Phonology-Syntax Interface[1]

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0. Introduction

Since the early 1970's it has been acknowledged that (i) phonological phenomena often apply with reference to domains that do not necessarily coincide with morphological or syntactic constituents and (ii) the interaction between the phonological and syntactic components is limited and principled. These observations have led to the construction of the theory of Prosodic Phonology (Selkirk 1984, Nespor & Vogel 1986). This chapter provides an overview of the work on prosodic phonology and the syntax-phonology interface in Brazilian and European Portuguese (BP and EP, respectively). Section 1 focuses on the evidence available for prosodic domains above the foot-level. The construction of prosodic domains and the interaction between phonology and other components of the grammar are surveyed in section 2. We conclude in section 3 with some final remarks.

1. Evidence for prosodic structure from Portuguese

In this section we review some of the phonological evidence for prosodic constituents in Portuguese, a topic that has received great attention since the seminal work by Bisol (1992) on BP and Frota (1995) on EP, both of which articulated within the framework of Prosodic Phonology developed in Nespor & Vogel (1986). As phonologists disagree on whether the lowest prosodic domain that interacts with syntax is the clitic group or the (post-lexical) prosodic word, we start by looking at the available evidence for the level of prosodic word in both varieties of Portuguese (subsection 1.1) and discussing the prosodic status of clitics and the

internal prosodic structure of compounds (subsection 1.2). We then consider the phonological properties of higher levels of the prosodic hierarchy, namely, the phonological phrase (subsection 1.3) and the intonational phrase (subsection 1.4).

1.1. The Prosodic Word

Early insights regarding the distinction between morphosyntactic and prosodic words may be traced back to Morais Barbosa (1965) and Mattoso Câmara (1972). Acknowledging the mismatch between these two types of grammatical constructs, recent work has mainly focused on (i) identifying phonological diagnostics for the level of prosodic word (henceforth, PW) and (ii) defining the prosodic organization of morphosyntactic units at this level. In this subsection we will focus on the former.

In both varieties of Portuguese, the presence of word stress and the (non-)application of phonological rules that are sensitive to it provide the major cues for the identification of PW.[2] Examples include various processes that target unstressed vowels, such as neutralizations in BP involving pretonic (/ɛ/ > [e]; /ɔ/ > [o]; cf. (1a)) and post-tonic final vowels (/e/ > [i]; /o/ > [u]), the so-called process of vowel reduction in EP (/e, ɛ/ > [ɨ]; /o, ɔ/ > [u]; /e a/ > [ɐ]: cf. (1b)), and the optional processes of V1 glide formation (cf. (1c)) and vowel deletion to break a hiatus in both varieties.[3]

(1) a. p[o]rteira (porteira)$_{PW}$ 'gate'   vs. p[ɔ́]rta (porta)$_{PW}$ 'door'   (BP)

   b. p[u]rteira (porteira)$_{PW}$ 'door keeper$_{FEM}$' vs. p[ɔ́]rta (porta)$_{PW}$ 'door'   (EP)

   c. ad[j]ar   (adiar)$_{PW}$ 'to delay'   vs. ad[í]o (adio)$_{PW}$ '(I) delay' (EP, BP)

Both varieties also have a number of assimilation rules that are circumscribed to PW, as illustrated in (2). These include vowel harmony (cf. (2a)) and nasalization of vowels preceding a nasal onset consonant in BP (this process occurs in all dialects if the target vowel is stressed, as in (2b), and in some dialects also if it is unstressed, as in the first syllable of *banana* (2b)); stressless *e*-deletion in EP, which is (almost) obligatory in PW final position (cf. (2c)); and the

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[2] For details and relevant discussion, see among others, Wetzels (1992), Bisol (2000), Schwindt (2000), and Vigário (2003).
[3] When relevant, syllables bearing word stress will be represented with capital letters.

2

optional processes of vowel deletion (cf. (2d)), glide formation (cf. (2e)), and syllable degemination (cf. (2f)) at the right edge of the PW in both varieties.

(2) a. p[e]PIno ~ p[i]PIno 'cucumber'

b. baN[ẽ]na ~ b[ẽ]N[ẽ]na *baN[á]na 'banana' vs. *VEl[ẽ] NOva 'new candle' and *RApid[ẽ]MENte (rapida)PW(mente)PW 'rapidly'

c. bebe água > beb água '(he) drinks water'

d. bela organização (bela)PW (organização)PW > bel[o]rganização *nice organization*

and ultra-ocupado (ultra)PW (ocupado)PW > ultr[o]cupado 'extra busy'

vs. maometano >*m[o]metano 'mohammedan'

e. iogurte > [j]ogurte 'yogurt '

f. gato temeroso > ga temeroso 'scared cat'

Nonsegmental phenomena may also cue the PW.[4] Prominence related phenomena such as initial stress, emphatic stress, and pitch accent, for instance, signal the presence of PW, as initial and emphatic stress are assigned to PW initial syllables and, at least in EP, pitch accents can only be associated with syllables bearing primary word stress. Furthermore, some deletion processes, namely, deletion under identity (as we will see subsection 2.5) and word clipping or truncation in EP target the prosodic word. For example, in this variety clipping consists of the deletion of a PW and thus cannot target part of a PW, as illustrated by the contrast in (3) below.[5]

(3)   a. TEleMÓvel (tele)PW (móvel)PW >   móvel   'mobile phone'

b. teleFOne (telefone)PW   > *fone, *tele   'telephone'

Finally, there are several phonotactic restrictions that apply to PWs in both varieties. For example, no PW starts in [ɾ, ɲ, ʎ], while these segments may be syllable initial within words, as in a[ɾ]a[ɾ]a *arara* 'macaw', se[ɲ]or *senhor* 'sir', ca[ʎ]a *calha* 'roof rack').

