

# THE DOMAIN OF ACCENTUAL LENGTHENING IN SCOTTISH ENGLISH

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## ABSTRACT

This study describes speech production experiments designed to determine the domain of accentual lengthening in Scottish English. Results suggest that accentual lengthening affects not only the syllable which bears the pitch accent (phrasal stress), but extends rightwards beyond this syllable. Secondly, the amount of lengthening on a syllable adjacent to a pitch accent appears to depend upon its membership in a pitch accented unit. Several candidates for the accentual-lengthening unit are entertained.

## 1. INTRODUCTION

The experiments presented in this paper were designed to determine the domain of the durational effects of accent (phrasal stress). Phrasal stress is phonologically associated with a particular vowel, or stress-bearing unit, but its durational correlates may extend beyond the unit with which it is associated. Knowledge about how far durational effects extend is crucial for modelling durational effects in automatic speech recognition and synthesis. Furthermore, evidence for a particular linguistic domain of a durational effect may be taken as evidence for the cognitive use of this particular unit in speech production planning.

The domain of accentual lengthening in Dutch appears to be the word— [3], [1], [4]—so that one would expect to find all parts of a word lengthened when some part of the word is pitch accented. Studies of American English [5] suggest that in English the domain may be delimited by a unit which is larger than the syllable but smaller than the word. Thus both syllables are lengthened under accent in a disyllabic word which begins with a lexically stressed syllable and whose second syllable is unstressed (e.g. “ba-con”), whereas an unstressed syllable in initial position in a disyllabic word (e.g. the first syllable in “en-force”) is on average the same length when the word is accented or unaccented. This finding suggests that the domain of accentual lengthening in American English may be smaller than the word.

The experiments reported here represent a replication and extension of the studies of American English. The methodology is similar: segments and syllables were measured in different pitch accent and constituent structure environments to determine if the lengthening effects of accent depends on the constituent structure of the phrase.

## 2. EXPERIMENT 1

### 2.1. Introduction

The first experiment examines whether the domain of accentual lengthening corresponds to a linguistic unit, and if so, whether this domain is a vowel, a syllable rime, or a syllable or something larger. In order to determine this, the constriction durations of certain consonants (underlined in Table 1) are measured in a matrix of accentual and lexical environments. In order to keep extraneous phonetic influences to a minimum, homophonic word pairs are used, where the consonant to be measured may belong to either the first or the second word in the phrase.

Pitch Accent environment	consonant is syllable-initial	consonant is syllable-final
PA on first word	“BE <u>n</u> ice”	“BEAN <u>n</u> ice”
PA on second word	“be <u>N</u> ICE”	“bean <u>I</u> CE”

Table 1. Design of experimental materials

If the domain is non-linguistic it would be expected that lengthening should occur according to proximity to the pitch accent regardless of the linguistic environment. (Thus, for example, all consonants preceding the pitch accented vowel might be lengthened, whether separated from it by a linguistic boundary or not.)

If the vowel is the domain of accentual lengthening, then clearly no consonantal effects should be observed. If the syllable rime is the appropriate domain, however, one would expect to see consonants lengthened only when following the pitch accented vowel and within the same syllable, because

the syllable-initial consonant does not form part of the rime.

Finally, if the domain is at least as large as a syllable, both preceding and following consonants which are tautosyllabic with the pitch accented vowel should be lengthened.

## 2.2. Method

### 2.2.1. Materials

Two sets of sentences were prepared for each of the consonants /n/, /b/, /k/ and /f/. These consonants were embedded in four different accent and position environments at the heart of two-word phrases, as shown in Table 1.

These phrases were placed in carrier sentences designed to elicit (contrastive) accent on the appropriate words, for example (measured syllables are underlined, pitch accented syllables are in capitals):

- I said "BE nice", not "ME nice"
- I said "be NICE", not "be NOOSE"
- I said "BEAN ice", not "MEAN ice"
- I said "bean ICE", not "bean IKE"

Thus, there were 32 test sentences in total. Seven Scottish subjects read these sentences in random order along with an equal number of similarly structured foil sentences, included to draw subjects' attention away from similarities within sets of sentences. After a brief practice session, subjects read all the materials twice, in two separate randomly ordered blocks. The sentences were presented one at a time on a computer screen.

