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Vowel Reduction in Catalan Varieties

Catalan typologies and property analysis

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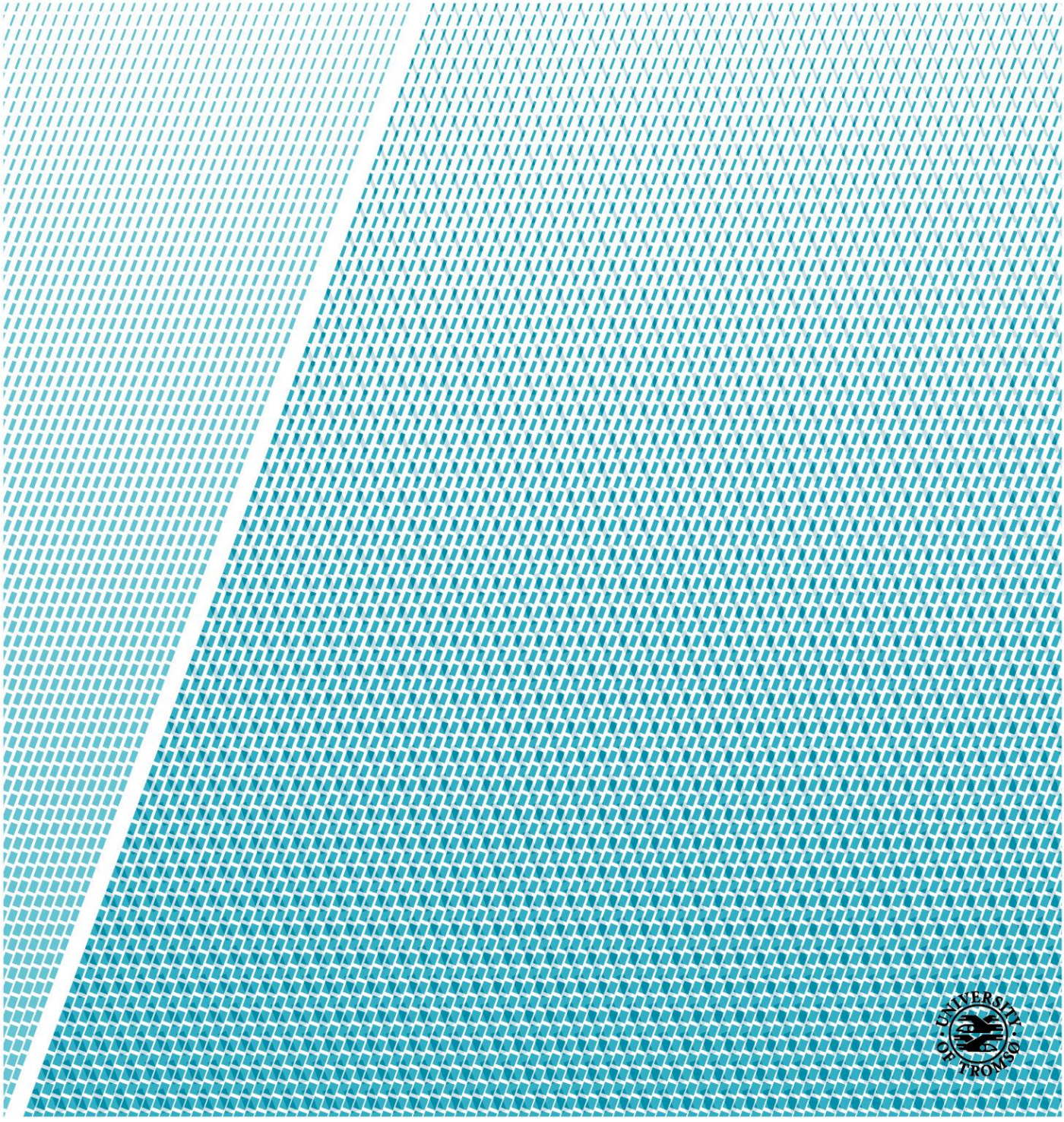

Abstract

In this thesis we work on the main topic of vowel reduction phenomenon. We develop a dialectological description of the different varieties of Catalan, depending on how vowel reduction works. We can find five main varieties: 1) Central, 2) Northern, 3) Majorcan, 4) North-Western & Valencian and 5) Algherese; and three transitional ones: 6) Central-Septentrional, 7) Tarragonian and 8) Tortosan. Each variety has its own linguistic phenomena and the distinction between main varieties and transitional ones is depending on which contexts does vowel reduction vary. Main varieties will show vowel reduction in the same contexts, meanwhile transitional areas will show variation on how vowel reduction behaves in one same context. To give account for that (micro)variation, we develop a Property Theory analysis, working on Optimality Theory, which consists in the division of languages and grammars into properties with binary values. In the case of Catalan, we find three main properties: P1, which works with the widest faithfulness constraint, ID[high,low,ATR], and the markedness ones (Lic-Nonperiphery, Lic[MidLax], *Unstressed/low, *Unstressed/-high, NoSchwa); P2 which works with the second biggest faithfulness constraint, ID[high,low], and the markedness constraints; and P3, which works with the most concrete faithfulness constraint, ID[high], and the markedness ones. The particularity of using a property analysis for approaching micro-variation is that properties will need to develop parallel micro-steps to give in account that micro-variation. For that reason, we will find how each property has several sub-divisions, consisting in re-rankings of one or some constraints, that keep on evaluating every variety until all are described with each property. In that sense, the micro-steps for each property look like value additions to the main property. If P3, for example, can re-rank in both values a and b it will add an addition number: P3|1 or P3|1; if P3 with value a (P3|1) has, at the same time re-rankings that result in other varieties, it will have, once more, an addition: P3|1|1 or P3|1|2, and so on. This additions, or sub-steps, for each property are the steps parallel to micro-variation of each Catalan variety that will permit us show which constraints we must re-rank to get each variety and analyse them in a unique way.

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1. Introduction

Catalan varieties show different realizations regarding the phenomenon of vowel reduction. We would expect it to act the same, as it is a language spoken in a small area in, mostly, the North-East part of Spain. Even though, things are not always what they seem, and even we face a small geographical region where Catalan is spoken, its phonological phenomena can present interesting and curious variation. That is the case, among others, of vowel reduction in the different varieties of Catalan.

Standard Catalan presents a seven-vowel system where vowel reduction acts, basically, neutralizing to schwa ([ə]) front non-high vowels ([a, ɛ, e]) and rising (to [u]) back vowels ([ɔ, o]). However, not all the different varieties of Catalan are as systematic as Standard Catalan. Due to geographical, historical or sociological influence we can observe differences in how vowel reduction acts.

The goal of this thesis is to take in account how vowel reduction is manifested in the different varieties of Catalan and, by using a property analysis developed in optimality theory, which properties are the responsible for giving in account the variation. With a property analysis we will be able to establish which constraint rankings exist and which ones will penalize one or other patterns to give in account the vowel forms in the outputs within the variation. Also, a property analysis will permit us show the re-ranking that need to be established in order to show the different micro-variation parameters among all varieties, either the main ones or the transitional ones.

The structure of the thesis is the following one. Section 2 presents the state of the art of Catalan, including Catalan varieties, and vowel reduction. In section 2.1 we present the Catalan language. For that, first we make a description about where is spoken (in the different regions in Spain, mostly Catalonia and the Valencian Autonomous Community, in the south of France; in Andorra and in the Sardinian city of Alghero); second, what different varieties are there and, third, where we can find them and how the vocalic system works (note that the geographical and the linguistic distribution sometimes is not going to be the same, for example in the case of the Balearic Islands we can find differences between the linguistic properties in the same region). We introduce the description of the stressed system (5-, 7- or 8-vocalic system) and the unstressed system (3- or 5-vocalic system, in Eastern and Western varieties, respectively). In section 2.2 we introduce a theoretical overview to vowel reduction, for that, we present evidence of vowel reduction

in many different languages and we will introduce some authors' approaches to vowel reduction, in concrete, we will pay special attention to Crosswhite (1999), Walker (2011) and DeLacy (2006). Next, we make a more detailed description of the process of vowel reduction in the different varieties of Catalan, those varieties include "main" varieties (1-5) and some transitional areas (6-8) which are the following ones: 1) Central Catalan, 2) Northern Catalan, 3) Majorcan, 4) North-Western & Valencian, 5) Algherese, 6) Central-Septentrional, 7) Tarragonian and 8) Tortosan. In the final part of this section we introduce some contexts where vowel reduction is blocked, like in Hiatus, Compounds and Loan words. To end with, section 2.3 reviews and discusses the theoretical approaches that we need to consider for the study of the phenomenon of vowel reduction in Catalan. First, we introduce Optimality Theory (Prince & Smolensky 1993/2004), a phonological theory of well-formedness for a given input after considering a set of candidates and constraints for a resulting optimal output or candidate (the less violated for the constraints, and more satisfying). Secondly, we introduce Property Theory (Alber & Prince 2016, 2017; Alber, DelBusso & Prince 2016) a theory of typological structures where each grammar (of the same language or for different languages) is identified by its own property values. Finally, we retake the theoretical concept of vowel reduction made by Crosswhite, Walker and DeLacy. We present their analysis and the typologies found in their works and we discuss their constraints and understanding of vowel reduction. To end with, we take Crosswhite's side for our analysis, which is developed in the following section.

