4. THE INTERACTION BETWEEN FINAL AND ACCENTUAL LENGTHENING: DUTCH VS. ENGLISH

4.1. Introduction

Lengthening is used to mark both the heads and the edges of intonational phrases; final lengthening is an important cue to intonational phrase boundaries, and accentual lengthening is one of a set of cues to phrasal prominence (accent). Lengthening may also mark the heads and/or edges of constituents smaller than the intonational phrase. A lexically stressed syllable, for instance, is longer than an unstressed syllable (other things being equal; see e.g. Sluijter & van Heuven, 1996), which can be interpreted as lengthening of the head of the word. Beckman & Edwards (1990) found some evidence for a word-final lengthening effect, although this effect is much smaller than the phrase-final effect and also not consistent across speakers and speech rates. In this chapter, we will be concerned with intonational phrase-final lengthening and its interaction with accentual lengthening, i.e. lengthening due to a pitch accent.

In Chapter 2 (§2.2.2), an experiment was described in which we attempted to address the interaction between final lengthening and accentual lengthening by including focus distribution as a variable, while the effect of boundary type (hence, final lengthening) was our main concern. However, focus did not have a significant effect on the segment durations, suggesting that the [−focus] condition was not always successful in eliciting a non-prominent realization of the target word. In §2.2.2.5, we argued that the target word in [−focus] condition was likely to receive prominence on the basis of rhythmical principles. In any case, since no accentual lengthening was found, we could not investigate its interaction with final lengthening either, and it was decided not to include focus as a variable in the following production experiment (§2.2.3).

In Chapter 3, we accidentally stumbled across what appears to be an effect of position in the phrase on the amount of accentual lengthening found in Dutch. In the first attempt to replicate the American English experiments by Turk & Sawusch (1997) to investigate the domain of accentual lengthening in Dutch, sentences of the

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1 Parts of this chapter have been published as Cambier-Langeveld (1999a) and Cambier-Langeveld (1999b).
following type were recorded (with target material underlined):

(1) a. Ik zei ‘PANDa masten’, niet ‘HINde masten’.
    ‘I said panda masts, not hind masts’

b. Ik zei ‘panda MASTen’, niet ‘panda POORten’.
    ‘I said panda masts, not panda gateways’

The accentual lengthening effect on MASTen (in (b)) was only 6%, as opposed to an effect of 25% on PANda (in (a)). This asymmetry forced us to deviate from the literal translation of the frame sentence used in the Turk & Sawusch (1997) study, and to construct a revised frame sentence (see §3.3.3). Noticeably, Turk & Sawusch did not find such different amounts of accentual lengthening, and neither did Turk & White (1999), in a Scottish English experiment with similar material: in English, the accentual lengthening effect was more or less consistent across positions (ranging from 19-25%). So, although these materials were not designed to investigate the lengthening of the accented syllables, and consequently have different sets of syllables in the two accentable positions in these studies, still the results strongly suggest that there is less accentual lengthening in final position than in non-final position in Dutch, but not in English. Together, this leads us to the following research questions:

(2) a. Is there an interaction between final lengthening and accentual lengthening in Dutch?

b. Is Dutch different from English with respect to the above?

Many studies on final lengthening or accentual lengthening were concerned with either one of these effects, but not both. Especially studies on cues to accent, one of which is accentual lengthening, have been careful to avoid phrase-final positions, in order to avoid any interaction effects. There are some exceptions to this generalization, such as Cooper, Eady & Mueller (1985), Beckman, Edwards & Fletcher (1992) and other papers by the same or a subset of these authors (e.g. Edwards & Beckman, 1988; see §1.2), and Cummins (1999). These studies are all on English, and will be discussed below in §4.1.1. Following these reviews, we will elaborate on an often suggested explanation for interactions of lengthening and shortening effects in speech, namely the existence of expandability and compressibility constraints.
4.1.1. Previous work on final and accentual lengthening

In Cooper, Eady & Mueller (1985), the effect of accent (contrastive focus) on the duration and F0 peak value of several target words in a number of test sentences was investigated. The utterance-final word was always one of the target words, so that accentual lengthening in final and non-final positions could be studied. A preceding question put narrow focus on only one target word at a time (e.g. "Did Chuck like the present that Shirley sent to her sister or the one she sent to her brother?") Test sentence: "Chuck liked the present that Shirley sent to her SISTER."). Every target word (in this case, the words Chuck, present, Shirley and sister) occurs once in accented position, and several times in unaccented position (i.e., when one of the other target words in the sentence is accented).

In two experiments (differing primarily in test sentence length), target words occurring at the end of the utterance were found to be lengthened less by a pitch accent than words elsewhere in the utterance. Averaging across the two experiments, the utterance-final words were lengthened by about 15% when accented, while utterance-initial and utterance-medial words were lengthened by about 40%. Presumably, it is the presence of final lengthening which interferes with accentual lengthening in utterance-final position. Also when expressed in absolute terms (ms), the two lengthening effects did not appear to be additive (i.e., their combined effect was not as large as the simple addition of effects would predict; the presence of one inhibited the realization of the other). Note, however, that the sets of words occurring in each position were not controlled; strictly speaking, the magnitude of effects found in each position are not directly comparable, since different words are involved.

Some results are summarized in Table 4.1. In Cooper et al. (1985), the mean unaccented duration and percent increase in duration due to accent were calculated for each test sentence (averaged across six speakers). In Table 4.1, the average values across test sentences are given for the two experiments. An example of a test sentence is given in (3). The italicized target words were placed in focus by a preceding question one at a time. In the second experiment there were seven target words, but only three of these (in italics) were placed in focus, i.e. occurred in accented environment as well as in unaccented environments.

(3) exp. 1 (10 sentences)  Kate went to Kansas with Jack and Peter.
exp. 2 (4 sentences)  My sister took the trolley from school to the store to buy fish and chips on Tuesday.
Table 4.1. Mean unaccented duration (ms) and percent increase in duration due to accent per target word in Cooper et al. (1985). The results for utterance-final target words are shaded.

<table>
<thead>
<tr>
<th>target word</th>
<th>experiment 1</th>
<th>experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>- accent</td>
<td>314.8</td>
<td>379.0</td>
</tr>
<tr>
<td>incr.+acc</td>
<td>42.9%</td>
<td>40.8%</td>
</tr>
</tbody>
</table>

As far as the peak F0 values are concerned, a reduced effect on F0 for contrastive focus in utterance-final position was found, which coincided with the results for duration: perhaps the smaller durational effect of accent in final position even originates from the smaller peak in that position. Together, these results suggested that in speech production, English speakers do not mark focus in utterance-final position nearly as distinctively as in other positions.

