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Prosodic effects and crosslinguistic segmental durations

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Abstract

The present study is an experimental investigation of the effects of syllable position, stress, focus and tempo on segmental durations in American English, British English, Greek and Swedish. Nonsense disyllabic CVCV words were produced in a carrier sentence under different conditions of stress, focus and tempo. The results indicate that stress and tempo have a major effect on both consonant and vowel across all four languages, whereas the effects of syllable position and focus are hardly evident. Significant interactions were mostly found between syllable position and stress for the vowel.

Introduction

This study is an experimental investigation on the effects of the prosodic categories of syllable position, stress, focus and tempo on segmental durations in American English, British English, Greek and Swedish. The central question concerns the main effect of each prosodic category in the investigated languages; a subsequent question concerns the interactions of prosodic categories and, finally, the ultimate general question concerns crosslinguistic characteristics and prosodic typology.

Experimental procedures

The speech material of this investigation consists of a set of nonsense key words in the carrier sentence "the club {key word} plays good music" in the corresponding languages. The key words have a constant CVCV structure, where C consists of the voiceless fricative /s/ and V of the low vowel /a/, i.e. "the club sasa plays good music".

The speakers are four female adults in each language with Ohio, London, Athens and Stockholm typical pronunciation for American English, British English, Greek and Swedish respectively. They produced the sentences, and thus the key words, with alternative stress patterns (i.e. first or second syllable stress), two tempi (i.e. normal and fast), six times each production. The key words were also pronounced in variable focus conditions, i.e. neutral-focus, pre-focus and focus. The neutral-focus productions were pronounced more or less "neutrally" i.e. the speakers had no contextual information. The alternative focus productions, on the other hand, were pronounced as a response to a question, which elicited a part of the sentence as the information required by the question.

The speech material was recorded in sound-treated room environments in Ohio (USA), London (UK), Athens (Greece) and Stockholm (Sweden) and some basic instructions were provided just before the recordings. Speakers varied the prosodic conditions, especially tempo, at an individual basis, in accordance with their speech habits.

Results

The results are based on duration measurements of part of the recorded speech material, i.e. one speaker's six productions and are thus basically qualitative. Statistical processing was carried out and the results are presented in two main sections: main prosodic effects and prosodic interactions with reference to syllable position, stress, focus and tempo.

Main prosodic effects on segment durations

The main prosodic effects are shown in figures 1-4.

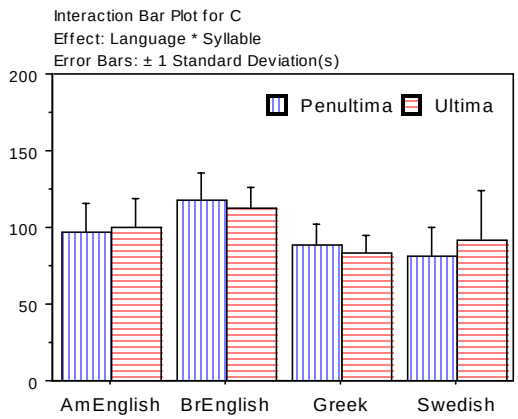

Figure 1a: Consonant duration of American English, British English, Greek and Swedish as a function of syllable position (Penultimate vs. Ultimate).

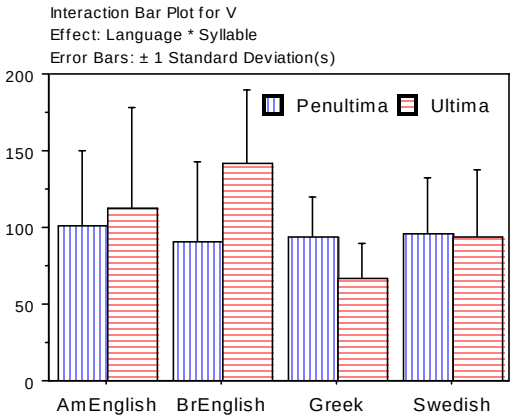

Figure 1b: Vowel duration of American English, British English, Greek and Swedish as a function of syllable position (Penultimate vs. Ultimate).

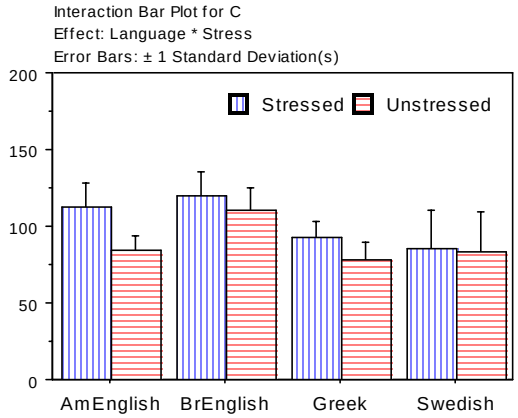

Figure 2a: Consonant duration of American English, British English, Greek and Swedish as a function of stress (Stressed vs. Unstressed).