Section 3 is about the analysis of vowel reduction in the different varieties of Catalan. To take it in account, we use a property analysis using the program OTWorkplace (Prince, Tesar & Merchant 2018). The inputs we consider are the largest vocalic system found in Catalan, the Majorcan, which is formed by the eight underlying vowels /a, ɛ, e, i, ɔ, o, u, ə/. The other varieties just exclude some of the vowels, for example in Northern Catalan we can just find a five-vocalic system (/a, e, i, o, u/), while in the rest of the varieties we find a seven-vocalic system (/a, ɛ, e, i, ɔ, o, u/). The different outputs for all those inputs are divided between front (/a, ɛ, e, ə, i/) and back (/ɔ, o, u/) vowels, where all vowels are possible outputs for each vowel of the group, as we are assuming that backness and roundness never change in Catalan vowel reduction. Next, we consider three types of constraints, following Crosswhite's (1999, 2001) work: three Faithfulness constraints, which are ID[high], ID[high,low] and ID[high,low,ATR]; three Markedness constraints,

*Unstressed/low, *Unstressed/-high and NoSchwa; and two Licensing constraints, Lic[MidLax] and Lic-Nonperiphery. Realizing a property analysis permits us check how properties work for each variety. We propose three main properties, P1, which works with the biggest faithfulness constraint, ID[high,low,ATR], and the markedness ones; P2, that works with ID[high,low] and the markedness; and P3, that works with ID[high] and the markedness constraints. All those faithfulness constraints are in evaluation via re-ranking either among themselves or even with the markedness constraint, and the same case happens for the markedness constraints among themselves. For make that explicit, each property presents several micro-steps to give in account the micro-variation each variety of Catalan has. Those properties' micro-steps are defined like P1|1 or P1|2, for example, depending if the value of P1 is a or b. For each sub-property, we also need to assign values to its ranking, which is every time more concrete to be able to give account for the variation of each Catalan variety, from the biggest variations to the smallest ones. The results of our analysis show that depending on which constraints we rank higher or which constraints we rank lower, and its possible re-ranking combinations, we are be able to picture the phenomenon of vowel reduction in the Catalan varieties using a property analysis.

Finally, section 4 points out the conclusions we can draw from the analysis. First, which property should be used to characterize which variety and how the ordering of constraints, either ranked in higher or lower positions inside of each property, gives us, as a result, different varieties from bigger to minimal modifications. So, depending on which group of constraints is recognized, if Faithfulness, Markedness or Licensing, as the highest ranked, and how their interactions are able to support the micro-variation among each variety and property.

2. State of the art

2.1. Catalan

2.1.1. Catalan and its varieties

Catalan is a language from the Romance family spoken, mostly, in the Autonomous Community of Catalonia (in the North-East part of Spain). In addition, we can also find some other parts of Spain where Catalan is also spoken, like the Eastern fringe of Aragon (Autonomous Community at the West of Catalonia), most of the Valencian Autonomous Community (at the South of Catalonia), El Carxe (in Murcia, in the South-East of Spain, right below Valencia), and most of the Balearic Islands. Catalan is also spoken in Andorra -a small country in the Pyrenees, between Spain and France-, in the south of France and in the Sardinian city of Alghero. (Wheeler 2005: 1) (see Appendix, Image 1. Catalan-speaking Countries).

As we can find Catalan spoken in that many different geographical regions it is normal to think about if it is all the same language or it has different varieties. In broad strokes, we can divide Catalan into two big blocks of varieties: Easter Catalan and Western Catalan. However, we must note that each block has, at the same time, subdivisions. For our study we will focus on those subdivisions (with some modifications depending on linguistic criteria, not only geographical) that are the following six ones. In the Eastern part we can find: 1) Central Catalan (sometimes also called just Eastern Catalan in some literature), which includes the province of Barcelona, the oriental part of the province of Tarragona and most of the province of Girona; 2) Northern Catalan, which includes the north of the province of Girona and some parts of the south of France (the Occitan-speaking area or Roussillon), and a small country in the Pyrenees called Andorra; 3) Balearic, which includes the Balearic Islands; and 4) Algherese, which includes the city of Alghero, in the North-West of Sardinia, in Italy. For the Western part we can find the remaining regions: 5) North-Western Catalan, which includes the province of Lleida, most of the parts of the province of Tarragona and some regions of the Eastern part of Aragon (called *La Franja* 'The Strip'); and, finally, 6) Valencian, which includes the Autonomous Community of Valencia and the province of Carxe in the Autonomous Community of Murcia. (For more detail see Veny & Pons i Griera 2013; Montoya-Abat 1999, 2002: 8; Wheeler 2005, among others). (see Appendix, Image 2. Catalan Dialects).

Next, we summarize the dialect division in (1):

(1) Catalan dialectal division

Eastern Catalan	Western Catalan
Central Catalan Northern Catalan Balearic Alghерese	North-Western Catalan Valencian

At the same time, we can find more sub-subdivisions, as each dialectal division has sub-dialectal characteristics, for example, we can divide the Balearic dialect in its different islands, or the sub-division of the North-Western Catalan. We present in (2) a table with the division of the sub-dialects and, in the next sections we present in more detail some of them, the most relevant ones linguistically talking. For more detail, check Montoya-Abat (2002: 8-13), Veny (2007), Veny & Massanell (2015), Veny & Pons i Griera (2001, 2013), among others.

(2) Catalan sub-dialectal division

<table>
<tr><td rowspan="10">Eastern Catalan</td><td colspan="2">Alghерese</td></tr>
<tr><td rowspan="3">Balearic</td><td>Majorcan</td></tr>
<tr><td>Menorcan</td></tr>
<tr><td>Eivissan</td></tr>
<tr><td rowspan="2">Northern Catalan</td><td>Capcinian</td></tr>
<tr><td>Central-Septentrional</td></tr>
<tr><td rowspan="2">Central Catalan</td><td></td></tr>
<tr><td>Tarragonian</td></tr>
<tr><td rowspan="8">Western Catalan</td><td rowspan="4">North-Western Catalan</td><td></td></tr>
<tr><td>Ribagorsan</td></tr>
<tr><td>Pallaresian</td></tr>
<tr><td>Tortosan</td></tr>
<tr><td rowspan="4">Valencian</td><td></td></tr>
<tr><td>Septentrional</td></tr>
<tr><td>“Apitxat”</td></tr>
<tr><td>Meridional (or Alicantinian)</td></tr>
</table>

2.1.2. Vocalic system

In this thesis we focus only on the vocalic system of Catalan. Catalan has many interesting phenomena regarding the consonant system too, but for now we just pay attention on the vocalic one. In that sense, we proceed to make a description of the vocalic system and, in further sections, we develop it in more detail and its characteristics regarding the different varieties of Catalan.

Basically, Catalan has a seven-vowel vocalic system in stressed positions. In most of the varieties of Catalan we can observe the following underlying vowels: /a/, /e/, /ɛ/, /i/, /o/, /ɔ/ and /u/ (Lloret 2001; Bonet & Lloret 1998; Mascaró 1978, 2002; IEC 2017; Julià i Muné 2002; Prieto 2004, Recasens 1996). In some other varieties, such as Majorcan, we can find one more underlying vowel in the stressed system: /ə/, giving us an eight-vowel stressed system. In the Northern Catalan variety, we can find a smaller system with just five vowels that only includes /e/ and /o/ and leaves out /ɛ/ and /ɔ/ in stressed positions (IEC 2017: 38-39).

We want to point out two historical factors regarding those two last dialects, Majorcan and Northern Catalan. First, in Majorcan, as the literature pointed out (Moll 2006), the fact of finding schwa as an underlying vowel and, thus, in stressed positions is due to the evolution of the Latin vowels *ĕ, ĭ* and *œ*. The evolution from Latin to Catalan regarding those three vowels took three different paths in stressed positions: it evolved to /ə/ in Majorcan (non-evolved Balearic), /ɛ/ in Eastern Catalan and /e/ in Western Catalan (Moll 2006: 74). We remark the "non-evolved" character of the underlying schwa because as some authors points out (Moll 2006, Puigròs i Caldentey 2001, Pons Moll 2013), the evolving steps Latin followed until it became Catalan where, first, *ĕ* evolved to /ə/ and, afterwards, in Central Catalan it evolved to /ɛ/ while in the Western dialects it evolved to /e/. The process seems not finished yet in the Balearic Islands, as we can still find different steps of the process: in some areas of Minorca and Eivissa the realization of *ĕ* is complete (or almost) as we find in the majority of the regions /ɛ/, like in Central Catalan; in Majorca, on the other hand, the majority of regions still have the underlying schwa /ə/ but it is an obsolete vowel as this is found mostly in old-traditional words while new words are realized with /ɛ/ (Puigròs i Caldentey 2001). That would make us think that the normal process this vowel followed during its evolution was, first to be schwa all around the territory (as Moll 2006 points out citing Brekke 1888 and Meyer-Lübke 1926), then Central Catalan started leaving it as obsolete and using /ɛ/ instead, and now, the process

is taking place in the Islands as we can observe the change already in most of the areas, even in some regions of Majorca like Lloseta, Binissalem, Porreres or Alaró (Moll 2006: 76).

Second, in Northern Catalan we must note that, strictly, the /e/ and /o/ we find in this variety are two mid-vowels in between the opened-mid /ɛ/ and /ɔ/, and the closed-mid ones /e/ and /o/, so we would be better talking about /ẹ/ and /ọ/ (Mascaró 2002: 105). The interesting point we would like to talk about here is that in the stressed system of the Northern Catalan, as Gómez Durán (2002: 51) notes, we find this tinier stressed-vocalic system due to the closing of the opened *e* (/ɛ/) and opening of the closed *e* (/e/), so in stressed positions they are represented as a single one, the middle-opened *e*: /ẹ/. In the case of *o* what happened is a bit similar, the opened *o* (/ɔ/) closes a bit its features becoming the middle vowel between /ɔ/ and /o/: /ọ/, while in the case of the closed *o* (/o/) it followed the same path and it also became more closed until it became /u/ in, already, stressed positions.[1] Some examples of this can be found in Gómez Durán (2002: 51) and we will reproduce here two examples for better illustrating: *cor* ('heart') is ['kɔr] in the majority of Catalan dialects, but in some areas of the Northern Catalan variety it is pronounced ['kọr]; and *gos* ('dog') is ['gos] is the majority of Catalan dialects but ['gus] in Northern Catalan.

Finally, another interesting and unexpected aspect of the Northern Catalan stressed system is that following Coromines' law (1974) we can find words with vowels where in the rest of the varieties of Catalan suffered from an opening condition and thus are pronounced with the open-mid vowel /ɔ/, for example, *flor* ('flower') ['flɔ], however in the diocese of Girona and in the Roussillon they maintain their closed nature (coming from the Latin word[2]), so they are pronounced with the closed-mid vowel ['flo][3]. The process does not end here for Northern Catalan though, as long as mid-closed vowels closed even more until they become /u/, the process continued until they reached an even closer articulation, so in those cases, *flor*, for example, would be pronounced like ['flu] in the strictly Northern Catalan variety (Gómez Durán 2002: 52)[4]. Note that this is the

[1] Also commented by Mascaró (2002: 119) in footnote 11.

