The postvocalic consonant as a complementary cue to the perception of quantity in Swedish

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Abstract

There have been discussions and studies concerning the possible influence of the postvocalic consonant on the discrimination of /VːC/ and /VCː/ words in Swedish. This study uses manipulations of durations in two series – one with changing of vowel duration only and one with changing of vowel and consonant duration in combination. Native Swedish listeners decided whether they perceived test words as original quantity type or not. The results indicate that the complementary consonant duration has an influence only on the vowel phonemes that have great spectral differences between long and short vowel allophones, in this case /a/ and /u/. Test words containing /ɛ/ and /ø/ were affected by vowel duration only. The study also includes naturalness judgements of the test words, and here the post-vocalic consonant duration did not have any systematic influence on naturalness.

Introduction

Swedish is known to have a phonologic quantity distinction with a complementary relation between vowel and post-vocalic consonant duration in stressed syllables (e.g. Elert 1964). This means that a long vowel is followed by a short consonant /VːC/, and a short vowel is followed by a long consonant /VCː/. Traditionally, the vowel length is regarded as the phonological distinction, and the consonant duration is regarded as redundant. Hadding-Koch & Abramson (1964) and Behne et al. (1998) have manipulated post-vocalic consonant duration, and found that it did not function as a primary cue to the Swedish quantity distinction.

Behne et al. (1998) suggest that “…adjustments of post-vocalic consonant duration in Swedish productions may be temporal artifacts of the preceding vowel quantity rather than an acoustic cue for linguistically relevant information.” If a syllable containing a short vowel is going to be prolonged, an increased post-vocalic consonant duration is a convenient way of executing the lengthening of the syllable. This is in good agreement with the opinion that greater duration is the most reliable phonetic correlate to stress in Swedish (Fant & Kruckenberg 1994).

For pedagogical purposes it is valuable to follow a linguistic description that renders the most intelligible and natural sounding speech. Since every teacher and learner of Swedish as a second language cannot specialise in phonetics, the robust rules in a pedagogical linguistic description should be carefully chosen. The temporal organisation of Swedish has acquired great influence as an important pedagogical tool during the last two decades. Thorén (2001) showed that digitally increased duration in phonologically long segments in Swedish with a foreign accent tended to be judged as improved Swedish pronunciation by native Swedish listeners. The foreign speaker in the study was Polish, and Polish is a language without phonological quantity. For pedagogical and scientific purposes it would be valuable to know if the complementary consonant length is a mere “duration buffer” to give a stressed syllable its proper duration, or an important cue contributing to the discrimination between /VːC/ and /VCː/ in Swedish.

Thorén (2003) recorded and manipulated 12 Swedish words that provided 6 minimal pairs with respect to quantity. The words with original /VːC/ were gradually given shorter vowel durations combined with longer consonant durations, and the words with original /VCː/ were gradually given longer vowel durations and shorter consonant durations, thus maintaining a constant duration of the entire V+C sequence of 600 ms. The durations in the mentioned study were based on durations in the original readings of one male and one female native Swedish speaker. There was no manipulation of spectral properties.
20 native Swedish listeners judged whether they perceived stimuli as a /VːC/-word or as a /VCː/-word.

The result showed that native Swedish listeners changed their perception of quantity type, once the V/C ratio was different enough from the original one. It also showed that different Swedish vowel phonemes were not equally inclined to be perceived as non-original quantity type.

The conclusion of Thorén (2003) is that all Swedish vowel phonemes are sensitive to temporal change that is not accompanied by spectral change. Since it seems as though native Swedish listeners can perceive a quantity type as the non-original type, by means of temporal change only, we can test the relative effects of changed vowel duration only, and complementary vowel-consonant change, insuring that effects of vowel spectrum don’t confuse the result.

The test material and the findings of Thorén (2003) serve as the base for the present study, where a series of “complementary” manipulations i.e. constant V+C-duration, is compared to a series of “vowel-only” manipulations.

Hypothesis: Complementary vowel + consonant duration change, helps the listener perceive the non-original quantity type more efficiently than change of vowel duration only.

Hypothesis 2: Test words with complementary duration (/VːC/ or /VCː/) will – when perceived as non-original quantity type – be judged as more natural sounding than words with non-original vowel duration and original consonant duration (/VC/ or /VːC:/).

