Perceived vowel quantity in Swedish: Effects of postvocalic voicing

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Abstract This study examines the perceptual weight of vowel duration and F1-F2 frequencies when distinguishing phonologically long and short Swedish vowels before a voiceless consonant and before a voiced consonant. Results suggest that vowel quantity is primarily cued by vowel duration, but when the duration of a vowel is already relatively long, due to factors such as inherent vowel duration or postvocalic voicing, vowel quantity is less likely to be cued by vowel duration alone.

BACKGROUND

In many languages differences in vowel duration are produced, and used as perceptual cues to distinguish linguistically relevant information, such as vowel quantity and postvocalic voicing. Vowel quantity refers to the phonologically distinctive length relative to one or more vowels of similar quality. In Swedish, vowels are described as having a distinction between phonologically long and short vowels (1). In 1964, a classic study (2) using carefully spliced tape recordings investigated vowel duration and spectra as perceptual cues for distinguishing the phonologically length of three Swedish vowel pairs. Their results showed that vowel duration is a primary parameter distinguishing Swedish vowels, but the vowel spectra could not be excluded as a possible perceptual cue.

More recent results (3) indicate that vowel duration is indeed used to distinguish [iː]-[ɪ] and [oː]-[ɔ], but that for [ɑː]-[a], which are inherently longer in duration than the other vowel qualities examined, the vowel duration and spectra are both used to identify vowel quantity. This suggests that the vowel duration may not have the same unique role in distinguishing vowel quantity when the vowel duration is already relatively long.

The results in (3) were obtained using stimuli with a voiceless postvocalic consonant following the target vowel, a factor which was not regulated across vowel qualities investigated in (2). Vowels preceding a voiceless consonant are known to be shorter than those before a voiced consonant (e.g., (4) for English and (5) for Swedish). If a vowel with a relatively long duration is less likely to be cued by vowel duration alone, vowel duration is expected to be a lesser cue to vowel quantity preceding a voiced consonant than preceding a voiceless one. This question is investigated in the present study by comparing the results from (3) using /kVt/ stimuli (re-presented in Figure 1) with results using an identical experimental procedure as in (3) but with /kVd/ stimuli.

METHOD

Based on recordings by a native male speaker of standard Swedish, three sets of /kVd/ words were resynthesized. Each set was based on one of three Swedish vowel pairs: [iː]-[ɪ], [oː]-[ɔ], and [ɑː]-[a]. For each set of words, the vowels of the pair were used as extreme points of a 10x10 synthesis matrix, having ten degrees of vowel duration and ten degrees of F1 and F2 adjustment. The full randomized set of resynthesized /kVd/ words (5 repetitions x 3 vowel pairs x 100 items) were presented to 19 native Swedish listeners from different parts of Sweden. For each item, listeners were asked to decide whether the target word rhymed with one of two given real words which differed only in the phonological length of the vowel. Subjects’ responses and reaction times were analyzed to determine the extent to which vowel duration and spectral characteristics perceptually cue phonologically long and short vowels.

RESULTS AND CONCLUSIONS

Figure 1 shows subjects responses for the /kVt/ stimuli in (3) and the /kVd/ stimuli from the current experiment.3 The results demonstrate two general patterns. First, vowel duration was found to be a dominant perceptual cue for listeners when distinguishing phonologically long and short vowels of each of the three vowel pairs before either a postvocalic voiceless (/kVt/) or voiced (/kVd/) consonant. Notably, this is particularly evident in the /kVt/ context where the vowel duration is relatively short compared to corresponding vowels in the /kVd/ context. In addition, for

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3 Reaction times support the discussion of subjects responses, but are not presented here due to space limitations.
[α:] and [a], which are inherently longer than the other vowels due to the extensive jaw movement used in their production, listeners also used the vowel spectra to distinguish phonological length. This was especially evident in the /kVd/ context where the duration of the vowel is already relatively long.

These findings and other details which merit discussion strongly support the conclusion that vowel quantity is primarily cued by vowel duration, but when the duration of a vowel is already relatively long due to factors such as inherent vowel duration or postvocalic voicing, vowel quantity is less likely to be cued by vowel duration alone. In the case of the low vowels, the vowel spectra comes into play. For the high front vowels and mid back vowels, additional acoustic cues, such as corresponding postvocalic vowel duration, may also need to be available in order for a listener to clearly perceive this distinction in natural productions. These findings suggest a complex but systematic role of vowel duration and resonance characteristics in distinguishing phonological length in Swedish.

![Graphs showing vowel duration and spectral steps](image)

**FIGURE 1.** For vowel sets [i:]-[i], [o:]-[o], and [α:]-[a], mean percent long responses are plotted for the 10 synthesized duration steps and spectral steps in /kVt/ (→) words (3) and /kVd/ (–) words from the current experiment.

**REFERENCES**