[2] For a detailed historic evolution see Veny (1980) or Escudero (1999).

[3] This phenomenon is a regionalism from the diocese of Girona (Gómez Durán 2002).

[4] Those processes regarding stressed vowels can probably be due to influence of Occitan and French (Gómez Durán 2002: 62).

description of the stressed vowel representation, but there are some interesting issues regarding the unstressed vowel patterns that we develop below, for example, vowel reduction in unstressed positions, the topic that we are taking in consideration in this thesis.

2.2. Vowel Reduction

2.2.1. Theoretical Overview

One of the most interesting phenomena that can be found in the vocalic system in Catalan is vowel reduction (Crosswhite 1999, 2000, 2001, 2004; DeLacy 2002, 2006; Walker 2011; Perry 2018; Cabré 2006; Herrick 2003; Mascaró 1978, 2002; Recasens 1991; IEC 2017, among many others). We have to remark that Catalan is not the only language where we can find vowel reduction. Some examples from other languages would include: Russian (Crosswhite 1999, 2000, 2001, 2004), Bulgarian (Crosswhite 1999, 2001; d'Andrade & Hristovsky 2005; Radkova 2009), European Portuguese (Crosswhite 1999, 2001; d'Andrade & Hristovsky 2005; Machnicki 2014), Brazilian Portuguese (Crosswhite 1999, 2001; Kenstowicz & Sandalo 2016; Nevins 2012), Belarusian (Crosswhite 2000), Slovene (Crosswhite 2000; Bidwell 1969), Italian (Crosswhite 2000; Baroni 1996) or Hungarian (Blaho & Szeredi 2013; Szeredi 2009, 2010).

Every author comment vowel reduction in a different way, but we focus now on the vowel reduction approaches made by three important authors in the field: Crosswhite (1999, 2001), Walker (2011) and DeLacy (2006).

Now, we present each authors' approaches as an introductory overview in relation to the topic, however we are going to go back to the subject in more detail in further sections (section 2.3.3) and we are going to discuss the authors' approximations to vowel reduction. There, we make a discussion of their theoretical technicalities, explaining in more detail, for example, the markedness and faithfulness constraints their use for their analysis, which inputs and outputs they choose to exemplify vowel reduction, which typologies they get and how they face and solve their predictions. In this section, though, we summarize their respective vowel reduction ideas in brief explanations on how they understand it and with some examples of representative constraints.

First, Crosswhite talks about two different approaches to vowel reduction: 1) Contrast-Enhancing and 2) Prominence Reduction. The first one, Crosswhite (1999: 68) describes it as "maintenance of only the contrast presence of the vowel vs. absence of the vowel" here listeners only pay attention "to the fact that a vowel of some underlying quality appears in that position in the word". To analyse this kind of vowel reduction, Crosswhite uses licensing constraints. Some examples could be *Lic-nonperiph*, where "the elimination of unstressed non-peripheral vowels equates to elimination of unstressed mid-vowels" or any *Lic*[*F*]-like constraint, for example, *Lic(-low,-ATR)/primary-stress*, where "distinction between /ɛ, e/ and /ɔ, o/ only occur under primary stress" (Crosswhite 1999: 60, 69). This kind of vowel reduction under licensing constraints can be found in some dialects of Russian, some dialects of Catalan and Brazilian Portuguese, to enumerate some.

The second case Crosswhite (1999: 72-73) describes, she defines it as an "acoustic-enhancement" phenomenon, here "elements with the same or similar acoustic cues are mode to co-occur, mutually strengthening one another's phonetic realization" but vowels are also reduced in environments where time is limited that increases the articulatory ease. To analyse this second type of vowel reduction, Crosswhite uses Prominence Alignment constraints. Examples of this kind of constraints could be **Unstressed/non-high*, where "an unstressed syllable may not contain only a vowel with sonority greater than that of [i] or [u]" or **Unstressed/low* where "an unstressed syllable may not contain only a vowel with sonority equal to that of a low vowel" (Crosswhite 1999: 75, 76). This type of vowel reduction under prominence alignment constraints can be found in languages like Bulgarian or Sri Lankan Portuguese.

Finally, apart from those two vowel reduction patterns, Crosswhite talks about a two-pattern vowel reduction system. In those cases, we can differentiate "extreme" and "moderate" forms of reduction. "Extreme" reduction occurs in certain unstressed syllables and it is always sonority-decreasing, that would equate to Prominence-Reduction; while "moderate" takes place in the remaining syllables, and can be sonority-increasing too, this would equate to Contrast-Enhancement (Crosswhite 1999: 79, 81). In the case of "extreme" reduction, vowel reduction will be moved by foot-form constraints, for example *RhType=Iamb* where "vowels within foot are durationally different from vowels outside the foot: the unfooted vowels are shorter than footed vowels" or **Nonmoraic/-high* where "non moraic vowels may not have a sonority greater than that

of [i] or [u]" (Crosswhite 1999: 105, 107). In the case of "moderate" reduction, we can find constraints like the ones in the Constraint-Enhancing and Prominence Reduction type, for example, the *Lic*[*F*] kind of constraint or the ones like **Unstressed/F* type. In addition, we can also observe faithful constraints like *MAX*[*F*], *DEP*[*F*] or *Ident-IO*[*F*]. Russian for example, presents both kind of "extreme" and "moderate" patterns.

In second place, Walker talks about vowel reduction in terms of generalized licensing constraints, where the "positions or contexts that show the capacity to asymmetrically license distinctive phonological properties are liable to be ones that facilitate perception or production" (Walker 2011: 12). For her, there are several types of licensing: Indirect, identity, direct and maximal licensing. In the case of vowel reduction, she focuses in direct licensing. Direct licensing patterns "are characterized by the restriction of some material to a prominent position only. Many vowel patterns that show direct licensing are faithful to the vowel in the licensing position and alter, reduce, or eliminate a vowel in a non-licensing position" (Walker 2011: 230). Some constraints Walker uses for her analysis are the type of *Lic*[*F*]*,σ* (similar to Crosswhite's Constraint-Enhancing type). Examples of this kind of constraints would be, for example, *License*[+*round*]*/*$\sigma_{post\text{-}tonic}$*, 'σ*, where "the phenomenon involves licensing by a stressed syllable of the specification [+high] when it occurs in a post-tonic syllable", or even Ident-IO-like faithfulness constraints (Walker 2011: 48). This type of patterns can be found for example in Belarusian and in some dialects of Italian.

Finally, DeLacy talks in terms of DTE (stressed part of a foot) and non-DTE (unstressed part of a foot) constraints (DTE stands for 'Designated Terminal Element'[5]) and its conflicting and overlapping environmental demands. That "conflict of sonority requirements was shown to produce many types of vowel inventory. In non-DTE constrains dominated, inventories contained very low-sonority elements, while if DTE constraints dominated, inventories contained only very high-sonority elements. If member of the two sets of constraints are interleaved in the ranking, they produce gapped inventories" (DeLacy 2006: 332). This kind of constraints are also foot form, as we saw in Crosswhite's "extreme" reduction. Examples of constraints for this kind of reduction would be *-$\Delta_{Ft} \geq \{a\}$, where we "incur a violation for each low vowel in the non-DTE of a Ft" or *- $\Delta_{Ft} \geq \{i,u\}$, where we "incur a violation for each low or peripheral vowel in the

[5] Term taken from Liberman & Prince (1977).

non-DTE of a Ft" (DeLacy 2006: 227). This type of neutralization can be found in languages like Berguener Romansh or Central Catalan.

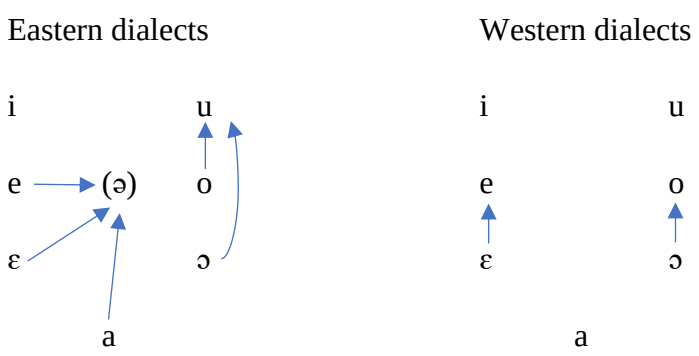
To sum up, Crosswhite talks about two general vowel reduction patterns: 1) Contrast-Enhancing, and 2) Prominence Reduction; and a third two-pattern type, which can be "moderate" or "extreme". For Walker, vowel reduction is understood in terms of Direct Licensing, which is similar to Crosswhite's Prominence Reduction approach. And, finally, DeLacy understands vowel reduction as a conflict between DTE and non-DTE constraints, which can be similarly understood as Crosswhite's two pattern vowel reduction.

2.2.2. Catalan Vowel Reduction

In this section we focus in Catalan, which presents some interesting issues regarding vowel reduction and, moreover, we can appreciate how different this phenomenon is in each of its different varieties.

We can observe, as we showed in previous sections, two big blocks of varieties of Catalan: Eastern and Western. The majority of dialects of the Eastern and Western part have a stressed vocalic system of 7 vowels: /a, e, ɛ, i, o, ɔ, u/, the main difference is that most of the Eastern dialects of Catalan have an unstressed vocalic system of three vowels: [ə, i, u], where /a, e, ɛ/ become [ə], and /o, ɔ/ become [u] in unstressed positions; while in the majority of dialects of the Western part we can observe a five-vowel unstressed vocalic system [a, e, i, o, u] where /ɛ/ becomes [e], and /ɔ/ becomes [o] in unstressed positions (IEC 2017: 41-42).

