

Positional and metrical prominence effects on vowel sandhi in Catalan*

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The goal of this article is to account for the resolution of vowel sequences across word boundaries in Catalan. Specifically, the paper accounts for the distribution of hiatuses and syllable contraction cases between two lexical words in this language. It is shown that when the second vowel of a VV sequence carries the phrasal (nuclear) stress, V1 does not undergo any change (ie, it cannot delete or diphthongize). The blocking of V1 glide formation will be related to the systematic maintenance of schwa in this position (canti ara [i 'a] 'you sing.imp now', canto ara [u 'a] 'I sing now', tallo ungles [u 'u] 'I cut nails', canta ara [ə 'a] 'he/she sings now'). Blocking of glide formation or schwa deletion is thus not due to rhythmic reasons (stress clash), as some previous studies have contended, but rather to a prosodic restriction related to the presence of a nuclear stress prominence on V2. This phenomenon will be interpreted as the instantiation of an alignment constraint which aligns the word-initial nuclear stressed foot to the left edge of the prosodic word. It is argued that an alignment between the main phrasal foot and the left-edge of the lexical word triggers a 'prosodic isolation' phenomenon which prevents vowel gliding or deletion from applying. Similar blocking effects of the nuclear stress prominence have been reported in Galician, in Spanish, as well as in Brazilian and European Portuguese (see Fernández Rei 2002 for Galician, Navarro Tomás 1926 for Spanish, Frota 2000 and Vigário 2003 for European Portuguese, Tenani 2002 and Bisol 2003 for Brazilian Portuguese). Finally, the paper also accounts for external vowel sandhi in contexts where V2 is not stressed: in these contexts, syllable contraction is the norm.

1. Introduction

In Catalan, as other languages, vowel contacts across word boundaries are resolved in a variety of ways. First, the two vowels can be pronounced in

two different syllables, that is, forming a **vocalic hiatus**. This solution is common when the two vowels are stressed: *signà actes* [ˈa ˈa] ‘he/she signed grade sheets’, *xampú òptim* [ˈu ˈɔ] ‘optimal shampoo’, *compongué himnes* [ˈe ˈi] ‘I composed hymns’, *camí ample* [ˈi ˈa] ‘broad path’. On the other hand, the two vowels can contract into one syllable. Catalan displays three different strategies for eliminating vowel hiatus: 1) **glide formation**, as in *faci amigues* [jə] ‘you make.imp friends’, *dono alegries* [wə] ‘I make people happy’, *cafè irlandès* [ɛj] ‘Irish coffee’, and *compra olives* [əw] ‘he/she buys olives’; 2) **deletion** of one of the vowels, as in *oli especial* [i] ‘special oil’, *sabó artesà* [o] ‘handcrafted soap’, and *trenta anys* [ˈa] ‘thirty years’; and 3) **fusion** (also called **vowel degemination**), as in *compro ulleres* [u] ‘I buy glasses’, *porta abric* [ə] ‘he/she is wearing a coat’, and *pati infantil* [i] ‘childrens’ playground’.¹

The main goal of the paper is to account for the resolution of vowel sequences across word-boundaries in Central Catalan and report new findings coming from the transcription of a corpus of spontaneous speech (COC, *Corpus Oral de Català*; Payrató and Alturo 2002) and from the results of an 96-utterance questionnaire answered by 8 speakers of Central Catalan (see Appendix). The article demonstrates that the distribution of hiatus and syllable contraction processes is not random, but rather that it can be predicted quite systematically. As will be shown, stress is the main factor involved in this phenomenon: basically, nuclear stress prominence protects vowels from devocalizing or deleting. This tendency can be regarded as a general tendency of languages to preserve phonological material in prominent positions. The article will account for the observed restrictions on vowel sandhi resolutions within a constrained-based framework. Similarly, the different strategies used by Catalan to eliminate vocalic hiatus (namely, vowel gliding, elision or fusion) will follow from general principles of syllabification and metrical licensing. In sum, the analysis presented in this article allows for a unified view of vowel sandhi phenomena in Catalan.

Most studies on vowel sandhi in Catalan have pointed out that when a word ends in an unstressed high vowel and the following word starts with a stressed vowel, hiatus is the general outcome. In this environment, glide formation does not occur, and vowel sequences such as *canto àries* [u ˈa] ‘I sing arias’ or *begui aigua* [i ˈa] ‘you drink.imp water’ are pronounced in two syllables. Even though most authors have claimed that in the rising sonority cases stress clash competes with the onset condition, preventing glide formation from applying (Oliva 1977, 1992; Bonet and Lloret 1998; Jiménez 1999; Wheeler forthcoming), the data presented in this article demonstrates that

stress clash is *not* the reason behind blocking of syllable contraction: thus, *doni eïnes* [i 'ɛ] ‘you give.imp tools’, *canto òpera* [u 'ɔ] ‘I sing opera’ are pronounced with a hiatus, as are *dóna-li eïnes* [i 'ɛ] ‘you give.imp tools to him/her’), *canta-li òpera* [i 'ɔ] ‘you sing.imp opera to him/her’, even though in the latter examples the two stresses are separated by two unstressed syllables (see also Recasens 1993 and Prieto 2001). As the data will show, what blocks vowel gliding is the presence of **nuclear stress** (or **phrasal stress**) on the second vowel. We will claim that an alignment constraint gives rise to a ‘prosodic isolation’ phenomenon which favors vocalic hiatus. Furthermore, it will be shown that the blocking effects of nuclear stress prominences apply to other vowel contacts, that is, neither schwa deletion nor vowel fusion occur when the second vowel bears phrasal stress (e.g., *amiga íntima* [ə 'i] ‘intimate friend’, *amiga òrfena* [ə 'ɔ] ‘orphan friend’, *carro únic* [u 'u] ‘unique cart’, *territori inca* [i 'i] ‘Incan territory’).

On the other hand, Catalan presents a very interesting case from a cross-linguistic point of view. When a schwa occurs in word-initial position, deletion is the general norm (*sofà elegant* [,a] ‘elegant sofa’, *ressò ancestral* [,ɔ] ‘ancestral echo’, *camí enfangat* [,i] ‘muddy path’). In this case, the well-known tendency to preserve material in word-initial position is not strong enough. In a recent crosslinguistic survey, Casali (1997) reported that deletion of a word-final vowel is far more common than deletion of a word-initial vowel. As he pointed out, “at the boundary between two lexical words, elision is always of V1” and that “exceptions occur only under very special circumstances.” (Casali 1997:498). To motivate the well-known prosodic strength of word-initial segments, Casali posits a series of position-sensitive faithfulness constraints: among them, maximization of a word-initial segment, MAX-WI, requires that segments in word-initial position must be parsed into the surface representation. At first sight, the facts in Catalan contradict Casali’s generalization: typically, V1 is kept when V2 bears nuclear stress; by contrast, V2 deletes (see the examples above) or turns into a glide when V1 is stressed. We claim that the apparently ‘unexpected’ behavior of Catalan vowel sandhi can be explained by resorting to prosodic prominence effects. In Catalan, metrical prominence faithfulness will outweigh position-sensitive faithfulness (word-initial prominence) and that explains the preferential preservation word-initial (and word-final) material when V2 bears nuclear-stress prominence.

The paper is organized as follows. Section 2 presents the materials and questionnaires used for collecting the data. Section 3 presents the data on vowel sandhi in Catalan as well as a brief overview of the literature on vowel

sandhi in other Romance languages. Finally, section 4 presents an Optimality Theory analysis of the vowel sandhi data.

2. Methods

The data reported in this article comes from two different sources. A key source of data comes from the phonetic transcription of the vowel contacts present in five spontaneous conversations of half an hour of duration belonging to the *Corpus Oral de Català* (COC; Payrató and Alturo 2002).² All vowel sandhi environments present in these conversations were phonetically transcribed. Throughout the article, references to examples extracted from the corpus are given as follows: (COC, c01) will mean “extracted from conversation number 1, *Corpus Oral de Català*”.

Given that not all possible environments occurred in the spontaneous speech database (or at least in sufficient numbers), we decided to use a second source of data coming from a controlled set of utterances. We constructed a set of 96 utterances taking into account three different factors: a) the position of the prominent syllables in relation to the vowel sequence V1 and V2 (stress position); b) the syllable structure (closed vs. open) of the second syllable; c) the sonority scale of the vowel sequence (see the questionnaire in the Appendix). Typically, the test utterances included in the questionnaire consist of two-word sequences of noun plus adjective (e.g., *matí avorrit* ‘boring morning’) or verb plus object noun (e.g., *demano eines* ‘I ask for tools’).³ This structure guarantees that the two words are pronounced in one phonological phrase (hereafter, p-phrase or ϕ -phrase). As we know, syllable contraction strategies do not apply as regularly when the vowel sequence does not belong to the same p-phrase (as is well-known, intonational boundaries can optionally block syllable contraction). Thus, while it is very unlikely that the vowel sequences in (*compraré ulleres*) ϕ ‘I will buy glasses’ or (*és un fuster humil*) ϕ ‘he/she is a humble carpenter’ is pronounced with a hiatus *[^he u], a hiatus pronunciation would be more acceptable in utterances such as (*compraré*) ϕ (*ulleres de veritat*) ϕ ‘I will buy real glasses’ or (*és un fuster*) ϕ (*humil de veritat*) ϕ ‘he/she is a truly humble carpenter’.