Cummins (1999) also investigated the combined effect of accent and final position in English, at a range of speech rates. In this study, the words or word sequences painful BLOW, PAINfully, COUNTERpane and cancer PAIN (target syllable underlined) were placed in a short text which put focus on the capitalized syllable, e.g. Didn’t he say painful SHOT? The message was painful BLOW. Surely that’s not what he said. Speakers were instructed to read these texts at a range of speech rates; the duration of the fragment message was was used to quantify speech rate.

In contrast to Cooper et al.’s (1985) findings, Cummins (1999) found that a simple additive model provides a good fit for the durations found when final position and accent are combined, at most rates (at a very high speech rate only found for one of the four speakers, final lengthening and accentual lengthening disappeared altogether). In other words, within the range of speech rates produced by all speakers the lengthening effects of accent and final position were found to be additive.

Another study, reported on in various papers (Edwards & Beckman, 1988; Beckman & Edwards, 1990; Edwards, Beckman & Fletcher, 1991; Beckman, Edwards & Fletcher, 1992) provides data which can be used to study both final lengthening and accentual lengthening in English (see §1.2 for a discussion of this work). None of these papers address the question whether there is an interaction between final lengthening and accentual lengthening, yet if there had been any such clear effect, it would probably not have gone unnoticed. Probably, then, no results were found to support Cooper et al.’s (1985) finding of an interaction between final lengthening and accentual lengthening in English.
Summarizing, only Cooper et al. (1985) found evidence for an interaction between final lengthening and accentual lengthening in English. No such data are available for Dutch.

4.1.2. Compressibility and expandability constraints

Klatt (1973b) examined the combined effect of two vowel-shortening factors in English: voiceless versus voiced coda consonants and the addition of unstressed syllables following the stressed syllable within the word. The results of this study led him to the concept of incompressibility, incorporated into his duration model of 1976 with the help of an absolute minimum duration $D_{\text{min}}$. Shortening rules can only affect the duration exceeding this minimum duration (Klatt, 1976):

$$D_j = k(D_i - D_{\text{min}}) + D_{\text{min}}.$$  
Shortening rules: $0 < k < 1$. Lengthening rules: $k > 1$.

With respect to shortening rules, this model predicts that they will combine subadditively (i.e., their combined effect is smaller than the simple addition of effects of each factor alone). This approach to inherent segment durations, limits to phoneme shortening and combining factors has found practical application in speech-synthesis algorithms (e.g., Allen, Hunnicutt & Klatt, 1987). For lengthening rules $(k > 1)$, however, the prediction is that they combine superadditively, since the duration $(D_i - D_{\text{min}})$ that is affected by the lengthening rules gets larger as more lengthening rules apply. It is this prediction which was tested and refuted by Cummins (1999, see above; for a more extensive evaluation of duration models, see van Santen & Olive, 1990, and Gopal, 1996). In Cooper et al. (1985), on the other hand, final lengthening and accentual lengthening were found to combine subadditively rather than superadditively, which led them to suggest that there is an upper limit to the amount of lengthening a word can undergo, comparable to Klatt's (1976) limit on phoneme shortening: "(...) utterance-final lengthening of the last word yields a duration that limits further elongation by focus assignment, constituting an expandability constraint." (Cooper et al. 1985, p. 2153).

Berkovits (1991) comes to a similar expandability constraint on the basis of a study of utterance-final lengthening (as compared to durations at a Phonological Phrase/Major Phrase boundary) at two speech rates in Hebrew. In (5), a translation of one of her test sentences is given, with the target word in italics:
(5) translations of an example set of sentences from Berkovits (1991)

a. Utterance-final: I've arranged to take a week's *vacation*.

b. Phrase-final: I've arranged to take a week's *vacation* starting next Monday.

At a fast speech rate, the target word is significantly longer in (5a) than in (5b). This could be due to utterance-final lengthening, as Berkovits assumes, or to the fact that sentence (5a) is shorter than (5b). Crucially, however, the durational difference found at a fast speech rate disappears at a slow speech rate. In other words, and in line with Berkovits' own account, the amount of lengthening due to a slower speech rate is limited in utterance-final position because this position is already characterized by lengthening, and this yields comparable durations across positions at a slow speech rate. So, quite independently, Berkovits (1991) also makes use of an expandability constraint to account for her data, similar to Cooper et al. (1985).

Finally, Elsendoorn (1984) found that English has a wider range of vowel durations than Dutch, perhaps because it needs to accommodate not only a long-short distinction (as Dutch does), but also a phonological rule lengthening vowels before voiced obstruents. So, there is evidence for cross-linguistic differences in expandability at the phonemic level. This is especially relevant should we find differences in expandability between Dutch and English on the basis of lengthening effects at the intonational phrase level. If we were to find that final lengthening and accentual lengthening interact more or sooner in Dutch than in English, this would be evidence of a difference in expandability at the phrasal level which is completely in line with the difference at the phonemic level found by Elsendoorn (1984) (see §4.3 for more discussion).

4.2. Production experiment

4.2.1. Introduction

The present investigation involves a comparative study on Dutch and English in order to answer the main research question in (2), repeated below:

2. a. Is there an interaction between final lengthening and accentual lengthening in Dutch?

b. Is Dutch different from English with respect to the above?

Based on results given in Chapter 3, we hypothesize that the answer to both of these
questions is affirmative: we expect to find an interaction between final lengthening and accentual lengthening in Dutch, but not in English, or at least not as strong in English. The literature on the combination of these two effects is restricted to English, and the various studies are not in agreement with one another. It is noteworthy that the study which did find an interaction in English (Cooper et al., 1985) did not have comparable material across positions. The data from Chapter 3 on which we base our hypothesis suffers from the same drawback.

Besides the main research question in (2), other issues will also be addressed in this chapter. In the experiment described in Chapter 3, the frame sentence was adjusted so that the test material was no longer in phrase-final position, acting on the assumption that the near lack of accentual lengthening on the final stressed syllable was due to an interaction with final lengthening (see §3.3.3). However, there is another difference between the final words (e.g. masten) and the non-final words (e.g. panda) in the Dutch material used there, an example of which was given in (1), repeated below:

(1)  Ik zei 'PAnDa masten’, niet ‘HINde masten’.
     ‘I said panda masts, not hind masts’
     Ik zei ‘panda MASten’, niet ‘panda POORten’.
     ‘I said panda masts, not panda gateways’

In unaccented condition, panda is prenuclear (it precedes the accent), whereas masten is postnuclear (it follows the accent). These different positions relative to the pitch accent may affect the unaccented durations of the target words, even though the effect of prenuclear vs. postnuclear position on segment durations (or speech rate) is far from clear. Still, if there is such a thing as a slower speech rate in postnuclear position, this could explain the smaller accentual lengthening effect on masten, since it would have longer unaccented durations. In the material in (1), however, one cannot distinguish between an effect of final position and an effect of unaccented postnuclear position, because these positions coincide. Since final lengthening is a well-documented phenomenon, we assume it is this effect (rather than an effect of prenuclear vs. postnuclear position) that interacts with accentual lengthening in Dutch. Still, three positions rather than two were included in the experiment so that we can see in medial position whether there is an effect of pre- vs. postnuclear position on the unaccented durations.

