

AN ACOUSTIC STUDY OF STRESS IN L2 PRODUCTION OF GERMAN AND SPANISH

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1. INTRODUCTION

Stress is a multi-faceted construct and its correlates may differ in different languages. Among the physical dimensions perceived as stress are higher pitch and longer vowel duration. The phonetic realization of stress may be subject to interference from the learner's L1, and may be interpreted by a native speaker (NS) as a phonological problem (stress misplacement) [7]; we therefore set out to compare the correlates of stress in vowels produced by American English speakers learning German or Spanish in a classroom setting.

1.1 Acoustic correlates of stress in German and English

In German, the experimentally established acoustic cues of word stress include vowel duration, pitch and intensity changes, as well as laryngeal features [2, 6]. Studies have confirmed that vowel duration is regarded as the primary cue to German word stress and that the phonetic realization of word stress also involves an increase in F0 [6]. The intensity (loudness) of a stressed vowel is higher than that of an unstressed vowel in German, but the contrast is weaker than for the other cues [6]. This has also been confirmed for English [4], namely that the intensity correlates of stress are weaker than the duration and pitch changes.

In stressed syllables, only tense vowels are lengthened, whereas in unstressed position the quantity contrast is neutralized [8].

1.2 Acoustic correlates of stress in Spanish

Pitch, duration, and intensity are the main correlates of stress in Spanish [9, p. 400 and literature cited therein]. Quilis and Esgueva [10] also maintain that there is no significant correlation between the vowels' spectral quality and stress. They do find that stressed vowels are significantly longer than unstressed ones.

1.3 L2 production of stress

A number of studies have addressed how L2 learners master the stress patterns of the language they are learning, particularly the placement of primary word stress [1]. There are not many that have investigated the acoustic correlates of stress among L2 learners. An exception is [3] where both stress placement and the

phonetic realization of English stress by Spanish learners of English were studied. They found that the magnitude of vowel duration differences between stressed and unstressed syllables were greater in the English NSs' speech than in the L2 Spanish learners' speech.

Some common errors in L2 German mentioned in [5] are related to reduction and stress and attributed to interference from L1: among others, English NSs reduce unstressed syllables too drastically, Spanish NSs learning German do not produce the contrast between stressed and unstressed syllables correctly, and mark accent predominantly by intensity.

2. METHOD

2.1 Vowels in Standard German

The vowel inventory of Standard German contains 7 pairs of tense and lax vowels /i-ɪ, γ-ʏ, e-ɛ, ø-œ, a:-a, u-ʊ, o-ɔ/. Words containing these vowels were embedded in a carrier sentence *Sag das Wort X noch einmal* ('Say the word X again'). In this pilot study, three NSs of German, five American students in an advanced German language class, and five American students in a beginner class read these sentences.

Both tense and lax vowels in German may occur in stressed and unstressed syllables. In order to determine the acoustic correlates of stress, measurements of F0, F1, F2, and F3, along with measurements of vowel duration and intensity were taken. Since the front rounded vowels (*Umlaute*) are notoriously difficult for English-speaking L2 learners, we are not including them in this pilot study.

2.2 Vowels in Spanish

The vowel inventory of Spanish contains 5 vowels /i, e, a, o, u/. Words containing these vowels were embedded in a carrier sentence *Dime la palabra X otra vez* ('Say the word X again'). Three NSs of Spanish (two Mexican and one Peninsular), five American students in an advanced Spanish language class, and five in a beginner class read these sentences.

All Spanish vowels were recorded in open stressed and unstressed syllables in word pairs of the type *p[i]pa - p[i]sar*. In order to determine the acoustic correlates of stress, measurements of F0, F1, F2, and F3, along with measurements of vowel duration and intensity were taken.

3. RESULTS

3.1 Results for the German vowels can be seen in Figure 1-2. In the analysis of the German vowels, the stressed tense (ST T) vowels were distinguished from the unstressed tense vowels (UN T), as were the stressed lax (ST L) and the unstressed lax (UN L) vowels.

Figure 1. Duration of German vowels (ms)

	ST T	UN T	ST L	UN L
NS	140.7	87.6	72.0	69.9
L2-adv	107.2	82.3	90.7	73.3
L2-beg	111.1	87.3	99.5	76.3

Figure 2. F0 (Pitch) of German vowels (Hz)

	ST T	UN T	ST L	UN L
NS	160.7	138.9	165.7	141.1
L2-adv	137.6	127.2	144.3	123.8
L2-beg	162.9	147.3	153.5	146.0

German NSs use longer duration and higher pitch on stressed than unstressed vowels, with a considerable difference in duration between tense and lax vowels (and very little variation in intensity): (1) Unstressed tense vowels are 62% as long as stressed tense vowels; (2) Unstressed lax vowels are 97% as long as stressed lax vowels; (3) Unstressed tense and lax vowels are 86% and 85% as high in pitch as stressed tense and lax vowels, respectively.

Both the upper division (L2 advanced) and the lower division (L2 beginning) students manipulate duration, pitch (and intensity) to signal stress, but to lesser degrees than NSs: (1) Unstressed tense vowels are 77% (L2 adv) and 79% (L2 beg) as long as stressed tense vowels; (2) Unstressed lax vowels are 81% (L2 adv) and 77% (L2 beg) as high in pitch as stressed lax vowels.

3.2

Results for the Spanish vowels can be seen in Figure 3-4.

Figure 3. Duration of Spanish vowels (ms)

	ST	UN	%
NS	125.6	98.9	78
L2-adv	92.2	87.5	94
L2-beg	95.5	90.1	94

Figure 4. F0 (Pitch) of Spanish vowels (Hz)

	ST	UN	%
NS	162.0	135.0	83
L2-adv	206.5	184.3	89
L2-beg	213.9	209.0	98

Spanish NSs clearly manipulate duration and pitch as correlates of stress [9]: unstressed vowels are only 78% as long as stressed ones (as in [10]), and their pitch is 83% lower than stressed counterparts. So do L2 learners, but to a considerably lesser extent. Differences in intensity among groups are too slight to evaluate (unlike in [5]).

4. DISCUSSION

As [8] reports for German NSs, our NS data also show that in stressed syllables, only tense vowels are lengthened, whereas in unstressed position the quantity contrast is neutralized.

In addition, as [3] reports for L2 Spanish speakers learning English, our data for L2 German and Spanish learners also reveal that the magnitude of vowel duration differences between stressed and unstressed syllables was greater in the native speakers' speech than in the L2 learners' speech, though learners do use both duration and pitch to signal stress. Our L2 German and Spanish advanced learners show greater differences in intensity than NSs do, but use intensity in general much less than duration or pitch to signal stress.

Contrary to expectation [9, 10] our data for Spanish show that NSs tend to reduce (centralize) unstressed vowels, and that beginners do not implement this tendency with any consistency, whereas advanced learners approximate the NSs' vowel systems. Our German data on the other hand do not consistently show centralization in any group.

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