Eight native speakers of Central Catalan, including one of the authors, responded to the questionnaire.⁴ Speakers were asked both to evaluate and produce the target word sequences, paying special attention to the surface realization of the vowel sequences. In some cases speakers reported two optional resolution strategies, depending on speech rate. Throughout the article

we report the general solutions given at a normal rate of speech, even though in some cases we also point out possible outcomes at faster speech rates.

3. Data

3.1. Hiatus environments

3.1.1. *The effects of nuclear stress*

Most studies on vowel contact resolutions in Catalan have reported that when a word ends in a stressed vowel or an unstressed high vowel and the following word starts with a stressed vowel, the two vowels generally form a hiatus (e.g., *cantà àries* [i a 'a] 'he/she sang arias', *canti àries* [i 'a] 'you sing.imp arias', *begué aigua* [e 'a] 'he/she drank water', *begui aigua* [i 'a] 'you sing.imp water') (see Oliva 1977, 1992; Bonet and Lloret 1998; Jiménez 1999; Wheeler forthcoming). Nevertheless, the data from both the spontaneous speech corpus and the questionnaire show a clear contrast between vowel contact resolutions involving different degrees of prominence: that is, when V2 bears nuclear stress (or phrasal main stress) hiatuses appear in a systematic fashion, while when V2 bears a primary stress that is subordinated in the phrase syllable contraction is the general solution (see also Recasens 1991:163; 1993:125). In Catalan, as in other Romance languages, the prominence peak of the intonational phrase is carried by the last primary stressed syllable in that domain.

The examples in (1) and (2) exemplify this contrast for stressed-stressed (see 1) and for unstressed-stressed vowel sequences (see 2). That is, when V2 bears phrasal prominence, hiatuses are the norm, regardless of the prominence status of V1 (see *parla ara* [ə 'a] 'he/she speaks now' and *això obre* [ɔ 'ɔ] 'this opens (it)')⁵. By contrast, when V2 is not the last tonic syllable in the utterance, then different antih hiatus strategies emerge, namely, glide formation, schwa deletion, or fusion (e.g., *algú obre la porta* [ɫwɔ] 'someone opens the door' and *això obre la porta* [ɔ] 'this opens the door')⁶.

The subsequent table shows the frequency of occurrence of hiatuses in unstressed-stressed vowel sequences across word-boundaries (that is, V##'V contexts) for each of the 8 Central Catalan speakers who answered the questionnaire. Of the 96 total tokens included in the questionnaire, 35 are combinations of unstressed V1 followed by a vowel V2 with nuclear stress. Of the 32 tokens, 25 involve combinations of non-identical vowels and 7 combina-

tions of identical vowels; finally, 7 utterances are examples with non-nuclear stress on V2.

(1) Stressed-Stressed

V2 with nuclear stress

V2 with non-nuclear stress

a. *Hiatus*

algú obre [ɫu 'ɔ]
 ‘someone opens it’
 així entra [ɫi 'e]
 ‘he/she enters like this’
 conté eines [ɫe 'ɛ]
 ‘it contains tools’
 això entra [ɔ 'ɛ]
 ‘this fits’

Glide formation

algú obre la porta [ɫwɔ]
 ‘someone opens the door’
 així entra al matí [ɫje]
 ‘he/she enters like this in the morning’
 conté eines de fusta [ɫɛɛ]
 ‘it contains wooden tools’
 això entra bé [ɫɔɛ]
 ‘this fits well’

b. *Hiatus*

això obre [ɫɔ 'ɔ]
 ‘this opens (it)’
 convé eherba [ɫe 'e]
 ‘grass is needed’
 algú unta [ɫu 'u]
 ‘someone smears’
 així infla [ɫi 'i]
 ‘it inflates like this’

Fusion under identity

això obre la porta [ɫɔ]
 ‘this opens the door’
 convé eherba fresca [ɫe]
 ‘fresh grass is needed’
 algú unta la fusta [ɫu]
 ‘someone smears the wood’
 així infla el globus [ɫi]
 ‘he/she inflates the balloon like this’

(2) Unstressed-Stressed

V2 with nuclear stress

V2 with non-nuclear stress

a. *Hiatus*⁷

parli ara [ɫi 'a]
 ‘you speak.imp now’
 parlo ara [ɫu 'a]
 ‘I speak now’
 demani hora [ɫi 'ɔ]
 ‘you make.imp an
 appointment’

Glide formation

parli ara mateix [ɫja]
 ‘you speak.imp immediately’
 parlo ara mateix [ɫwa]
 ‘I speak immediately’
 demani hora ara mateix [ɫjɔ]
 ‘you make.imp an appointment now’

<p>b. <i>Hiatus</i></p> <p>parla <u>ara</u> [ə 'a] 'he/she is speaking now'</p> <p>sempre <u>omplen</u> [ə 'o] 'they always fill (it)'</p> <p>compra <u>herba</u> [ə 'e] 'he/she buys grass'</p>	<p><i>Schwa deletion</i></p> <p>parla <u>ara</u> mateix [,a] 'he/she is speaking immediately'</p> <p>sempre <u>omplen</u> el calaix [,o] 'they always fill the box'</p> <p>compra <u>herba</u> fresca [,e] 'he/she buys fresh grass'</p>
<p>c. <i>Hiatus</i></p> <p>compri<u>il</u>les [i 'i] 'you buy.imp islands'</p> <p>porto <u>un</u>gles [u 'u] 'I have nails'</p> <p>compongui <u>him</u>nes [i 'i] 'you compose hymns'</p>	<p><i>Fusion under identity</i></p> <p>compri<u>il</u>les verges [,i] 'you buy.imp virgin islands'</p> <p>porto <u>un</u>gles llargues [,u] 'I have long nails'</p> <p>compongui <u>him</u>nes solemnes [,i] 'you compose.imp solemn hymns'</p>

Table 1. Raw frequency of occurrence of hiatuses in unstressed-stressed vowel sequences across word-boundaries (V## 'V) for eight speakers. N = number of tokens.

% of hiatuses	V## 'V (NUC) non-identical vowels N = 25	V## 'V (NUC) identical vowels N = 7	V## 'V (NON-NUC) N = 7
Speaker TB	100%	100%	0%
Speaker AG	100%	100%	0%
Speaker XV	100%	100%	0%
Speaker TE	96%	100%	0%
Speaker NM	100%	100%	0%
Speaker JS	92%	100%	0%
Speaker JC	96%	100%	0%
Speaker TC	100%	100%	0%

As expected, the data reveals a systematic contrast between the presence vs. absence of nuclear prominence (in the table, the two groups are separated by a double line): while hiatuses arise systematically in the nuclear stressed cases regardless of vowel quality (from 92% to 100%, depending on the speakers), no tokens of hiatus occur when V2 does not bear nuclear stress (0% for all speakers; e.g., *convé herba fresca* [,e] 'fresh grass is needed', *això obre la porta* [,ɔ] 'this opens the door'). Finally, we should point out

that, in some exceptional cases, syllable contraction occurs when V2 bears nuclear stress. If we examine the few exceptions present in the data, they could be interpreted as having a ‘semilexicalized’ pronunciation (vg. *menja herba* ‘he/she /it eats grass’, *porta-me-la ara* ‘you bring.imp it to me now’; e.g. also *en deu tenir onze* [‘jo] (COC, c01)).