Monosyllabic as well as disyllabic words were placed in these three positions. The distribution of both types of lengthening in disyllabic words with initial stress will be another issue addressed in this chapter. Previous research has shown that final lengthening is progressively distributed across the preboundary segments, and is
therefore mainly found in the final syllable (Wightman et al., 1992, see also Chapter 2). Accentual lengthening, on the other hand, may be spread across the entire word (Sluijter & van Heuven, 1995; see also Chapter 3). In Dutch in particular, where we expect final lengthening to interfere with the realization of accentual lengthening, disyllabic words may offer the room needed to implement both types of lengthening (while monosyllabic words do not), since accentual lengthening can be realized in the penultimate (stressed) syllable while final lengthening is realized in the final syllable. This predicts a weaker interaction effect in the disyllabic words than in the monosyllabic words, and a concentration of accentual lengthening in the first syllable of the disyllabic words in final position.

Cooper et al. (1985), while finding an interaction between final lengthening and accentual lengthening, also found a reduced effect on F0 peak values in final position. Following the duration measurements necessary to address the issues above, a preliminary attempt was made to investigate whether position in the phrase has any effect on pitch excursion size. To this end, two phoneticians marked the beginning and end point of the rising part of the pitch movements of part of the data, so that the pitch excursion in each position could be estimated. More details are given in §4.2.5.

4.2.2. Material

Dutch and English frame sentences were made up containing proper names in three positions, as exemplified in (6):

(6) Dutch:  
Volgens mij sprak Ko met Jan over Mie.
‘according-to me spoke Ko with Jan about Mie’

English:  
I think that Joe told John about May.

The name positions will be referred to as ‘initial’ (1), ‘medial’ (2) and ‘final’ (3), even though position 1 is not really domain-initial; rather, the term ‘initial’ refers to its sequential position within the phrase (relative to the other proper names).

In each of these positions, four monosyllabic and four disyllabic names occurred in each language. Names were chosen such that the disyllabic names were extensions of the monosyllabic names. The monosyllabic names were of the form CV(C), while the disyllabic names were of the form CVcv(c) (with capitals indicating lexical stress).
THE INTERACTION BETWEEN FINAL AND ACCENTUAL LENGTHENING

(7) DUTCH ENGLISH

<table>
<thead>
<tr>
<th></th>
<th>monosyllabic</th>
<th>disyllabic</th>
<th>monosyllabic</th>
<th>disyllabic</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVC - CVcv</td>
<td>Jan /jan/</td>
<td>Jannie /jani/</td>
<td>John</td>
<td>Johnny</td>
</tr>
<tr>
<td>CVC - CVcvc</td>
<td>Peet /pet/</td>
<td>Peter /petər/</td>
<td>Mike</td>
<td>Michael</td>
</tr>
<tr>
<td>CV - CVcv</td>
<td>Mie /mi/</td>
<td>Mina /mi:nə/</td>
<td>May</td>
<td>Macy</td>
</tr>
<tr>
<td>CV - CVcvc</td>
<td>Ko /ko/</td>
<td>Kobus /ko:bus/</td>
<td>Joe</td>
<td>Joseph</td>
</tr>
</tbody>
</table>

All these names occurred in each of the three target positions. The frame sentence contained either three monosyllabic names or three disyllabic names, so that the total number of syllables in the phrase was the same for each occurrence of any particular name.

A preceding question put narrow focus on only one of the three names. The name which was consequently accented is given in capitals and bold face in (8), giving English examples:

(8) a. Who told John about May?
   I think that JOE told John about May.

b. Who did Joe tell about May?
   I think that Joe told JOHN about May.

c. Who did Joe tell John about?
   I think that Joe told John about MAY.

d. I think that Joe told JOHN about May.  Joe = prenuclear, close

e. I think that JOHN told May about Joe.  Joe = postnuclear, far

f. I think that John told MAY about Joe.  Joe = postnuclear, close

Any name in any position was thus once accented, and twice unaccented (i.e. when one of the other two names was accented). When unaccented, the position relative to the accented name will be expressed using the terms ‘prenuclear’ (preceding the accent) and ‘postnuclear’ (following the accent), and ‘close’ (one word intervening) and ‘far’ (three words intervening). This is exemplified in (9) for the name ‘Joe’ (in italics):

(9) a. I think that Joe told JOHN about May.  Joe = prenuclear, close

b. I think that Joe told John about MAY.  Joe = prenuclear, far

c. I think that JOHN told Joe about May.  Joe = postnuclear, close

d. I think that John told Joe about MAY.  Joe = prenuclear, close

e. I think that JOHN told May about Joe.  Joe = postnuclear, far

f. I think that John told MAY about Joe.  Joe = postnuclear, close
Naturally, an unaccented name in initial position is always prenuclear, and an unaccented name in final position is always postnuclear; similarly, an unaccented name in medial position is always close to the accented name, whether preceding or following it. Only the unaccented durations in medial position can therefore be used to see if prenuclear versus postnuclear position has an effect on the name durations.

In all, (8 names x 3 positions x 3 accent environments =) 72 items were included for each language. Since every utterance contains three names, (72/3 =) 24 utterances were required for each language to obtain a complete set of stimuli.

### 4.2.3. Subjects and procedure

Three male and three female native speakers of Dutch with no obvious regional accents or speech impairments participated in the Dutch part of the experiment. Three male and three female native speakers of RP-English participated in the English part of the experiment.

The utterances were quasi-randomized such that two utterances in sequence never had the same accent position. The test utterances were preceded and followed by a number of practice sentences, which were not analyzed. All utterances were preceded by a question, putting focus on one of the proper names, so as to elicit a pitch accent on this name (see (8)). The name which was to be accented was given in capitals.