(3) Two main Catalan varieties



Even then, we can find some variation inside each of the block. That is why for the analysis of vowel reduction in the different varieties of Catalan, we divide the main dialects in the five following ones: 1) Central Catalan (which includes the varieties of central area of Catalonia and some of the Balearic Islands, like Minorca and Ibiza, and Sóller, a city in Majorca), 2) Northern Catalan (the Roussillon area); 3) Majorcan (Balearic Island of Majorca), 4) North-Western Catalan (most parts of the province of Lleida and Tarragona, and the Eastern areas of Aragon) and Valencian; and 5) Algherese (this variety also includes the city of Barcelona, where the phenomenon is the same as in the Algherese variety). (For more detail see Recasens 1990/1991, 1996; Veny & Massanell 2015; Mascaró 2002, among others).

Note that even the dialect division (in this case, particularly talking about vowel reduction) and the regional division would seem to be the same, there are some important differences. For example, in the dialect division, the Balearic Islands have different behaviours in the vowel reduction phenomenon. We remark that Majorcan and the other Balearic variations act differently, and even a city in Majorca, Sóller, acts differently than the other parts of Majorca, or there exit regions where the dialectal behaviour of the vowel reduction phenomena is the same one in two different geographical regions, for example in Valencia and in Western Catalonia.

In addition, we should also notice that there exist some *transition* areas, which include the contact areas between two different varieties (as we showed in (2)), there we can observe a *mix* between both areas or even some concrete regionalisms. The criteria to talk about transition areas was made by Recasens (1996: 109-110) when he observed that the dialects that neutralize both *a* and *e* in [ə] in all the contexts where vowel reduction is motivated belong to the Eastern block, but they belong to the Western bloc if they maintain the distinction between *a* and *e* in unstressed positions in all the contexts; finally, those regions where we can find neutralization in just some contexts but not all, those consist in the transition areas. The same phenomenon happens in the case of the distinction between neutralization or not of /ɔ-o/ to only [u] (in the Eastern dialects) or the distinction between [o] and [u] (in the Western dialects) in unstressed positions, but when the neutralization is found in just some contexts, we are talking about the transition areas (Recasens 1996: 142).

We are not going to focus in all of those transition areas due to extension reasons, but we would like to pay attention to the vowel reduction phenomena in the Central to Northern-

Eastern transition area (the Central-Septentrional one, located in some points of the south of France, Andorra and some regions of the province of Girona and Lleida), and the North-Western in contact with the Central dialects (Tarragonian, mostly in the province of Tarragona but also found in some western regions of the province of Barcelona) or with Valencian (Tortosan, mostly in the province of Tarragona, but can be also found in both the northern and southern parts of Valencia[6], or even in areas of the eastern Aragon). As shown, the following parts regarding the transition areas will be divided in three: 6) Central-Septentrional (a transition between Central and Northern Catalan), 7) Tarragonian (a transition between Western and Central Catalan), and 8) Tortosan (a transition between Central and Valencian). Even though, for more detail, and to name some works done in the field, see Veny (2007), Veny & Massanell (2015) or Recasens (1991, 1996) for a general transition area work; Navarro (1999) for the Eastern-Western transition dialects; Cubells (2009), Navarro & Cubells (2017), Beltran (1999) and Rehues (2013) for the North-Western and South-Western/Central transition area; and Adam (2006), Campmany (2008) and Monturiol & Domínguez (2001) for the Central and North-Eastern transition area.

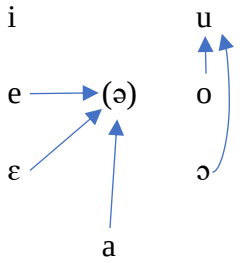
Next, in the eight following sub-sections (2.2.2.1-2.2.2.8), we will describe the vocalic reduction system of each of the different varieties we just enumerated, and, also, for easier comprehension we add to the description an illustrative graphic of the processes of vowel reduction in the end of each dialectal characterization.

2.2.2.1. Central Catalan

In Central Catalan we can find a vocalic system compound by seven vowels in stressed positions: /a, e, ɛ, i, o, ɔ, u/. Talking now about vowel reduction, we can observe that /a/, /e/ and /ɛ/ reduce to [ə], and /o/ and /ɔ/ reduce to [u] in unstressed positions, so we conclude in a system with three vowels: [i, u, ə] (Mascaró 2002: 96-97, 105).

[6] We want to add that the dialect of Valencian spoken in the south of the Valencia Community, Alacantinian, and the one spoken in the Murcia Community are going to be part of the Tortosan dialect, as they behave in similar ways.

(4) Central Catalan vowel reduction

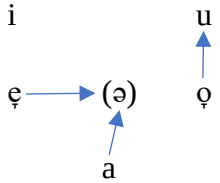


Examples for that will be the following ones. Words like *pom**a*** (['po.mə] 'apple'), *par**e*** (['pa.rə] 'father') and, in the case of /ɛ/ we can observe it when the root has that vowel but it becomes unstressed because of a morphologic process: *p**e**ra* (['pɛ.rə] 'pear'), but when we find *p**e**rer* ([pə.'re] 'pear tree') we can observe the reduction /ɛ/ > [ə]. We can observe the same case in the /ɔ, o/ to [u] patterns. For example, *pian**o*** ([pi.'a.nu] 'piano') or in the case of *s**o**l* (['sɔl] 'sun') becomes *s**o**let* ([su.'lɛt] 'little sun').

2.2.2.2. Northern Catalan

In Northern Catalan (also known as *rossellonès* in Catalan) we can find a five-vowel system in stressed positions, we can just find /a, ɐ̟, i, o̟, u/. If we talk now about unstressed positions, we can find that /a/ and /ɐ̟/ reduce to schwa [ə], and /o̟/ reduces to [u], so we have a system of three vowels: [i, u, ə] (Mascaró 2002: 105).

(5) Northern Catalan vowel reduction

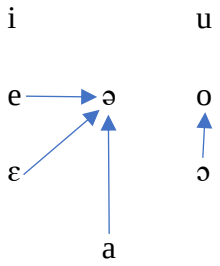


So, words like *port**a*** (['poɾ.tə] 'door') and *arbr**e*** (['a.bɾə] 'tree') we can observe that become [ə] in unstressed positions. In the same case of /o/ it becomes [u] in unstressed positions, for example, *carr**o*** ('ka.ru] 'carriage').

2.2.2.3. Majorcan

In Majorcan Catalan we can find an eight-vowel type vocalic system. In addition to the seven vowels we could appreciate in the eastern Catalan variety: /a, e, ɛ, i, o, ɔ, u/, we should add also the schwa /ə/ in stressed positions. In unstressed positions we can observe that the reduction to [ə] follows the same pattern than in eastern Catalan, /a/, /e/ and /ɛ/ become [ə] in unstressed positions. However, in the case of /o/ and /ɔ/ we can observe some differences, we only find reduction from /ɔ/ to [o], so we have a system of four vowels in unstressed positions: [i, o, u, ə] (Mascaró 2002: 104).

(6) Majorcan vowel reduction

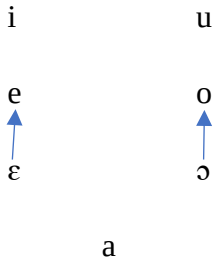


In this variety, /ɔ/ and /o/ just reduce to [o] in unstressed positions, not to [u] as we saw in the previous variant. For example, the word *c**o**lom* (‘pigeon’) will be pronounced like [ko.’lom] in this variety (not like [ku.‘lom] that will be in the eastern Catalan varieties), and words like *p**o**c* ([‘pɔc] ‘few’) when it becomes *p**o**quet* (‘little few’) it would be represented like [po,’ket] and not like [pu.’ket] as in other varieties.

2.2.2.4. North-Western & Valencian

In North-Western Catalan and Valencian varieties, we can observe again the seven-vowel division system for stressed positions: /a, e, ɛ, i, o, ɔ, u/. In the case of unstressed positions, we can observe that the reductions process is not the similar as the eastern varieties. Instead, /a/ does not reduce to anything, it just stays like [a] in unstressed position; then, just /ɛ/ reduces to [e] and /ɔ/ reduces to [o], this last process is the same as we could observe in the Majorcan variety. The result is an unstressed system with five vowels: [a, e, o, i, u] (Mascaró 2002: 103).

(7) North-Western & Valencian vowel reduction

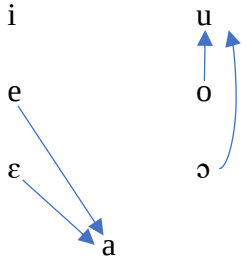


Some examples for that kind of reduction would be the following ones. First of all, /a/ just stays like [a] in unstressed positions, for example, in the case of *p**a**raula* ([pa.'ɾaw.la] 'word'). In the case of /e/ we can observe that it is pronounced like [e] in unstressed position: *quatr**e*** (['kwa.tɾe] 'four') and in /ɛ/ *c**e**ba* (['sɛ.βə] 'onion'), we would just find [e] like in *c**e**beta* ([se.'βe.ta] 'little onion') also in unstressed position. In the case of /ɔ/ and /o/ we will be able to appreciate that follows the same pattern as in the Majorcan variety, they reduce to [o], so, as say, *ferr**o*** would simply be pronounced as (['fɛ.ro] 'iron') and in *c**o**l* (['kɔl] 'cabbage') it would become [o] like in *c**o**leta* ([ko.'le.ta] 'little cabbage') in unstressed positions.

*2.2.2.5. Alghere*se

To finish with, the last variety we will talk about is the Algherese one (also the variety of Barcelona city). This variety has also a seven-vocalic system for stressed positions: /a, e, ɛ, i, o, ɔ, u/. In this variety, maybe because it is the furthest one with the Catalan-speaking region, we can observe different -and more curious- processes regarding vowel reduction, where we can find reduction from /ɛ, e/ to [a], and reduction from /ɔ, o/ to [u]. The result is an unstressed system with three vowels: [a, i, u] (Mascaró 2002: 107).

(8) Algherese vowel reduction



In the case of /ɔ, o/ they have a similar process as we could see before in other varieties, in unstressed positions, they become [u], like in *tr**o**b* ([‘trɔb] ‘I find’), it becomes [u] in unstressed positions, *tr**o**bar* ([‘tru.βar] ‘to find’); and in *t**o**n* ([‘ton] ‘I thunder’) that it is realized like *t**o**nar* ([tu.‘nar] ‘to thunder’). In addition, in the case of /ɛ/ and /e/ we can observe that the reduction is realized as [a] when /ɛ/ and /e/ are found in unstressed positions, like in the case of *Miqu**e**l* ([mi.‘kɛl] ‘Michael’) that becomes *Miqu**e**lutxo* ([mi.ka.‘lu.ʧu] ‘nickname for Michael’) and in the case of *pr**e**ga* ([‘pre.ga] ‘(s)he prays’) realized like *pr**e**gar* ([pra.‘gar] ‘to pray’).