The blocking effects of nuclear (or sentence) stress on syllable contraction can be understood as a way to strengthen its prominence when located in word-initial position: parsing the nuclear stressed syllable as a separate syllable in the surface representation prevents both gliding or deletion from applying and it allows for a higher perceptibility of this prominent syllable. This phenomenon has also been observed in other Romance languages. According to Navarro-Tomás (1926:153), in Peninsular Spanish “different vowels with a stress in either one of them are usually contracted into one syllable. (...) Examples: *según se ha notado*, *de ambos modos*, *vendrá en seguida*, *hablemos de otra cosa*, *lo abrigó en su seno*, *medité un momento*, *no hay quien lo haga mejor*, *con pie indiscreto*, *desplegó audaz las alas*, *venció a un jayán soberbio*. This contraction usually does not take place in slow or emphatic speech nor when the stress is the last one in the group: *Sonó pausada en el reloj la-una*, *Y hoy guardo en él como en sagrada-urna*, *Detenida en el polvo de la-hoja*.” [our translation; TC & PP]

A similar situation arises in Brazilian and European Portuguese as well as in Galician (see Frota 2000 and Vigário 2003 for European Portuguese, Tenani 2002 and Bisol 2003 for Brazilian Portuguese and Fernández Rei 2002 for Galician). As Tenani (2002) points out, “in Brazilian Portuguese, external sandhi rules are categorically blocked by the nuclear (or sentence-) stress, i.e. the stress of phonological or intonational phrase. The (variable) application of sandhi rules is guided by the fact that they apply on syllables not submitted to intonational, nuclear stress.” In Brazilian Portuguese we can observe the same result when V1 is /a/, in other cases V1 becomes a glide but never will be deleted (e.g. *coma uvas* [a ‘u] ‘you eat.imp grapes’, *fala isto* [a ‘i] ‘he/she speaks this’. But *come uvas* [‘ju] ‘you eat grapes’, *como uvas* [‘wu] ‘I eat grapes’, *como ostras* [‘wo] ‘I eat oysters’; Tenani 2002:159). In both Brazilian and European Portuguese there is a contrast between the following two cases: *Ele compra uvas caras* [u] ‘She bought expensive grapes’ vs. *Ele compra uvas* [a ‘u], not *[u] ‘She bought grapes’; *O João compra ovos frescos* [‘o] ‘John buys fresh eggs’ vs. *O João compra ovos* [a ‘o] *[‘o] ‘John buys eggs’ (Frota 2000, Tenani 2002, Vigário 2003). Finally, for Galician, Fernández Rei (2002:130) points out that “if the second vowel is stressed, the elision process is blocked (100% hiatuses)”. “Clashes in Galician [...]

are strongly disfavored except when the syllables bear the main stress in the intonational phrase” (p. 142). Examples: *o aceite arde* ‘oil burns’, *a rapaza ora* ‘the girl prays’, *o neno ora* ‘the boy prays’ (see Fernández Rei 2002:140). [our translation; TC & PP]

Finally, let us note that the role of main accents within the p-phrase can be similar to nuclear accents. In the examples in (3), both V1 and V2 carry word stress but acquire a different phrasal prominence depending on the context: in the first column, V2 is the nucleus of the intonational phrase IP; in the second column, V2 bears primary stress but is not the main prominence within the IP; finally, in the third column, V2 bears the main prominence within the ϕ -phrase, and hiatuses are preferred (e.g., *Ha vingut a dir hola per tu sola* [i'ɔ] (COC:01)). A similar effect has also been reported in Galician by Fernández Rei (2002).⁸ This topic is left for further study.⁹

(3)((això <u>entra</u>) ϕ)IP	((això <u>entra bé</u>) ϕ)IP	(això <u>entra</u>) ϕ (per la porta) ϕ
[ɔ 'e] 'this fits'	[i,ɔe] 'this fits well'	[ɔ 'e]/[i,ɔe] 'this fits in through the door'
((algú <u>obre</u>) ϕ)IP	((algú <u>obre la porta</u>) ϕ)IP	(algú <u>obre</u>) ϕ (cada matí) ϕ)IP
[u 'ɔ] 'someone opens (it)'	[i,wɔ] 'someone opens the door'	[u 'ɔ]/[i,wɔ] 'someone opens (it) every morning'
((sempre <u>omplen</u>) ϕ)IP	((sempre <u>omplen el calaix</u>) ϕ)IP	(sempre <u>omplen</u>) ϕ (pels volts de Nadal) ϕ)IP
[ə 'o] 'they always fill (it)'	[i,o] 'they always fill the drawer'	[ə 'o]/[i,o] 'they always fill (it) around Christmas'
((parli <u>ara</u>) ϕ)IP	((parli <u>ara mateix</u>) ϕ)IP	((parli <u>ara</u>) ϕ (a l'escola) ϕ)IP
[i 'a] 'you speak.imp now'	[i,ja] 'you speak.imp immediately'	[i'a] / [i'ja] 'you speak.imp now in school'

3.1.2. No stress clash effects

Previous studies on Catalan vowel sandhi phenomena have claimed that vocalic hiatus arises as a way to avoid a **stress clash** situation (see Oliva 1977,

1992; Bonet and Lloret 1998; Jiménez 1999; Wheeler forthcoming). Nevertheless, the examples in (3) show that the presence of vocalic hiatuses is independent of the distance to the following word stress (see also Recasens 1993 and Prieto 2001): thus, in the first example, *crisi **ú**nica* [i 'u] 'unique crisis' is pronounced with a hiatus, as is *anàlisi **ú**nica* [i 'u] 'unique analysis', even though the second example has two unstressed syllables separating the two stresses. Notice that V1 keeps its nuclear status regardless of its quality: a high vowel (group 4a), a schwa (group 4b) or another vowel (group 4c). In (4), word stresses are marked in boldface.¹⁰

(4) One-syllable distance With more than one-syllable distance

a. *With high vowel: I ## 'V, u ## 'V*

crisi <u>ú</u>nica [i 'u] 'unique crisis'	anàlisi <u>ú</u>nica [i 'u] 'unique analysis'
compro <u>a</u>ra [u 'a] 'I buy (it) now'	compra-m'ho <u>a</u>ra [u 'a] 'you buy.imp it for me now'
tesi <u>a</u>mpla [i 'a] 'broad thesis'	pròtesi <u>a</u>mpla [i 'a] 'broad prosthesis'
canti <u>ò</u>pera [i 'ɔ] 'you sing.imp opera'	canta-me-li <u>ò</u>pera [i 'ɔ] 'you sing.imp opera for him/her'

b. *With schwa: ə ## 'V*

posa <u>a</u>ra [ə 'a] 'you put.imp now'	posa-te-la <u>a</u>ra [ə 'a] 'you put.imp it on now'
compra <u>o</u>bres [ə 'ɔ] 'you buy.imp artworks'	sàpiga <u>h</u>ores [ə 'ɔ] 'you know.imp times'
feina <u>ú</u>til [ə 'u] 'useful work'	filípica <u>ú</u>til [ə 'u] 'useful philippic'
cara <u>a</u>mpla [ə 'a] 'broad face'	hèlice <u>a</u>mpla [ə 'a] 'broad helix'

c. *With vowel identity: Vx ## 'Vx*

tesi <u>h</u>íbrida [i 'i] 'hybrid thesis'	anàlisi <u>h</u>íbrida [i 'i] 'hybrid analysis'
carro <u>ú</u>nic [u 'u] 'unique cart'	ímpetu <u>ú</u>nic [u 'u] 'unique impetus'
oli <u>h</u>íbrid [i 'i] 'hybrid oil'	pròtesi <u>h</u>íbrida [i 'i] 'hybrid prosthesis'

canti <u>himnes</u> [i 'i]	canta-li <u>himnes</u> [i 'i]
'you sing.imp hymns'	'you sing hymns for him/her'

The data presented in this section demonstrates that the reason for blocking glide formation or vowel elision across word boundaries in Catalan is **not** stress clash avoidance but rather the presence of a nuclear stress prominence on V2. A similar behavior has been reported for vowel fusion in Greek (a process that involves deletion of vowels of the same quality). As Nespór (1987:67) points out, "the stresslessness of the final vowel of the first word is not the correct generalization. Instead, a similar constraint must be put on the second vowel, that is, the initial vowel of the second word. This is shown in the examples in (5), where in each case the second word of the sequence has initial stress, while the location of the stress on the first word varies; in each of these examples vowel degemination yields ungrammatical results". In other words, the contexts where hiatuses occur across word boundaries in Greek is parallel to the ones in Catalan, that is, when V2 bears a stress (no matter how long the distance to the preceding stress). The examples below reveal that degemination is ungrammatical when V2 is stressed:

- (5) palió ónoma *paliónoma 'old name'
 oréa árθra *oréárθra 'beautiful articles'
 tésera áloya *téseráloya 'four horses'

Nespór (1987:67)

3.2. Syllable contraction environments

3.2.1. Stressed-unstressed sequences: glide formation, schwa deletion and fusion

When a word ends in a stressed vowel and the following word begins with an unstressed high vowel, the most general outcome is a diphthong (e.g., *cafè irlandès* [ɛj] 'Irish coffee', *comprà ulleres* [ɪaw] 'he/she bought glasses'). As Recasens (1993:126) points out, syllable contraction in the latter cases can only be prevented in extremely slow speech and when rhythm is specially marked. The examples in (6) exemplify the basic contrast between glide formation in word-initial position preceded by a lexical stressed vowel vs. non-glide formation in word-final position preceded by a lexical and nu-

clear stressed vowel (in the examples in (6), stressed syllables are marked in boldface).

(6) 'V ## V stressed-unstressed	V ## 'V unstressed-stressed
<i>Glide formation</i>	<i>Hiatus</i>
fuster humil [,ew] 'humble carpenter'	de mano eines [u 'ɛ] 'I ask for tools'
xamp ú idoni [,uj] 'ideal shampoo'	crisi única [i 'u] 'unique crisis'
pag ar interessos [,aj] 'to pay interest'	indi alt [i 'a] 'tall Indian'
can çó illenca [,oj] 'island song'	compri oli [i 'ɔ] 'you buy.imp oil'
com prar ulleres [,aw] 'to buy glasses'	carro ample [u 'a] 'broad cart'

Results from both the spontaneous speech data and the formal questionnaire reveal that roughly the same pattern is found when a schwa is present or when identical vowels are in contact (see examples in (7)).¹¹ Schwa-deletion in word-initial position and fusion of the two vowels are the general solutions at a normal speech rate.