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[4] See a.o. Vigário (2003), Fernandes (2007), Toneli (2014).

[5] Vowel Reduction and deletion provide evidence that in (3a) there are two PWs, while in (3b) there is only one: in *telefone* all letters *<e>* are either pronounced as schwas or deleted, which means that they do not bear stress. In turn, in *telemóvel* the first *<e >* is low, and stress is perceptible in the first syllable. EP differs from many other languages, including BP, in that clipping targets the whole PW. In fact, in EP truncation of words that form a single PW is usually impossible, unlike in BP (e.g. *refri* is acceptable as a reduction of *refrigerante* 'soda'in BP, but not in EP).

3

1.2. Clitic-host combinations and compound-like groupings

As in many other languages, a number of functional words in Portuguese do not bear word stress. Which words are clitics and which ones have the status of PWs is to a certain extent language-specific. Processes that apply in unstressed environments in Portuguese, such as stressless vowel neutralization, glide formation, and deletion, as well as violations of phonotactic restrictions imposed on PWs (cf. (4)), show that weak personal pronouns, many monosyllabic prepositions and complementizers, and definite articles are clitics (Bisol 2000, Vigário 2003).

(4) p[u]r tela   'by screen'   vs. p[o]rtela   'Portela (proper name)' (BP)

    de [dɨ]~ [d], da [dɐ] 'of', 'of + the_FEM' vs. dê [dé], dá [dá] 'give_IMP.', 'give_PRES.3rd-sg'   (EP)

    no alto [nua]~[nwa] 'in the_MASC high' vs. nu alvo [nua]/*[nwa] 'naked white'   (BP, EP)

    lhe [ʎɨ]   pronoun-_DAT-3rd-sg   vs. *lhado   *non-word*   (BP, EP)

Clitics display specific phonological behavior in each variety of Portuguese, depending on the particular prosodic organization they establish with their hosts, which depends on their position relative to the host (this issue is adressed in section 2).

    Unlike simplex words and most morphologically complex words, transparent compounds, and some derived words are formed by more than one PW. The PW status of the internal components of the latter category of words is shown, among other facts, by their behavior with respect to processes that refer to the PW domain, such as word stress (cf. (5a)), the impossibility for glide formation to affect stressed vowels (cf. (5b)), deletion under identity (cf. (5c)), or resyllabification (cf.(5d)) (data from Bisol 2000, Schwindt 2000, and Vigário 2003).

(5)   a. PÓS-acentuAL 'post-stressed', agraDAvelMENte 'pleasantly', PORta-banDEIras 'flag-
     stand', FMI (Efe-Eme-I) 'IMF'

    vs. p<u>o</u>sPÔR 'postpone', visi<u>o</u>naMENto 'viewing', p<u>o</u>rtaGEIro 'toll   collector',
    ef<u>e</u>miNAdo[6] 'effeminate'

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[6] The underlined vowels undergo neutralization in stressless position in both varieties, the process being obligatory in EP and optional in BP.

b. b[í]-anuAL 'biannual', b[í]o-degraDÁvel   'biodegradable'

  vs. r[i]organizar or r[j]organizar 'to reorganize', b[i]ologia or b[j]ologia 'biology'

c. aLEgreMENte ou TRIsteMENte> aLEgre ou TRIsteMENte 'happily or sadly'

d. sub+locar [sub.lo]car ~ [su.bi.lo]car *[su.blo]car   'sublease'

  vs. sublime [su.bli]me   * [sub.li]me *[su.bi.li]me 'sublime'   (BP)

Depending on the intrinsic properties of the morphemes or words involved and the type of morphosyntactic construction they integrate, compound-like internal elements may behave phonologically in different ways. The prosodic organization displayed by this sort of words when formed by more than one PW is discussed in section 2.

1.3. *The Phonological Phrase*

The phonological phrase (PhP) is the next higher level in the prosodic hierarchy. Like other domains, PhP also has a prominent element, which in neutral utterances corresponds to its rightmost PW. Both stress clash resolution phenomena and tone distribution are constrained by PhP-level prominence. For example, optional vowel deletion processes across words may be blocked under certain stress conditions, as illustrated in (6), taken from Frota (2000). In (6a) deletion is not available because V2 bears PhP prominence. As for (6b), deletion is possible because although V2 has word-level stress, it is not the head of its PhP. Similar data are available for BP as well, as illustrated in (7) (from Bisol 2003).

(6)   a. O dançaRIn<u>o A</u>ma a bailarina russa   *dançarin[a]ma

             'The dancer loves the Russian chorus girl'

         b. O bailaRIn<u>o AN</u>da sempre de limousine preta   [ok]bailarin[an]da

             'The dancer always drives a black limousine'

(7)   a. Ele masTIga Ervas   *mastig[ɛr]vas

             'He chew herbs'

         b. Ele masTIga Ervas amargas   [ok]mastig[ɛr]vas

             'He chew bitter herbs.'

Vowel deletion and semivocalization are affected by stress clash configurations, although the specific strategy employed to resolve stress clashes varies depending on the prosodic configuration and the language variety (Tenani 2002). According to Frota (2000), in EP, when the clashing sequence is part of the same PhP, the first syllable of the clashing pair is lengthened (cf. (8a)), but there is no lengthening effect when a PhP boundary intervenes between the clashing syllables (cf. (8b)).