As a summary of all the vowel reductions seen until now, we illustrate a compilation of them below in (9), putting all together Eastern and Western dialects and each vowel reduction process:

(9) Vowel reduction processes

Northern Catalan	/a, e̯/ > [ə]	/o̯/ > [u]
Algherese	/ɛ, e/ > [a]	/ɔ, o/ > [u]
Central Catalan	/a, ɛ, e/ > [ə]	/ɔ, o/ > [u]
Majorcan	/a, ɛ, e/ > [ə]	/ɔ/ > [o]
North-Western & Valencian	/ɛ/ > [e]	/ɔ/ > [o]

If we pay now attention to the transition dialects, we just show the contexts in which vowel reduction is involved -there are much more interesting phenomena in these regions, but we are not going to focus in them in this thesis. In this case, as there are more concrete regions, we name the city (if it is a very concrete phenomenon), the *comarca*[7] (each of the regions inside of a province), and the province in which they are located.

For the transition varieties we take in account the contextual position in which the vowel is placed in the word (post-tonic, pre-tonic or unstressed in the beginning, middle and end of the word or sentence) and we can appreciate also the phenomenon regarding the diphthongizing processes (diphthong that becomes a monophthong or a simple vowel that

[7] For practical reasons, we name every city, region and province with the Catalan name, we do not translate (or try to) the proper names that we enumerate (see Appendix, Image 3. Provinces and “Comarques” in Catalonia, for an illustrative map of the Catalan regional division).

diphthongizes). We want to note too that some of the phenomena are shored between some (or sometimes even all) of those transition varieties, that is because they have inputs from all the varieties they are in contact and each one realizes the outputs in a different way, however, that does not mean that it is impossible for them to share some of those phenomena with the other varieties.

For this part, we work on Catalan phonetics, mostly following Recasens (1996) but also complementing it with works from other authors.

2.2.2.6. Central-Septentrional

In regions where there is just distinction between [o] and [u] we can find that [u] is often realized in post-tonic position while [o] is realized in pre-tonic ones, for example in Josa i Tuixén and Fórnols (Alt Urgell, province of Lleida), and in some regions of the Tarragonian variety, growing in number in the Tortosan one in pre-tonic positions. We should note too that, even there are some regions where we can find alternation [e]-[a] in some contexts but they all neutralize [u] everywhere, we will consider them as a transition regions anyway, for example, Odèn and Fórnols (Alt Urgell, in the province of Lleida) and in some regions of the Tarragonian variety (Recasens 1996: 142).

In post-tonic positions, /e/ realized as [ẹ], in the end of the word or when followed for plural inflections (-e, -es, -en) in the areas of Segarra, Solsonès, Alt Urgell, Pallars Sobirà, Noguera and Segrià (province of Lleida), Capcir (a city in the south of France) and Andorra, also in the Tarragonian dialect) (Recasens 1996: 71)

In pre-tonic initial and, in less cases, in the middle of the word, unstressed /a/ can be realized as [ə] in the areas of the Pallars Jussà, Pallars Sobirà, Alt Urgell, Noguera, Segrià, Segarra, Urgell (in the province of Lleida), Andorra, and areas of the Tarragonian and Tortosan dialects too (Recasens 1996: 92).

In this position, we can also find vowel palatalization ([ə] > [e, i]) in the Roussillon area, but also in some regions of the North-Western variety, like Alt Urgell, Noguera and Pallars (in the province of Lleida) and in some areas of the Tortosan variety; in less degree we can also find it in the Empordà and Cerdanya (province of Girona) and in the Tarragonian dialect. Examples of this phenomenon would be the alternation *genoll/ginoll* (‘knee’) or *llegenda/lligenda* (‘legend’) (Recasens 1996: 129).

More pre-tonic interesting realizations are regarding the alternation of [o] and [u] as realizations of unstressed /o/. This phenomenon can be found in Andorra, Pallarès, Alt Urgell (province of Lleida) and in the Tarragonian dialect. It mostly works because of assimilation of high vowels [i, u]: *s*[u]*rtir* (*sortir* 'to leave, exit'), *s*[u]*spira* (*sospira* 'sigh'), *c*[u]*mú* (*comú* 'common'), *c*[u]*nsum* (*consum* 'consumption'), but in other circumstances, through dissimilation within hiatus vowels (*c*[u]*ent*, *coent* 'boiling') or within same vowels from different syllables (*c*[u]*rcó*, *corcó* 'woodworm'). The unstressed nature of some clitics can also produce this dissimilation in Tortosan. (Recasens 1996: 138).

In initial position of the word, unstressed /e/ is realized as [a]: [a]*spatlla* (*espatlla* 'shoulder'), [a]*nciam* (*enciam* 'lettuce') in areas of North-Western Catalan (Pallars Jussà and Pallars Sobirà, province of Lleida) (Recasens 1996: 75).

In the end of the word and of the sentence, unstressed /a/ is realized as [ə] in the areas of La Seu d'Urgell (like the town of Oliana), Solsonès (like the town of Solsona), Pallars Sobirà, and in Andorra (Recasens 1999: 98). In this position, we can also find opposition between unstressed /a/ and /e/ in areas that have border with Aragon, the Pyrenees area (Andorra, Pallars Sobirà, Pallars Jussà, Alta Ribagorça and Alt Urgell (in the province of Lleida), central areas of the North-Western region (Segarra, Urgell, Garrigues), and areas of the Tarragonian and Tortosan dialects (Recasens 1996: 94; Navarro 1999).

Finally, the last case of final position of the sentence, we can observe that unstressed [ə] can also alternate with the realization [e] in the Roussillon areas (specially, Vallespir, in the south of France), in the septentrional areas of the Eastern dialect like Alt Empordà, Baix Empordà, Selva, Gironés, Garrotxa, Baixa Cerdanya (in the province of Girona) and Berguedà (in the province of Barcelona), and in areas of the Tarragonian dialect (Recasens 1996: 109).

In the case of the diphthongs, we can appreciate the monophthongation of the diphthong *au* to *o* ([o]), like *escofar* (*escalfar* > *escaufar* 'to warm up') in Garrigues (in the province of Lleida) (Recasens 1996: 103).

In final position, the unstressed vowel [ə] can be deleted in combination with i[ə] diphthongs for example *besti* (*bèstia* 'beast') or *gàbi* (*gàbia* 'cage'). This phenomenon can be found mostly in the Roussillon area, in Andorra, in the septentrional part of Alt

Empordà and Ripollès, also in Baixa Cerdanya and in some towns of Garrotxa (like Olot) (in the province of Girona), and, also, in the Tarragonian dialect (Recasens 1996: 123).

In post-tonic position, the unstressed vowel /e/ can be deleted in combination with u (diphthong *eu*) in some verbal terminations (*-rí(e)u, -v(e)u, -(e)u, -ss(e)u,* etc.) in the septentrional areas of the Eastern dialect and in the Roussillon (Recasens 1996: 125).

It is also possible to delete the first vowel in the diphthong combination Vi (in this case *ai*) in the septentrional Eastern dialect and in the Roussillon, for example, *rim* (instead of *raïm* 'grapes'), *sangtrit* (for *sangtraït* 'bruise, hematoma'). This deletion can be also found in the diphthong combination Va, for example *conrar* (*conrear* 'cultivate') in the Empordà (province of Girona). (Recasens 1996: 125).

In initial position of the word, unstressed /o/ can diphthongize in [əw] or [aw], for example in words like *ovella* ('sheep'), *orella* ('ear') or *olor* ('smell') and in some cases can also affect an unstressed /u/, like in *humit* ('damp') or *ufanós* ('vain'). We can find this phenomenon in the North-Western areas, like Andorra, Segrià, Noguera, Garrigues, Alt Urgell (in the province of Lleida), and in both the Tarragonian and the Tortosan dialects (Recasens 1996: 138-139).

The case of the diphthong *ou* (/ɔ/ + [w]) can be opened to *au* in regions of the north-Western dialect, like Noguera or Alt Urgell (in the province of Lleida) or can be closed to [ow] in the frontier regions of the Easter and North-Western dialects (like in Ripollès (province of Girona) or Solsonès (province of Lleida)) with the Tarragonian dialect, and Eastern with the North-Western Septentrional dialects (like in Pallars, Alta Ribagorça, Noguera (in the province of Lleida) or Garrotxa (in Girona)). Some examples could be the realization of words like *bou* ('ox'), *dinou* ('nineteen') or *dijous* ('Thursday') (Recasens 1996: 132-133). Another further step of the diphthong [ow] can be the opening of the first vowel ([ow] > [ɔw] > [ɛw]) in septentrional Eastern Catalan, for example, in *tou* (*t*[ɛw] 'soft') or *roure* (*r*[ɛw]*re* 'oak') (Recasens 1996: 137).

2.2.2.7. Tarragonian

As we could observe in the previous dialect, post-tonic /e/ is realized as [ẹ], in the end of the word or when followed for plural inflections (-e, -es, -en) in areas of the Central-Septentrional dialect, but also in areas of Conca de Barberà (province of Tarragona).

However, in this dialect it is also realized like an [i] when /e/ is in the end of the word before a consonant, for example, *àngil* (instead of *àngel* 'angel') is very frequent in the area of Conca de Barberà and a bit less frequent in the Alt Camp and Baix Camp (in the province of Tarragona) (Recasens 1996: 71; Navarro 1999; Rehues 2013).

In pre-tonic initial and, in less cases, in the middle of the word, unstressed /a/ can be realized as [ə] in the areas of the Central-Septentrional, Andorra, and areas of Priorat and Baix Camp (in the province of Tarragona), and in Tortosan dialects (Recasens 1996: 92). However, in some regions, we can find alternation between the realization of [a] and [ə] (see Rehues 2013 for the distinction Baix Camp and Prades).