(7) a. <i>Schwa deletion</i> (in closed syll) ¹²	<i>Schwa maintainance</i>
xamp ú excel·lent [,u] 'excellent shampoo'	mare única [ə 'u] 'unique mother'
act or esplèndid [,o] 'splendid actor'	amiga òrfena [ə 'ɔ] 'orphan friend'
pat é andorrà [,e] 'Andorran pâté'	llibre ètnic [ə 'ɛ] 'ethnic book'
mir ar especial [,a] 'special way of looking'	article àrab [ə 'a] 'Arab article'
cam í enfangat [,i] 'muddy path'	canta himnes [ə 'i] 'you sing.imp hymns'
b. <i>Fusion (under identity)</i>	<i>Vowel maintainance</i>
men ú opcional [,u] 'optional menu'	carro únic [u 'u] 'unique cart'

dest <u>i</u> ncert [i]i 'uncertain destiny'	territori <u>i</u> ncà [i 'i] 'Incan territory'
xamp <u>ú</u> oliós [i]u 'oily shampoo'	tal lo <u>u</u> ngles [u 'u] 'I cut fingernails'
submar <u>i</u> inactiu [i]i 'inactive submarine'	canti <u>h</u> imnes [i 'i] 'you sing.imp hymns'

What is the reason behind the contrast exemplified by the vowel sequences above? Let us first note that we are not dealing with a simple mirror-image contrast of the type stressed-unstressed vs. unstressed-stressed (that is, V##'V vs. 'V##V). Crucially, while in the sequence V##'V the stressed vowel bears a nuclear stress, in the sequence 'V##V the stressed vowel bears a 'secondary stress' – notice that the nuclear stress is always located further to the right into the second word, at the end of the sentence. Different authors have pointed out that sentence-internal stresses in Catalan undergo stress subordination (see Oliva 1992 and Recasens 1993, among others). Similarly, recent results by Prieto *et al.* (2001) demonstrate that the first stress of a stress clash sequence can be eliminated.¹³ Thus the behavior of V1 and V2 can be accounted for, on the one hand, by the nuclear stress on V2, which isolates prosodically the stressed syllable from the previous one and, on the other hand, by the weakening of the secondary stress on V1, which equates this vowel to an unstressed one.

3.2.1.1. The special behavior of schwa

In section 3.1, we noted that schwa tends to delete in word-initial (closed) syllables (e.g., *paper antic* [i,e] 'old paper', *xampú excel·lent* [i,u] 'excellent shampoo', *sabó especial* [i,o] 'special soap'). Results from both the spontaneous speech database and the questionnaire indicate that the basic set of exceptions to schwa deletion corresponds to schwas in word-initial **open** syllables (e.g., *tabú amorós* [i,wə] 'amorous taboo'). Thus, in spite of the weakness of [ə], this vowel is specially resistant to deletion when there is no coda consonant remaining in the syllable. Some examples are shown in (8). As we will see later, the sonority value of the vowel sequence generally determines the nucleus (e.g., high vowels and less sonorous vowels become glides). Note that again the examples in (8) prove that prefinal stresses lose some degree of prominence and thus can become glides.¹⁴

(8)	matí <u>a</u> vorrit [jə]	‘boring morning’
	tabú <u>a</u> morós [wə]	‘amorous taboo’
	actor <u>e</u> nèrgic [ɔə]	‘energetic actor’
	tambor <u>a</u> legre [ɔə]	‘happy drum’
	vestir <u>e</u> legant [jə]	‘elegant dressing’
	destí <u>a</u> nòmal [jə]	‘anomalous destiny’
	xampú <u>a</u> romàtic [wə]	‘aromatic shampoo’
	paper <u>a</u> dient [ɛə]	‘suitable paper’
	paté <u>a</u> romàtic [ɛə]	‘aromatic paté’
	solució <u>e</u> legant [ɔə]	‘elegant solution’

Table 2 shows the percentages of schwa deletion in sequences of stressed vowel followed by schwa (${}^{\vee}\#\#[\text{ə}]$). The data are separated by syllable structure type: of the 21 examples, 12 involve open syllables and 9 closed syllables. The results show systematic effects of syllable structure on schwa deletion: while the frequency of [ə]-deletion is rather low in open syllables (it ranges between 9 and 33%, depending on the speaker), it is quite high in closed syllables (between 66 and 100%, depending on the speaker). This behavior could have a phonetically-motivated explanation, as there is a well-known phonetic tendency for vowels to be shorter in closed syllables than in open syllables.

Table 2. Raw frequency of schwa deletion in ${}^{\vee}\#\#[\text{ə}]$ vowel sequences across word-boundaries for 8 speakers

% [ə]-deletion	${}^{\vee}\#\#[\text{ə}]$ [ə] in open syllable N= 12	${}^{\vee}\#\#[\text{ə}C]$ [ə] in closed syllable N=9
Speaker TB	9%	77%
Speaker AG	25%	66%
Speaker XV	25%	77%
Speaker TE	16%	66%
Speaker NM	33%	66%
Speaker JS	25%	100%
Speaker JC	25%	100%
Speaker TC	25%	88%

If we take a close look at the deletions of the first column in Table 2, [ə]-deletion tends to take place in open syllables after low vowels: *sofà elegant*

[₁a] ‘elegant sofa’, *cafè aromàtic* [₁ɛ] ‘aromatic coffee’, *ressò eixordador* [₁ɔ] ‘deafening echo’.¹⁵ We argue that there is a gradation in the deletion of schwa depending on the sonority features of the two vowels. As the examples in (9) show, schwa undergoes deletion when preceded by a stressed low vowel [a] or after the mid low vowels [ɛ and ɔ].

(9) *Low vowel contacts*

sofà <u>e</u> legant [₁ a]	‘elegant sofa’
està <u>a</u> tordit [₁ a]	‘he/she is puzzled’
faisà <u>e</u> norme [₁ a]	‘huge pheasant’
cafè <u>a</u> romàtic [₁ ɛ]	‘aromatic coffee’
ressò <u>a</u> llunyat [₁ ɔ]	‘distant echo’
això <u>a</u> llunya [₁ ɔ]	‘this distances (it)’
ressò <u>e</u> ixordador [₁ ɔ]	‘deafening echo’
cinquè <u>e</u> legit [₁ ɛ]	‘fifth elected’

3.2.2. *Unstressed sequences: Glide formation, schwa deletion and fusion*

Unstressed sequences of two vowels across word-boundaries always undergo syllable contraction. Since the only unstressed vowels in Central Catalan are [i], [u] and [ə], the four possible types of vowel sequences are the following: combinations of schwa plus a high vowel (that is, [ə] ## [i,u] and [i,u] ## [ə]), combinations of two different high vowels and combinations of two identical sequences.

3.2.2.1. *Combinations of schwa plus high vowels*

Schwas in contact with unstressed high vowels can be deleted (as in *oli esplèndid* [i] ‘splendid oil’) or maintained, giving rise to both rising and falling diphthongs (e.g., *faci amigues* [jə], ‘you make.imp friends’, *dóna imatges* [əj] ‘he/she/it gives images’). The examples in (10) show that it is easier to delete the vowel [ə] in word-initial than in word-final position. The results from the COC database confirm this observation, as the percentages of V1 deletion cluster around 40% and the percentages of V2 deletion cluster around 90% in closed syllables.

- (10) a. [ə] ## [i,u]
 reserva hotels [əw] ‘you make.imp hotel reservations’
 perspectiva històrica [əj] ‘historical perspective’
 cara horrible [əw] ‘horrible face’
 empresa inútil [əj] ‘useless enterprise’
 sobre impres [əj] ‘printed envelope’
- b. [i,u] ## [ə]
open syllables *closed syllables*
 oli aromàtic [jə] oli esplèndid [i] ‘aromatic oil’ ‘splendid oil’
 dóna-li amics [jə] dibuixo angelets [u] ‘you give.imp him/her friends’ ‘I draw little angels’
 savi amable [jə] vengui entrades [i] ‘kind sage’ ‘you sell.imp tickets’
 porto amics [wə] amo entusiasmat [u] ‘I bring friends’ ‘enthusiastic boss’
 amo atabalat [wə] passo angúnia [u] ‘flustered boss’ ‘I feel anguish’

Table 3 shows the percentages of [ə]-deletion in unstressed vowel sequences across word-boundaries. Of the 16 examples included in the questionnaire, 6 involve combinations of a high vowel plus a schwa, 5 combinations of a high vowel plus a schwa in an open syllable and 5 combinations of a high vowels plus a schwa in a closed syllable.

