from two independent studies (involving both nonsense and real words) thus converge on showing that primary stress is realised in the same bimoraic domain as accents, and that in Finnish, too, then, (primary) stress involves greater segmental and syllabic duration than does lack of stress, as in presumably most languages. This conclusion is possible once it is understood that while primary stress is formally associated with the word-initial syllable, its phonetic alignment with the segmental material follows the bimoraic pattern described above.

Secondary stress

The vowel duration variations found in the word’s second syllable as a function of the moraic structure of the second syllable occur in the word’s first foot. If these variations are correlates of stress (or metrical structure), as we wish to argue, then there is a principled reason to expect the same pattern of variation to occur between the first and second syllables of later feet. Thus if the pattern of vowel duration variation found in the second syllable of a word’s first foot were also found in later feet, we would interpret the finding as strong support that the variation is a correlate of (in this case: secondary) stress. For example, keisarinna (‘as an emperor’) consists of two disyllabic feet, as does keisarina (‘empress’). The second feet are ri na and rin na, the former having a monomoraic first syllable, the latter a bimoraic one. If the foot is the relevant domain, then the prediction is that the /a/ at the end of keisarina should be longer than the /a/ at the end of keisarina. Since we are here dealing with secondary stress, the difference is expected to be smaller than in the case of primary stress.

An experiment was conducted using 10 pairs of words of the keisarina - keisarinna structural type, embedded in short carrier sentences in which they were at most moderately accented. The sentences were spoken by 5 speakers, and durations of the three phonetic segments in the V1(C).CV2 sequence in the second foot of the target words were measured. The predicted durational difference was observed. There was no significant difference in the V1 segments between the two structures, but V2 had reliably longer duration in keisarinna type of words than in keisarina type of words. In the former, the V2/V1 durational ratio was 1.43, in the latter it was 0.98. Compared to the ratios observed in the first foot by Ylitalo (submitted) under otherwise comparable conditions, which were 1.87 and 0.87, respectively, the present ratios are closer to unity, the value that would be expected if there were no positional effects on vowel durations.

Since the well documented vowel duration variation in the second syllable of words’ first foot was reliably attested also in the second foot, we conclude that the variation is a correlate of secondary stress. As expected, the durational
correlates of secondary stress were attenuated relative to those of primary stress.

Second-mora lengthening: consonants

The ‘half-long’ V₂ in (C)V₁.CV₃(X) words clearly involves lengthening of the word’s second mora. Similarly, the fact that a double vowel in the first syllable is usually more than twice as long as a single vowel in the same position, can also be interpreted as second-mora lengthening: in Ylitalo’s (forthcoming) material the first-syllable VV/V ratio was 2.60 in the comparison of CVV.CV and CV.CV words, and 2.45 in the comparison of CVV.CV and CV.CV words. These moraic effects on vowel durations are robust and well documented.

Second-mora lengthening has also been reported to affect coda consonants in the first syllable. Karlsson (1983) claims that resonants have a clearer propensity for lengthening than obstruents. Given the Finnish consonant system, this amounts to saying that voiced consonants are lengthened more than voiceless ones. However, Karlsson does not make his sources explicit, and we therefore decided to run our own experiment. We wanted to see whether or not voiced and voiceless consonants behave differently with respect to the lengthening, and whether the lengthening is limited to consonants that constitute the word’s second mora, or whether it applies to all first-syllable consonants in the coda position.

Twenty triplets of target words were selected in each of which the words represented the structural types (C)V₁.KV, (C)V₁.K,C₂V and (C)V₁.V₁.K,C₂V. In half of the triplets K was a voiced consonant (e.g. /l/ in ku.lo, kul.ta, kuul.to), in the other half K was voiceless (e.g. /s/ in la.si, las.ti, laas.ti). In the first word of each triplet, K occupies a syllable initial position, and the duration of K in this position gives us the baseline with reference to which eventual lengthening can be assessed. In the other two words of each triplet, K is syllable final. In the second word K constitutes the word’s second mora, in the third one the word’s third mora. Each word was embedded in a short carrier sentence in which it was at most moderately accented. The sentences were spoken by the same 5 speakers who participated in the preceding experiment, and durations of the K segments were measured.

The results showed that voiced consonants in the second-mora position were reliably and considerably lengthened relative to the baseline, while voiceless consonants were not lengthened at all. Voiced consonants constituting the third mora were also lengthened (but the effect was small), while voiceless consonants in the same position were not. Both voiced and voiceless consonants exhibited a shortening in the third-mora position relative to the second-mora one.