In pre-tonic position, we can also find vowel palatalization ([ə] > [e, i]) in minor degree than in the previous dialect and in the following that we will introduce, but we can still find it in Alt and Baix Camp and in Conca de Berberà (in the province of Tarragona), examples for that could be *genoll/ginoll* ('knee') or *xemeneia/ximeneia* ('chimney) (Recasens 1996: 129).

More pre-tonic interesting realizations are regarding the alternation of [o] and [u] as realizations of unstressed /o/. This phenomenon can be found too in Priorat (province of Tarragona). It mostly works because of assimilation of high vowels [i, u]: *s*[u]*rtir* (*sortir* 'to leave, exit'), *s*[u]*spira* (*sospira* 'sigh'), *c*[u]*mú* (*comú* 'common'), *c*[u]*nsum* (*consum* 'consumption'), but in other circumstances, through dissimilation within hiatus vowels (*c*[u]*ent, coent* 'boiling') or within same vowels from different syllables (*c*[u]*rcó, corcó* 'woodworm'). The unstressed nature of some clitics can also produce this dissimilation in Tortosan. (Recasens 1996: 138; Navarro 1999). We can find also alternation in the same region, Priorat (in the province of Tarragona), between the realizations [o] (*rem*[o]*lí* 'whirlwind') and [u] (*c*[u]*nill* 'rabbit') (Rehues 2013). This can have a relation between the fact of the neutralization and distinction between unstressed [o] and [u] in Prades (Baix Camp) and Rocafort and Sarral (Conca de Barberà) (the three in the province of Tarragona). We could even start seeing variation between [o] and [u] in towns in the Western region, like Vandellò or Pratdip (Baix Camp) and Torre de Fontaubella (Priorat) (all in the province of Tarragona) due to the deletion of distinction between stressed /ɔ/ and /o/, where they are both starting to be realized in a closer way: closed-/ɔ/ in Vimbodí, Santa Coloma de Queralt (Conca de Barberà) and the region of Alt Camp (all in the province of Tarragona), and closed-/o/ in Conca de Barberà and Alt Camp (in the province of Tarragona) (Recasens 1996: 134).

In the end of the word and in the end of the sentence positions, we can observe an opposition between unstressed /a/ and /e/. We could appreciate that too in the previous variant, but in this case, we can observe it in Priorat and Baix Camp (in the province of Tarragona) and in other regions of the Tortosan dialect (Recasens 1996: 94). However, there is also alternation between Baix Camp ([ə]) and Priorat ([e]) (in the province of Tarragona) (Rehues 2013). Also, we will find the unstressed [ə] realization of /a/ in regions like Vandellós or Pratdip (Baix Camp) or Espluga de Francolí (Conca de Barberà) (Recasens 1996: 98).

In endings of word we can also find alteration between [e] and [a] in the realization of unstressed /a/ in some verbal inflections. In the majority of the North-Western regions, verbal terminations in *-en* and *-es* are realized like -[en] and -[es], however, in some regions of Baix Camp, in concrete the city of Colldejou (in the province of Tarragona) they are realized as -[an] and -[as] (Recasens 1996: 108; Rehues 2013).

In the case of the diphthongs, it is possible to delete the vowel [ə] when in combination with iV diphthongs, as we could appreciate in the previous dialect too. In addition, in this case we will be able to find the phenomenon in Altafulla (Tarragonès, in the province of Tarragona) and in Vilanova i la Geltrú (Garraf, in the province of Barcelona) (Recasens 1996: 123).

In combination with *u* (diphthongs Vu), in concrete the diphthong *au*, can be reduced to just [u] in the Eastern Catalan varieties but in the regions of Baix and Alt Camp (in the province of Tarragona) they maintain the diphthong [aw], like in the North-Western varieties. It is also possible to delete the first vowel of the combination Vu, resulting in *suc* (instead of *saüc* 'elder') in Baix and Alt Camp (in the province Tarragona) (Recasens 1996: 124, 126).

In the case of *o*, /ɔ/ close to [o] in diphthongs combined with [w] in the frontier regions between Eastern and North-Western Catalan, for example in Alt and Baix Camp (in the province of Tarragona), like in the examples of *bou* ('ox') or *dijous* ('Thursday'). Unstressed /o/ can diphthongize in [əw] and [aw] in the beginning of the word like in *ovella* ('sheep') or *olor* ('smell'), and in some cases it even affects /u/ in unstressed initial position, for example *humit* ('damp'). We can find this phenomenon in areas of Priorat (normally [aw]) and in areas of Baix Camp (normally [əw]) (in the province of Tarragona) (Recasens 1996: 133; Rehues 2013).

Finally, remark that in the city of Tarragona, diphthongs like *-qua* and *-gua* will realize like -[*ke*] and -[*ge*], respectively, for example *aige* (*aigua* 'water') (Rehues 2013).

2.2.2.8. Tortosan

In pre-tonic initial position, and in less cases in the middle of the word, unstressed /a/ can be realized like [ə] in areas of the two previous dialects but also in Baix Ebre (in the Province of Tarragona) and Marina Alta (in Valencia) (Recasens 1996: 92). Vocalic palatalization ([ə] > [e, i]) can be found in areas of the previous dialects but also in Baix Ebre (province of Tarragona) in examples like *melic/milic* ('bellybutton') or *ginecòleg/ginicòleg* ('gynaecologist') (Recasens 1996: 129).

Other pre-tonic realizations are regarding the alternation of [o] and [u] as realizations of unstressed /o/, apart from the phenomena seen previously, the unstressed nature of some clitics (*mon* 'mine', *ton* 'yours', *son* 'his/hers') can also produce this dissimilation in the general regions where Tortosan is spoken (Meridional part of the North-Western dialect and septentrional part of Valencian). (Recasens 1996: 138).

In the end of the word and sentence, the distinction between unstressed /a/ and /e/ can be found in a general way in the regions of Terra Alta, Ribera d'Ebre, Baix Ebre and Montsià (in the province of Tarragona), apart from the areas already pointed form the previous varieties (Recasens 1996: 94). But if the word starts with unstressed /e/ the general way of reduction is with a resulting [a] (Beltran 1999).

In end of the word position, regarding verb inflection, in the North-Western we tend to find *-a* (3rd person present indicative of the 1st conjugation, conditional and imperfect of indicative) realized like [e] but in some meridional regions, like in Tortosa (in the province of Tarragona) and in the cities of Bonansa and Benabarri (Huesca, in Aragon), they are realized like a [a] (Recasens 1996: 88-89).

In the case of diphthongs, the combination Vi can lead to deletion in words like *benir* (*beneir* 'to bless') or *provir* (*proveir* 'provide') in the regions of the meridional part of the North-Western Catalan. In the case of Vo, for example in *llauró* (*llauraó* 'farmer') can be found in Baix Ebre (in the province of Tarragona) and in Valencian (Recasens 125-126).

Finally, diphthongs with unstressed /o/ can be realized like [əw] or [aw], like in previous dialects but in this case can be found in Baix Ebre (in the province of Tarragona), like in the examples of *ovella* ('sheep') or *orella* ('ear') or with unstressed initial /u/, *ufanós* ('vain') (Recasens 1996: 133).

As a summary, in (10) we are able to find the following alternations in the transitional areas (leaving the diphthongs aside):

(10) Reduction variation in transitional areas

Central-Septentrional	/a/ > [a, ə] /e/ > [a, e, ə] /o/ > [o, u] [ə] ~ [e, i]
Tarragonian	/a/ > [a, e, ə] /e/ > [e, ə] /o/ > [o, u] [ə] ~ [e]
Tortosan	/a/ > [a, e, ə] /e/ > [a, e] /o/ > [o, u] [ə] ~ [e, i]

In the previous table we summarized the alternation on vowel reduction in the transitional areas. This is the data we take in account for the analysis (section 3) for these dialects. In the table we illustrate the different possibilities of vowel reduction for the vowels under study (/a, e, o/) and the possible alternations between schwa ([ə]) and other vowels, in this case [e] and, sometimes, [i]. For now, we will leave the diphthong phenomena out of the analysis, but they are interesting patterns to take in account in future research.

2.2.3. Vowel Reduction Blocking

Once we presented the phenomenon of vowel reduction, it is interesting to point out that there are some cases where that reduction is blocked. We can observe three contexts where we can find reduction blocking: 1) Hiatus, 2) Compounds, and 3) Loan Words.

By now, we just focus in the case of the Standard variety of Catalan (Central/Eastern) because most studies made about vowel reduction blocking in Catalan centre their attention on the Standard variety. Due to the lack of data and studies from the other varieties we can only talk about those three phenomena -Hiatus, Compounds and Loan Words- as examples of blocking of vowel reduction (see Mascaró 2002, 2016; Cabré 2006; Badia i Cardús 2001 among others).

Even so, we would like to give a brief comment that we could find some interesting studies from Jiménez & Lloret (2008, 2011) that take in account dialectal variation about the vowel harmony phenomenon -which could be related to the vowel blocking-. In those studies, Jiménez & Lloret explain how vowel harmony works in some varieties of Catalan (Valencian, Tortosan, Majorcan and Central Catalan). Although those are interesting studies about vowel harmony, this is not one of the topics we are going to talk about in this project, due to extension limitations. Moreover, we felt the need to comment them because, in the first place, they take in account dialectal variation and, secondly, because those are some interesting papers that remark the processes in which vowels happen to *avoid* the vowel reduction phenomena too.

For example, in the centre of Valencia, we can appreciate that when a word ends in an unstressed /a/ and it is preceded by /ɛ/ or /ɔ/, the realization of that /a/ is not [a], as expected for Western dialects, but /ɛ/ or /ɔ/ too due to the sharing of the labial or the palatal features (Jiménez & Lloret 2011: 54-55; Palmada 1994). Examples of this phenomena could be the case of *terra* (‘t[ɛ]rr[ɛ] ‘ground’) or *cosa* (‘c[ɔ]s[ɔ] ‘thing’).

