Vowel length in Scottish English:
new data based on the alignment of pitch accent peaks

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1. "Missing" vowel length/tenseness contrasts in Scottish Standard English (SSE)

Typical vowel inventory for RP (ignoring /ɜː/, and ignoring diphthongs except /ai/):

/iː/ (beat)	/uː/ (*Luke*)
/ɪ/ (*bit*)	/ʊ/ (*look*)
/eɪ/ (*bait*)	/əʊ/ (*coat*)
/ɛ/ (*bet*)	/ʌ/ (*luck*)
/ɑː/ (*psalm*)	/ɔː/ (*caught*)
/æ/ (*Sam*)	/ɒ/ (*cot*)

/ai/ (*side*)

Typical vowel inventory for SSE (ignoring diphthongs except /ai/):

/i/ (*beat*)	**/ʉ/ (*look, Luke*)**
/ɨ/ (*bit*)	/ʌ/ (*luck*)
/e/ (*bait*)	/o/ (*coat*)
/ɛ/ (*bet*)	**/ɒ/ (*caught, cot*)**

/a/ (*Sam, psalm*)
/ai/ (*side*)

2. Scottish Vowel Length Rule (SVLR) effects (e.g. Scobbie et al. 1999)

a. Basic SVLR duration allophony:

"Short" allophones occur before voiceless stops and fricatives *and also before voiced stops, nasals, and /l/.* "Long" allophones occur before voiced fricative and /r/, and in open syllables. Definitely applies to /i, ʉ, ai/, does not apply to /ɛ, ɨ, ʌ/, other vowels uncertain or disputed.

b. "Quasi-contrasts" based on SVLR duration allophony:

(i) arising from paradigm uniformity: *sighed/side, brewed/brood, (a)greed/greed* (past tense forms have longer allophone)

(ii) variable selection of allophone esp. in monomorphemic disyllabic words: *spider, viper, Bible, libel,* etc. (Speakers often differ which allophone they have in these, and many speakers have different allophones in pairs like *Bible/libel*.)

3. What is a long (tense) vowel in SSE?

If e.g. /ʉ/ counts as a single phoneme (because *Luke* and *look* don't contrast), then it must be long/tense, because it satisfies minimal word constraints in words like *blue*; but that means that *look* has a long vowel, and more importantly, we can't describe the surface contrast of *brood* and *brewed*. But if /ʉ/ counts as two phonemes (because of *brood* and *brewed*), then an open syllable with the "short" phoneme should count as light and therefore not available for stress in a word like *Garuda* or *Caruso*.

4. Background on alignment studies

General finding is that alignment of pitch peaks relative to segmental landmarks is very consistent in a given language and for a given set of experimental conditions. Goal of this paper is to see whether alignment facts that seem to distinguish long/tense and short/lax vowels in other languages or other varieties of English can be used to shed light on which SSE vowels should be considered long/tense and which short/lax.

a. General methodology:

- Based on lab recordings of controlled speech materials read aloud.
- Typically 3-6 speakers per experiment, 10-20 instances of each test case (e.g. each vowel).
- ANOVA or multiple regression / correlation design.
- Most experiments have measured local pitch peaks (i.e. not valleys, "elbows")

b. Sample sentences from our experiments (test words in bold). Most of what is reported here is based on the prenuclear materials.

- Dutch **prenuclear** accents (Ladd, Mennen & Schepman 2000):

*Hij had de **rillende** peuters warme chocolademelk gegeven.* 'He had given the shivering toddlers some hot chocolate'.

- English **prenuclear** accents:

*He gave **lenient** marks to his favourite students.*

- Dutch **nuclear** accents (Schepman, Lickley & Ladd in press):

*Ze kon een **man** zien.* 'She could see a man.'

- English **nuclear** accents:

*We have to **kneel** now.*

5. Dutch vowel system

iː	yː	uː
ɪ	ʏ	
eː	øː	oː
ɛ	ɔ	
aː	ɑ	

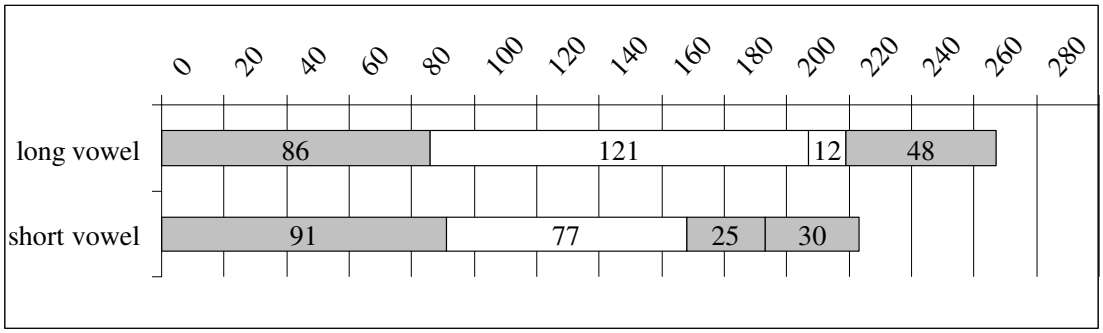
"Long" high vowels are often transcribed with IPA half-long mark [iˑ yˑ uˑ] but instrumental measurements (e.g. Nooteboom 1972) reveal that they are only a few percent longer than short vowels. However, they are clearly phonologically long/tense, in the sense that they act as long for phonotactic purposes. Phonotactic

effects include syllabification (*cv̄cv* is unambiguously *cv̄.cv*, but medial consonant in *cv̆cv* is arguably ambisyllabic) and minimal word effects of the sort found in English and German (*cv̆* is not a possible monosyllabic word, but *cv̄* and *cv̆c* are OK).

6. Effect of vowel length on prenuclear pitch peak alignment *in Dutch* (Ladd, Mennen & Schepman 2000)

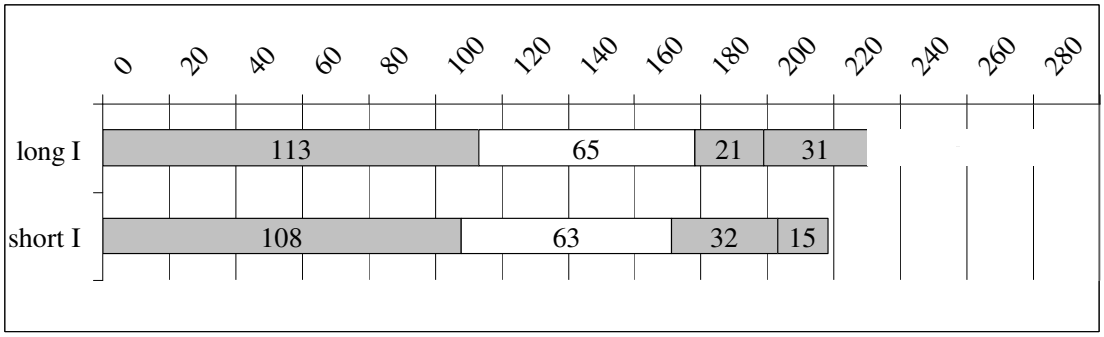
In the following graphs, the dark-light-dark pattern shows the relative length of the CVC sequence that includes the accented vowel. The cell-divider marked by a vertical arrow indicates the alignment of the accentual pitch peak. Note that the utterance continues after the second consonant.

a. Results for all vowels:



There seems to be a difference between long vowels and short vowels: the peak is aligned late in the vowel with long vowels and well into the consonant with short vowels. This could be a low-level phonetic effect of rise duration (i.e. the rise lasts a fairly fixed amount of time but the accompanying segments have markedly different duration so the alignment of the peak is superficially quite different), but it could also be an effect related to syllable structure (i.e. the peak aims to align near the end of the syllable, which is in a different place depending on whether the vowel is long or short). We compared these explanations in a separate experiment in which we looked specifically at "long" /iː/ and "short" /ɪ/, which are of similar duration:

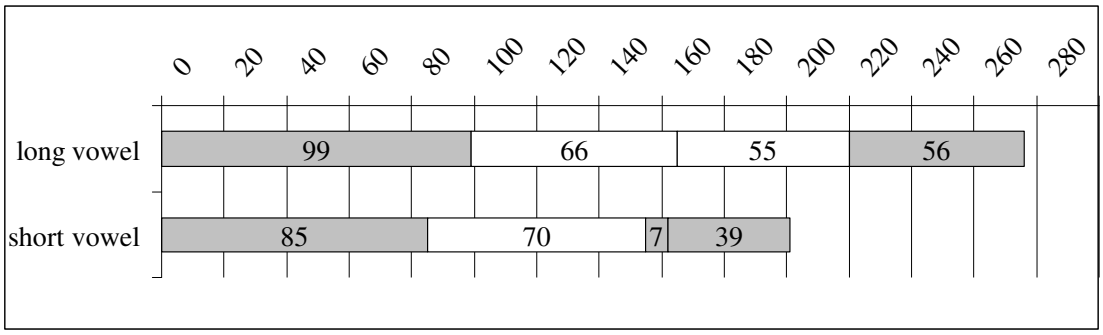
b. Results for "long" /i/ and "short" /ɪ/:



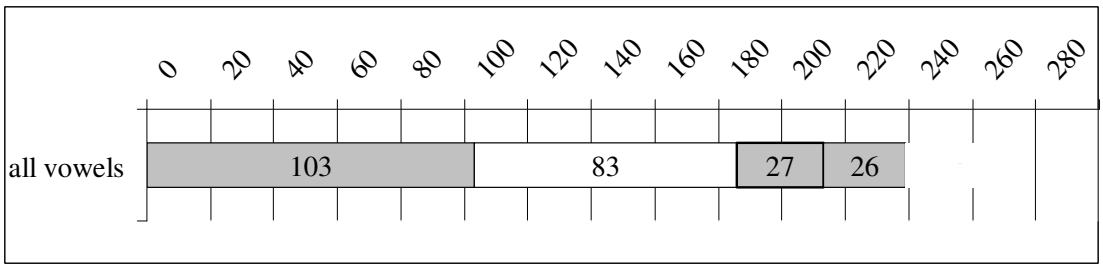
Even though "long" /i/ and "short" /ɪ/ have essentially the same duration (cf. 5 above), the alignment of the peak with /ɪ/ is slightly but significantly later, suggesting that the effect illustrated in 6a may be due to syllable structure, not duration.

7. Effects of vowel length on pitch peak alignment in English

a(i). Results for all vowels in ***RP*** (cf. 6a)

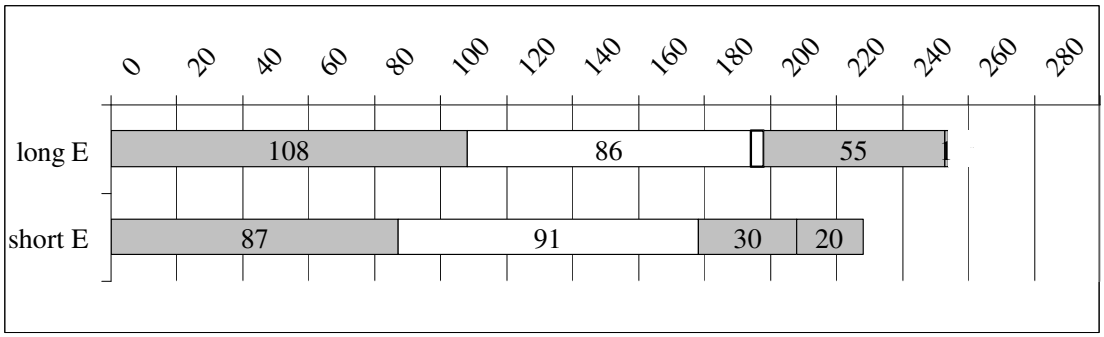


a(ii). Results for all vowels in ***SSE*** (cf. 6a)



As in Dutch, alignment appears to be "later" in RP short vowels than in long vowels. Something similar seems to be true for some of the putative long-short pairs in SSE. In fact, SSE provides a case similar to the Dutch /iː - ɪ/ case, in which the alignment data may reveal the effects of "vowel length" on syllable structure:

b. Results for "long" /e/ and "short" /ɛ/ in ***SSE*** (cf. 6b)



Even more than with Dutch /iː/ and /ɪ/, we see a marked difference in alignment between SSE /e/ and /ɛ/, despite the virtually identical vowel duration, suggesting that in some sense /e/ counts as a long vowel for syllable structure and /ɛ/ counts as a short vowel.

General observation about the graphs in 7: Alignment is globally earlier in English than in Dutch, and globally earlier in RP than in SSE. Similar differences were found between Northern and Southern German by Atterer & Ladd 2004 and for Shetland and Orkney English by van Leyden 2004. These differences are interesting for other reasons but do not affect our conclusions about vowel length.

8. Expressing prenuclear alignment as a proportion of CVC duration

Can we use facts of the sort shown in 7 as the basis for distinguishing long/tense and short/lax vowels in SSE? As a first approximation, for every vowel, we can express the alignment of the pitch peak as a *proportion* of the duration of the CVC sequence. If the alignment is somehow tracking syllable structure, then it should be proportionally later with short/lax vowels than with long/tense vowels. Results (based on approximately 110 tokens of the front vowels and 60 of the back vowels) are as follows, with the vowels arranged from highest values (which should be short/lax vowels) to lowest (which should be long/tense vowels).

