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CLASHES AND PROSODIC DOMAINS IN EUROPEAN PORTUGUESE

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Abstract

This paper looks at stress clashes and prosodic phrasing in European Portuguese (EP), with the purpose of examining what strategies of clash resolution are available in the language, in what prosodic configurations. The experimental data do not support either beat deletion or stress shift as clash resolution strategies in EP. The lengthening of the first stressed syllable (together with the lengthening of the following consonant) is the only strategy used. However, this means of achieving beat insertion is not available across a phonological-phrase boundary. Furthermore, no evidence was found for any other means of beat insertion (e.g. different pitch levels, pauses) in this prosodic context. These results confirm previous findings and strengthen the case for a language difference in prosodic domain typology.

1. Introduction

The present paper investigates the resolution of stress clashes in European Portuguese (EP), and examines whether rhythmic phenomena provide evidence for prosodic domains in this language.

In previous work, the search of evidence for prosodic phrases in EP has shown the absence of positive evidence for the Phonological Phrase (ϕ), in contrast with the strong evidence provided for the Intonational Phrase (I) (Frota 1994, 1995). The segmental rules which are known to be sensitive to phonological phrasing do not refer to the ϕ-juncture nor to the ϕ-domain. By contrast, they form a cluster of domain juncture or domain span rules bounded by the I-domain. Some of these rules are constrained by rhythmic restrictions, i.e. they do not apply when a clash configuration would result. However, while the creation of a potential I-level clash is not at all constrained, the creation of ϕ-level clashes seems to be more constrained than the creation of lower level clashes. A reason for this unusual pattern, as suggested in Frota (1994), would be the unavailability of a potential readjustment, due to the language lack of resources at ϕ-level.

Additional evidence for the contrast between ϕ and I comes from intonation. In neutral utterances, the ϕ-domain does not have to be marked either by a pitch accent or a boundary tone. The opposite situation characterizes the I-domain, which is always tonally marked at least by a pitch accent and a boundary tone (Frota 1994, and forthcoming a).

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The previous findings set EP apart from most of the languages described in the literature, which show both ϕ-level segmental rules and ϕ-level suprasegmental phenomena. English, Italian, Greek, and Bengali are well-known examples (cf. Nespor and Vogel 1986, Beckman and Pierrehumbert 1986, Condoravdi 1990, Hayes and Lahiri 1991, Arvaniti 1992, Grice 1992).

In English and Italian, the ϕ-level is not only crucial to segmental rules, but also to rhythmic phenomena (cf. Nespor and Vogel 1979, 1982, 1986, 1989). A clash configuration within-ϕ is readjusted either by stress shift or by beat deletion: the first strategy applies in English and is exemplified in (1a); the second strategy applies in Italian and is exemplified in (1b). (Nespor and Vogel (1989) argue for the beat deletion analysis instead of the stress shift one, both for Italian and English.)

(1) a.

```
    *  *          *     *
  *  *  *        *  *  *
  *  *  *        *  *  *
thirteen men  >  thirteen men
```

b.

```
  *  *              *
 * *  *           * *  *
 * *  *           * *  *
sara fatto    >   sara fatto    '(it) will be done'
```

Across a ϕ-boundary, in both languages clashing sequences are remedied by means of beat insertion, as in (2).

(2) a.

```
  *     *
  *     *
  *     *
  *  *  *
Tennessee]ϕ won
```

b.

```
  *     *
  *     *
  *     *
  *  *  *
la verità]ϕ vince    'the truth wins'
```

In Greek, although stress shift is not a permissible strategy, a clash configuration is readjusted and beat insertion is the used strategy both within-ϕ and across-ϕ (cf. Nespor and Vogel 1989, Arvaniti 1992).

The physical correlate of beat deletion is destressing, acoustically signalled by a decrease in duration in languages like Italian or Greek, in which stressed syllables are longer than unstressed ones (cf. Arvaniti 1992). The acoustic measures which are usually expected to reflect a shift in stress are changes in duration and fundamental frequency (cf. Shattuck-Hufnagel 1991). As for beat insertion, it may be achieved by several means: (a) the lengthening of the first syllable involved in the clash, or (b) of the consonant following it; (c) the insertion of a pause between the two stressed syllables; (d) the pronunciation of the two stressed syllables with different pitch levels. Languages like Italian or English have been reported to use (a) and (c), whereas Greek uses (a), (b), and also (d) according to some authors (cf. Nespor and Vogel 1989, Arvaniti 1992).

In EP, little is known about the resolution of stress clashes. To date, no work has specifically addressed the issue, and the suggestion put forward in Frota (1994) needs testing. It is the purpose of the experiment described in this paper to investigate whether EP exhibits strategies of clash resolution, and if so what strategies in what prosodic configurations. Should the results provide contrastive evidence for the ϕ-domain, as shown by a difference in the properties of the word, the ϕ-phrase and the

I-phrase, the present work will contradict previous studies, and EP will be shown to pattern like many other languages in this respect. Should the results fail to provide such evidence, they will support the previous findings and thus contribute to the statement of a language difference which Prosodic Hierarchy Theory may have to account for.

2. The experiment

EP stress has clear acoustic correlates, and duration is one of the dominant cues to word stress (cf. Delgado-Martins 1977, Andrade and Viana 1988 and 1989). Delgado-Martins' (1977) and (1986) experiments showed that duration and 'energy' (a measurement similar to the 'total amplitude' of Beckman 1986) clearly outweighed both peak amplitude and fundamental frequency. Andrade and Viana's (1989) phonetic data showed that there is a significant difference in duration between stressed and unstressed vowels (and syllables), which is a reliable cue to word stress.

As stressed vowels (and syllables) are regularly longer than unstressed ones, durational changes are expected to be the acoustic correlate of beat deletion and stress shift phenomena. As for beat insertion, both the lengthening of the elements involved in the clash and the presence of a pause or a pitch difference will be examined as possible cues to the insertion of phonological distance between two clashing syllables.