Also, in the Balearic Islands we would be able to find the alternation of [a] that is produced like [ɛ] or [ə] realized like [e] (Puigròs i Caldentey 2001, Bibiloni 1983) when followed by a palatal or palatal-alveolar segment, and other alternation, that crosses through backness, is the assimilation of [ə] when preceded by [o]. So, these could be explained by harmony processes. In addition, we would also like to note that Recasens (1996: 108-109) finds an alternation between the realizations of [ə] and [ɒ, ɔ, o] in final position, also due to harmony, in areas like Baix Empordà, Selva, Osona (in the province

of Girona); Vallès Oriental i Vallès Occidental, Maresme, Baix Llobregat, Alt Penedès (in the province of Barcelona); Solsonès (in the province of Lleida); in concrete cities like Igualada (Anoia, Barcelona) and Cadaqués (Alt Empordà, Girona) from the Central-Septentrional area, but also in Conca de Barberà, Alt Camp and in the centre region of Baix Camp (province of Tarragona) in the Tarragonian dialect.

This is another case of vowel reduction blocking which is not included in the studies we took in consideration about the phenomenon of vowel reduction blocking. We would like to comment it and point out the relation (or better say alternation) that exists between vowel reduction and harmony. It seems that these cases in the Western dialects where harmony is linked with the prominent position of the word (in this case, the stressed syllable) block vowel reduction too. The context in which we find this kind of harmony is also very precise, syllabic contact of stressed mid-opened-vowel and the following syllable -post-tonic- in a weak position. This could mean that they are two different phenomena that tend to satisfy the same markedness constraint. In the case of vowel reduction, the features that take place are banned so they weaken and, in some cases, lose features, while in the case of harmony (at least in these varieties), the features are linked to the prominent stressed vowels and that is the reason why they assimilate to it[8].

After this interesting aside, we would like to continue with our main topic about the contexts where we can find vowel reduction blocking described in the literature: Hiatus, Compounds and Loan Words:

1) Hiatus

Hiatus is a "break or interruption in the continuity of a work, series, action, etc."[9], in concrete if we talk about language, a hiatus is a "break between adjacent vowels in the pronunciation of a word"[10].

[8] This could be related to the Coda Condition phenomenon, where certain marked features are prohibited in a specific position (in this case, coda positions) unless they are linked to a positional faithfulness feature (for example, an onset) (Lamont 2015, Beckman 2004, van Oostendorp 2005, Bakovic 2007).

[9] www.wordreference.com

[10] www.wordreference.com

Reduction from /e/ and /ɛ/ to [ə] is blocked if the unstressed vowel is immediately followed by [a] or [ə] (Crosswhite 1999: 181; Mascaró 1978)[11]. We can exemplify that with words like *teatre* ('theatre'), *realitat* ('reality') or *lineal* ('lineal')[12]:

In the case of *teatre* the expected pronunciation would be *[tə.'a.trə] as long as the stress is in the /a/, the other vowels should be reduced and, therefore, produced like a schwa [ə] but it is not the case. As we presented, neutralization of /e/ and /ɛ/ are blocked when they are immediately followed by an [a] or an [ə], so in this case, the correct pronunciation of the word *teatre* has to be [te.'a.trə]. In the case of derivates from *teatre* like *teatral* ([te.ə.'tral] 'theatrical'), we can observe that vowel reduction is still blocked in the first element, in /e/, but the second one, as it is not anymore in stressed position (now the stress is in the final syllable) indeed it is subject to reduction, that is why we will produce it with a schwa. In addition, related to the different varieties of Catalan, we would find this neutralization of the second element and producing [te.ə.'tral] just in the Eastern varieties, in the Western ones, as /a/ does not reduce to schwa, we would just find it as [te.a.'tral][13]. In both cases, though, vowel reduction of the first /e/ is blocked.

The same process can be observed in the other two examples. In the case of *realitat* it is not pronounced like *[rə.ə.li.'tat] but like [re.ə.li.'tat]. even though the stressed syllable is in the end, so we would expect the other vowels to be schwa [ə], we do not find in because /e/ is immediately followed by a [ə] -because /a/ follows the normal process of reduction-, that blocks the reduction of /e/.

Finally, in the case of *lineal* we would expect too the pronunciation like *[li.nə.'al], but as long as /e/ is followed by /a/, in this case the stressed syllable, vowel reduction does not take place: [li.ne.'al]. It would seem that all adjectives or substantives that end in *-eal* are going to suffer from vowel reduction blocking as they bear the stress. Other examples

[11] At this point we want to remark that we will only pay attention to the hiatus combination *ea*, *ae* because it is the only one that present this kind of phenomenon. In other combination of hiatus like, for example, *eo* (*reorganitzar* [rə.ur.ga.nit.'za] 'reorganize') or *oe* (*roent* ['ru.en] 'red hot') we do not find the blocking neutralization phenomenon, so here the pronunciation will be as in any other normal unstressed syllables, with only one stressed vowel.

[12] Same cases can also be found in Spanish (see Cabré & Prieto 2006).

[13] This information can also be found in the online official Catalan linguistic webside *ésAdir*: http://esadir.cat/entrades/fitxa/id/266

can be *ideal* ([from *idea* 'idea', [i.de.'al] 'ideal') or *cereal* ('cereal' [se.re.'al] or [sə.re.'al], depending on if it is a Eastern or a Western variety).

2) Compounds

Composition is a morphological process that creates words based on the union of two other words and that, that resulting compound, maintains the meaning of the union of both words.

In compounds and certain other derived environments, previously stressed vowels are immune to vowel reduction (Crosswhite 1999: 201; Mascaró 1978). Examples of that would be words like *semicentre* [ˌsɛ.mi.'sen.trə] ('semi-center'), *rentaplats* [ˌren.tə.'plats] ('dishwasher') or *coragre* [ˌkɔr.'a.grə] ('heartburn').[14]

In the case of *semicentre* [ˌsɛ.mi.'sen.trə] we can appreciate that this compound is formed by the words *semi* ['sɛ.mi] and *centre* ['sen.trə]. As they are independent words with their own stressed -and unstressed- syllables, when the compound is formed both stresses are maintained (in a primary and secondary stress) in the compound, even tough, the principal stress falls in the second word, *-centre*.

The same principle is followed by the word *rentaplats* [ˌren.tə.'plats] where *renta* ['ren.tə] 'wash' and *plats* ['plats] 'dishes' have their own previous stresses as independent words and then the compound is combined they maintain both the stressed and unstressed properties of the two words, adding, though, a primary and a secondary stress even though the primary word stress is in the second word of the compound, *-plats*.

Finally, *coragre* [ˌkɔr.'a.grə] goes through the same process. We can previously find the words *cor* ['kɔr] ('heart') and *agre* ['a.grə] ('sour, bitter'). Both words have already their own stressed and unstressed syllables but when the compound is formed even both maintain the stressed-like vowels (as a primary and secondary stresses), but the stress of the compound is only in the second element of the compound, *-agre*.

The same process would happen in adverbs that end in *-ment*. Both the root word and the adverbial termination would have stress. The main stress would be in the last member of

[14] The representation of the primary stress is it going to be illustrated with a high apostrophe (') while the secondary stress is going to be represented by a low coma (,).

the semi-compound (*-ment*), and the secondary stress would stay in the normal stress of the primary word (Recasens 1996, Prieto 2003, among others).

For example, we could appreciate that in adverbs like *malauradament* ([mə.ləw.,ra.də.'men] 'unfortunately') we can find the secondary stress of the word *malaurada-* ([mə.ləw.'ra.də] 'unfortunate') and the stress in *-ment* (['men] '-ly').

In all those cases we can appreciate that the already unstressed vowels before the formation of the compound are maintained in the compound resulting word, that is the same case that happens with the stressed ones. That is the reason why we have also unstressed vowels in those examples, we maintain the unstressed vowels as they are, and we maintain the stressed ones as secondary stress for the first element (or word) of the compound and primary stress in the second element of the compound. We can say then, that compounds have their main stress in the end of the word.

In relation with that, we would like to comment secondary stress in Catalan. Regarding the existence or not of it, some authors argue that Catalan does not have secondary stress (Cabré & Kenstowicz 1995: 697; Forcadell 2015: 71; Prieto 2001), but the authors that do assume that it exists divide the opinion in if whether it is binary, as say there is a secondary stress every two syllables before the main stress (Coromines 1971) or ternary, when the stress is set every three syllables (Ferrater 1981). In addition, there are some authors that claim that in Catalan stress can be both binary and ternary at the same time and it just alternates depending on the linguistic variation of each speaker (Prierto 2003, Oliva 1977, Serra 1995).

Some examples of those claims could be long words like *monotonia* ('monotony') which could be realized as a mono-stressed word -in the sense of without secondary stress- ([mu.nu.tu.'ni.ə]), ([binary-stressed word ([mu.,no.tu.'ni.ə]) or as a ternary-stressed word ([,mo.nu.tu.'ni.ə]), or *fatalitat* ('fatality') represented with only a primary stress ([fə.tə.li.'tat]) or as a binary-stressed ([fə.,ta.li.'tat]) or as a ternary-stressed word ([,fa.tə.li.'tat]).

3) Loan Words

Finally, a loan word is a "word in one language that has been borrowed from another language and usually changed to fit the new language, naturalized"[15].

In this case, there are loan words that are complete adapted to Catalan and, by that, follow strictly the Catalan phonological processes, but, at the same time, we can find loan words that are non-nativized, that means that they maintain some traits from the original language. In non-nativized loan words, reduction does not occur, -if it had to occur, we would find it in vowels [e, o] but not in unstressed [ɛ, ɔ]- (Crosswhite 1999: 214; Mascaró 1978). Here we can find that non-nativized loan words in Catalan do not follow very precisely the Catalan phonological rules and that is why we can find non-reduction cases: *classe* ['kla.se] ('class'), *soprano* [so.'pra.no] ('soprano') or *vàter* ['ba.ter] ('bathroom').

In the case of *classe* the expected pronunciation in a nativized way would be like ['kla.sə], with the final /e/ pronounced as a schwa due to the vowel reduction process, but as it is non-nativized, we pronounce it like ['kla.se], without any unstressed-like vowel. The second case, *soprano*, if it would be nativized we would pronounce it like [su.'pra.nu] but, instead, we pronounce all the vowels like stressed-like [so.prá.no]. Finally, the third case, *vàter* should be like ['ba.tər], but it is not actually the case, we pronounce this loan word in a non-nativized way, as say, like ['ba.ter].