### 2.2.2. Recording and duration measurement

The constriction duration of the consonants was determined by analysis of the waveform and the wide-band spectrogram. The criteria used to determine the onset and offset of closure were similar to those described in [5].

## 2.3. Results

Figure 1 shows the typical pattern of results, exemplified by the duration of constriction for the consonant /k/. There was a significant interaction between accent environment and position for all four consonants. The consonants were lengthened when either initial or final within a pitch accented syllable/foot/word. The difference was statistically significant for initial consonants, but not for final consonants. A similar pattern of results was found in American English, where the small difference for syllable-final consonants was found to be reliable

## 2.4. Discussion

Because of the lengthening of both initial and final consonant constrictions when tautosyllabic with a pitch accent, the results indicate that the domain of accentual lengthening in Scottish English is a linguistic unit at least as large as a CV unit, and possibly the syllable. It cannot be determined from these results if the domain extends beyond the syllable.

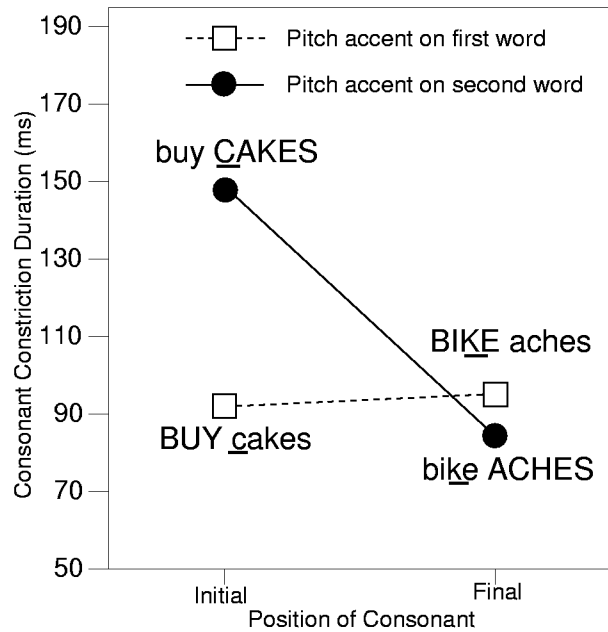


Figure 1. Experiment 1 results

Experiment 2 attempts to ascertain if lengthening extends to syllables other than that which carries the pitch accent.

## 3. EXPERIMENT 2

### 3.1. Introduction

This experiment goes beyond the pitch accented syllable to examine whether or not syllables *adjacent* to a pitch accent undergo lengthening, and if so, under what conditions. The design is a replication and extension of one of the studies of American English [5], and focuses on syllables in a similar matrix of accent environments and positions.

Because we are interested in segments beyond the pitch accented syllable, we measure homophonic word pairs in which the measured central syllable (underlined) may belong to either the first or the second word, for example "pay perform" vs "paper form". In all cases, the central target syllable does not carry the main lexical stress when it belongs to either the first or the second word and thus should never be pitch accented itself. It is the duration of this syllable, under different pitch accent conditions, that is measured.

#### 3.1.1. Three pitch accent conditions

Pitch accent environment	syllable is word-initial	syllable is word-final
Accented	"PAY <u>perform</u> "	"PA <u>per</u> form"
Unaccented	"pay <u>per</u> FORM"	"paper <u>FOR</u> M"
Unaccented	"pay <u>per</u> form"	"paper <u>form</u> "

Table 2. Pitch accent conditions

There were three pitch accent conditions, exemplified in Table 2, rather than the two conditions in previous experiments. (The syllable carrying the pitch accent is shown in capitals.) As in Experiment 1, we attempted to elicit a pitch accent on either the first or the second word of a two-word phrase, by altering the point of contrast in a carrier sentence. In this experiment, however, we also aimed to examine a “baseline” condition in which no pitch accent occurs within the target phrase. This is the third condition exemplified in Table 2. Carrier sentences for this condition were of the form: SAY “*paper form*”, don’t SHOUT “*paper form*”.