2.1. Materials

The corpus consisted of 3 sets of 5 pairs of test-sentences (see Table 1). Each set comprises pairs of words containing a stress clash (SC) which are compared with pairs of words not containing a stress clash (NSC). The pairs of words in the SC and the NSC conditions are segmentally identical as far as the entire first word and the first syllable of the second word are concerned, i.e. there is segmental identity between the clashing syllables and any other elements that may be involved in a clash resolution strategy. The quality changing effects of vowel reduction were therefore avoided. In the NSC word-pairs there are either 1 or 2 phonetic syllables intervening between the two stresses. Both the SC word-pair and the corresponding NSC word-pair are embedded in similar sentences, as (3) exemplifies.

(3) O caFÉ LUso contém cevada de boa qualidade
'the Lusitanian coffee contains barley of good quality'
O caFÉ lusiTAno contém grãos de várias qualidades
'the Lusitanian coffee contains grains of various qualities'

The 5 pairs of test-sentences vary in their prosodic structure. In test-pair 1, there is an intervening ϕ-boundary between the two words. In test-pairs 2 and 3, the two words are at the end of the same ϕ-domain: in pair 2 this domain is in an early position in the sentence - the subject (Sub) position -, whereas in pair 3 the relevant ϕ is in a late position in the sentence - the object (Obj) position. In test-pairs 4 and 5, the two words are at the end of the same I-domain, but while in pair 4 there is 'broad focus' and thus the second word carries the nuclear pitch accent, in test-pair 5 there is 'narrow focus' on the first word and thus it is the first word that carries the intonational nucleus of the sentence. The 'narrow focus' renditions were elicited with the help of a question to which the narrow focus rendition is the 'natural' response (in the sense of Chomsky, 1971, and Jackendoff, 1972).

Table I. The test-sentences pairs. Stressed syllables are in capitals. Bold signals focus.
(see next page)

Set 1

1. O gaLÃ]$_{\phi}$ ANda de porsche [gɐ'lɐ̃ 'ɐ̃ dɐ]
   O gaLÃ]$_{\phi}$ anDAva de porsche [gɐ 'lɐ̃ ɐ̃ 'davɐ]
   'the gallant drives/drove a Porsche'
2. Uma maNHÃ ÂMbar]$_{\phi}$ inspirou o pintor [mɐ 'nɐ̃ 'ɐ̃ bar]
   Uma maNHÃ angeliCAL]$_{\phi}$ inspirou o poeta [mɐ 'nɐ̃ ɐ̃ ʒli'kal]
   'an amber/angelic morning inspired the painter/poet'
3. O pintor retratou uma maNHÃ ÂMbar]$_{\phi}$ invulgar [mɐ 'nɐ̃ 'ɐ̃ bar]
   O poeta cantou uma maNHÃ angeliCAL]$_{\phi}$ perturbadora [mɐ 'nɐ̃ ɐ̃ ʒli'kal]
   'the painter/poet painted/sang an unusual/disturbing amber/angelic morning'
4. O pintor retratou uma maNHÃ ÂMbar]$_{I}$ [mɐ 'nɐ̃ 'ɐ̃ bar]
   O poeta cantou uma maNHÃ angeliCAL]$_{I}$ [mɐ 'nɐ̃ ɐ̃ ʒli'kal]
   'the painter/poet painted/sang an amber/angelic morning'
5. O pintor retratou uma **maNHÃ** ÂMbar]$_{I}$ [mɐ 'nɐ̃ 'ɐ̃ bar]
   O poeta cantou uma **maNHÃ** angeliCAL]$_{I}$ [mɐ 'nɐ̃ ɐ̃ ʒli'kal]
   'the painter/poet painted/sang an amber/angelic **morning**'

Set 2

1. O esQUI]$_{\phi}$ ANda desprezado actualmente ['ʃ ki'ɐ̃ dɐ]
   O esQUI]$_{\phi}$ anDAva desprezado há anos ['ʃ kiɐ̃ 'davɐ]
   'skiing is/was not promotted presently/for years'
2. Um javaLI Ático]$_{\phi}$ encontra-se entre as figuras de um fresco de Pompeia [ʒɐ vɐ 'li 'atiku]
   'an Attic wild pig is among the pictures of Pompei'
   Um javaLI acTIvo]$_{\phi}$ destruiu o campo inteiro [ʒɐ vɐ'li a'tivu]
   'a wild pig in action ruined the whole field'
3. O professor mostrou-me uma figura com um javaLI Ático]$_{\phi}$ em bronze [ʒɐ vɐ 'li 'atiku]
   'the teacher showed me a picture of a bronze Attic wild pig'
   Vi imagens da destruição causada por um javaLI acTIvo]$_{\phi}$ numa quinta [ʒɐ vɐ'li a'tivu]
   'I saw pictures of the chaos due to a wild pig in action in a farm'
4. O professor mostrou-me uma figura com um javaLI Ático]$_{I}$ [ʒɐ vɐ 'li 'atiku]
   'the teacher showed me a picture of an Attic wild pig'
   Vi imagens da destruição causada por um javaLI acTIvo]$_{I}$ [ʒɐ vɐ'li a'tivu]
   'I saw pictures of the chaos due to a wild pig in action'
5. O professor mostrou-me uma figura com um **javaLI** Ático]$_{I}$ [ʒɐ vɐ 'li 'atiku]
   'the teacher showed me a picture of an Attic wild pig'
   Vi imagens da destruição causada por um **javaLI** acTIvo]$_{I}$ [ʒɐ vɐ'li a'tivu]
   'I saw pictures of the chaos due to a **wild pig** in action'