Subjects were seated in a sound-insulated booth. The Dutch subjects’ speech was recorded onto DAT-tape, copied onto a computer disk and down-sampled to 16 kHz. The English subjects’ speech was recorded directly to disk, after being amplified, low-pass filtered at 7.8 kHz and sampled at 16 kHz, with a 16 bit amplitude resolution.

After some practice utterances, subjects read the questions and the test sentences first in the order A-B, and then in the order B-A, with a short break in between. They were instructed not to pause within utterances. The experiment was monitored by the author. In case of speech errors, speakers were asked to repeat the whole question-answer pair.

Most speakers produced the test utterances with a default ‘pointed hat’ (1&A, cf. ’t Hart, Collier and Cohen, 1990; or H*L, cf. Gussenhoven, 1988) on the accented name, without being told to do so; if a speaker did not, (s)he was interrupted and told explicitly what the desired intonation contour was (but see also §4.2.5).
4.2.4. Results

The results for each language are based on (8 names × 3 positions × 3 accent environments × 6 speakers × 2 repetitions =) 864 measurements in total (108 per name). Segmentation was done by hand. In the case of initial voiceless plosives (Peet-Peter, Kobus), the onset of the burst was taken as the beginning point of the test word, thus excluding the preceding silent interval. This was done because in some cases gemination took place (e.g. in Volgens mij sprak Ko ...), a process which lengthens the silent interval. Also, burst onsets provide much more reliable measurements than the preceding segments' offsets.

We will first look at the effects of Accent and Position on the total name durations in each language (§4.2.4.1), and then we will look into the distribution of accentual lengthening in final and non-final position across the two syllables of the disyllabic names (§4.2.4.2).

4.2.4.1. Total name duration

In each position, there are two unaccented conditions (cf. (9)) and one accented condition. The mean total name durations in Dutch, broken down by Position and Accent condition, are given in Figure 4.1.

![Figure 4.1: Total name durations in Dutch, broken down by position and accent condition.](image-url)
Planned comparisons (ANOVA's with Names and Speakers as random factors) show that the two unaccented conditions in each position do not differ from one another (Initial, by Names: F[1,7]=1.53, n.s.; by Speakers: F[1,5]=3.12, n.s. Medial, by Names: F[1,7]=3.14, n.s.; by Speakers: F[1,5]<1. Final, by Names: F[1,7]<1; by Speakers: F[1,5]=1.23, n.s.). This means that neither pre- versus postnuclear position nor being close versus far from the accent have any effect on the duration of the unaccented names. The two unaccented conditions in each position are therefore collapsed in the following analyses, so that we are left with a design in which all cells are filled (with n accented measurements and 2n unaccented measurements per position), allowing us to check for interactions.

An ANOVA was run with total name duration as the dependent variable, fixed factors of Accent (accented/unaccented) and Position (initial/medial/final), and random factors of Names and Speakers. Position has a highly significant effect (by Names: F[2,14]=78.74, p<.001; by Speakers: F[2,10]=70.88, p<.001): names in final position are much longer than in non-final position due to final lengthening. The effect of Accent is also significant (by Names: F[1,7]=27.60, p=.001; by Speakers: F[1,5]=39.13, p=.002). Crucially, the interaction between Position and Accent is highly significant (by Names: F[2,14]=47.45, p<.001; by Speakers: F[2,10]=146.44, p<.001). This interaction is clearly visible in Figure 4.1: the amount of accentual lengthening (i.e. the distance between the dashed line and the solid line) is fairly large in initial and medial position (a lengthening effect of 25% and 18% respectively), but strongly reduced in final position, where a lengthening effect of only 4% is found. The results of planned comparisons per position are given in (10).

(10) The effect of Accent in each Position in Dutch

    | by Names: | by Speakers: |
    |-----------|--------------|
    | initial   | F(1,7)=44.64, p<.001 | F(1,5)=66.30, p<.001 |
    | medial    | F(1,7)=27.05, p=.001 | F(1,5)=46.21, p=.001 |
    | final     | F(1,7)=5.72, p=.048  | F(1,5)=7.22, p=.043  |

While the effect of Accent is highly significant in initial and medial position, it is only significant at a .05 level in final position.

In Figure 4.2, the total name durations per accent condition and position are shown for English. Again, no effects of pre- versus postnuclear position or close versus far from the accent were found, since none of the unaccented conditions within each position differ from one another (Initial, by Names: F[1,7]=1.46, n.s.; by Speakers: F[1,5]<1. Medial, by Names: F[1,7]<1; by Speakers: F[1,5]<1. Final, by Names: F[1,7]=1.44, n.s.; by Speakers: F[1,5]=3.03, n.s.)
Grouping all unaccented conditions together as was done for Dutch, an ANOVA was run with total name duration as the dependent variable, fixed factors of Accent and Position, and random factors of Names and Speakers. Both Position and Accent were found to have a significant effect on the results (Position, by Names: F[2,14]=130.26, p<.001; by Speakers: F[2,10]=77.70, p<.001). Accent, by Names: F[1,7]=194.55, p<.001; by Speakers: F[1,5]=57.41, p=.001). In contrast to the results for Dutch, however, there is no interaction between the two (by Names: F[2,14]=1.12, n.s.; by Speakers: F[2,10]<1).

When the effect of Accent is expressed in percentages, it seems as if in English, too, we find less accentual lengthening in final position (a lengthening of 14%) than in the other two positions (26% in initial position, 22% in medial position); indeed, Figure 4.2 clearly shows that the absolute amount of accentual lengthening is quite constant (approximately 60 ms) across positions in English, but relatively speaking this amount is smaller in final position, since final lengthening gives longer unaccented durations. In any case, the effect of Position on the amount of accentual lengthening in English is not nearly as strong as it is in Dutch. The results of planned comparisons per position for the English data are given in (11).
The effect of Accent in each Position in English

by Names:

- initial: $F(1,7) = 111.72, p < .001$
- medial: $F(1,7) = 75.32, p < .001$
- final: $F(1,7) = 91.42, p < .001$

by Speakers:

- initial: $F(1,5) = 24.15, p = .004$
- medial: $F(1,5) = 37.47, p = .002$
- final: $F(1,5) = 323.40, p < .001$

Since durations in initial and medial (i.e. non-final) positions are comparable, and there are no effects within the various unaccented conditions, the phrase positions can be regrouped into +/- final, and the accent environments into +/- accent. This is done in Figure 4.3, in which the total name durations are given for the monosyllabic and disyllabic names separately.