(8)   a. (O caFÉ: LUso)ϕ contém cevada de boa qualidade
           'The Lusitanian coffe contains barley of good-quality '
        b. (O caFÉ)ϕ (LUta)ϕ pelo prémio do produto mais qualificado
           'The coffee disputes the award for the best product'

In BP, different prosodic domains also show different means to resolve internal stress clashes. Within the PhP, (optional) stress shift is applied, as in (9a) vs. (9b) (Abousalah 1997). When the stress clash occurs between PhPs, as in (9b), one clash-avoiding strategy consists in inserting a pause between the clashing syllables (Gravina & Fernandes-Svartman 2013).[7] The fact that stress shift is the preferred option not only in sentences such as (9a), but also in (9c), where the adjective follows the nominal head, provides evidence for the possibility of reestructuring non-branching phonological phrases with the preceding PhP in this variety.

(9) a. (dezeSSEIS HOmens)ϕ   DEzesseis Homens   'sixteen men'
    b. (o daVI)ϕ (GOSta)ϕ   * o DAvi GOSta   'David likes'
    c. (caFÉ)ϕ (QUENte)ϕ   CAfé QUENte   'hot coffe'

The different strategies employed to resolve clashes reflect different prosodic mappings for the clashing stressed syllables. For instance, given that optional stress shift only takes place within PhPs in BP, it always prompts the reading in (10a) below. By contrast, the insertion of a pause or the association of a pitch accent with each word involved in the clash prompts the

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[7] According to Tenani (2002), furthermore, in addition to stress shift, BP also uses beat insertion as a strategy for hiatus resolution when the central vowels (*a a*) are involved, within and across PhPs, unlike in EP.

reading given in (10b), as these are processes that apply between PhPs (Gravina & Fernandes-Svartman, 2013; example taken from Guimarães, 1998).

(10) o professor de balé russo   'The Russian ballet teacher'
    a. Russian ballet: (o professor)ϕ (de baLÉ RUsso)ϕ   BAlé RUsso ~ baLÉ RUsso
    b. Russian teacher: (o professor de baLÉ)ϕ (RUsso)ϕ *BAlé RUsso

Tonal marking also makes reference to PhP in both varieties, although in different ways. In BP, a phrasal accent (L-) optionally marks a PhP boundary after a focalized element (Fernandes 2007). In EP, pitch accents are optional in non-nuclear positions and when they occur in this position, they are usually only associated with the prominent element of the PhP (Frota 2014).

1.4 The Intonational Phrase

The intonational phrase (IP) defines the domain of intonational contours (minimally formed by a nuclear pitch accent and a boundary tone), final lengthening, and constitutes the loci for pause insertion (see chapter 9, *Intonation of European and Brazilian Portuguese*, this volume). Like all other levels mentioned in this chapter, IP neutral prominence is rightmost, a fact that is corroborated by the obligatory presence of a pitch accent associated with the head of the IP, the final PhP, as well as stress clash effects on vowel hiatus resolution (Frota 2000, Tenani 2002).

The IP is also the domain of an array of sandhi phenomena involving resyllabification in both varieties of Portuguese. These include optional word final deletion, vowel degemination[8], and prevocalic gliding as ways of breaking a hiatus, syllable-final fricative voicing, and syllable degemination (cf. (11a-e), respectively) (Bisol 1992, et seq., Tenani 2002, for BP; Frota 2000, for EP).

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[8] In EP, syllable degemination is characterized as involving fusion between two vowels (cf. Frota 2000) - in (11b), for instance, the two medium central vowels merge into a low central vowel. In BP, on the other hand, linguists disagree on the actual process that takes place, as the vowel does not change in quality. For Bisol (1992), for example, the process deletes the first vowel, whereas for Tenani (2002) there is fusion and optional shortening of the vowel.

(11) a. bel~~o~~ amigo   'great friend_{MASC}'

   b. bel[a]miga   'great friend_{FEM}'

   c. bel[w]amigo   'great friend_{MASC}'

   d. boa[z] avaliações   'good marks'

   e. A gen~~te~~ tocou.   'People played.'

Besides their different sensitivity to stress clash configurations, EP and BP differ with regard to the domain of sandhi phenomena and resyllabification.[9] While in EP the domain is clearly the IP (Frota 2014), in BP it appears that these phenomena are prosodically unbound. The example in (12) below, taken from Tenani (2002), illustrates diphtongation and resyllabification across semantically unrelated utterances in BP, which are not allowed in EP.

(12) O Pedro comprou pêsseg**o**. Alegaram falta de provas. >> pesseg[wa]legaram

    'Petter bought peaches. (They) alleged lack of proofs'

2. Construction of prosodic domains and the syntax-phonology interface

Within Prosodic Phonology, domains at the PW-level and above are built with reference to syntactic information. Nevertheless, it is generally assumed that phonological domains are distinct from syntactic ones in a number of fundamental ways: they are composed of a limited number of constituents that occupy a fixed position within a prosodic hierarchy and are organized in a way such that higher domains always contain one or more domains of the immediate lower level (except for the syllable). The organizational principles which account for the wellformedness of prosodic trees are known as the *Strict Layer Hypothesis* (Nespor & Vogel 1986; Selkirk 1996). Work on Portuguese phonology provides strong evidence for this type of prosodic organization. Nevertheless, a number of questions regarding the precise interaction between phonology and other components of the grammar remain controversial: To what extent is syntactic structure relevant for the specific organization of word and sentence prosody? What

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[9] BP and EP also seem to differ with respect to the possibility of V2 semivocalization: while *camisa usada > camisa*[w]*sada* 'used shirt' is possible in BP, it has been described as marginal in EP (cf. Bisol 1992 and Vigário 2003, respectively).

are the phonological conditions imposed on the formation of prosodic constituents? Exactly which domains compose the prosodic hierarchy and which tree configurations are (im)possible? In the following subsections, we address these questions.