Set 3

1. O caFÉ]$_{\phi}$ LUta pelo prémio do produto mais qualificado [kɐ 'fɛ'lutɐ]
   O caFÉ]$_{\phi}$ luTOU pelo prémio do produto mais qualificado [kɐ 'fɛ lu'to]
   'the coffee disputes/disputed the award of the best product'
2. O caFÉ LUso]$_{\phi}$ contém cevada de boa qualidade [kɐ 'fɛ'luzu]
   O caFÉ lusiTAno]$_{\phi}$ contém grãos de várias qualidades [kɐ 'fɛ luzi'tɐ nu]
   'the Lusitanian coffee contains barley of good quality/grains of various qualities'
3. Aquela loja também vende lotes de caFÉ LUso]$_{\phi}$ para exportação [kɐ 'fɛ'luzu]
   Aquela loja também vende lotes de caFÉ lusiTAno]$_{\phi}$ para exportação [kɐ 'fɛ luzi'tɐ nu]
   'that store also sells packages of Lusitanian coffee for exportation'
4. Aquela loja também vende lotes de caFÉ LUso]$_{I}$ [kɐ 'fɛ'luzu]
   Aquela loja também vende lotes de caFÉ lusiTAno]$_{I}$ [kɐ 'fɛ luzi'tɐ nu]
   'that store also sells packages of Lusitanian coffee'
5. Também vendo **caFÉ** LUso]$_{I}$ [kɐ 'fɛ'luzu]
   Também vendo **caFÉ** lusiTAno]$_{I}$ [kɐ 'fɛ luzi'tɐ nu]
   'I also sell Lusitanian **coffee**'

The 3 sets of test-sentences differ from one another in the segmental make-up of the clashing syllables. In sets 1 and 2 the first word ends with a stressed vowel and the second word begins with an unstressed vowel. As was shown in Frota (1994, 1995), word stress blocks the application of segmental rules affecting syllable nuclei, and therefore these are vowel adjacency cases amenable to verify whether and what stress clash resolution strategies apply. In set 3 the first word also ends with a vowel, but the second word begins with a consonant. The other possibility available in the language - the first word ending with a consonant - was not included in the experiment due to the wide range of phenomena that may affect the properties of a word-final consonant (such as voicing, primary and subsidiary articulation changes, and even resyllabification).

Due to the close nature of the issues considered, and for the sake of cross-linguistic comparison, the corpus design is similar to that reported in Arvaniti's (1992) experiment on stress clash resolution in Greek.

In addition to the 3 sets of test-sentences, the recording materials included an equal number of distractor sentences, which were part of a different study.

2.2. Speakers and procedure

The materials were recorded by three female native speakers of the EP Lisbon variety. At the time of the recordings they were all in their twenties. None of the speakers had known speech or hearing problems. CF and MV (undergraduate and graduate students at the University of Lisbon, respectively) were naive as to the purposes of the experiment. SF is the author.

The recordings took place in the phonetics room of the Center of Linguistics of the University of Lisbon. The speakers were asked to read the sentences as naturally as possible, and to repeat them in case of misreading. Each sentence was read 3 times by each speaker. The sentences were presented in random order. Each sentence was typed on a separate sheet to avoid a list reading effect.

The materials were digitized at 22.05 kHz, using the Silicon Graphics' workstation facilities at the Institute of Phonetic Sciences of the University of Amsterdam (IFA). Waveforms, spectrograms and F0 tracks were obtained from PRAAT, a computer program for signal analysis, manipulation, editing and visualization, developed at IFA by P. Boersma and D. Weenink. Version 2.25 of PRAAT was used.

2.3. Measurements

Durational measurements were obtained from zoomed waveform images, with the occasional help of the spectrographic image. As it is not known whether durational changes affect mainly the vowel or the whole syllable, the duration of both vowel and syllable was considered.

For each test-sentence several measuments were obtained: (a) the duration of the first word's stressed vowel/syllable; (b) the duration of the first word's unstressed vowel/syllable to which the stress could be shifted; (c) the duration of the first vowel/syllable of the second word; (d) the duration of the consonant that begins the second word (only in set 3); (e) the duration of the first word.

In addition to the durational measurements, F0 contours were plotted using the pitch tracker facility of PRAAT.

3. Results

3.1. Duration

Table II shows mean vowel and syllable durations for the first stressed vowel/syllable of the first word, both in the SC and the NSC conditions. The data were analysed by appiying the sign test and Wilcoxon matched-pairs signed-ranks test. The significance of the differences observed at the .05 level is also shown in Table II.

Lengthening of the first word's stressed syllable was systematically observed in the three sets of test-sentences and in all the prosodic configurations considered except across a ϕ-boundary. In other words, the lengthening of the first vowel/syllable involved in the clash is a means used for stress clash resolution within the ϕ-domain, in EP.

Table II. Mean durations (in ms) of the stressed vowel/syllable of the first word, and probability levels associated with the differences observed. Type of boundary is indicated by], vowel is indicated by v, syllable by s, SP stands for speaker, and the numbers 1, 2, and 3 indicate the sets of test-sentences.