### 3.1.2. The syllable hypothesis

If the domain of accentual lengthening is the syllable, then we would expect to see no effects of accent on segments which do not belong to the pitch accented syllable. We would therefore expect to see no effect of accentual lengthening on the unstressed syllable

### 3.1.3. The within-word foot hypothesis

The within-word foot is a prosodic unit beginning with a lexically stressed syllable, and including (optionally) an unstressed syllable to its right within a word [2]. In order to investigate the hypothesis that the within-word is the domain of accentual lengthening we included a set of materials analogous to those exemplified in Table 2, but in which the measured syllable contains carries a (secondary) lexical stress and is thus separately footed from the preceding syllable.

So, for example, “paper” is composed of one within-word foot—[paper]<sub>WWF</sub>—but words such as “kneecap” are composed of two feet—[knee]<sub>WWF</sub>[cap]<sub>WWF</sub>. If the accentual lengthening unit is the within-word foot, we would expect to see lengthening effects on the second syllable in “PA-Per”, as it belongs to a pitch accented foot, but we would expect to see no lengthening effect on the second syllable in “KNEEcap”, since it does not belong to the pitch accented foot.

### 3.1.4. The word hypothesis

If the accentual lengthening unit is the word, we would expect to see lengthening on all syllables in an accented word.

### 3.1.5. Nonsense vs meaningful phrases

In order to determine whether lengthening effects observed in the highly contrived two word phrases are generalizable to more natural phrases, we included some meaningful phrases for comparison, in which we only varied the pitch accent environment, the measured syllables (underlined) all being word-initial (e.g. “PLEASE perform vs please perFORM vs please perform).

## 3.2. Method

The sentences were printed onto record cards and sorted into groups of 48 designed to keep contrasting

homophonic pairs apart. Subjects read the complete set of sentences twice, with the order of presentation randomised.

Before reading the sentences, subjects were instructed to read each sentence naturally and emphasise the words in capital letters. The subjects controlled the rate at which they read the sentences, although the experimenter asked them to repeat sentences on which the emphasis sounded incorrect.

## 3.3. Results

### 3.3.1. Meaningful vs nonsense phrases

The pattern of durational variation due to pitch accent environment was found to be the same for nonsense and meaningful phrases, thus validating the experimental methodology of the previous experiments in terms of the design of the materials.

### 3.3.2. Accentual lengthening effects

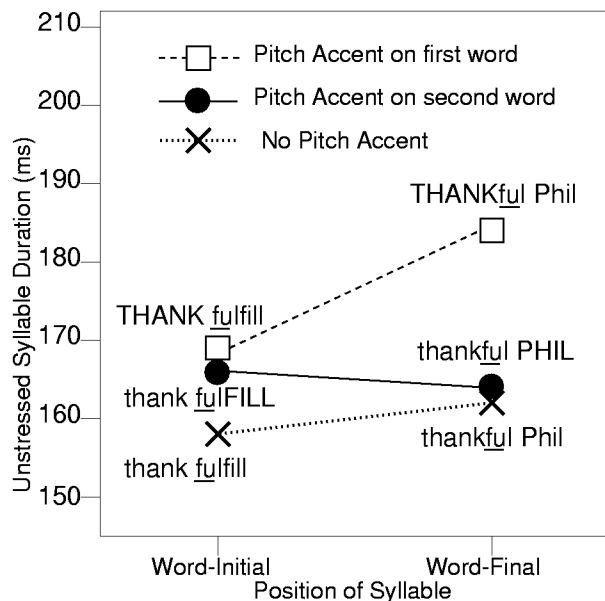


Figure 2. Experiment 2 results—reduced syllables

Figure 2 shows the interaction between accent environments and position. This pattern replicates the results found for American English [6].

This result indicates that the effect of accentual lengthening depends on membership of an accented unit—the lengthening effect of a preceding accent on an unaccented syllable is greatest when the unaccented syllable belongs to the same word as the pitch accent. Thus, the accentual lengthening effect on “ful” is significantly greater in “THANKful Phil” compared with “thankful phil”, than it is in “THANK fulfill” compared with “thank fulfill”.

However, in addition to the effect of belonging to an accented unit, results also show an effect of accent on syllables which immediately follow the pitch accent, regardless of membership in an accented unit—there is some lengthening of “ful” in “THANK fulfill” compared with “thank fulfill”. That this adjacency effect is asymmetrical is shown by the lack

of evidence of lengthening in “thankful PHIL” compared with “thankful Phil”.