ʌ	1.07	ʉ	0.91
ɨ	1.00	ai	0.88
a	0.94	o	0.86
ɒ	0.93	i	0.78
ɛ	0.92	e	0.76

This quantification seems to "work", in the sense that vowels with higher values are plausibly short and those with lower values are plausibly long, but there is no clear grouping into two classes. Possible conclusions could be that:

- "Long" vowels in SSE are /i, e, o, ai/. Short vowels are all the rest. *Or:*
- "Short" vowels in SSE are /ɨ/ and /ʌ/. Long vowels are all the rest. *Or:*
- Syllable structure affects alignment in some way we still don't understand.

9. New duration data

a. Duration of following consonants. It can be seen from the graphs in 7 that the consonants seem to be shorter in duration when they immediately follow a short/lax vowel than when they follow a long/tense vowel. Similar facts seem to apply to consonants following nuclear accented vowels. This means that consonant duration may provide yet another clue to the phonological status of SSE vowels – a shorter following consonant could be an indication that the preceding vowel is short/lax. Our materials were not designed with this comparison in mind, so these data should be treated with caution, but the general pattern that emerges makes sense (consonant duration values in milliseconds; averages across all speakers in two separate experiments; number of tokens shown in parentheses):

a	48 (n = 114)	o	51 (n = 57)
ɨ	49 (n = 100)	e	58 (n = 105)
ɛ	50 (n = 100)	i	58 (n = 111)
ɒ	50 (n = 95)	ai	59 (n = 57)
ʌ	51 (n = 56)	ʉ	61 (n = 57)

Like the quantification in 8, these numbers make sense, in that vowels with shorter following consonants are plausibly short/lax phonologically, and those with longer following consonants are plausibly long/tense. Here there even seems to be a grouping into two classes, except that /o/ is in the "wrong" group.

b. Onset consonant duration. In 7 we can also see a slight tendency for the duration of consonants *preceding* long vowels to be greater than the duration of consonants preceding short vowels. As with the greater duration of following consonants (9a), this seems to apply to nuclear accented vowels as well. This apparent regularity may give us yet another way of determining the phonological status of SSE vowels. Again, these results should be treated with caution, because our materials were not designed with this comparison in mind. (Again, values in ms.)

ɛ	87 (*n* = 100)	i	100 (*n* = 111)
ɨ	92 (*n* = 100)	o	106 (*n* = 57)
a	94 (*n* = 114)	ʌ	108 (*n* = 57)
ɒ	96 (*n* = 95)	e	108 (*n* = 105)
ʉ	99 (*n* = 57)	ai	130 (*n* = 57)

Again, the data broadly make sense (except for /ʌ/) and specific comparisons of putative long-short pairs /i-ɨ, e-ɛ, o-ɒ/ all go in the "right" direction.

Considering the results in both 9a and 9b, possible conclusions could be that:

- "Long" vowels in SSE are /i, e, ai/ for sure and probably also /o, ʉ/. Short vowels are /ɨ, ɛ, a, ɒ/ and probably /ʌ/. *Or, once again:*
- Syllable structure affects segment duration in ways we don't understand.

10. What about SVLR effects?

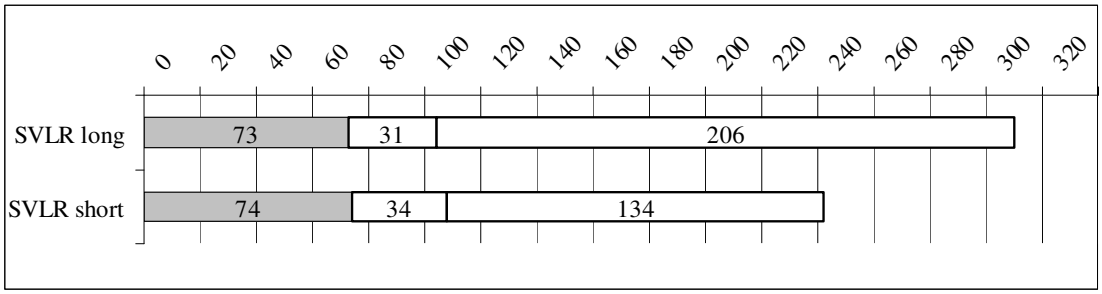
Let us return briefly to SVLR effects, specifically the allophonic duration differences before different consonant types. Our prenuclear materials do not allow us to examine this issue, but in our nuclear accent materials we specifically included a comparison of "SVLR long" contexts (mostly preceding voiced fricatives) and "SVLR short" contexts (mostly preceding nasals and /l/). We find a big SVLR effect on **vowel duration** in **nuclear accented monosyllables**, consistent with traditional impressionistic descriptions. There is also an effect in RP, but it is much smaller (values in ms.):