]	v / σ	SP	1		α=	2		α=	3		α=
			SC	NSC	.05	SC	NSC	.05	SC	NSC	.05
_]ϕ_	v	CF	144.6	187.5	<	136.7	133.0	not =	117.3	122.0	not =
		MV	76.9	84.1	s.	85.7	53.4	N.S.	104.0	96.3	N.S.
		SF	89.4	105.8	.010	75.0	88.0	.454	163.1	116.3	.180
	σ	CF	233.9	276.8	<	250.1	242.9	not =	236.8	242.3	not =
		MV	141.0	153.5	s.	178.1	143.7	N.S.	226.6	215.5	N.S.
		SF	169.2	187.6	.020	184.8	193.9	.454	313.2	245.4	.508
__]ϕ	v	CF	148.3	101.6	>	85.2	72.5	>	95.4	72.3	>
		MV	128.9	94.9	s.	63.7	62.6	s.	102.3	77.4	s.
		SF	186.5	118.3	.001	104.9	81.3	<.001	113.2	89.0	<.001
	σ	CF	230.6	199.1	>	134.0	128.1	>	209.4	181.1	>
		MV	214.5	176.8	s.	116.0	117.2	s.	217.0	188.5	s.
		SF	265.0	197.4	.001	164.5	139.0	<.001	221.0	206.0	<.001
__] I	v	CF	147.1	120.4	>	95.0	72.9	>	97.9	66.7	>
		MV	133.1	97.3	s.	68.7	57.1	s.	113.1	82.2	s.
		SF	174.7	115.2	.020	90.4	77.7	.002	113.0	85.8	.001
	σ	CF	231.6	212.1	>	151.7	132.2	>	205.2	190.1	>
		MV	213.1	175.1	s.	123.3	115.0	s.	236.1	195.1	s.
		SF	260.2	203.5	.020	162.1	148.6	.011	226.2	208.3	.011
_ _] I F	v	CF	186.8	170.6		108.9	100.8		-------	-------	*Total
		MV	194.4	155.9		134.1	93.6		-------	-------	> s.
		SF	267.6	177.7	*	172.2	173.6	*	215.9	165.8	<.001
	σ	CF	281.4	284.1		191.2	178.4		-------	-------	*Total
		MV	292.4	258.1		183.2	157.3		-------	-------	> s.
		SF	376.6	288.6	*	267.0	264.6	*	376.3	319.0	<.001

When a ϕ-boundary intervenes between the two clashing syllables, different trends are observed: either there is no significant durational difference (sets 2 and 3), or there is shortening of the first vowel/syllable involved in the clash (set 1). The shortening result was found to be a consequence of the insertion of acoustic pauses. All the pauses found in the data were inserted after the ϕ-boundary, which is a predictable position for pause insertion as ϕ-boundaries may restructure and become I-boundaries (particularly if the ϕ-boundary coincides with the NP/VP boundary - cf. Frota 1994, 1995). What is not a predictable result, if pause insertion were to be interpreted as a stress clash resolution strategy in EP, is the fact that 71.4% of the pauses occur in the NSC condition. The presence of a pause is correlated with the longer duration of the stressed syllable of the first word (which is also the last syllable before the pause - see section 3.2.2.), and thus this syllable happens to be longer in the NSC condition than in the SC condition. This difference becomes a significant one only in set 1 because in this group of test-sentences all the pauses observed occur in the NSC condition. Consequently, neither shortening nor pause insertion constitute strategies for the resolution of stress clashes across ϕ-domain boundaries, in EP.

Besides the stressed vowel/syllable lengthening, a stress clash across a ϕ-boundary could be remedied by lengthening the consonant between the two clashing vowels. However, Table III shows that this possibility does not hold. The durations of the second syllable consonant pattern in the same way as the durations of the first stressed vowel/syllable: the consonant is lengthened except across a ϕ-boundary.

Table III. Mean durations (in ms) of the second syllable consonant in set 3 of test-sentences, and probability levels associated with the differences observed (there was not enough data to test the significance of the difference in the - F -]$_I$ situation).

]	SP	SC	NSC	α= .05
_]ϕ _	CF	69.9	64.8	
	MV	56.0	50.6	N.S.
	SF	75.4	62.0	.090
_ _]ϕ	CF	74.4	55.8	
	MV	59.4	55.5	s.
	SF	90.1	58.6	.001
_ _] I	CF	77.5	52.3	
	MV	73.5	51.5	s.
	SF	91.3	59.9	.001
_ _] I (F)	CF	-------	-------	
	MV	-------	-------	
	SF	84.6	76.9	-------

Table IV shows the mean durations of the unstressed vowel/syllable to which the stress could be moved if a stress shift strategy would apply, as illustrated in (4).

(4) a.
```
  * *          *  *
* * *        * * *
* * *        * * *
café luso  >  café luso
```
b.
```
   * *            *    *
 *  * *          *  *  *
 * * * *        * * * *
javali ático  >  javali ático
```

In the large majority of cases there is no lengthening effect. Crucially, this effect never shows up as a possible stress clash resolution strategy when a ϕ-boundary separates the clashing elements.

Table IV. Mean durations (in ms) of the unstressed vowel/syllable which is the target for stress shift, and probability levels associated with the differences observed if H_1=SC>NSC ((i) signals the cases in which no exact p value is provided by the test applied). (For more details see Table II.)

]	V / σ	SP	1		α=	2		α=	3		α=
			SC	NSC	.05	SC	NSC	.05	SC	NSC	.05
_]φ _	V	CF	73.6	61.9		-------	-------		40.5	38.7	
		MV	69.1	62.0	N.S.	-------	-------		44.1	43.9	N.S.
		SF	85.0	96.4	.50	-------	-------	-------	53.0	51.9	.50
	σ	CF	143.2	132.5		-------	-------		134.5	137.3	
		MV	120.6	109.3	N.S.	-------	-------		130.0	124.0	N.S.
		SF	160.0	164.9	.254	-------	-------	-------	144.3	140.1	.746
_ _]φ	V	CF	41.2	45.3		63.4	56.8		38.2	34.4	
		MV	60.5	50.2	N.S.	61.4	72.9	N.S.	38.8	37.9	
		SF	78.1	73.4	.407	60.0	52.6	.593	51.1	50.9	N.S.(i)
	σ	CF	110.1	114.2		131.7	121.4		128.1	119.6	
		MV	140.7	128.6	N.S.	115.4	133.3	N.S.	118.8	114.3	S.
		SF	138.5	139.7	.760	129.5	121.3	.240	129.6	125.1	.001
_ _] I	V	CF	49.5	44.8		54.2	60.9		38.0	33.9	
		MV	51.8	43.6	N.S.	58.1	60.4	N.S.	34.3	33.5	N.S.
		SF	69.2	64.3	·.090	61.3	51.0	.145	39.8	37.1	.377
	σ	CF	121.8	115.2		123.0	124.0		121.9	109.3	
		MV	121.2	121.5	N.S.	111.2	115.1	N.S.	107.3	102.4	N.S.
		SF	128.3	129.3	.254	138.4	120.1	.254	119.6	114.4	.377
_ _] I F	V	CF	41.5	53.6		74.8	58.5		-------	-------	*Total
		MV	46.4	45.0		58.6	55.2		-------	-------	N.S.
		SF	83.3	78.8	*	59.9	55.2	*	53.4	48.9	.151
	σ	CF	116.7	129.7		144.4	134.2		-------	-------	*Total
		MV	125.6	122.0		116.3	96.8		-------	-------	S.
		SF	153.7	147.1	*	140.3	136.4	*	153.2	139.1	.025