![Figure 4.3](image)

*Figure 4.3. Total name durations in final vs. non-final position and in accented vs. unaccented conditions in Dutch and English; monosyllabic vs. disyllabic names.*

On the left, the results for Dutch are given. The converging lines for Dutch show the interaction between final lengthening and accentual lengthening. Separate ANOVA’s for the monosyllabic and disyllabic words, with fixed factors of Accent (accented/unaccented) and Position (final/non-final) and random factors of Names
and Speakers, show that the interaction is significant for both groups of names (Monosyllabic, by Names: F[1,3]=25.32, p=.015; by Speakers: F[1,5]=122.33, p<.001. Disyllabic, by Names: F[1,3]=32.25, p=.011; by Speakers: F[1,5]=128.54, p<.001). Judging from these results, the interaction does not appear to be any weaker in disyllabic names than it is in monosyllabic names.

On the right, the results for English are shown. The lines run virtually parallel, implying that there is no interaction between final lengthening and accentual lengthening in either the monosyllabic words or the disyllabic words. This is confirmed by the results of separate ANOVA's for each group of names (Monosyllabic, by Names: F[1,3]<1; by Speakers: F[1,5]<1. Disyllabic, by Names: F[1,3]<1; by Speakers: F[1,5]=1.80, n.s.).

The results (in ms) per accent condition and position, for the monosyllabic and disyllabic names and all names taken together, are given in Appendix G.

4.2.4.2. Syllable durations in disyllabic names

Disyllabic names were included in the material to see if speakers use the larger size of the word to realize final lengthening and accentual lengthening in different syllables, i.e., to avoid an interaction by realizing accentual lengthening in the initial ( accented) syllable and final lengthening in the final syllable. This hypothesis predicts that accentual lengthening is concentrated in the initial syllable of the disyllabic words in final position.

In Table 4.3, the syllable durations of the disyllabic words are given per accent condition and position in the phrase, as well as the standard deviations and the amounts of accentual lengthening on each syllable. Since durations in initial and medial (i.e. non-final) positions are comparable, the phrase positions have been regrouped into +/- final. On the left, the results for the Dutch disyllabic names are given; on the right, the results are given for the English disyllabic names.

In Dutch, the accentual lengthening effect in non-final position is larger than in final position (14%-23% vs. 0%-6%), as was already observed in the previous section (Figure 4.1). The accentual lengthening effect in final position is therefore small, and what is more, the lengthening we do find in final position is realized in the second (final) syllable (6%). These results do not agree with the suggestion that final lengthening will interfere with accentual lengthening primarily in the final syllable, since this is where final lengthening occurs: if this were true, we would expect the accentual lengthening in final position to be realized on the first syllable, and not on the second syllable.
Table 4.3. Syllable durations and standard deviations (in parentheses) in ms of the disyllabic names in final and non-final positions, broken down by accent condition. The accentual lengthening found in each syllable in final and non-final position is given in ms and in percentages.

<table>
<thead>
<tr>
<th>Language</th>
<th>DUTCH</th>
<th>ENGLISH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1st syllable duration</td>
<td>2nd syllable duration</td>
</tr>
<tr>
<td>Syllable environment</td>
<td>s.d.</td>
<td>s.d.</td>
</tr>
<tr>
<td>-final, unaccented</td>
<td>n=192</td>
<td>141.0 (25.2)</td>
</tr>
<tr>
<td>-final, accented</td>
<td>n=96</td>
<td>160.9 (22.8)</td>
</tr>
<tr>
<td>Accentual lengthening:</td>
<td></td>
<td>19.9 = 14%</td>
</tr>
<tr>
<td>+final, unaccented</td>
<td>n=96</td>
<td>172.7 (28.2)</td>
</tr>
<tr>
<td>+final, accented</td>
<td>n=48</td>
<td>172.3 (23.6)</td>
</tr>
<tr>
<td>Accentual lengthening:</td>
<td></td>
<td>-0.4 = 0%</td>
</tr>
</tbody>
</table>

As a matter of fact, the amount of accentual lengthening on the first syllable is smaller than that on the second syllable in non-final position, too (14% vs. 23%). The small effect of accent on the first syllable may be (partly) due to the exclusion of the silent interval of the onset plosives /p/ and /k/ from the measurements (in *Kobus* and *Peter*), because part of the accentual lengthening is probably realized in this interval. Indeed, the initial syllables of *Mina* and *Jannie* show a mean lengthening of 30% and 23% respectively in non-final position, while the first syllables of *Kobus* and *Peter* were each lengthened by only 4%. The silent interval of initial voiceless plosives was excluded from the measurements in all cases, so that it does not interfere with comparisons across conditions, but it does account for the seemingly small amount of accentual lengthening on the first syllable (both in non-final and in final position).

The English results, given on the right in Table 4.3, show that accentual lengthening is evenly distributed across the first and second syllables. In non-final position, both syllables are lengthened by 21%. In final position, both syllables are lengthened by 11%. This shows that both the lexically stressed syllable and the following unstressed syllable are equally lengthened by a pitch accent, whether in final position or not.

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2 Note that this issue doesn't come up in English, since none of the English target names begin with a voiceless stop.
4.2.5. Pitch excursion

The duration results given above show that the amount of accentual lengthening found in different positions is not constant in Dutch, but is reduced from 18-25% in non-final positions to a mere 4% in final position. A pitch accent in final position is therefore hardly cued by duration. Cooper et al. (1985), who found a reduced amount of accentual lengthening in final position in English, also found a reduction of F0 peak value in final position, suggesting that a smaller accentual lengthening effect may find its origin in smaller pitch excursion sizes. If the durational effects described above can be traced to effects on the size of the pitch movements, this would support the notion that accentual lengthening is merely a consequence of the extra time needed to realize an accent-lending pitch movement, making duration a secondary cue to accent in a more literal sense. On the other hand, an accent in final position presumably needs to be as perceptible as any other accent, and so it must be cued in one way or another. Following this reasoning, it is especially important for the perception of a pitch accent in final position that it is marked by intonation, since it lacks a durational cue. Thus, we have two competing hypotheses concerning the relationship between pitch and duration as acoustic accent cues: they could arguably be positively or negatively correlated. In this section, we will examine the pitch excursions in part of our data to see if position in the phrase has any effect on the size of the pitch movements.

4.2.5.1. Method

Only part of the data from the duration experiment was used: the utterances with accented Mie and Mina (for Dutch) and the utterances with accented May and Macy (for English) were selected, because they contain mostly voiced phonemes, and all begin with the nasal consonant /m/, which makes it easy to measure F0. The fundamental frequency was determined using the subharmonic summation method (Hermes, 1988).