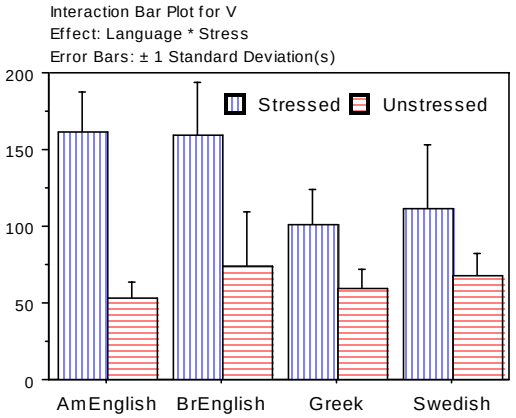

Figure 2b: Vowel duration of American English, British English, Greek and Swedish as a function of stress (Stressed vs. Unstressed).

Syllable position

Figures 1a-b show the effects of syllable position (*penultimate* vs. *ultimate*) on consonant and vowel segment durations. Syllable position has a significant effect on the consonant duration in British English (df 1; F=4.8, p=<0.02) and Greek (df 1; F=6.6, p=<0.01) but not in American English or Swedish; vowel durations also show significant differences in British English (df 1; F=42.3, p=<0.0001) and Greek (df 1; F=54.0, p=<0.0001) but not in American English or Swedish. British English and Greek have however a mirror image pattern in syllable position durations.

Stress

Figures 2a-b show the effects of stress (*stressed* vs. *unstressed*) on consonant and vowel durations. Stress has a significant effect on the consonant duration in American English (df 1; F=226.9, p=<0.0001), British English (df 1; F=13.9, p=<0.0003) and Greek (df 1; F=82.5, p=<0.0001) but not in Swedish; vowel durations show significant differences in American English (df 1; F=1353.9, p=<0.0001), British English (df 1; F=236.0, p=<0.0001), Greek (df 1; F=246.5, p=<0.0001) as well as Swedish (df 1; F=26.9, p=<0.0001).

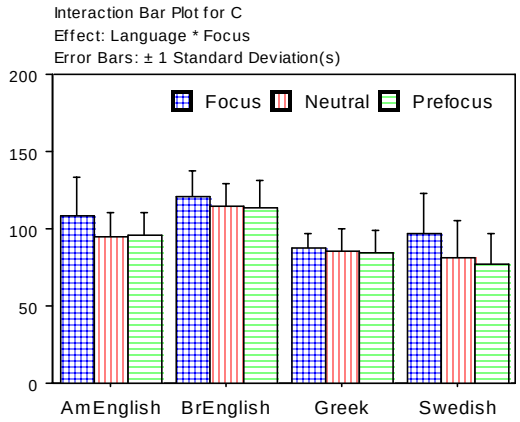

Figure 3a: Consonant duration of American English, British English, Greek and Swedish as a function of focus (Focus vs. Neutral vs. Prefocus).

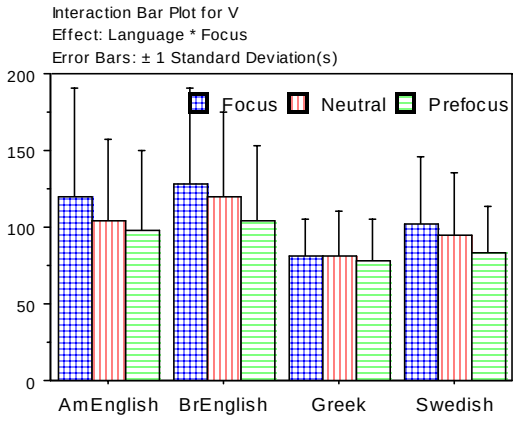

Figure 3b: Vowel duration of American English, British English, Greek and Swedish as a function of focus (Focus vs. Neutral vs. Prefocus).

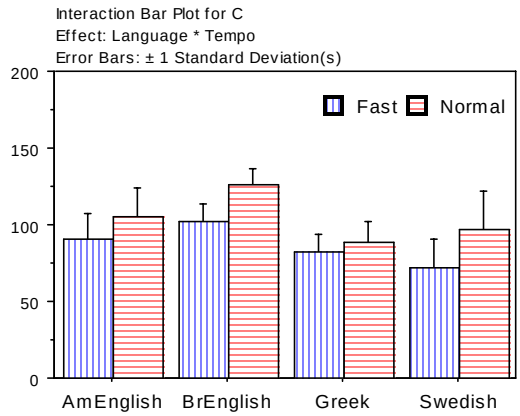

Figure 4a: Consonant duration of American English, British English, Greek and Swedish as a function of tempo (Fast vs. Normal).