As a stress shift strategy could be shown by a change of the relative duration of the relevant unstressed vowel/syllable, relative measurements were obtained. Table V shows the existence of two main trends: either the difference is not significant, or there is a significant difference that goes in the opposite direction, i.e. the relative duration of the unstressed syllable is shorter in the SC condition. This shortening occurs only in the cases where lengthening of the stressed syllable was observed (see Table II). Therefore, the shortening of the unstressed syllable is a side effect of the lengthening of the stressed syllable.

There is one case of significant lengthening of the unstressed syllable in the SC condition across a φ-domain boundary. However, this lengthening is again a result of pause insertion. As mentioned, the occurrence of pauses in set 1 NSC test-sentences accounts for the apparent shortening of the stressed syllable in the SC condition. The reverse of that shortening effect is the case of lengthening of the unstressed syllable showed in Table V.

Table V. Mean durations of the unstressed vowel/syllable which is the target for stress shift, expressed as percentages of the whole word duration, and probability levels associated with the differences observed if H_1=SC>NSC (**< indicates a significant difference that does not support H_1). (For more details see Table II.)

]	v / σ	SP	1		α=	2		α=	3		α=
			SC	NSC	.05	SC	NSC	.05	SC	NSC	.05
_]φ _	v	CF	19.6	15.2		-------	-------		11.0	10.2	
		MV	26.3	23.7	N.S.	-------	-------		12.5	12.9	N.S.
		SF	25.8	27.4	.09	-------	-------	-------	11.6	13.6	.965
	σ	CF	38.1	32.4		-------	-------		36.5	36.3	
		MV	45.9	41.7	S.	-------	-------		36.5	36.5	N.S.
		SF	48.7	46.8	.005	-------	-------	-------	31.7	36.3	.980
_ _]φ	v	CF	12.1	14.6		16.9	15.6		11.3	11.5	
		MV	17.0	16.5	N.S.	16.5	18.7	N.S.	11.6	12.5	N.S.
		SF	19.4	21.8	.952	14.1	13.7	.593	14.6	15.3	.881
	σ	CF	32.4	36.5	**<	35.1	33.3		35.5	39.7	**<
		MV	39.7	41.8	S.	31.1	34.2	N.S.	35.4	37.7	S.
		SF	34.4	41.5	.004	30.6	31.6	.760	36.9	37.8	<.001
_ _] I	v	CF	14.0	13.6		14.0	15.9		11.6	11.3	
		MV	15.5	14.7	N.S.	16.1	16.8	N.S.	10.0	11.3	N.S.
		SF	17.9	19.2	.254	14.2	12.9	.637	11.6	11.5	.838
	σ	CF	34.5	35.3	**<	31.7	32.7		37.3	36.4	
		MV	36.3	41.0	S.	30.8	32.0	N.S.	31.1	34.4	N.S.
		SF	33.3	38.9	.020	32.0	30.3	.363	34.7	35.4	.838
_ _] I F	v	CF	10.4	12.9		16.2	14.0		-------	-------	*Total
		MV	11.1	11.8		12.6	14.2		-------	-------	N.S.
		SF	15.7	18.1	*	10.6	9.8	*	10.1	10.7	.982
	σ	CF	29.3	31.3		31.4	30.8		-------	-------	*Total
		MV	30.1	32.1		25.0	24.7		-------	-------	N.S.
		SF	29.0	33.9	*	24.8	24.2	*	29.0	30.5	.696

To conclude, lengthening is the strategy used for stress clash resolution in EP in all the prosodic configurations with the exception of one: when the two clashing stresses are separated by a φ-boundary, no consistent nor significant durational difference was found.

3.2. Fundamental frequency

The F0 contours of the three speakers show no difference between the SC and the NSC elements of each pair of sentences, independently of prosodic structure: the patterns observed in the SC condition also occur in the NSC data, as the F0 contours in Figs. 1 and 2 illustrate.

As mentioned in section 1., neutral declarative intonation in EP is minimally defined by a nuclear pitch accent and a final I-boundary tone. In an utterance with at least two stressed syllables, a prenuclear accent is also expected to occur in the vicinity of the first stressed syllable of the Intonational Phrase. However, as φ's do not have to be

tonally marked, the stressed syllables between the first stressed syllable and the last one, which carries the nuclear pitch accent, may not carry any tonal event (cf. Frota forthcoming a).

In Fig. 1(A) and (B) the same pattern is observed for both SC and NSC word-pairs within the ϕ-domain: the first stressed syllable gets an H* and a L*+H is associated with the second stressed syllable. As the second stressed syllable is more distant from the first one in the NSC condition, the F0 minimum is reached farther on in the sentence. Fig. 1 (C) and (D) tell the same story for word-pairs within the same ϕ and adjacent to the final I-boundary: the first stressed syllable in either of the pairs gets no pitch accent and the second syllable, which is the last one of the I-domain, carries the nuclear pitch accent H+L*. Again, the F0 minimum is closer to the first word's stressed syllable in the SC case than in the NSC case, due to the different number of syllables intervening between the two stresses.