Both the author and a phonetician working in the field of intonation marked the beginning and end point of the rise (1) of the rise-fall (1&A) combinations realized on the target names. The fall (A) was not measured, for several reasons: first, final lowering would confound the measurements in utterance-final position, and second, the fall was realized partly in the voiceless /s/ of the name Macy, so that F0 could not be measured. Third, the beginning and end points of a rise are easier to establish than those of a fall, because a rise goes against the overall declination, giving a kink in the F0 contour at its beginning point, while a fall may fade gradually into declination, hence lacking a clear end point.
Close examination of the intonation contours revealed that one of the Dutch speakers regularly realized the pitch accent with a slow rise, starting well before the accented syllable (often starting from the pitch accent on *mij* in the sentence ‘*Volgens mij* sprak ...’), giving a pitch accent of the type 4A instead of 1&A (*t* Hart *et al*., 1990; see also Appendix A). This speaker’s utterances were excluded from the analysis, because the beginning point of the rise could not be reliably determined.\(^3\) Two utterances by another speaker were excluded for the same reason (4A instead of 1&A). For Dutch, this leaves (2 names x 3 positions x 5 speakers x 2 repetitions - 2 =) 58 utterances for analysis.

In some English cases, no reliable measurements could be made (due to creaky voice, unreliable pitch measurement and/or ambiguous beginning or end point of the rise). Of the 72 available utterances (2 names x 3 positions x 6 speakers x 2 repetitions), 5 were excluded in advance because the beginning or end point of the rise could not be established, leaving 67 utterances for analysis.

### 4.2.5.2. Results

The agreement between the two labelers as to the points in time marked as the beginning and end points of the rise was very high (\(r=1, p<.001\) for the beginning points and \(r=.99, p<.001\) for the end points), so that the measurements were accepted as being reliable. The F0 of the beginning and end points of the rise as indicated by the labelers were extracted from the data in Hz, and the pitch excursions were calculated by subtracting the F0 value at the beginning point from that of the end point (averaged across labelers). A transformation from Hz into ERB (Equivalent Rectangular Bandwidth) was also made, since the latter is a psychophysical scale which is claimed to be the most appropriate scale for perceived prominence (Hermes & *van Gestel*, 1991), at least in intonation languages.

In Table 4.4, the pitch excursions found in each position in Dutch and English are given, for the male and female speakers separately. At the bottom, the total mean for each language is given.

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\(^3\) Inspection of the duration data show that this speaker’s durations do not deviate in any way from those of the other speakers, so we did not feel inclined to exclude these data from the durational analyses.
Table 4.4. Pitch excursion of 1&A pitch accents in Hz and ERB in Dutch and English, broken down by position in the phrase and sex of speaker.

<table>
<thead>
<tr>
<th>language</th>
<th>sex</th>
<th>position</th>
<th>Dutch</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>n Hz</td>
<td>ERB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>initial</td>
<td>8 80.4</td>
<td>1.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medial</td>
<td>8 88.5</td>
<td>2.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>final</td>
<td>8 58.4</td>
<td>1.40</td>
</tr>
<tr>
<td>male</td>
<td></td>
<td>initial</td>
<td>12 143.6</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medial</td>
<td>11 132.1</td>
<td>2.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>final</td>
<td>11 111.7</td>
<td>2.13</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td>initial</td>
<td>12 143.6</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>medial</td>
<td>11 132.1</td>
<td>2.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>final</td>
<td>11 111.7</td>
<td>2.13</td>
</tr>
<tr>
<td>total</td>
<td></td>
<td>mean</td>
<td>58 107.3</td>
<td>2.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mean</td>
<td>67 36.2</td>
<td>.76</td>
</tr>
</tbody>
</table>

The data in Table 4.4 indicate that the pitch excursions in English are on average nearly three times as small as in Dutch. This is surprising, since English is said to have a pitch range that is generally twice as large as that of Dutch (de Pijper, 1983). Two factors that could possibly affect pitch excursion, speech rate and male-female speaker ratio, were examined (a higher speech rate could reduce pitch excursion size, and female speakers may make larger pitch movements than male speakers); however, the small differences between the two languages with respect to these factors were not likely to be able to account for the considerable difference in pitch excursion size (average speech rate, Dutch: 5.2 syl/sec, English: 5.1 syl/sec; percentage of utterances spoken by female speakers, Dutch: 59%, English: 51%). Instead, we think that the rise may not have been the most appropriate measure for pitch range in English, since many English intonation contours start on the mid level and have only ‘half’ a rise followed by a full fall (cf. de Pijper, 1983; Sanders, 1990; ’t Hart, Collier & Cohen, 1990), as shown schematically in (12):

(12)

Visural inspection of the English data confirms that the pitch level before the pitch accent is very often higher than the pitch level after the pitch accent, i.e., the pitch accent consists of a relatively small rise and a large fall. In such cases, measuring the rise does not do justice to the actual pitch range in English. Also, listening to each of
the speakers gives the impression that the Dutch speakers made more of an effort to
realize a clear (contrastive) pitch accent than the English speakers, making the former
sound livelier than the latter.

Since there were several reasons for measuring the rise rather than the fall (see
Method section above), and since we are not interested in pitch excursion size per se,
but rather in the effect of position on pitch excursion size (particularly in Dutch), we
continued the present preliminary investigation with these data, despite the fact that
the English measurements may not be very representative of the actual pitch range. In
Figure 4.4, the mean frequency at the beginning and end points in both languages are
presented, averaged over all speakers. The vertical distance between the two data
points in each position represents the pitch excursion in that position. Note that we
measured only one accent per utterance; the measurements for the different positions
come from different utterances, and hence do not necessarily show declination (as
three accents within one utterance would be expected to do).

Figure 4.4. Frequency (in ERB) of the beginning and end points of the rise in 1&A
pitch accents per language, broken down by position in the phrase.

In English, the pitch excursion becomes slowly smaller as the accent occurs later in
the phrase. In Dutch, the pitch excursion also becomes smaller with later position in
the phrase, and the reduction in size is only slightly stronger in final position than in
Separate ANOVA's for each language with mean excursion size (averaged across labelers) as the dependent variable, Position as a fixed factor and Speakers as a random factor show that Position has a significant effect (at a .05 level) on pitch excursion in both languages, even with this small data set (Dutch, by speakers: F[2,8]=6.42, p=.02; English, by Speakers: F[2,10]=4.44, p=.04). Apparently, the effect is consistent across speakers. Post-hoc analyses (Newman-Keuls) place the pitch excursions in initial and medial position in Dutch in one homogeneous subset, while final position forms the second subset, i.e. the pitch excursion in final position is statistically smaller than in the other two positions. In English, the pitch excursion in final position only differs statistically from that in initial position, i.e. the homogeneous subsets that are formed are {initial, medial} and {medial, final}.