2.1. The syntax-phonology mapping and the construction of prosodic domains

In this subsection we present the main features that have been proposed to account for the construction of prosodic domains in Portuguese.

### 2.1.1 Prosodic structure between the Prosodic Word and the Phonological Phrase

Usually a morphosyntactic word in Portuguese forms a PW (*fé* 'faith', *belo* 'beautifull_MASC', *adorou* 'loved_{3p.sg.}'). However, some morphosyntactic words, namely clitics (among which complementizers, prepositions, and the weak personal pronouns), are prosodically dependent in the sense that they do not form PWs by themselves. In other words, clitics are syntactic words that occupy syntactic terminal nodes, but which are defectively prosodized, since they do not form autonomous PWs. Conversely, some morphological words may include more than one PW, as in the case of compounds and certain derived words (e.g. *sócio-cultural* 'social-cultural', *guarda-chuva* 'umbrella', *pós-guerra* 'after war', *sinceramente* 'sincerely', *sozinho* 'alone'). It is worth observing that (i) words belonging to open classes always form (at least) one PW; (ii) clitics always belong to closed classes, are highly frequent, and have at most two syllables; and (iii) some affixes are assigned lexical stress and may form a PW independent from their bases. In what follows, we will focus on the (post-lexical) prosodization of clitics and the prosodization of syntactic words containing more than one PW.

Because of the phonological properties of clitic-host combinations, it has been proposed that clitics combine with their hosts to form a post-lexical PW or, in some accounts, a clitic group (CG). While in some studies the post-lexical PW and CG coincide (Bisol 2000a, Brisolara 2008), in others the CG is explicitly rejected, based on arguments against clitics being parsed within a fixed domain of the prosodic hierarchy (Vigário 2003, Simioni 2008).

In EP, evidence points fairly clearly to the prosodic adjunction of proclitics to the host PW and the incorporation of enclitics into the host PW, as depicted in (13a-b), respectively (Vigário 2003).
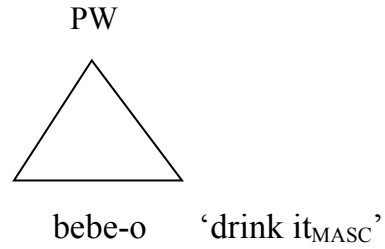
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(13) a. Proclitics: b. Enclitics:
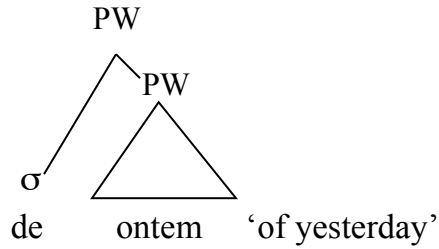
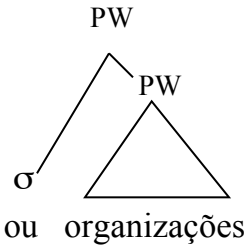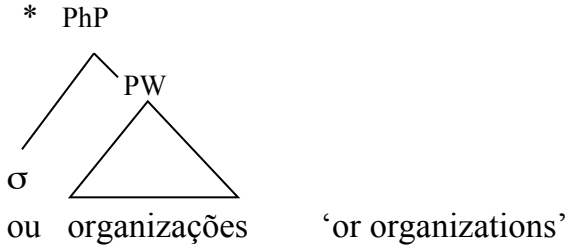 Prosodic adjuction to PW   Prosodic incorporation into PW

      de   ontem   'of yesterday'   bebe-o   'drink it_MASC'

The process of front vowel deletion − a rule that applies (nearly always) at the right-edge of the PW in intonational phrase internal position −, illustrates the main facts (see 14). The process of *e*-deletion applies in (14a-c) but not in (14d-e), because only in the former the non-back vowel is in PW-final position. Notice that in (14c) and (14e) the weak pronoun incorporates into the host PW, meaning that in (14c) the clitic final vowel becomes PW final and deletes, and in (14e) the host final vowel is nolonger PW final, and therefore cannot delete. In turn, *e*-deletion is not mandatory in (14f), indicating that the clitic by itself does not pattern like a PW and is not enclitic to the previous PW (this and other facts argue in favor of the proclitic nature of preverbal weak pronouns); here deletion may optionally occur due to a reduction process typically found in highly frequent words. In the examples below '^{x}' signals very infrequent, marked realizations; bold signals the target vowel.

(14)   a. DEv**e** $0/^x[ɨ]$ '(he) owes'

       b. DEv**e** aconteCER $0/^x[j]/^x[ɨ]$ '(it) must happen'

       c. DEve-t**e** aconteCER $0/^x[j]/^x[ɨ]$ '(it) must happen to-you'

       d. r**e**aliZAR $*0/[i]/[j]$ '(to) accomplish'

       e. DEv**e**-a $*0/[j]$ 'owes-it_{3p-sg}'

       f. JÁ t**e** aconteCEU $0/[j]/^x[ɨ]$ '(it) has already happended to-you'

Importantly, proclitics as well as the initial elements of their host behave like PW initial and unlike PW non-initial syllables in that they may bear emphatic stress and allow variable realization of stressless vowels, as in ***ou* organizações** 'or organizations'. Hence, these EP data are only compatible with an analysis in which proclitics adjoin to the PW, instead of attaching to a higher prosodic level (as in 15a, and unlike 15b).