Table 3. Raw frequency of schwa deletion in unstressed vowel sequences across word-boundaries (V##V) for 8 speakers

% [ə]-deletion	[ə] ## [i,u] N= 6	[i,u] ## [ə] [ə] in open syllable N= 5	[i,u] ## [ə] [ə] in closed syllable N= 5
Speaker TB	0%	0%	100%
Speaker AG	0%	0%	80%
Speaker XV	0%	0%	100%
Speaker TE	66%	0%	80%
Speaker NM	0%	20%	100%
Speaker JS	50%	20%	100%
Speaker JC	66%	0%	60%
Speaker TC	0%	0%	100%

As expected, [ə] is generally pronounced in word-final position (the majority of speakers have 0% deletion), even though some speakers deleted schwa in contexts such as *casa humida* ‘humid house’ or *reserva hotels* ‘he/she makes hotel reservations’. By contrast, the results reveal a high frequency of [ə]-deletion in word-initial position when [ə] is in a closed syllable (between 60–100% deletion, depending on the speaker). The few tokens with deletion were *dibuixo angelets* ‘I draw little angels’, *amo entusiasmats* ‘enthusiastic boss’. However, when [ə] was in an open syllable it did not delete as easily.

3.2.2.2. Combinations of two different high vowels

When two high vowels of different quality are in contact, the outcome is an obligatory diphthong. The diphthong will be generally rising, as the examples in (11) show. Yet if the distance between stresses is shorter, the nucleus can be located on the left-hand side: *codi obert* [iw] ‘open code’, *miro illots* [uj] ‘I look at big islands’. Further work is needed to determine with more precision whether the resulting diphthong surfaces as a rising or as a falling sonority diphthong.

- (11) i,u ## i,u
- | | |
|-------------------------------------|------------------------|
| porto <u>i</u> nvitacions [wi] | ‘I bring invitations’ |
| porto <u>i</u> nformes [wi] | ‘I bring reports’ |
| port <u>i</u> <u>u</u> niforme [ju] | ‘you wear.imp uniform’ |
| porto <u>i</u> mitacions [wi] | ‘I bring imitations’ |
| compri <u>u</u> lleres [ju] | ‘you buy.imp glasses’ |

3.2.2.3. Combinations of two identical vowels

The only combinations of two identical unstressed vowels are [ə] ## [ə], [i] ## [i] and [u] ## [u]. These are invariably reduced into one vowel.

- (12) canvi important [i] ‘important change’
- doni il·lusió [i] ‘you motivate.imp’
- amo universal [u] ‘universal master’
- compto ovelles [u] ‘I count sheep’
- amiga amable [ə] ‘kind friend’
- canta alegre [ə] ‘you sing.imp happily’

Finally, it is worth pointing out the parallelism between the behavior of two unstressed vowels and the behavior of a sequence of stressed-unstressed vowels is due to the weakening effect of the secondary stress in the latter case. First, V1 high vowels always become glides (*camí elegant* [jə] ‘elegant path’ and *canvi elemental* [jə] ‘basic change’). Second, schwas in V2 positions delete in closed syllables (*camí especial* [i] ‘special path’ and *canvi especial* [i] ‘special change’). And finally, fusion always occur when the two vowels are identical (*camí important* [i] ‘important path’ and *canvi important* [i] ‘important change’).

4. Prominence and alignment conditions

The Catalan data clearly supports the view that prosodic and alignment constraints play a major role in external vowel sandhi phenomena. Remember that in Catalan, the right edge of words must coincide with the left edge of a syllable only when V2 bears the main phrasal stress (e.g., *canti ara* [i 'a] ‘you sing now’). By contrast, when the sentence stress is not present the result is syllable contraction (*canti ara mateix* ['ja] ‘you sing.imp immediately’) – remember that the hiatus solution is always the same independently of the quality of the adjacent vowels. We interpret this prosodic isolation phenomenon as a consequence of the prosodic alignment constraint stated in (13). Generalized Alignment (McCarthy and Prince 1993), developed within Optimality Theory framework (Prince and Smolensky 1993), has adapted the notion of edge alignment from the original proposal by Selkirk (1984). In the case at hand, we claim that the alignment constraint ALIGN (PrWd, L, NucF, L), which aligns nuclear stressed vowels to the left boundary of prosodic words, is responsible for blocking deletion or glide formation in this context. The result of this is that word-initial syllables are ‘isolated’ from the preceding syllables, blocking schwa deletion and glide formation of V1.¹⁶ A similar constraint can be found in Bisol (2003:186) to explain the blocking effects of the phrasal stress in Brazilian Portuguese.

- (13) ALIGN (NucF, L, PrWd, L)
The left edge of the main phrasal foot must coincide with the left edge of the prosodic word.

The effects of nuclear stress on vowel sandhi phenomena can be understood as a particular instantiation of the tendency to strengthen segmental

and prosodic properties in positions with stronger stress (see Dresher and van der Hulst 1998, Dilley et al 1996). Similarly, the preservation of phonological elements in certain prominent positions (e.g., word-initial segments) has been clearly demonstrated in recent work on positional faithfulness (Beckman 1998, among others). In Catalan, as stated in Cabré and Prieto (2004), word-initial prominence is reflected in the maintenance of high vowels as vowels at the initial syllable of the word if the lexical stress is no more than two syllables away from this vowel (e.g., *tió* [i'o] 'log', *diana* [i'a] 'target', *diadema* [iə] 'diadem'). This behavior can be interpreted as a position-sensitive phenomenon, as vowels at the beginning of the word are more salient than those at the end of the root. Catalan behavior regarding vowel sandhi resolutions shows that it is both the prominence of word-initial positions and the presence of a word-initial nuclear stress which are triggering prosodic isolation.

As the tableaux in (14) show, the top-ranked alignment constraint ALIGN-L (NucF, L, PrWd, L), which aligns nuclear (or sentence-) stressed vowels to the left boundary of prosodic words, prevents syllable contraction in cases such as *pròtesi ampla* [i 'a] 'broad prosthesis', *article àrab* [ə 'a] 'Arab article' and *territori inca* [i 'i] 'Incan territory'. Glide formation, vowel elision and fusion are mechanisms available to satisfy the crosslinguistic constraint ONSET (the tendency for syllables to have onsets). This constraint is thus violated by heterosyllabic sequences of the type V.V. As the tableau shows, the alignment constraint dominates ONSET and prevents syllable contraction.

(14)

<i>pròtesi ampla</i>	ALIGN-L (NucF, PrWd)	Onset
a. ☞ pròtes[i 'a]mpla		*
b. pròtes[_i ja]mpla	*!	

<i>article àrab</i>	ALIGN-L (NucF, PrWd)	Onset
a. ☞ articl[ə 'a]rab		*
b. articl[_i əa]rab	*!	

<i>territori inca</i>	ALIGN-L (NucF, PrWd)	Onset
a. ☞ territor[i 'i]nca		*
b. territor[_i i]nca	*!	

By contrast, when the same ranking is applied to cases such as *cançó illenca* [ˌo j] ‘island song’ or *sabó aromàtic* [ˌoə] ‘aromatic soap’ or *camí important* [ˌi] ‘important path’ (that is, stressed V1 plus unstressed V2), the alignment constraint ALIGN-L (NucF, PrWd) is not violated by the data because the sentence stress lies further away on the second word. Consequently, syllable contraction (through gliding or vowel deletion, depending on the case) is the outcome in this context. The different outcomes of syllable contraction will be dealt with later in this section.

(15)

<i>cançó illenca</i>	ALIGN-L (NucF, PrWd)	Onset
a. φ canç[ˌo j]llenca		
b. canç[ˌo i]llenca		*!
<i>sabó aromàtic</i>	ALIGN-L (NucF, PrWd)	Onset
a. φ sab[ˌoə]romàtic		
b. sab[ˌo ə]romàtic		*!
<i>camí important</i>	ALIGN-L (NucF, PrWd)	Onset
a. φ cam[ˌi]mportant		
b. cam[ˌi i]mportant		*!

Let us now examine a case such as *cap orfe* ‘no orphan’ or *peu ample* ‘wide foot’, syllabified as [ka.ˈpɔr.fə] or [ˌpɛ.ˈwam.plə], and not *[kap.ˈɔr.fə] or *[ˌpɛw.ˈam.plə]. In Catalan, word-final codas are always resyllabified as onsets with word-initial vowels. However, this phenomenon represents a violation of Align-L (NucF, PrWd). In order to account for segmental resyllabification, we propose to resort to a constraint which disallows a configuration such as C.V, that is, *C.V (Universally optimal syllable), which is undominated in Catalan.¹⁷ In Catalan, ONSET can be violated, as we find onsetless syllables (e.g., *illa* [ˈiʎə] ‘island’, *ona* [ˈonə] ‘wave’, *teatre* [teˈatrə] ‘theater’); yet there are no cases of *C.V.¹⁸

(16) *C.V

No segment available can be syllabified as coda if it is followed by a vowel.