Finally, Fig. 2 shows a pair of test-sentences in which the two words are separated by a ϕ-domain boundary. The first word exhibits the same F0 pattern in both SC and NSC conditions: an initial I-boundary tone is realized on the first syllable, and the stressed syllable carries the L*+H pitch accent. In the NSC pair, the second word's stressed syllable also gets a pitch accent.

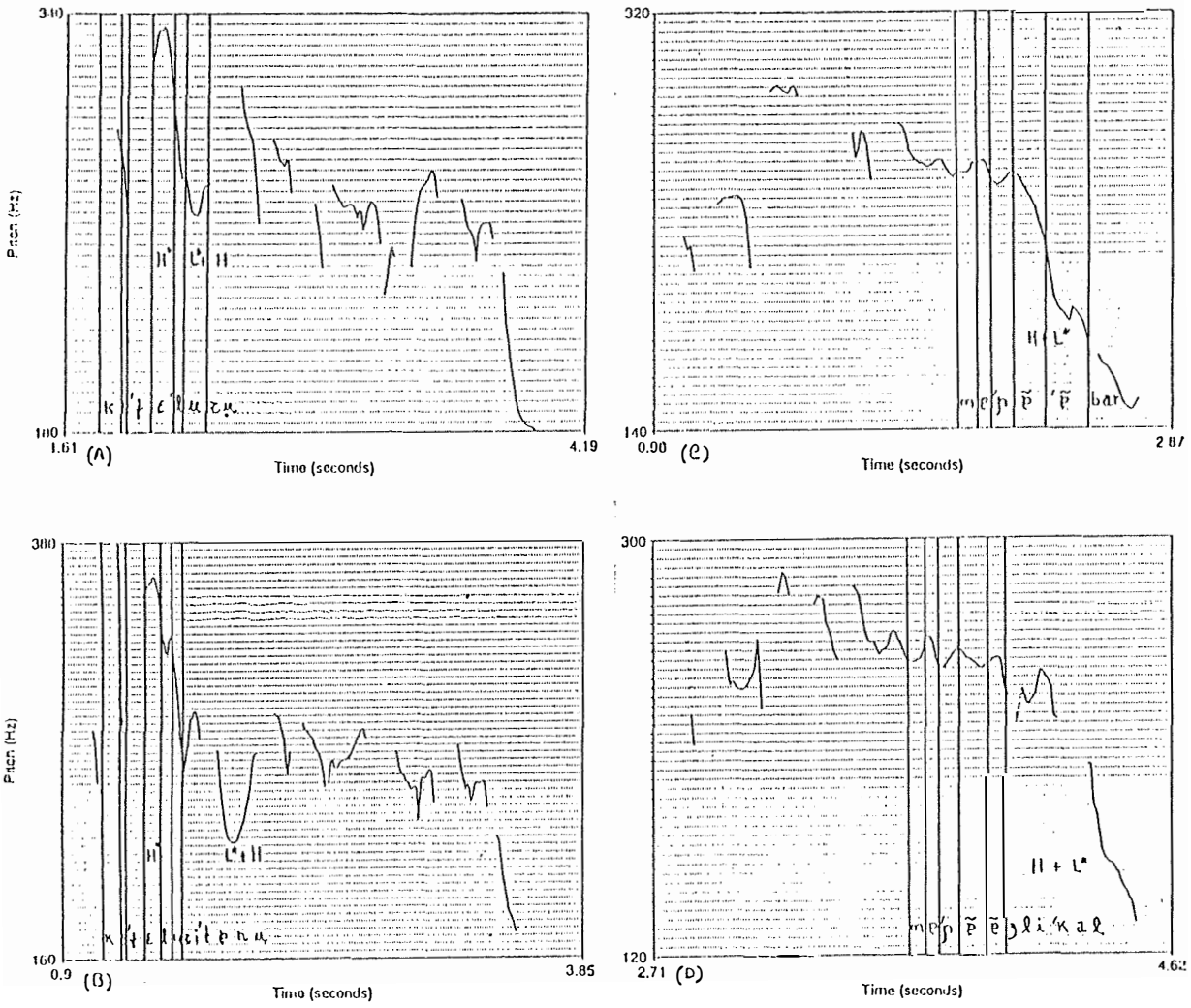

Fig. 1. F0 contours: (A) and (B) test-pair 2 (set 3) by speaker CF; (C) and (D) test-pair 4 (set 1) by speaker MV.

To summarize, pitch difference in not a strategy for stress clash resolution in EP. Different pitch levels may characterize the two clashing syllables in the same way as they may characterize any other stressed syllables, following the usual pattern of declarative tunes.