(15) a.   PW   b.   * PhP

                    PW   PW

        σ   σ

        ou   organizações   ou   organizações   'or organizations'

For BP, all studies agree that proclitics and enclitics behave alike, but the evidence for where and how clitics are prosodically structured is less clear. Bisol (2000), for instance, claims that clitics (whether proclitic or enclitic) do not integrate the PW host, but rather adjoin to it in an extended prosodic word (postlexical prosodic word) or a clitic group, based on the fact that many clitics (e.g. *de* 'of', *me* 'to-me' or *por* 'by') optionally exhibit a high vowel ([i, u]) regardless of their position (as in m[e] fala ~ m[i] fala and fala-m[e] ~ fala-m[i] 'talk to me'), just like final weak syllables in lexical PWs (e.g. *fale* fal[e] ~ fal[i] 'speak, imp'; *árabe* arab[e] ~ arab[i] 'Arabic'). [10] In addition, vowel elision can occur between a clitic and its host (e.g. *uma hotelaria* > um[o]telaria 'a hotel management', *da hotelaria* d[o]telaria 'of-the$_{fem}$ hotel management'), while elision does not occur inside the PW (e.g. *maometano > m[o]metano 'mahhomedan'). The fact that palatalization of plosives followed by [i, j] applies to clitics, but not across PWs (e.g. *da historia* [ok][dʒ]istória 'of-the history', but *carta importante* *car[tʃ][i]mportante 'important letter') is seen as evidence that clitics are not adjoined to the PhP. In turn, Toneli (2009) defends the view that clitics adjoin to the PW in BP, based on the fact that proclitics, like in EP, may bear PW initial stress, which is assigned to stressless syllables in PW initial position. Toneli also claims that when clitics are under focus, they form independent PWs.

That clitics are inert with respect to stress location (e.g. *víamos-te* / *viamós-te* 'we used to see you') and may violate phonotactic restrictions on PWs is usually assumed to follow from the view that stress assignment and phonotactic restrictions operate in the lexical phonology only (Bisol 2000, Vigário 2003). Alternatively, Simioni (2008) suggests that BP clitics attach directly to the PhP, and therefore do not interact with word-stress and are not subject to the phonotactic restrictions imposed on PWs (e.g. they may start in [ʎ]). We may note that this analysis cannot account for the fact that proclitics pattern like PW initial, at least in EP, nor can it be extended to

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[10] See also Brisolara (2008), who shows that vowel height alternations in pronominal clitics do not result from Vowel Harmony, but from the neutralization of stressless vowels.

11

EP enclitics, which behave like PW internal syllables with respect to the postlexical phonology (although they are also inert with respect to primary word stress location in the host).

The exact mechanism responsible for the prosodic organization of clitics with their hosts has been investigated in Vigário (2003) for EP and Simioni (2008) for BP. In the former, the mapping between lexical and postlexical PW boundaries plays an important role: it is proposed that the lowest syntactic Lex° is mapped onto a PW and that only the left edge of the lexical PW is projected postlexically; this is meant to account for the fact that in EP only the left, but not the right boundary of lexical PWs is reflected postlexically (recall that in EP the phonological evidence indicates that proclitics adjoin to the PW and enclitics incorporate into the host PW). In turn, Simioni develops an OT analysis à la Selkirk (1996), with a particular constraint ranking accounting for the attachment of both proclitics and enclitics directly to the PhP.

Like clitics, compound-like constructs also occupy terminal nodes of syntactic structures. The prosodization of this type of expression has been subject to controversy, too. Admitting that some recursion is allowed in prosody, Guimarães (1998), Schwindt (2008), among many others, assume that the organization of compounds and other types of PW combinations involves recursive prosodic words (e.g. ((porta)$_{PW}$(bandeiras)$_{PW}$)$_{PW}$ 'flag stand'). Departing from previous work, Vigário (2010) claims that the constituents of these prosodic groupings form distinct domains instead of recursive prosodic words. It is argued that this type of constructions forms an independent domain, distinct from both the PW and the PhP (see subsection 2.3 below), which is referred to as the Prosodic Word Group (PWG) (instead of CG, as in previous accounts within prosodic phonology)[11]. Evidence for the PWG in Portuguese includes segmental and suprasegmental phenomena, briefly illustrated below.

As we have seen above, vowel deletion processes are possible across words as a means for hiatus resolution, but are blocked under stress clash. Within compounds, PW-final deletion in EP is obligatorily blocked if V2 bears PWG prominence (corresponding to the rightmost PW within PWG). This is exemplified in (16): in (16a) V2 bears PWG (but not PhP) prominence, and PW-final vowel deletion is blocked (in the case of *e*, it typically surfaces as [j] in this context); in (16b), by contrast, V2 is not the head of the PWG and V1 may delete.

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[11] A fundamental difference distinguishes the Prosodic Word Group from the Clitic Group (Nespor & Vogel 1986) and the Composite Group (Vogel 2009): the former, unlike the latter two, is assumed to have no special status with respect to the prosodization of clitics.

(16)   a. SN (ess<u>e</u>-ene) complexo   [ɛ́sj ɛ́n]   JS (jot<u>a</u>-esse) envelhecida   [ʒɔtɐ ɛ́s]
        'complex NP (nominal phrase)'   'aged JS (youth party organization)'
        b. FMI (ef<u>e</u>-eme-i)   [ɛ́f ɛ́mj í]   JSD (jot<u>a</u>-esse-dê)   [ʒɔt ɛ́s dé]
        'IMF (International Monetary Fund)'   'JSD (youth party organization)'

According to Vigário & Fernandes-Svartman (2010), the PWG is a crucial domain for pitch accent assignment in BP, because pitch accents are obligatory on the rightmost PW of complex words containing more than one PW, whereas non-final PWs only have to be pitch-accented if they are long.