The following two tableaux compare a sequence such as *cap orfe*, with an onset consonant available, with *pròtesi ampla* ‘broad prosthesis’, with no such consonant. While the first surfaces as [ka.ˈpɔr.fə] because it satisfies the *C.V requirement, *pròtesi ampla* ‘broad prosthesis’ respects the alignment constraint and surfaces as [prətəsi ˈamplə].

(17)

	<i>cap orfe</i>	*C.V	ALIGN-L (NucF, PrWd)	Onset
a.	cap[ˈɔ]rfe	*!		*
b.	ca[ˈpɔ]rfe		*	

	<i>pròtesi ampla</i>	*C.V	ALIGN-L (NucF, PrWd)	Onset
a.	pròtes[iˈa]mpla			*
b.	pròtes[jˈa]mpla		*!	

Let us now deal with the different mechanisms available in Catalan to attain syllable contraction. How do we predict the fact that different vowel sequences give rise to different outcomes such as gliding, vowel elision or fusion? One of the main factors to be taken into account is the **sonority properties** of the vowels involved. We will rely on the well-known cross-linguistic generalization that more sonorous segments are chosen to occupy the syllable nuclei positions, while less sonorous segments will surface as syllable margins. Within OT, this tendency has been formalized using the Harmony scale HNUC (Nuclear Harmony Constraint; after Prince and Smolensky 1993:16):

(18) **Nuclear Harmony Constraint**
(HNUC, Prince and Smolensky 1993)

A higher sonority nucleus is more harmonic than one of lower sonority.

To instantiate HNUC into binary constraints, Prince and Smolensky (1993:136ff) propose a process of universal alignment (iii) of the following two phonetic pre-defined scales (i and ii): a binary structural dimension (Peak/Margin) and a segmental sonority prominence scale.

- (19) i. Syllabic Position Prominence: Peak > Margin
 ii. Vocalic sonority scale: a > ε, ɔ > ə > e, o > i, u
 iii. Universal Syllable Position/Segmental Sonority Prominence Alignment (Prince and Smolensky 1993:137):
 The syllable position and segmental sonority prominence scales are universally aligned: the harmonic alignments are the Peak and Margin Harmony scales; the constraint alignments are the Peak and Margin Constraint Hierarchies.

Crossing of two phonetic scales gives rise to the Peak Hierarchy in (20) which motivates the relationship between sonority and syllabicity. In Catalan, this relationship explains the fact that high vowels are the ones that occupy the syllable margins when there is any other vowel competing with them. This hierarchy will also determine nucleus placement in the case of contact between any other two vowels:¹⁹

- (20) Peak Hierarchy in Catalan
 *P/i, *P/u >> *P/e, *P/o >> *P/ə >> *P/ε, *P/ɔ >> *P/a

In the following tableau, the fact that *P/V[i,u] dominates *P/V[–high] brings about the selection of candidate (a) *cançó illenca* [ɔj] as the optimal candidate (over candidate (b) *[ɔi]) because the nucleus is the most sonorous vowel. MAX-SEG (MAXIMIZE-SEGMENT), a constraint which dictates that every input segment should be maximally represented in the surface, has to dominate both *P/[i,u] and *P/V[–high] (MAX-SEG >> *P/[i,u] >> *P/V[–high]) in order to prevent vowel deletion from applying. The same result would be obtained in sequences of two unstressed vowels (e.g., *empresa inútil* [əj] ‘useless enterprise’)

- (21)

<i>cançó illenca</i>	ALIGN-L (NucF, PrWd)	ONSET	Max-Seg	*P/[i,u]	*P/V[–high]
a. φ canç[ɔ j]llenca					*
b. canç[ɔ i]llenca				*!	
c. canç[ə i]llenca		*!		*	*
d. canç[ə]llenca			*!		*

Peak Hierarchy also accounts for the resolution of gliding with no high vowels. In the case of *sabó aromàtic* [i,ɔə] ‘aromatic soap’ – remember that word-initial schwas in open syllables are generally not deleted; the schwa is not deleted and keeps its nuclear position while the preceding closed mid vowel becomes a glide because of the Peak Hierarchy ranks *P/e,o above and *P/ə below. Nucleus placement is thus derived from the Peak hierarchy: since *P/e, *P/o outweighs *P/ə, candidate (a) *sabó aromàtic* *[i,ɔə] is ruled out.

(22)

		ALIGN-L (NucF, PrWd)	ONSET	Max-Seg	*P/[e,o]	* P/[ə]
a.	<i>sab</i> [i,ɔ ə]romàtic				*!	
b.	☞ <i>sab</i> [i,ɔ ə]romàtic					*
c.	<i>sab</i> [i,ɔ ə]romàtic		*!			*
d.	<i>sab</i> [i,ɔ]romàtic			*!	*	

Let us now consider the cases of [ə]-deletion. As is well-known, schwa is the least prominent vowel with a general tendency to delete. Except for cases of vowel identity, schwa is the only vowel that deletes in Catalan. We resort to Crosswhite's (2001) vocalic prominence scale shown in (23), in which the low vowel [a] is the most prominent and the schwa the least prominent in the scale. This prominence scale motivates the constraint *[ə] which counteracts the schwa deletion blocking stated in MAX-SEG. The constraint *[ə] should not be interpreted as a ban against schwas in Catalan, as this language has plenty of them, but rather as a constraint which chooses the best segmental candidate to be deleted, if necessary.²⁰

(23) Vocalic prominence scale (after Crosswhite 2001):
a > ε,ɔ > e,o > i,u > ə

The data in the preceding sections has shown that, in general, schwa deletion is blocked in open syllables (*sabó aromàtic* [i,ɔ ə] ‘aromatic soap’), while it is permitted in closed syllables (*sabó especial* [i,ɔ] ‘special soap’). This contrast is most probably rooted in phonetic behavior: as it is well-known, vowels tend to be shorter in closed syllables than in open syllables. As a

consequence, shorter vowels are less perceptible and more prone to deletion. Formally, we resort to Jiménez (1999:97ff), and also Wheeler (forth.) and propose the Syllable Preservation Principle (SPP) to account for this distinction (see also observations by Colina 1995 and Palmada 1994). This constraint, stated in (24) should be interpreted as a correspondence constraint preventing a segment from deleting if this means deleting the only segment representing that syllable. The interpretation of this constraint is somewhat lax: it does not require that syllables be preserved absolutely: they may overlap as long as there remains some distinct independent material belonging to each:

- (24) Syllable Preservation Principle (SPP) (after Jiménez 1999:97 and Wheeler forthcoming)
 Let $[\alpha]$ and $[\beta]$ be two domains composing a domain $[\gamma]$; $[[\alpha][\beta]]\gamma$.
 The number of syllables in γ corresponds to the number of syllables in $[\alpha]$ and $[\beta]$.

The ranking of constraints will be as follows:

- (25) ALIGN-L >> ONSET >> SPP >> $*[\emptyset]$ >> MAX-SEG >> $*P/i, u$ >> $*P/V[-high]$

The following two tableaux contrast the examples *cançó especial* $[_i o]$ vs. *sabó aromàtic* $[_i \emptyset \emptyset]$. Crucially, the Syllable Preservation Principle Constraint is not violated by candidate (d) in the first tableau, and thus $[\emptyset]$ is deleted. By contrast, candidate (d) in the second tableau crucially violates SPP. Please note that the same contrast would obtain with sequences of two unstressed vowels (e.g., *oli esplèndid* $[i]$ ‘splendid oil’ and *savi amable* $[j\emptyset]$ ‘kind sage’).

- (26)

		ALIGN-L	ONSET	SPP	$*[\emptyset]$	MAX-SEG	$*P/[e, o]$	$*P/[\emptyset]$
a.	canç _[i] o _[o] special				*!		*	
b.	canç _[i] ∅ _[∅] special				*!			*
c.	canç _[i] ∅ _[∅] special		*!		*		*	*
d.	☞ canç _[i] o _[o] special					*	*	

		ALIGN-L	ONSET	SPP	*[ə]	MAX-SEG	*P/[e,o]	*P/[ə]
a.	sab _[l] o ə]romàtic				*		*!	
b.	☞ sab _[l] o ə]romàtic				*			*
c.	sab _[l] o ə]romàtic		*!		*		*!	*
d.	sab _[l] o]romàtic			*!		*	*	

Finally, let us deal with a sequence of two vowels of the same quality. Why is fusion and not gliding the strategy used by Catalan in this case? The fact that fusion is the outcome (rather than realization with a long vowel) reflects the fact that it is a high-ranked constraint in Catalan (see Wheeler, chapter 3 and similar ideas in Mascaró 1984) which does not allow vowels of the same quality to stand adjacent to one another.):²¹

- (27) *OCP/V (or *Vμμ; after Wheeler forthcoming):
A sequence of two identical vocoids is disallowed

The following tableau derives the optimal candidate of *camí important* [_[i]i] (as well as potential examples such as *amiga amable* [ə] ‘kind friend’) because it is the only candidate which does not violate *OCP/V. Note that the rest of the constraints are irrelevant.