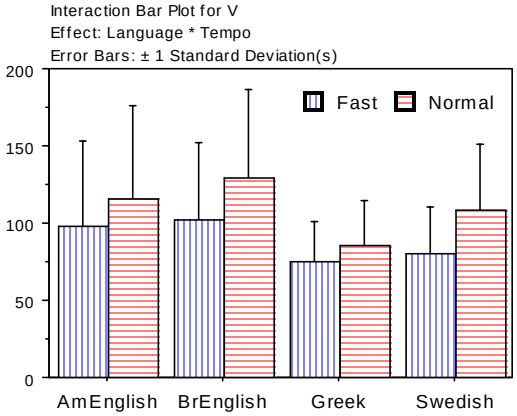

Figure 4b: Vowel duration of American English, British English, Greek and Swedish as a function of tempo (Fast vs. Normal).

Focus

Figures 4a-b show the effects of focus (*focus* vs. *neutral* vs. *prefocus*) on consonant and vowel durations. Focus has a significant effect on the consonant duration in American English (df 2; F=10.0, p=<0.0001); Scheffe's post-hoc test showed significance for focus vs. neutral (p=<0.0001) as well as focus vs. prefocus (0.004) but not for neutral vs. prefocus. No significant differences for focus were found in British English, Greek or Swedish. Vowel durations did not show significant differences in any of the four languages.

Tempo

Figures 4a-b show the effects of tempo (*normal* vs. *fast*) on consonant and vowel durations. Tempo has a significant effect on the consonant duration in American English (df 1; F=34.6, p=<0.0001), British English (df 1; F=182.1, p=<0.0001), Greek (df 1; F=13.4, p=<0.0003) and Swedish (df 1; F=20.2, p=<0.0001); vowel durations show significant differences in American English (df 1; F=4.5, p=<0.03), British English (df 1; F=9.8, p=<0.002), Greek (df 1; F=6.2, p=<0.01) and Swedish (df 1; F=9.3, p=<0.003).

Prosodic interactions on segment durations

Interactions with syllable position.

The interactions between syllable position and stress were not significant for the consonant in any language but did reach a significant level for the vowel in American English (df 1; F=31.1, p<0.0001), British English (df 1; F=10.0, p<0.001), Greek (df 1; F=9.4, p<0.002) and, marginally, Swedish (df 1; F=3.8, p<0.05).

Interactions between syllable position and focus did not reach a significant level for either consonant or vowel in any of the four languages.

Interactions between syllable position and tempo did not reach a significant level for either consonant or vowel in any of the four languages.

Interactions with stress

The interaction between stress and focus did reach a significant level for both consonant (df 1; F=11.9, p<0.0001) and vowel (df 1; F=16.3, p<0.0001) in American English but not in any other language.

The interaction between stress and tempo did not reach a significant level for either consonant or vowel durations in any of the four languages.

Interactions with focus

The interaction between focus and tempo did not reach a significant level for either consonant or vowel in any of the four languages.

Discussion

The results should be considered with some caution with reference to the experimental conditions. First, the data is restricted to six productions by one speaker and has thus statistical shortcomings (more work is on the way). Second, the key material consisted of nonsense rather than real words with the advantage of direct comparison of the results in the four languages. An obvious disadvantage was the production of the key words rather distinctively irrespective the focus conditions. Third, the acoustic measurements of the vowels, especially the ultimate syllable ones, were carried out with reference to the formant rather than the voicing extinction. Thus, the results of the present study may reveal phonetic reality but may also display considerable interference with regards to the effects of syllable position and focus.

Syllable position may have a lengthening effect on segment durations, according to which final segments at variable linguistic units (e.g. word, phrase, utterance) may be longer than non-final counterparts (e.g. Klatt, 1976). In the present study, however, although the ultimate syllable was the boundary of a noun phrase, the final lengthening effect was only evident in British English. Greek not only displayed no evidence of a lengthening effect in this environment, but in fact showed clear evidence of the opposite.

Stress had a considerable effect on segmental durations, according to which segments in stressed syllables were longer than segments in unstressed syllables (cf. Crystal & House 1988 for a review). This effect has been corroborated for all four languages in the present study.

Focus has also been repeatedly reported as a prosodic category with duration correlates (see Fant et al., 2000) but no widespread effect was observed in the investigated languages. This is in line with earlier studies in Greek where no substantial effect of focus application was found (Fourakis et al., 1999).

Tempo had a considerable effect on the segmental durations of both consonants and vowels in the present study and this is in accordance with reports in the international literature (e.g. Gopal, 1996).

In short, stress and tempo had the most substantial effect in the investigated languages but hardly syllable position or focus. Prosodic interactions were barely noticed whereas stress and tempo has shown significant interactions in earlier studies in Greek (Fourakis et al., 1999).

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