The coincidence most often observed between the edges of syntactic terminal nodes (specifically, lexical X^0) and the edges of the PWG is attributed to the role played by alignment constraints (McCarthy &Prince 1994) requiring that the right and left edges of a lexical X^0 coincide with the right and left edges of the PWG, respectively. Under Vigário's (2010) approach, every syntactic lexical terminal node forms a PWG, even if it is formed of a single PW (e.g. *brinquedo* 'toy'). This constituent is also subject to size conditions, which are purely phonological (see subsection 2.2. below).

2.1.2. The Phonological Phrase

We next consider the formation of the phonological phrase. The majority of studies on both varieties of Portuguese adopt (or adapt) Nespor & Vogel's (1986) basic algorithm for PhP formation. According to Frota (2000), for instance, the phonological phrase in EP includes the material within the maximal projection of a lexical syntactic head (Lex^{max}), namely the lexical head (Lexº) and the elements on the head's nonrecursive side within Lex^{max}. Nonbranching phrases are grouped within the PhP that contains the previous lexical head. Although this seems to be a phonological requirement, it is also constrained by syntactic information, since only complements or modifiers of the previous lexical head may be parsed within the PhP containing that head. Guimarães (1998) takes a somewhat different approach to the construction of prosodic domains, by making use of some aspects of the minimalist program in the syntax-phonology mapping he proposes. In his reanalysis, there are two linearization algorithms: one that applies to lexical items and generates unordered chains of lexical items (π chains) and another one that linearizes the π chains. In both Nespor & Vogel's system and Guimarães's reanalysis, heads and

specifiers are parsed into different PhPs. However, such parsing encounters a number of problems with respect to BP. Santos (1997), for instance, observes that stress shift is possible in a sentence like *de leite, o DAvi GOsta* '**Milk**, Davi likes' in wich *o Davi* cannot be restructured with *gosta* (compare this sentence with *o daVI GOSta de leite* 'Davi likes milk', in which stress shift is not allowed). In addition, Guimarães (1998) shows that stress shift may also take place when the subject is a pronoun (as in *voCÊ JOga futebol* 'You play football', which can be produced as *VOcê JOga futebol*)

2.1.3. The Intonational Phrase

Let us now consider the syntax-phonology mapping at the level of IP (Frota 2000, Tenani 2002, Fernandes 2007). The IP includes all adjacent PhPs within a root sentence. PhPs in a string not structurally attached to the sentence tree (e.g. parenthetical phrases, explicative clauses, vocatives, topics) form IPs on their own, and so does any remaining sequence of adjacent PhPs attached to the sentence tree. In an SVO sentence with a parenthetical intervening between S and VO, for instance, both S and VO form an IP. Long IPs are constrained by phonological conditions, which may be responsible for the formation of shorter IPs, as we will see in the next subsection. Importantly, however, these shorter IP must be obtained in compliance with a further syntactic requirement: head-complement and modifier-modifyee relations should not be broken.

Whereas in Standard European Portuguese (SEP) SVO sentences tend to be phrased as a single IP, unless the subject is long, in the variety spoken in Braga, in the North of Portugal (NEP), subjects very often form an IP irrespective of length considerations. Elordieta et al. (2005) propose that this difference follows from a difference in the syntax of subjects. Specifically, it is suggested that in NEP (like in Spanish) subjects may syntactically attach higher in the sentence than in SEP, being base generated as adjuncts to InflP or CP, instead of being internal to InflP (or the Extended VP projection), as in SEP. Being more external in the sentence, subjects in NEP tend therefore to form their own intonational phrase, like topics, for instance, unlike in SEP.

2.2. Purely phonological constraints on prosodic phrasing at different levels (PWG, PhP, IP)

The prosodic constituents from the PWG-level up are constrained by purely phonological requirements, such as maximal or minimal weight or size.[12]

In EP, PWGs seem to be maximally composed of three PWs. Evidence for this includes prominence and deletion processes (Vigário 2010). As we have seen above, PW-final *e*-deletion is obligatorily blocked only when V2 bears PWG prominence. The examples in (16) above show that PWGs formed of two or three PWs only block *e*-deletion once. However, as soon as a compound contains four PWs, pairs of PWs are grouped into two PWGs, each of which with the prominent PW on the right. Once V2 bears PWG prominence, V1 deletion is blocked.[13] Notice that, if the four PWs were grouped into a single PWG, there would be no explanation for V1 resisting deletion, like in other internal positions where V2 is not the PWG head. Besides that, prominence relations are also perceived. The example in (17) below, show the prominence relations at the PW and PWG level.

(17)   *w*   *s*   *w*   *s*   PWG-level prominence

               s   *s*   *s*   *s*   PW-level prominence

MRPP (Em<u>e</u>-Erre-PÊ-PÊ)   (Em[j]-Erre)$_{PWG}$-(PÊ-PÊ)$_{PWG}$

At the PhP level one also observes minimality conditions on its size. When a lexical phrase is a nonbranching modifier or a nonbranching complement of the previous Lex, it is grouped with the PhP containing the previous Lex. Evidence from EP includes stress clash resolution strategies as well as prominence and pitch accent assignment (Frota 2000). For example, it was shown in subsection 1.3 that lengthening is a strategy for stress clash resolution within a PhP, but not across PhPs, as exemplified in (8). (8b) further shows that a PhP may contain just one PW, which led Frota (2000) to propose that a PhP should contain more material than a PW if possible. According to Sândalo & Truckenbrodt (2002), this requirement is over-ruled in BP by the *Principle of Uniformity,* which favors PhPs of equal length. According to these authors, the construction of PhPs in BP takes into consideration not only syntactic

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[12] In many languages the PW is subject to minimality conditions (e.g. it cannot be shorter than a binary foot). However, this is not the case in Portuguese, as words like *li* '(I) read' or *nu* 'naked' are relatively frequent (Bisol 2000).