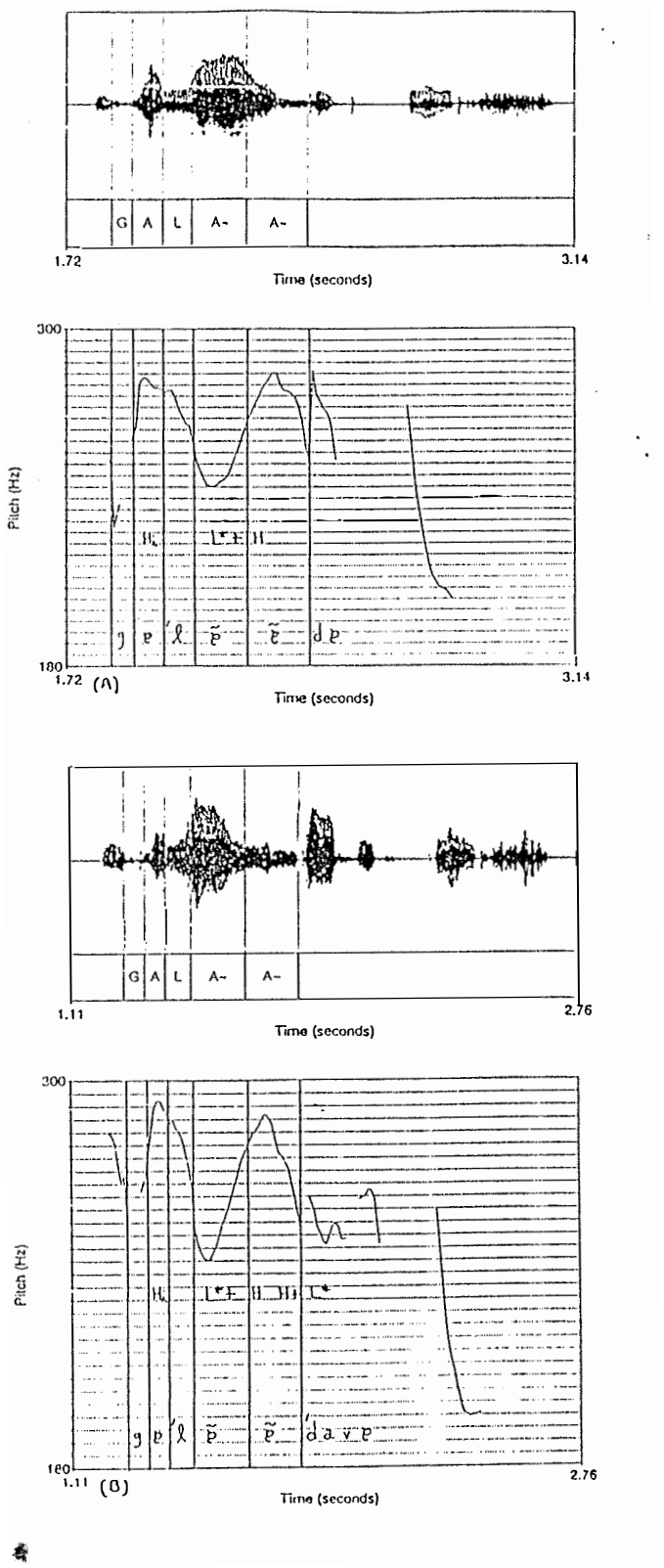

Fig. 2. F0 contours: test-pair 1 (set 1) by speaker MV.

4. Discussion

4.1. Shortening and Lengthening

The experiment on stress clash resolution provides no evidence of shortening of the first stressed vowel/syllable involved in the clash. Moreover, there is no lengthening of the pre-stressed vowel/syllable that could be the target for stress movement. Consequently, the data do not support either beat deletion or stress shift as stress clash resolution strategies in EP. This result is consistent both with the total unawareness of destressing or stress movement phenomena in the literature on stress in EP, and with the native speakers' strong intuition that such phenomena are awkward, if not true misaccentuations.

The lengthening of the first stressed vowel/syllable involved in the clash, together with the lengthening of the following consonant, is the clash resolution strategy supported by the experimental data. However, EP shows a particular behaviour: the lengthening occurs everywhere in the prosodic structure except across a ϕ-boundary. This result confirms the suggestion put forward in Frota (1994): EP shows a lack of resources at the ϕ-level. EP is thus different from Greek, or Italian, or English. It is different from Greek because it does not use lengthening (cf. Nespor and Vogel 1989). However, the results reported in Arvaniti (1992) show that in the same prosodic configuration (Arvaniti's test-pairs 1 and 2) there is also no lengthening in Greek. EP is different from both Italian and English because lengthening is an available strategy for stress clash resolution across a ϕ-boundary in these languages (cf. Nespor and Vogel 1986, 1989). Furthermore, whereas in Italian and English beat deletion or stress shift are available strategies for stress clash resolution within-ϕ (cf. Nespor and Vogel 1986, 1989), in EP beat insertion is the only strategy used.

4.2. Against the intonational hypothesis

Besides lengthening, the presence of pauses and of pitch differences are the other means of inserting phonological distance between two clashing stresses which have been proposed in the literature (see section 1.). If no evidence for beat deletion or lengthening was found across a ϕ-boundary in EP, beat insertion could nevertheless be the strategy used in this prosodic configuration.

The data show no evidence that different pitch levels are being used for stress clash resolution, and the same holds for pause insertion. These results are consistent with the findings of Arvaniti (1992) for Greek.

The fact that in the data pause insertion occurs only when there is a ϕ-boundary between the two test-words has a straightforward explanation: due to restructuring, a ϕ-boundary may become an I-boundary and therefore an I-boundary tone and a pause are predictable in this position, whether a stress clash is present or not. If the I-boundary is there it resolves the clash. However, there is no evidence that a ϕ-boundary tends to become an I-boundary for stress clash resolution purposes. In fact, the data show that this kind of restructuring occurs more frequently in the NSC than in the SC condition. In this respect, EP seems to be different from Greek: although lengthening is not used as a strategy for stress clash resolution across a ϕ-boundary in both languages, the insertion of an I-boundary between the two stresses is a strategy used in Greek, according to Arvaniti's (1992) experimental data.

In conclusion, the present results do not provide evidence for any means of stress clash resolution when a ϕ-boundary intervenes between the two stresses, in EP.

4.3. Focus and prosodic phrasing

A comparison between the data from test-pairs 4 and 5 shows that both in the neutral word-pair (pair 4) and the focus word-pair (pair 5) there is lengthening of the first stressed vowel/syllable in the SC condition. Despite the fact that lengthening was already shown to be a correlate of focus in EP (Frota 1991, 1993), there is a significant difference in lengthening between the NSC-focus condition and the SC-focus condition (see Table I). As shown in Fig. 3, the degree of the lengthening of the first stressed syllable increases from the NSC condition up to the SC-focus condition. All the four groups are significantly different from one another, both within and across speakers.