4.2.6. Discussion

The total name duration results given in §4.2.4.1 confirm the hypothesis based on previous results that the amount of accentual lengthening depends on the position of the accented word in the phrase in Dutch. We considered two possible positional factors that might have an effect on the amount of accentual lengthening: final versus non-final position and prenuclear versus postnuclear position (when unaccented). Position relative to the nuclear accent turns out to be inconsequential, while final versus non-final position has a strong effect on the amount of accentual lengthening: in final position, the amount of accentual lengthening is strongly reduced (from 18-25% to only 4%), yielding a significant interaction between the effects of accent condition and position, i.e. between accentual lengthening and final lengthening. Apparently, these two lengthening effects are not additive in Dutch: presumably, an expandability constraint is at work (cf. §4.1.2), blocking the simultaneous application of both lengthening effects because the maximal durational expansion of segments would be exceeded.

In English, the effects of accent and position on the name durations were similar to those in Dutch (compare Figure 4.1 and Figure 4.2), except that the two effects do not interact with one another. The absolute amount of accentual lengthening was fairly constant across positions. Expressed in percentages, however, the accentual lengthening effect in final position is also smaller than in other positions (14% versus 22-26%). Perhaps, then, the English target words have also reached their ceiling durations in the final accented environment, and it could be merely a coincidence that the absolute amount of accentual lengthening which could still be realized in final position is approximately the same absolute amount as was found in non-final
positions. Alternatively, our results might suggest that it is more appropriate to describe accentual lengthening in absolute terms (within a controlled experiment such as ours), and to say that accentual lengthening and final lengthening are simply additive in English. However, the effect of final position on the amount of accentual lengthening (even in absolute terms) found by Cooper et al. (1985) indicate that there might be some maximal expansion in English, which may simply not have been reached in studies finding no interaction. In any case, the fact remains that, while highly similar test material was used across languages, English exhibits a larger expandability of the target words than Dutch. This can be seen in Figure 4.3, in which both the English and the Dutch data are displayed.

In §4.2.4.2, we examined the distribution of accentual lengthening in final and non-final positions across the two syllables of the disyllabic names. In disyllabic words, both lengthening effects could be realized without exceeding the durational limitations of Dutch segments by placing accentual lengthening in the first syllable and final lengthening in the second syllable. Instead, however, we find that the interaction between final lengthening and accentual lengthening is just as strong in disyllabic words as it is in monosyllabic words. Moreover, the remaining amount of accentual lengthening in final position is not concentrated in the penultimate syllable. Apparently, Dutch speakers do not strive after a realization of accentual lengthening in final position, but exhibit a near lack of accentual lengthening in utterance-final words quite generally. Further research is needed to pinpoint what the minimal distance of a pitch accent to the boundary should be, and in what terms this distance should be stated, in order to find a ‘normal’ amount of accentual lengthening, comparable to that in non-final positions.

A preliminary attempt to investigate the effect of position on the size of the pitch movements was made in §4.2.5. Generally, in both Dutch and English, the pitch excursions tend to become smaller towards the end of the phrase, perhaps because accents early in the phrase are more likely to be contrastive. It may also have something to do with the claim that the declination of the top declination line is stronger than that of the bottom declination line, giving converging lines within which pitch movements are realized. Whatever the explanation is for the smaller pitch excursions towards the end of the phrase, the pitch excursions show no reduction in size in final position comparable to the reduction in the amount of accentual lengthening found for Dutch. So, while the pitch excursion was in fact slightly more reduced in Dutch

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4 A convergence of the top and bottom declination lines has been motivated by the finding that in a sequence of pitch accents, later accents require smaller pitch excursions than earlier ones in order to be perceived as equally prominent (cf. Pierrhumbert, 1979 for English; Gussenhoven & Rietveld, 1988; Terken, 1991 for Dutch).
final position than in medial position, and also more than in English final position, the
data do not fully agree with those of Cooper et al. (1985) for English, who found only
a slight F0 heightening together with a reduction of accentual lengthening in final
position. This made them wonder whether these reduced cues are sufficient for the
perception of accent. In our data, an accent in final position in Dutch is hardly marked
by lengthening, but still has an average pitch excursion of 1.8 ERB (89 Hz), which
should easily suffice for accent perception.

Although this study is too limited to draw any firm conclusions, these results
suggest that the effect of position on the amount of accentual lengthening is an effect
in its own right: in any case, our preliminary study indicates that it cannot be account-
ted for by differences in pitch range in various positions. The data show an overall
tendency for pitch excursions to become smaller as they occur later in the phrase, but
the small effect of final position on pitch excursion is not comparable to its large
effect on the amount of accentual lengthening in Dutch.

4.3. Conclusions

In this chapter, a comparative study was made of the combined effects of accentual
lengthening and final lengthening in Dutch and English. Previous results (discussed
in Chapter 3) suggested that the amount of accentual lengthening is not consistent
across positions in the phrase in Dutch, but the words occurring in these positions
were not really comparable. In the equivalent English experiments (Turk & Sawusch,
1997; Turk & White, 1999), no relation between amount of accentual lengthening
and position in the phrase was found. This suggests that, if such a relation indeed
exists in Dutch, it could be a language-specific phenomenon. However, since these
materials were not designed to make comparisons across accented positions, materials
were needed which were set up specifically to investigate the effect of position in the
phrase on the amount of accentual lengthening found.

The results of the present investigation confirm that there is an interaction between
final lengthening and accentual lengthening in Dutch, and that this interaction is
stronger in Dutch than it is in English. Following other researchers (e.g. Cooper et al.,
1985), we suggest that there is an expandability constraint which attenuates the
accentual lengthening effect when added on top of final lengthening. Presumably,
such a constraint exists for both languages, but is less stringent for English, allowing
longer durations.

While Cooper et al. (1985) found a significant interaction between final lengthen-
ing and accentual lengthening in English, Cummins (1999) did not, and Beckman et
al. (1992) do not mention such an interaction either. The English data presented here show a consistent absolute amount of accentual lengthening across positions, so that statistical analyses show no interaction effects, but relatively speaking the accentual lengthening effect in final position was smaller than that in other positions in English, too (as in Dutch). It could be that the relatively high ceiling durations in English do not always interfere with the combined lengthening effects of accent and final position, but only in somewhat extreme circumstances. What these circumstances should be is not clear. Perhaps the length of the intonational phrase in which the target words occur is a factor, since these are quite long in Cooper et al. (10-13 syllables in experiment 1, 20-25 syllables in experiment 2), while those in Cummins (1999) and Beckman et al. (1992) are quite short (7 and 1-8 syllables, respectively), with the sentence length in the present study taking an intermediate position (9 or 12 syllables).