[13] In the examples, '*s*' represents heads; '*w*' signals non-heads.

information, but also focus, eurythmic and length effects. Length effects are taken into account for explaining why stress shift is more acceptable in *o caFÉ QUENte queima a boca* 'hot coffe burns the mouth', whose PhPs are of the same size, than in *o caFÉ QUENte queima*, whose PhPs sizes are imbalanced. In the latter case, if each lexical word is the head of its own PhP, this creates more balanced phrases, but it also entails that stress shift, which is a strategy available only inside PhP, may no longer apply.

IPs are also subject to phonological conditions: long IPs tend to be divided and IP phrasing favors balanced phrases or else longer phrases at the rightmost position (Frota 2014). There is evidence for a maximal optimal IP size in EP. According to Elordieta, Frota & Vigário (2005), while short SVO sentences usually form a single IP, subjects containing more than 8 syllables tend to form an IP on their own. Furthermore, Frota's (2000) findings suggest that when syntax-phonology mapping requirements yield short IPs (e.g. when a parenthetical is short), these IPs are not avoided, but a compound domain may be formed instead, grouping a short IP with an adjacent IP, as in [[*as alunas*]I [*até onde sabemos*]I]I [*obtiveram boas avaliações*]I 'The students, as far as we know, have got good marks'. We return to IP compounding in subsection 2.3. below.

As in other languages, speech rate may also be responsible for mismatches between syntactic structure and prosodic structure, as the same sentence may be phrased differently, depending on speech rate.

2.3. On the geometry of prosodic trees

Among the most controversial issues in the syntax-phonology interface is the staus of recursivity. While recursivity is clearly a property of syntactic structures, phonology has been considered to be non-recursive since the early days of prosodic phonology (Selkirk 1984, Nespor & Vogel 1986). This was seen as one of the major differences between the two structures, the former being deeper, with (potentially) illimited depth, and the latter being flatter and composed of a fixed number of levels, as defined by the Strict Layer Hypothesis (SLH). In more recent work within optimality theory, the SLH has been reinterpreted as a set of constraints, some of which are violable (Selkirk 1996). This has given way to proposals in which adjunction and compound structures violating *Recursion may surface. As we have seen in previous sections, these structures involve proclitics (often argued to be adjunct to PW – as in *a alma* (a (alma)PW)PW 'the

soul'), compound-like elements with internal PWs (frequently claimed to be grouped into a recursive PW – as in (*ultra-calmo* (ultra)$_{PW}$-(calmo)$_{PW}$)$_{PW}$ 'extra calm'), and short IPs inside longer sentences, under particular conditions.

As was argued earlier, the prosodization of clitics is usually taken to allow prosodic configurations that violate restrictions otherwise respected in the construction of prosodic domains, even in proposals where the CG is adopted, as in Bisol (2005). In the case of compounding, often analysed as involving balanced recursion such that the higher node dominates two or more constituents of the same level, the possibility of PW recursion has been explicitly argued against, as by Vigário (2010), who argues in favor of an additional PWG domain. This author shows that several types of categorical phonological phenomena from EP and other languages make reference to this domain, and that the PWG is subject to size conditions that are not imposed on PWs. Another piece of evidence is especially telling in showing that the relevant constituent does not correspond to a recursive PW. In languages like Turkish and Dutch, the main rule for word stress refers to the *right* edge of the PW, whereas within compounds, stress is assigned with reference to the *left* edge of the higher node. Such different stress patterns would be unexpected in recursive PWs.

Differently from compound-like groupings, the topmost node that includes compound IPs (IP^{max}) appears to display exactly the same kind of phonology as the internal IPs, although with more salient traits. For example, IP^{max} may display pause insertion, its preboundary final lengthening is stronger, and its picth range at the right-edge is larger (see Frota 2012). Importantly, prosodic rules circumscribed to the IP domain (e.g. resyllabification) apply not only inside the internal IP but also across internal IPs, within IP^{max}, as expected if the higher node is also an IP.

The phonology of PWGs and of compound IPs has been argued to point to the existence of two distinct types of prosodic organizations. According to Frota (2012), there is a difference between prosodic constituents and levels of phrasing. The former are defined by syntax-to-phonology mapping relations and are cued by a particular set of phonological and phonetic properties, whereas the latter involve recursion and groupings of the same prosodic category and are cued by gradient differences in the strength of the same set of phonological and phonetic properties.

2.4 Phonological phenomena and the organization of grammar

In addition to syntax, phonology seems to relate to other grammatical components, as well. For instance, lexical phonology, unlike postlexical phonology, may refer to morphological, as well as lexical information (e.g. exceptions to rules must be lexically listed). In turn, postlexical processes may be sensitive to combinations of words and are often optional and only make reference to phonological information. As we have seen earlier, the division between lexical and postlexical phonology is in fact crucial for most proposals on the prosodic organization of clitics and compounds in Portuguese. For example, phonological phenomena in EP indicate a similar prosodization of enclitics and suffixes, on the one hand, and proclitics and prefixes, on the other; however enclitics and proclitics differ from suffixes and prefixes in not interacting with lexical phonological phenomena (see Vigário 2003).