(28)

		ALIGN-L	ONSET	*OCP/V
a.	cam _[i] i]important			*!
b.	cam _[i] i]important			*!
c.	cam _[i] i]important		*!	*
d.	☞ cam _[i] i]important			

The last tableau derives the cases whereby schwas in word-initial position delete after low and mid-low vowels [ɛ, a, ɔ]. The following restriction rules out combinations such as *ɛə, *aə, *ɔə. Exceptions to vowel reduction in Central Catalan (*teatre* ‘theater’, pronounced [te'atrə] rather than the expected outcome *[tə'atrə] or *teòric* [te'ɔrik] ‘theoretical’) also provide evidence for the presence of a similar constraint in another phonological domain.²²

This constraint can be understood as a specific version of an OCP type constraint banning vowels of similar qualities from being adjacent.

(29) *V_{Low.}ə : *εə, *aə, *ɔə

	sofà elegant	ALIGN-L	ONSET	*OCP/V _{low.} ə
a.	sof _[i] a _[ɔ] legant			*!
b.	sof _[i] a _[ə] legant			*!
c.	sof _[i] a əlegant		*!	*
d.	☞ sof _[i] alegant			

5. Conclusion

This article has offered a simple and unified account of vowel sandhi phenomena in Catalan. The paper shows that the surface realization of adjacent vowels at word boundaries is not a random phenomenon, but rather a quite systematic process which is basically guided by prosody. Nuclei properties in Catalan are maintained to preserve both morphological (word-initial) and sentence-stress prominence.

In Catalan, as in other Romance languages, final open vowels are parsed as nuclei when the following vowel bears nuclear stress; in other words, nuclear stress prominence protects the vowels from devocalizing (*canto àries* [u 'a], *canta himnes* [ə 'i]). The syllabic inalterability of word-final vowels applies regardless of the distance between adjacent stresses and thus cannot be explained by stress clash avoidance conditions (as it has been claimed in the literature). The blocking of V1 gliding/deletion is interpreted within OT as a consequence of the application of an alignment constraint which associates the lexical stress of the initial vowel with the prosodic word when it coincides with the nuclear stress of the utterance (AlignL NucStress-Pw). This constraint has the effect of triggering prosodic 'isolation' from the previous sequence and blocking V1 vowel gliding or deletion from applying.

On the other hand, when V2 is unstressed, the general solution is syllable contraction. For example, when a schwa occurs in word-initial position in closed syllables, deletion is the general norm (*passo angúnia* [u] 'I feel anguish', *oli esplèndid* [i] 'splendid oil'). In this case, the well-known tendency to preserve material in word-initial position is not strong enough. At

first sight, the facts presented in the preceding sections seem to contradict Casali's crosslinguistic generalization that languages preferentially preserve phonological elements in word-initial positions (namely, V2). Casali (1997) indicates that across languages deletion of a word-final vowel is much more common than deletion of a word-initial vowel and thus there is a preference for maintenance of features in word-initial position over word-final position. The work by Casali predicts that "a number of elision patterns which otherwise might plausibly be expected to occur are ruled out, for example, a language that regularly elides V2 at lexical word boundaries" (Casali 1997:509). In the case of Catalan, the syllabic properties in word-initial (and word-final) positions are only maintained when they are 'protected' by stress, indicating that faithfulness to word initial prominent positions is acting together with faithfulness to prosodic heads. Thus, the Catalan data clearly supports the view that position-sensitive faithfulness is not enough to explain the crosslinguistic behavior of some languages regarding vowel contact resolutions and that metrical faithfulness is needed as well.

Appendix

VOWEL CONTACT QUESTIONNAIRE

Nom i edat: _____

Lloc de naixement: _____

Transcriu els contactes vocàlics entre mots tal i com tu els pronuncies en la parla normal. Si tens dues possibles pronúncies, una en parla més ràpida i l'altra en parla més lenta, transcriu-les totes dues. També, en el cas que hi hagi diftong sense vocal alta, identifica el nucli:

Exs: cafè irlandès [ej], sabó aromàtic [ɔə], sofà elegant [a]

carro ample	cafè aromàtic
fuster humil	cançó íntima
cafè irlandès	matí avorrit
tallo ungles	paper artístic
crisi única	xampú aromàtic
cançó illenca	sofà únic
sofà unitari	ressò eixordador
monjo àgil	tabú amorós

indi alt	actor enèrgic
canti òpera	vestir elegant
demano eines	cafè amarg
compri oli	destí anòmal
canto àries	això allunya
cafè antic	paper adient
article àrab	tambor alegre
amiga òrfena	tambor antic
època òptima	jove alt
desprenia èter	llibre ètnic
canta himnes	àrea única
xampú excel·lent	conquesta illes
posa ara	menja herba
actor esplèndid	anàlisi única
camí enfangat	compra-li oli
collir espàrrecs	posa-li aigua
això encara	posa-te-la ara
paté andorrà	canta-me-li òpera
carro únic	sàpiga hores
territori inca	anàlisi híbrida
xampú oliós	ímpetu únic
metro únic	parli ara mateix
camí important	algú obre la porta
compri illes	parla ara mateix
sortir il·lusionat	sempre omplen el calaix
conté eines	això obre la porta
tabú humanitari	convé herba fresca
canta alegries	això entra bé
submarí inactiu	casa humida
destí incert	reserva hotels
menú opcional	perspectiva històrica
cara horrible	empresa inútil
sobre imprès	oli esplèndid
dibuixo angelets	vengui entrades
amo entusiasmat	passo angúnia
savi il·luminat	amo universal

Notes

- * Earlier versions of this work were presented at *PaPI 2003* (Phonetics and Phonology in Iberia, Lisbon), at the *Toulouse International Conference* “From rep-

resentations to constraints” (Toulouse, July 2003) and at the *XVth International Congress of Phonetic Sciences* (Barcelona, August 2003). A reduced version of this paper can be found in the 2003 ICPHS Proceedings (Cabr  & Prieto 2003). We are grateful to those who attended these meetings for interesting observations and comments, and especially to Eul lia Bonet, Sonia Colina, S nia Frota, Jos  Ignacio Hualde, Michael Kenstowicz, John Kingston, Maria Rosa Lloret, Joan Mascar , John McCarthy, Daniel Recasens, Elizabeth Selkirk, Donca Steriade, Hubert Truckenbrodt, Marina Vig rio, and Max Wheeler for discussion of some parts of the material included in the article. Thanks are also due to N ria Riera for transcribing the vowel contacts present in 5 spontaneous conversations of the *Corpus Oral de Catal * and to Marta Pay  and Llu s Payrat  for kindly providing us with a copy of this database before its publication. Finally, we thank Teresa Barenys, Juli  Cuf , Teresa Espinal, Anna Gavarr , N ria Mart , Jaume Sol , and Xavier Vall, who patiently responded to our questionnaire. All remaining errors are of course ours. This research was funded by grants 2002XT-00032 and 2001SGR 00150 from the Generalitat de Catalunya and BFF2003-06590 and BFF2003-09453-C02-C02 from the Ministry of Science and Technology of Spain.

1. Note that we transcribe word stresses appearing before the nuclear stress (or main phrasal stress) with a secondary stress mark (see section 3.2 for arguments that demonstrate stress subordination in Catalan). We must keep in mind that Central Catalan has seven vowels in stressed position ([i, e,  , a, ɔ, o, u]) which are reduced to three in unstressed positions ([i,  , u]). Non-high unrounded vowels [e,  , a] usually surface as schwa in unstressed position and rounded counterparts [ɔ, o] raise to high in the same circumstances.
2. The *Corpus Oral de Catal * is now publicly available on CD-ROM (Payrat  and Alturo 2002).
3. The database includes a couple of instances of subject plus a verbal projection (e.g., *alg  obre la porta* ‘someone opens the door’) and some instances of somewhat longer sequences (*conv  herba fresca* ‘fresh grass is needed’). These tokens constitute 7 examples in total.
4. The speakers who answered the questionnaire were the following. The fact that some of the subjects are linguists doesn’t affect the reliability of the questionnaire results, as all of them show the same tendencies and are in accordance with the database results.