Motivating second-mora lengthening

The word’s second mora is lengthened whether it occurs in the first or second syllable, but only if it is a voiced segment. Thus it applies to e.g. the /l/ in ka.to and in ruo.ka, and to the /l/ in kul.ta, but not to e.g. the /l/ in mak.su. What could be the motivation for this phenomenon that itself is a complication of the realisation of the quantity opposition? We wish to suggest that second-mora lengthening is motivated by the way accents are realised in Finnish. In Suomi et al. (submitted) it was found that the accentual rise-fall followed a moraic pattern: the rise during a word’s first mora, the fall during the second mora and later. Another finding was that the rise-fall pattern characterising strong accent was highly uniform across the investigated word structures CV.CV, CV.CV and CVV.CV: Statistically, the word structures were non-distinct with respect to the starting, peak and end f₀ values, as well as their total durations. Such uniformity would not be possible especially if the second syllable vowel in CV.CV words did not have the very long duration that it has. Speculating that if the second syllable in CV.CV were as short as the second syllable in CVV.CV, the total duration of CV.CV would be equal to the duration of the first syllable in CVV.CV, according to the measurements by Suomi et al. (submitted). This would mean that either the tonal movements in CV.CV would have to be much faster than they actually are, or they would have to be less extensive than they actually are. This, we are confident, is the motivation for the ‘half-long’ vowel: this vowel has the very long duration it has in order to provide room for the realisation of an eventual accent falling on the word, in particular for the fall part of the accentual movement, and to ensure a uniformity of accentual tonal gestures across different word structures. We also believe that this is the
motivation for the second-mora lengthening in
general. The lengthening only occurs when it
gives more room for the tonal realisation of
accentuation, namely when the second mora is a
voiced segment, but not when it is a voiceless
one.

Summary

Suomi et al. (submitted) have shown that, in
Finnish, when accentuation is controlled for,
stress is not realised tonally. Our present results
show that primary stress is realised in the same
bimoraic domain as accentuation: segments and
syllables have greater duration when they occur
within the domain of the first two morae than
when they occur elsewhere. The large variation
in the duration of the second syllable single
vowel dependent on the moraic structure of the
first syllable is part of the realisation of primary
stress. In fact the domain of the variation is the
metrical foot: the duration of a single vowel in
the second syllable of a foot is conditioned by
the weight of the foot-initial syllable. The
variation is largest in a word’s first foot that
bears the primary stress, it is similar but reduced
in the next foot that bears the secondary stress.
Thus when the distinction between formal
association and phonetic alignment is properly
appreciated, Finnish is no longer exceptional in
a crosslinguistic perspective: stressed positions
involve greater segmental and syllabic durations
than unstressed positions.

We believe that the ‘half-long’ vowel, which
has caused much puzzlement, is a felicitous
compromise between two opposing forces. On
the one hand, Finnish is a full-fledged quantity
language and therefore a pressure presumably
exists to maintain the V - VV opposition even in
the second, unstressed syllable. But lexically the
functional load of the second-syllable V - VV
opposition is definitely small, with minimal
pairs like vapa ‘rod’ - vapaa ‘free’ or palan ‘I
burn’ - palaan ‘I return’ being relatively rare
(although we are unable to present exact
statistics), and inflectionally it is to a large
extent predictable on syntactic grounds; in some
dialects the V - VV opposition is in fact
neutralised in non-initial syllables. On the other
hand, given that stress assignment in Finnish is
insensitive to syllable weight (in contrast to the
majority of syllabic trochee languages, in which
only heavy syllables can be stressed, see Hayes,
1995), the half-long vowel greatly contributes to
enabling the phonetic signalling of stress and
accent. Thus, given the existence of the half-
long vowel, the vowel quantity opposition in the
second unstressed syllable is maintained (albeit
not optimally), and at the same time stress (and
accent) can be signalled to fall on even light
initial syllables. That is, while itself a
complication of the phonetic realization of the
quantity opposition, the half-long vowel brings
about simplifications elsewhere in the prosodic
system.

In Finnish, then, stress is signalled at least
durationally and accents mainly tonally, and at
least strong accents also durationally. In this
respect, Finnish is like many other languages,
e.g. English and Swedish, see Cruttenden (1997)
and Bruce (1998), respectively. To what extent
there are other phonetic correlates of stress in
Finnish, e.g. spectral tilt differences between
vowels in stressed and unstressed syllables of
the sort observed by Sluijter & van Heuven
(1996) for Dutch, remains to be determined.

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