Phrasal prosody alone may also signal meaning, that is, in some cases information that is required for sentence interpretation comes from prosody alone. In languages like Portuguese, contrastive focus may be signaled solely by prosodic means. This happens, for example, when H*+L is assigned to a focused element, which becomes the head of IP, and tonal compression follows. Here phonology marking appears not to be just a reflection of syntactic structure, as in the case of topics, for example. Similarly, phonology alone may also signal sentence types by means of particular tunes. See chapter 9, this volume.

2.5 Other (non-trivial) interactions between syntax and prosody

While in general the relation between syntax and phonology seems largely confined to the point in the grammar where prosodic domains are built, in a number of specific constructions the two components seem to interact further. In coordinated structures in Portuguese, for example, a PW may be deleted under conditions of phonological identiy (Vigário & Frota 2001). The fact that deletion under identity targets PWs is shown by contrasts like those in (18a); in turn, the relevance of coordination is demonstrated by examples like (18b), which do not involve syntactic coordination and where deletion is impossible under the same prosodic conditions.

(18) a. (alegre)_{PW} (~~mente~~)_{PW} ou (triste)_{PW} (mente)_{PW}   'happily or saddly'

      vs. *(acampa~~mento~~)_{PW} ou (acantonamento)_{PW}   'camping or sheltering'

      (mono)_{PW}(~~gâmico~~)_{PW} e (poli)_{PW}(gâmico)_{PW}   'monogamic and poligamic'

      vs. *(mono~~grafia~~)_{PW} e (biografia)_{PW}   'monography and biography'

   b.   *(certa)_{PW}(~~mente~~)_{PW} (inteligente)_{PW}(mente)_{PW}   'certainly intelligently'

Another case of nontrivial syntax-phonology interaction involves word order preferences under prosodic conditions related to weight (size of prosodic constituents and prominence), as illustrated in (19) below. Some particular syntactic constructions (e.g. topicalization, parenthetical insertion, and heavy NP shift) suggest that the preference for a particular word order on the basis of phonological weight is restricted to *late* syntactic operations (stylistic or discourse related), still available when the syntax-phonology mapping takes place (Frota & Vigário 2002).

(19)   ??A Ana comprou o quadro do vencedor do concurso ao Pedro

       A Ana comprou ao Pedro o quadro do vencedor do concurso.

       'Ana bought from Pedro the paint by the winner of the contest'

Yet another case of complex interactions is illustrated by "syllabified intonation" in BP (Nunes 2000). This phenomenon involves a specific change in the speech rate triggered by certain determiners, which is used to signal an evaluative reading, as in *O João dançou com U-MA-me-ni-na-no-ba-ile* 'João danced with a girl at the ball' (meaning a very beautiful girl). Interestingly, such "syllabified intonation" must be maintained as far as the end of the IP. According to Nunes (2000), the domain of application of this process is to be defined in syntactic terms, namely, Spell Out domains.

Finally, it is worth mentioning the interesting issue of whether empty syntactic categories can be computed by phonology. Nespor & Vogel (1986) and others argue against the idea of empty syntactic categories playing a role in prosodic computations. However, Nunes & Santos (2009) show that stress shift in BP cannot apply blindly across any type of empty syntactic category. Specifically, traces of syntactic movement do not block stress retraction, but a null

pronominal (*pro*) does (regardless of the Case properties of the null elements), as illustrated in (19) below. Assuming Chomsky's (1995) copy theory of movement according to which traces are deleted copies, the authors argue that the data in (20) can be accounted for if copy deletion takes place before stress clash computation. In other words, traces have already been deleted at the point where stress shift applies, whereas *pro* is still present and is computed for adjacency purposes.

(20)　　a. [nem　　a　　unha]$_i$　　a　Maria CORtou t_i HOje

　　　　　'not even the fingernail, Mary cut today'

　　　　　b. [a carta da Maria]$_i$ CHEgou t_i Ontem

　　　　　'Mary's letter arrived yesterday'.

　　　　　c. # [esse bolo]　　a　　Maria passou mal [$_{island}$ depois que COmeu *pro* HOje]

　　　　　'This cake, Mary felt sick after she ate today.'

　　　　　d. # esse bebê,　a　babá　　CUIdou　　*pro* ontem.

　　　　　 'this baby the nany took care of yesterday.'

3. Concluding remarks

 Issues related to the syntax-phonology interface in Portuguese have been extensively studied in the past two decades, mainly within the framework of Prosodic Phonology. In general, the focus has been on the description of Portuguese from a crosslinguistic perspective. The major contribution of Portuguese-oriented studies has been their adding to the cumulating evidence in favor of the model of Prosodic Phonology and the view that the relation between phonology and other components of grammar is limited and principled.

Since prosody provides a structure for the organization of speech and establishes a principled interface with syntax and morphology, it plays a crucial role both in language acquisition and in speech processing by children and adults. For space limitations, we have not addressed these issues in the present chapter. However, it is worth mentioning some of the matters that have attracted the attention of researchers working on Portuguese in these domains: the role of prosody in early word segmentation and word categorization; the effect of morphosyntactic information and the position within prosodic domains on the emergence and

development of coda segments; the grammatical status of filler sounds in early speech; the role of prosodic information in speech processing and syntactic disambiguation.

Finally, we would like to point out thatpoint out that there is very little investigation on the prosody of varieties of Portuguese other than those spoken in Brazil and Portugal. Nevertheless, we believe that work on other varieties will provide fruitful grounds for future research and contribute to deepening our understanding of Portuguese grammar(s) and the possible sources of variation in prosodic organization.

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