### Method

#### Stimuli

The test words in the present study were recorded in a studio at the Phonetics department at the Institution of Linguistics at the University of Stockholm. Eight monosyllabic Swedish words served as the base for manipulations: mat [matː] food, matt [matː] faint, hut [hʊtː] manners, hutt [hʊtː] drink (snifter), tår [tærː] tight/close, tätt [tæːtː] tight/close, sött [sɔːtː] sweet, sött [sɔːtː] sweet. These words provide four minimal pairs with respect to phonologic quantity. Each word had its durations of vowel and post-vocalic consonant manipulated in Praat (Boersma & Weenink 2001). This resulted in six stimuli per original word, totally 48 stimuli. Each original word had its vowel duration changed into three values, typical for the non-original quantity type. Original /VːC/-words were given vowel durations of 150, 100 and 50 milliseconds, and original /VCː/-words were given vowel durations of 250, 300 and 350 milliseconds. Half of the stimuli kept a consonant duration typical for the original quantity type, and the other half were given consonant durations typical for the non-original quantity type, thus keeping the total V+C-sequence constant at 600 ms, in accordance with the original recordings. The manipulated durations are shown in table 1.

### Listeners

21 native speakers of Swedish listened to the 48 stimulus words, marking whether they perceived them as /VːC/ or /VCː/. The listeners were between 30 and 71 of age, and had different regional varieties, including Finland-Swedish, as their L1. None of them had any hearing deficiencies that affected their perception of normal speech.

### Presentation

The 48 stimuli were presented in random order, preceded by the reading of stimulus number. There was a 5 seconds pause between stimulus and next number reading, and a 1,3 second pause between number reading and the stimulus.
itself. The test was presented from computer or CD-player via headphones. The listener was first allowed to hear 2-3 stimuli while adjusting the sound level. The response was marked on an answering sheet, presenting the number and the pair of words providing the two choices. The listener had to chose one of the two possibilities. After the discrimination test, the listeners judged the naturalness of each stimulus on a scale from 1 (totally unnatural or unlikely pronunciation for a native speaker of Swedish) to 10 (totally natural pronunciation for a native speaker of Swedish, regardless of regional variety). In the naturalness judgement test, the order of presentation was the same as in the discrimination test, but the pause between stimulus and next number reading was 8 seconds, and the word chosen in the discrimination test was written next to the scale.

Result

Discrimination test

In both the vowel lengthening series and the vowel shortening series, the complementary consonant manipulation seems to have very little or no influence on the listeners’ choice in the case of /E/ and /O/. The only exception seems to be for original [tE˘t] tät, when the vowel duration is 150 ms (lowest degree of duration change). For /a/ and /u/, the two vowel phonemes that are traditionally – and according to Thorén (2003) – more spectrum dependent, the complementary consonant manipulation seems to have some influence, both when going from /V:C/ durations to /VC:/ and vice versa. The perceptual effect of the complementary consonant duration is greatest at the 100 and 300 ms vowel durations, i.e. durational values close to intact vowel durations and V/C-ratios for the recorded words. The respective influences from the manipulation series are shown in figures 1 and 2.

Naturalness rating

There was no systematic difference in influence from manipulation of vowel duration only, compared to manipulation of vowel and consonant duration. We can only state that the naturalness judgements for the words tät, tätt, söt and sött are generally higher than for mat, matt, hut and hutt, the former containing vowel phonemes that have minimal spectral differences between long and short vowel allophone, and the latter containing vowel phonemes that have great spectral differences between long and short vowel allophone.

Conclusion

The complementary consonant duration seems to play a distinctive role, but only in the case of /a/ and /u/, and these are the two vowel phonemes that are generally harder to have perceived as non-original quantity type, probably due to the greater spectral difference between
Figure 2. Number of /V:C/-responses for each value of vowel duration in original /VC:-words. A solid line with filled squares always represents manipulations of both vowel and consonant durations. Dashed line with open squares always represents manipulations of vowel duration only.

long and short allophone (cf. Hadding-Koch & Abramson 1964 and Thorén 2003). The question is why it did not affect the /e/ and /ø/ phonemes more than on one occasion. We can suspect that there are critical ranges in the vowel durations of /e/ and /ø/ that are not tested in this study. In the results from Thorén (2003) using complementary durations, the listeners begin to shift their judgements from /V:C/ to /VC:-words at a vowel duration of 150 ms for /a/ and /e/, at 100 ms for /u/ and at 200 ms for /ø/. Concerning perceptual shift from /VC:/ to /V:C/-words the critical values are 250 ms for /a/, 150 ms for /u/ and 200 ms for /e/ and /ø/. This indicates that the present study has missed critical duration ranges in some cases, and maybe has taken too big steps in the manipulation series.

Increased duration in phonologically long vowels and consonants in Swedish with a foreign accent, were mostly considered as improved Swedish pronunciation in Thorén (2001). Therefore one could expect that at least the increased post-vocalic consonant duration in the present study would help listeners perceive the test words as more natural sounding than words with short vowel followed by short consonant. One reason why the complementary consonant duration did not contribute to the naturalness ratings in the present study, could be the fact that it contains only monosyllabic words. The use of di- or polysyllabic words could provide short syllables for comparison, and make the “proper” duration of the stressed syllable easier to perceive.

References