<i>Name</i>	<i>Age</i>	<i>Locality</i>
Teresa Barenys	60	Barcelona
Teresa Cabr�	48	Reus (Baix Camp)
Juli� Cuf�	57	Sant Cugat (Vall�s Occidental)
M. Teresa Espinal	46	Manresa (Bages)
Anna Gavarr�	40	Barcelona
N�ria Mart�	37	Arb�cies (La Selva)

- | | | |
|-------------|----|------------------|
| Jaume Solà | 43 | Avià (Berguedà) |
| Xavier Vall | 41 | Reus (Baix Camp) |
5. Recasens (1993:130) also called attention to “the Catalan tendency to maintain V1 [ə] in front of V2 bearing word stress.” [translation ours]. In addition, when V1 is a schwa and belongs to a function word, a lexicalized form or a clitic (proclitic), deletion is the general norm: *pobre home* [ˈɔ] ‘poor man’, *aquella hora* [ˈɔ] ‘that time’, *quinze anys* [ˈa] ‘fifteen years’, *una eina* [ˈɛ] ‘a tool’, *l(a) obro* [ˈɔ] ‘I open it’, *una òliba* [ˈɔ] ‘an owl’, *bona ombra* [ˈo] ‘good shade’. Similarly, clitics such as the conjunction *que* have a different behavior depending on the modality of the sentence. If the utterance is a statement, deletion is the normal outcome: *no vull que obris* [ɔ] ‘I do not want you to open (it)’. If the utterance is interrogative or imperative both results are possible: yet, the vowel tends not to delete when the utterance is short and the intonational contour has to be realized in the (short) available segmental material: *que obres?* ‘Can you open (it)?’, *que obris!* ‘Open (it)!’ [ˈɔ]/[əˈɔ].
 6. Note that all word stresses preceding the main phrasal stress are transcribed with a secondary stress mark; see section 2.1 for arguments that demonstrate that prenuclear stresses are subordinated in Catalan).
 7. Clitic pronouns such as *ho* [u] and *hi* [i] work differently from word-final vowels. While they are quite resistant to becoming glides when a preceding consonant occupies the onset position (*li obro* [iˈɔ] ‘I open (it) for him’, *t’ho obro* [uˈɔ] ‘I open it for you’), if that is not the case, both diphthong and hiatus are possible depending on speech rate and the degree of prominence of the stress (*hi era* [iˈe] / [ˈje] ‘he/she was there’, *ho entro* [uˈe] / [ˈwe] ‘I bring it in’).
 8. Fernández Rei (2002: 140–141) gives the following examples. When V2 bears the main prominence in the intonational phrase (examples a, b, c), then vowel deletion is not possible; when V2 bears the main prominence within the phonological phrase (examples a”, b”, c”), vowel deletion is possible but rare (it occurs in 20,93% of the cases); finally, when V2 does not bear the main prominence in neither the intonational phrase nor the phonological phrase (examples a’, b’, c’), then deletion occurs in 68,89% of the cases:

a.	O <u>aceite</u> arde	‘Oil is burning’
b.	A rapaza <u>ora</u>	‘The girl is praying’
c.	O neno <u>ora</u>	‘The boy is praying’
a’.	O <u>aceite</u> arde moito	‘Oil is burning a lot’
b’.	A rapaza <u>ora</u> moito	‘The girl is praying a lot’
c’.	O neno <u>ora</u> moito	‘The boy is praying a lot’
a”.	O <u>aceite</u> arde na tixola	‘Oil is burning in the pan’
b”.	A rapaza <u>ora</u> na igrexa	‘The girl is praying in the church’
c”.	O neno <u>ora</u> na igrexa	‘The boy is praying in the church’
 9. Note that generally the nucleus is placed on the vowels with highest sonority and the margin is placed on the vowels with lowest sonority, which undergo glide

formation (e.g., *ho farà ell per demà* [i,aɛ̯] ‘he will do it for tomorrow’ (COC, c01), *menjar oli verge* [i,aɔ̯] ‘to eat virgin oil’ (COC, c01)). If vowels are of the same height, the nucleus tends to be placed on the rightmost vowel (e.g., *això entra bé* [i,ɔ̯e] ‘this fits well’). If vowels are of similar quality, vowel coalescence is also possible (e.g., *no sé què era ahir* [i'e] ‘I don’t know what day it was yesterday’ (COC, c01). Mascaró (1984:56) also notes that two identical vowels (whatever their degree of prominence) can be reduced to a single vowel in this context.

10. Similarly, Fernández Rei (2002: 130) demonstrates that in Galician stress clash does not affect the general hiatus solution of similar vowel sequences. The following examples show that the result is the same when the distance between stressed is one syllable (a, b, c) than when it is more than one syllable (a', b', c'):

a. Meu pai recibe <u>armas</u> de América	‘My father receives weapons from America’
b. Temos unha <u>nená</u> orfa na escola	‘There is an orphan girl at school’
c. Temos un <u>nenó</u> húngaro na escola	‘There is a Hungarian boy at school’
a'. Meu tío mándalle <u>armas</u> desde América	‘My uncle sends him weapons from America’
b'. Temos unha <u>pícará</u> orfa na escola	‘We have a naughty orphan girl at school’
c'. Temos un <u>pícaro</u> húngaro na escola	‘There is a naughty Hungarian boy at school’

11. It should be noted that there are major dialectal differences regarding the deletion of word-final schwas. The following examples show that deletion of word-final [ə] is more common in the Girona and Majorca region than in Barcelona (see also Bonet and Lloret 1998:185). While Barcelona Catalan tends to maintain word-final schwas before a following nuclear stressed vowel, Girona and Majorcan Catalan tend to delete them quite systematically in the same environment. Data from Majorcan Catalan come from Puigròs (2000).

	<i>Barcelona</i>	<i>Girona</i>	<i>Majorcan</i> (Puigròs 2000)	
època <u>ò</u> ptima	[ə 'ɔ̯]	['ɔ̯]	['ɔ̯]	‘optimal period’
jove <u>al</u> t	[ə 'a]	['a]	['a]	‘tall young person’
mare <u>ú</u> nica	[ə 'u]	['u]	['u]	‘unique mother’
llibre <u>è</u> tnic	[ə 'ɛ̯]	['ɛ̯]	['ɛ̯]	‘ethnic book’
conquesta <u>il</u> les	[ə 'i]	['i]	['i]	‘he/she conquers islands’
talla <u>h</u> erba	[ə 'e]	['e]	['e]	‘he/she/it cuts grass’

12. It should be noted that schwa deletion is not as common in open syllables, as will be shown in the next section.
13. A perception experiment with 500 target sentences proved a high level of confusion between stressed syllables in a clash environment (sequences such as *camí net* ‘clean path’) with sequences with only one stress (*caminet* ‘small path’). The

fact that these two sequences can be homophonous in normal speech demonstrates the systematic destressing of the first syllable in the clash.

14. Spanish displays a parallel behavior in this respect. As Hualde (1994:638) points out, “when two syllables merge, the element of greater sonority receives the stress prominence”. [our translation; TC & PP]. Examples are *jabalí atolondrado* [j**á**], *menú antiguo* [wa], *menú italiano* [wi], *café amargo* [e**á**], *cantó Antonio* [o**á**]. For this issue, cf. Hualde (1994), Navarro Tomás (1926), and Roca (1992).
15. The distance between stresses can also play a role in [ə]-deletion: the process is sometimes blocked when the syllable is next to a stressed syllable. For example, *ressò eixordador* [ɔ] ‘deafening echo’ vs. *ressò adient* [ɔə] ‘appropriate echo’; *café aromàtic* [ɛ] ‘aromatic coffee’ vs. *café amarg* [ɛə] ‘bitter coffee’. Nonetheless the result after [a] though does not happen after [a] is never *[aə]: *menjar amarg* [a] ‘bitter food’.
16. The constraint ALIGN (PrWd, L, NucF, L) has the function of aligning the left edge of the main phrasal foot to the left edge of the prosodic word when the head of the foot is in word-initial position. Yet, a higher-ranked constraint (FAITH-STRESS) does not allow the position of the stress to be moved from the target syllable in order to align it with the beginning of the word. Thus, in the word *aromàtic*, the ranking FAITH-STRESS >> ALIGN (PrWd, L, NucF, L) in fact preventing that the left edge of the phrasal foot strictly aligns with the left edge of the prosodic word.
17. Theorem – Universally Optimal Syllables (Prince and Smolensky 1993:89)
No language may prohibit the syllable CV.
18. Other potential constraints to explain this effect are SYLLCON (Syllable Contact Law: there should be a minimal sonority distance between syllable edges) or a local conjunction of ONSET+CODA conditions.
19. Note that [ə] is phonetically lower than [e, o] and thus it bears greater sonority.
20. The vowel deletion process in Catalan is basically ‘activated’ when two vowels are adjacent across word boundaries. Thus, the constraint *[ə] should be interpreted as a conjoined constraint *[ə] with the ban against having two consecutive vowels in a row *VV.
21. Note that when two identical vowels are adjacent within the same word (and *not* across word-boundaries), then deletion does not occur (e.g., *fii* [fii] ‘you trust. imp’, *paelleta* [pəə'ɛtə] ‘little frying pan’). The constraint I-CONTIGUITY offers a potential explanation for the maintenance of vowels in word-internal positions. This constraint would rule out deletion of elements internal to the input string (in this case the lexical forms).
INPUT-CONTIGUITY (“No skipping”) (McCarthy & Prince 1995:371)
The portion of S1 standing in correspondence forms a contiguous string.
Domain (R) is a single contiguous string in S1.

22. Wheeler (forthcoming), to explain exceptions to vowel reduction, proposes the following restriction:

*OCP/VA: A-coloured vowels do not stand adjacent to one another

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