On the basis of intonational phrase level lengthening effects, then, we conclude that English has higher ceiling durations than Dutch. As mentioned in §4.1.2, Elsendoorn (1984) found a similar difference (in the same direction) between Dutch and English at the phonemic level. Elsendoorn proposes that English has a larger range of vowel durations than Dutch because it needs to accommodate not only a long-short distinction, but also a phonological rule which lengthens vowels before voiced obstruents. Dutch, on the other hand, has a rule devoicing obstruents at the end of the syllable (Final Devoicing, e.g. hoed /hut/ 'hat' vs. hoeden /hu.dan/ 'hats'; Booij, 1995). The difference in expandability at the phonemic level is thus explained phonologically, by the existence of a lengthening rule that is present in English but absent in Dutch. However, the difference in expandability at the intonational phrase level found in this chapter may not follow so straightforwardly from some other (phonological) difference between English and Dutch.

Searching for relevant phonological differences in the English and Dutch use of duration, we come across a recent issue concerning the phonological primacy of the long-short distinction in the Dutch vowel system. In many languages, there is a phonetic correlation between vowel length and tenseness, such that all long vowels are tense and all short vowels are lax. This raises the question whether one of these properties should be derived from the other, and if so, which of these properties is phonological and which one is derived. Although Dutch phonologists generally make a distinction in terms of length (e.g. Zonneveld, 1978; van der Hulst, 1984; Kager, 1989; Booij, 1995), van Oostendorp (1995) offers some phonological advantages of a distinction in terms of quality. Notably, most of his arguments against a phonological vowel length contrast apply to Dutch, but not to English (see van Oostendorp 1995, p. 33, fn. 14). One of the differences involve the phonological weight of long vowels,
which count as light in the stress system of Dutch (cf. §1.3.2.4) but as heavy in the English stress system. Phonetically, however, both quality and duration have been found to contribute to the perceptual distinction between the vowel pair /a/ and /a/ in Dutch (van Heuven, 1986; Nooteboom & Cohen, 1988). So, although potentially of interest in an examination of durational differences between English and Dutch, until there is phonetic evidence for a difference between these languages with respect to the role of duration in the vowel contrast, this phonological discussion has little bearing on our findings.

Phonetically, and also at the segmental level, there may be one more piece of evidence for a larger flexibility of durations in English, for which it is hard to find a phonological explanation. Klatt (1973a) reports a shortening of consonants in consonant clusters in English, which is stronger in 3-element clusters than in 2-element clusters (see also Allen, Hunnicutt & Klatt, 1987). Waals (1999), studying consonant durations in Dutch, found shortening only in 2-element clusters, but no further compression in 3-element clusters. Even consonants, then, seem to be more sensitive to durational adjustments in English than in Dutch.\(^5\) We can think of no phonological contrast which could explain this particular difference. We therefore tentatively conclude that durational flexibility needs to be postulated as an independent property in which English and Dutch differ. Naturally, although we think that this cross-linguistic difference cannot be explained by a phonological conspiracy to use duration more for linguistic contrasts in English than in Dutch, there may still be some connection between the two: in English, there is more room for making multiple durational contrasts, while the lower ceiling durations for vowels in Dutch may prevent the development of duration as a reliable cue, and may enhance the exploitation of other ways to make phonological distinctions.

Throughout this chapter, we have assumed that it is accentual lengthening which is reduced in final position, rather than final lengthening which is reduced when accented. In principle, though, the significant interaction between the two can be interpreted in either of these directions (or even in both): instead of stating that the amount of accentual lengthening differs across positions (from 18-25% in non-final positions to 4% in final position), we could also summarize the Dutch results by saying that we found a final lengthening effect of 59% in unaccented conditions versus an effect of 36% in accented condition. On the basis of only duration, we

\(^5\) Note that the durational adjustment in consonant clusters involves compression rather than lengthening. Already in §4.1.2, we implicitly assumed that inexpandability is somehow connected to incompressibility. Cummins (1999) suggests we “accommodate limits on both expandability and compressibility by treating the segment (or syllable) as a hard spring with a neutral or preferred duration” (p. 480). In these terms, our claim is that the ‘spring’ is looser in English than in Dutch.
cannot really determine whether the duration of a phrase-final accented word is shorter than an additive model predicts because there is a reduction of accentual lengthening or because there is a reduction of final lengthening. Although final position affects the sonority profile of a syllable in a different way than a pitch accent does (Edwards & Beckman, 1988; see §1.2), we do not believe that a separate analysis of the duration of the opening and closing gestures could solve the problem, since neither final lengthening nor accentual lengthening exclusively affects only one of these gestures. In fact, they are not even necessarily restricted to one syllable, as the data and references in Chapters 2 and 3 have shown. Under the assumption that only a pitch accent increases jaw opening, articulatory studies of jaw position are perhaps more likely to be successful in disentangling the two effects (cf. Summers, 1987). In the meantime, we have claimed that it is the amount of accentual lengthening which is affected by position rather than final lengthening which is affected by accent condition, on a somewhat intuitive basis. In our view, final lengthening is more primary than accentual lengthening. Pitch accents are marked by a whole set of cues, and lengthening is just one of the cues subordinate to pitch (e.g. Sluijter, 1995).

Final lengthening, on the other hand, is the primary cue for boundary perception; its role in the perceptual segmenting of speech surpasses that of F0 boundary tones (de Rooij, 1979). The final lengthening effect also clearly exceeds that of accent in terms of size, perhaps reflecting the larger role that final lengthening has in boundary perception relative to the role of accentual lengthening in prominence perception. We think this makes our interpretation of a reduced accentual lengthening effect in final position far more likely than the interpretation implying a reduced final lengthening effect in accented condition.

Evidently, more research is needed addressing the realization of accent in final position, particularly in Dutch. On the production side, articulatory studies would be welcome, since they can potentially distinguish between lengthening due to accent and lengthening due to boundaries (Summers, 1987). A more extensive investigation of pitch excursion, as well as of other accent cues, in various positions in the sentence is also called for. The preliminary data discussed in §4.2.5 concerning pitch excursion size can only serve to prompt a more full-scale study addressing the effect of final position on the strength of each of the accent cues. In addition, perception experiments are in order to see if the reduction of important cues to accent in final position has an effect on the (relative importance of each cue for) perception of prominence.