	SSE	RP
/i, ʉ, ai/ in SVLR short context:	134	212
/i, ʉ, ai/ in SVLR short context:	206	257
long-short proportion:	154%	121%

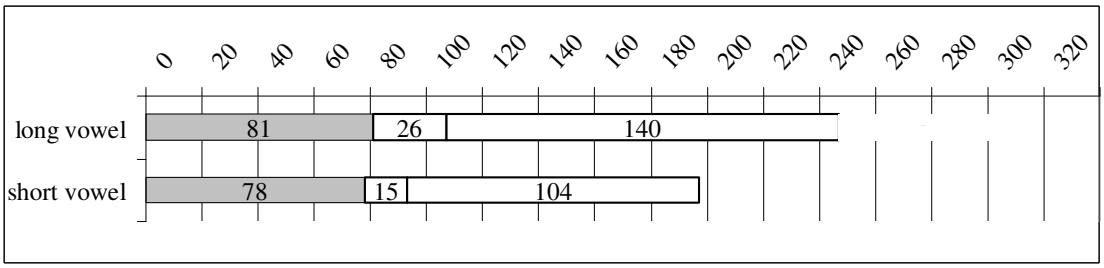
(Those who are surprised to find such an effect in RP should read McMahon 1990; one conclusion that emerges from a range of work, including the present study, is that "long allophone / short allophone" is far too crude a characterisation of the phonetic facts of SVLR.)

These SVLR-induced durational differences are not accompanied by differences in the duration of the onset consonant (cf. 9b). Nor are they accompanied by differences of alignment typical of phonologically long and short vowels. This can be seen in the following graphs: 10a shows consonant and vowel duration and alignment for SVLR-short and SVLR-long tokens of /i, ʉ, ai/ in SSE; for comparison, 10b shows vowel duration and alignment for long/tense and short/lax vowels in nuclear-accented monosyllables in RP.

10a. Consonant duration and alignment in different SVLR conditions in ***SSE***, **nuclear** accents.



10b. Consonant duration and alignment with phonologically long and short vowel in ***RP***, **nuclear** accents.



Conclusion: SVLR duration differences do not behave like differences of phonological vowel length in their effects on alignment of pitch peaks and duration of adjacent consonants.

11. And just for completeness:

We can rule out actual vowel duration as a cue to phonological length/tenseness in SSE, as can be seen from the following data, in which the vowels are arranged from shortest to longest. (Data are based on both prenuclear and nuclear accented vowels, and on all speakers and all experimental conditions *except* the SVLR-long contexts; values in ms.) The main influence on vowel duration in SSE appears to be vowel *height*. Note that the members of putative long-short pairs /e - ɛ/ and /o - ɒ/ are virtually identical in mean duration.

ɨ	66 (*n* = 188)	o	109 (*n* = 153)
ʌ	84 (*n* = 157)	ɒ	110 (*n* = 198)
ʉ	91 (*n* = 193)	ɛ	112 (*n* = 208)
i	92 (*n* = 233)	a	123 (*n* = 214)
e	109 (*n* = 214)	ai	147 (*n* = 190)

12. General conclusions

a. Vowel length or tenseness, to the extent that it means anything in SSE, is not a matter of duration. "Length" or "tenseness" may be only a phonological abstraction. On the basis of the indirect phonetic evidence presented here, we may tentatively conclude that /i, e, ai, o, ʉ/ are long/tense vowels in SSE.

b. SVLR duration effects are allophonic and do not affect syllable weight. If the "quasi-contrasts" involving the phonemes /i, ʉ, ai/ develop into distinct pairs of phonemes, both members of the pairs should be regarded as long/tense.

c. A more carefully controlled study of the effects of syllable structure on duration and alignment with /a/ and /ɒ/ would be worthwhile.

d. Looking beyond SSE, more carefully controlled studies of the duration of consonants flanking long and short vowels, and of the effects of syllable structure on segment duration, would be worthwhile.

13. References

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