The interest of these result is two-fold. First, it provides additional evidence for the absence of a focus effect on prosodic phrasing in EP (Frota 1993, forthcoming a): if focus led to the insertion of a ϕ-boundary, we would expect no difference between the NSC and the SC conditions in the focus cases, as lengthening is not a remedy for clash resolution across a ϕ-boundary. Second, it is a clear case for the independence of the rhythmic and intonational structures: although focus has to be intonationally signalled by a particular pitch accent which is the intonational phrase nuclear accent (Frota forthcoming a), the processes of readjusting an ill-formed rhythmic configuration remain unaffected.

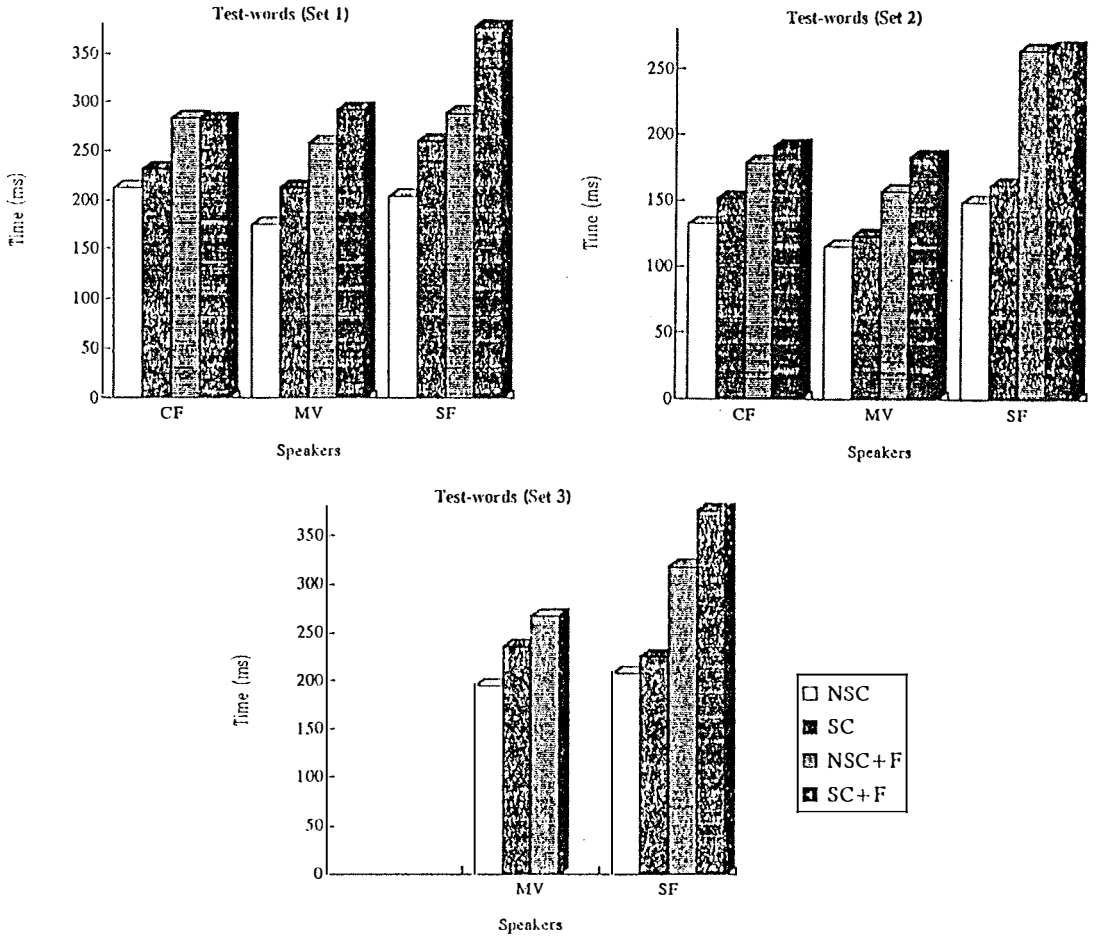

Fig. 3. Mean durations (in ms) of the stressed syllable of the first word in the following conditions: without stress clash (NSC), with stress clash (SC), without stress clash but in focus (NSC+F), with stress clash and in focus (SC+F). For all speakers and all sets of words, SC<NSC+F (p=.005).

5. Conclusion

The results of the experiment reported in the present paper support the previous segmental and intonational evidence for the 'invisibility'of the the ϕ-domain in EP (see Frota (forthcoming b) for additional evidence in the same direction: in EP pre-boundary lengthening is not a property of ϕ-boundaries, but only of I-boundaries (as opposed to English or Italian)). This lack of resources at the ϕ-prosodic level was also shown to be patent in the fact that no evidence was found for any means of stress clash resolution across a ϕ-boundary. As stress clashes are resolved by beat insertion in other prosodic configurations, the reason behind this absence of rhythmic readjustment must lie in the specific properties of the ϕ-domain in EP.

The existence of an assymetry between the Phonological Phrase and the Intonational Phrase does not mean that evidence for ϕ is totally absent in EP. In fact, the stress clashes results can be interpreted as some kind of (negative) evidence for ϕ, suggesting that this level is nevertheless distinct from the word-level. Moreover, as was mentioned elsewhere, ϕ is an operative concept for phrasing prominence assignment and tonal association in EP (Frota forthcoming a). Therefore, questioning the existence of the ϕ-domain does not seem to be the real issue, but rather understanding the cross-linguistic variation in the properties that define the prosodic phrases. The 'invisibility' of ϕ has to be considered a property of EP prosody, as opposed to languages like English, Italian, Greek, or Bengali, and probably closer to languages like Dutch or German (cf. Kleinhenz 1994, and Van Donzel 1994).

In conclusion, the specific properties of the Phonological Phrase in European Portuguese argue in favour of a language difference which enriches the discussion of prosodic domain typology.

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