### 3.3.3. The syllable hypothesis

The fact that the duration of an unaccented syllable is affected by an adjacent pitch accent suggests that the domain of accentual lengthening must be larger than the syllable.

The difference between “THANK fulfill” and “thank fulfill” shows that unaccented syllables to the right of a pitch accent are lengthened by the preceding pitch accent (the rightward adjacency effect), and the larger effect of accent on “ful” in “THANKful phil” suggests that membership in the same unit (foot? word?) as the pitch accent results in further lengthening.

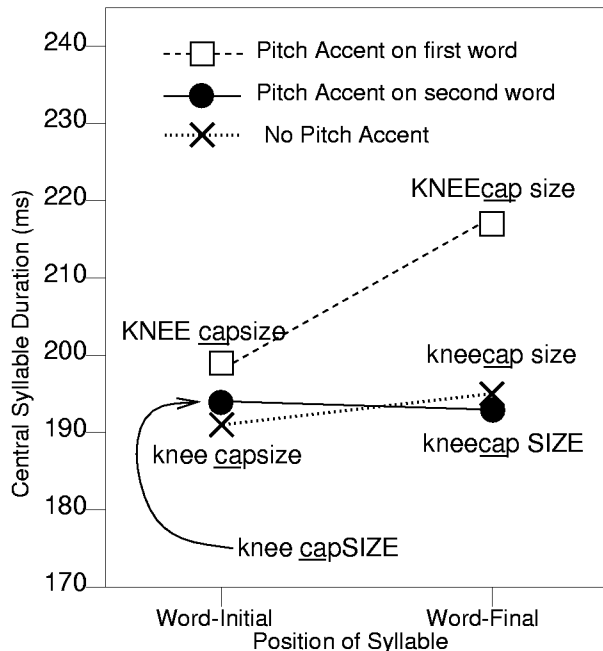


Figure 3. Experiment 2 results—stressed syllables

### 3.3.4. The within-word foot hypothesis

Comparing Figure 3 with Figure 2 shows that the effect of accent on following stressed syllables is similar to the effect of accent on following unstressed syllables—the large effect of accent on “cap” in “KNEEcap size” is similar to the large effect of accent on “ful” in “THANKful phil”).

This result suggests that the domain of accentual lengthening must be larger than a within-word foot, since segments outside the pitch accented foot are clearly affected by a preceding accent.

### 3.3.5. The word hypothesis

The fact that the difference between “KNEEcap size” and “kneecap size” is larger than the difference between “KNEE capsizE” and “knee capsizE” indicates that membership in a unit larger than a foot results in lengthening over and above the lengthening caused by being immediately to the right of a pitch accented syllable.

It is as yet unclear whether syllables to the left of a pitch accent within a pitch accented word (e.g. “cap” in “capSIZE”) are lengthened under accent. A visual comparison of Figures 2 and 3 suggests that unstressed word-initial syllables are lengthened slightly when the following syllable is accented, whereas lexically stressed word-initial syllables are not.

## 4. CONCLUSION

These results replicate those for American English in finding that the domain of accentual lengthening extends beyond the pitch accented syllable. As in [5], the greatest degree of lengthening is found on the syllable following the pitch accent within a word. Further to the previous result, this lengthening is found for lexically stressed syllables as well as for unstressed syllables. This clearly indicates that accentual lengthening can extend beyond the within-word foot.

Lengthening may indeed occur across a word boundary *following* a pitch accent, but there is no evidence for cross-boundary lengthening occurring on syllables preceding a pitch accent.

So, it appears that accentual lengthening begins with a pitch accent and may extend to a subsequent syllable, regardless of lexical structure or syllabic nature (stressed or unstressed)—this may be termed a rightward adjacency effect. There is also some evidence that lengthening may occur on a syllable preceding the pitch accent, when that syllable is reduced, but not when it is lexically stressed—this would clearly be an effect of constituency of some within-word prosodic unit. Further measurements are in progress to validate these conclusions.

## 5. ACKNOWLEDGEMENT

*This work was supported by an EPSRC grant.*

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