To finish with, we would like to point out that, as long as these are unassimilated or partially assimilated loan words, the degree of assimilation realized in its pronunciation can depend on the speakers.

2.3. Theoretical Approaches

We divide this section in three parts. The first two parts consist in an explanation of two of the main theoretical theories we are going to follow for our analysis: Optimality Theory (OT) (Kager 1999/2004; McCarthy 2004; Prince & Smolensky 1993/2004, Iosad 2018, among many others) and Property Theory (PT) (Alber & Prince 2016, 2017; Alber, DelBusso & Prince 2016; DelBusso 2018). For Prince & Smolensky (1993/2004: 5), among other authors, the OT is the theory of well-formedness, as it selects the optimal

[15] www.wordreference.com

candidate, the most well-formed, of a list of infinite possibilities. In addition, PT is a theory of typological structure in OT (DelBusso 2018), where "a typology is resolved into a set of properties, ranking conditions that have mutually exclusive values" (Alber, DelBusso & Prince 2016: 88). We are going to present and develop a further explanation of both theories in the following two parts of the thesis (sections 2.3.1. and 2.3.2.).

The last part of this section, Vowel Reduction (2.3.3.), is a pick-up of what we introduced in section 2.2.1. We to continue presenting the different theoretical approaches about vowel reduction made by three of the main authors in the field: Crosswhite (1999), Walker (2011) and DeLacy (2006). We explain in detail their understandings of vowel reduction, how they develop their analysis and how they satisfy their hypothesis. Finally, we finish this section with a discussion about the different approaches and taking sides in which is the approach that suits us best for our analysis (developed in section 3).

2.3.1. Optimality Theory

Two of the most important names in OT are Prince & Smolensky (1993/2004). They introduced important concepts and definitions about what is OT. They explain the proposal of the theory as,

> determining which analysis of an input *best satisfies* (or least violates) a set of conflicting conditions. For most inputs, it will be the case that every possible analysis violates many constraints. The grammar rates all these analyses according to how well they satisfy the whole constraint set and produces the analysis at the top of this list as the output. This is the *optimal* analysis of the given input, and the one assigned to that input by the grammar. The grammatically well-formed structures are those that are optimal in this sense. (Prince & Smolenskyn 1993/2004: 2).

There are several factors we need to take in consideration when we are talking about OT: 1) Constraints; 2) Ranking (of those constraints); 3) an Input; 4) Candidates (also known as outputs); and, finally, 5) the Optimal Candidate.

1) Constraints

As Kager (1999/2004: 4) said, the main focus of OT is that every language, and every grammar, consist in a system of conflicts, where these conflicts are demonstrated with constraints. For Iosad (2018: 1) constraints are realizations of the form "Assign a violation mark" for each input output of a structure under a property with a binary value.

Those constraints are one of the main points of the OT analysis that we must check right now. Every grammar is in conflict but, as long as there is not a perfect candidate, all candidates violate some or other constraints, the fact is that, the candidate that violates lower (in the ranking we encounter) constraints it is the one that has more possibilities to be the optimal one. Constraints are universal, but the ranking is what differs in each language (Kager 1999/2004: 4).

Constraints can be divided into makedness or faithfulness constraints. Kager (1999/2004: 9-10) defines both. For him, markedness constraints are evaluated under the well-formedness of each output, while faithfulness constraints need a comparison of equivalence or similarity between input and output. For Prince & Smolensky (1993/2004: 2) markedness constraints are those that assess output configurations and faithfulness constraints are the ones that try to maintain or preserve the underlying form of an input in the output.

For the markedness ones, Rice (2007: 79) remarks, referring to other authors:

> the term markedness is used in phonology to capture the central observation that not all elements in a phonological system are of equal status. The term was introduced by Trubetzkoy (1939/1969) to refer to relations between elements of a phonological class […] Jakobson (1941/1968) proposes that markedness constrains phonological inventories, systems, and rules and plays a role in determining sound change and the order of acquisition of sounds; relative frequency, combinatorial capacity, and assimilatory power of features are determined by the priority relationships within the universal feature hierarchy that he proposed.

Iosad (2018) at the same time citing Moreton (2004) defines markedness constraints by "the fact the number of violations they assign does not depend on the properties of the input in the {input, output} pair. […] Markedness constraints, therefore, are statements about the preferred shape of surface representations." (Iosad 2018: 2). Next, he talks about faithfulness constraints explaining that they,

> demand that certain aspects of the input should be preserved in the output. Formally, a faithfulness constraint never assigns a violation mark to the *fully faithful candidate*: a constraint *C* is a faithfulness constraint if there are no {input, output} pairs such that the input is identical to that output and *C* assigns a violation mark to the pair. A common type of faithfulness constraint, for example, demands that input and output be identical in the value of some distinctive feature. (Iosad 2018: 2)

2) Ranking

To be able to determine which constraints do we need to take more in account, which ones are more vital to not be violated for the optimal candidate, and which ones we need to dismiss other candidates, we need to propose a ranking for those constraints. The ranking goes from the first constraint in the leftmost part of the ranking, to the lowest one, at the rightmost part. As lower are the constraints, less vital are for our optimal candidate, less costly violation they have (Kager 1999/2004: 3).

For Prince & Smolensky (1993/2004: 2), "Optimality Theory relies on a […] notion of constraint interaction whereby the satisfaction of one constraint can be designated to take absolute priority over the satisfaction of another. That means that a grammar uses to resolve conflicts is to rank constraints in a *strict dominance hierarchy*. Each constraint has absolute priority over all the constraints lower in the hierarchy."

So, if, for example, we have a candidate that violates the first constraint but not any of the others, we will still dismiss it because the violation of the first constraint is fatal. On the other hand, if we find another candidate that does not violate the first and the second constraint, but violates the rest of them, we could be in front of a possible optimal candidate -depending on the other candidates- because violations are less fatal as in the other case, and with that the optimal candidate has to violate lower constraints (Grimshaw 1997).

Iosad (2018) understand this process in the following way. The Evaluation module choses the candidate that has the fewest violation marks of the highest ranked constraint. Normally, it is not enough with only one constraint to select an optimal candidate, so we need to follow a recursive strategy. For each constraint and candidate there is the possibility to establish a favoured constraint which has fewer violation marks assigned. Once we selected all the favoured candidates and dismissed the disfavoured ones by the highest ranked constraint, those favoured candidates "survive" the first step on the

evaluation process and should, next, be evaluated by the following highest ranked constraint. The winnowing is repeated until the bottom of the ranking is reached or there is only one candidate left (Iosad 2018: 4).

3) Input

The input is the original phonological word we encounter in the language, it is the underlying form for the optimal candidate's result.

At this point we need to take in account the richness of the base factor (Kager 1999/2004: 19). We have to make sure that the analysis we are proponing works for every word in that language, not just for the input and outputs we are analyzing in that moment. We must take in account that for the constraints and ranking we proposed, our analysis will be able to be transferred to other words apart from the one we are analyzing in that moment, because the base of the input of the languages is not always the same and we need to make sure it is going to be a correct analysis for all the possible candidates in the language.

As Prince & Smolensky (1992/2004: 4-5) remark, "the grammar must define a pairing of underlying and surface forms (input, output). Each input is associated with a candidate set of possible analyses […]".

4) Candidates/Outputs

One we know which ones our constraints are, the ranking we propose for them and the input from the which we are starting, we need to propose some candidates. As Iosad (2018) explains, the candidates are the set of potential output forms, which are infinite and independent of the properties of the input. One of the candidates, as we can already have in mind, will be the optimal one, and, for that, the *winner*. Next, we need to think about all other possibilities and combinations for other candidates, we can think about all the candidates we can, think as much as possible on how to combine them to result on the fatal violations of the constraint and hat with that, the optimal one will still be the one we want. The list of candidates is infinite, so we will need to show in a better way as much examples of them as possible.

5) Optimal Candidate

Finally, when we have our list of candidates, we have our input, and we have our constraints ranked, we can start analysing. As we said, the ranking of the constraints goes from higher to lower, so if a candidate violates the highest constraint and another candidate does not do it, but violates all the following ones, it will still be more optimal than the previous candidate, because the violated constraints -even that in this candidate there are more violations than in the first one- the violations are lower, and by that we mean that they are not as fatal as the first one. We need to make sure that all the non-optimal candidates have fatal violations in the constraints and that our optimal candidate, the one we want to "win" will be the less costly violated one. Finally, after assigning violation marks to our candidates, the remaining one will be the optimal one. As say, the best one within all the candidates we had (Prince 2007: 35).

For Prince & Smolensky (1993/2004: 2/191) "the licit analyses are those which satisfy the conflicting constraint *as well as possible*; they constitute the optimal analyses of underlying forms. This, then, is a theory of optimality with respect to a grammatical system rather than of wellformedness with respect to isolated individual constraints. […] The job of the grammar is not to accept or reject *inputs*, but rather to assign the best possible structure to every input."

In addition, Alber, DelBusso & Prince (2016: 89) define optimality in 3 items: ". [1] A candidate *is better on a constraint than* a competing candidate if the constraint assigns it fewer violations than its competitor. [2] Given a linear order or *ranking* of all the constraints in CONS, a candidate is *better on that ranking* than a competitor if it is better on the highest-ranked constraint that assigns them different violation values. [3] A candidate is *optimal* in its cset with respect to a given ranking if no other candidate in that cset is better on that ranking; an optimum is thus better than all other competitors that are distinct from it in constraint-assessed violations."

What would happen, though, if an OT analysis would give us different results, as say, grammars or optima? As Merchant & Prince (2017:2/6) "OT grammars arise from the comparison of candidates over a set of constraints. An OT *typology* […] compares entire grammars over the same set of constraints", then "a factorial typology comes into existence whenever we specify an OT system as a set of constraints and the candidates

they evaluate". To explain that we need to introduce now the second important theoretical concept of the thesis, Property Theory.

2.3.2. Property Theory

The first time PT appeared was in semantic papers during the middle of the decade of the 80's by the author Gennaro Chierchia. Chierchia claimed that properties existed in two forms: propositional functions (argument taking, as say, unsaturated structures) and nominalized properties (entities or non-argument taking) (Chierchia 1984, 1985; Huang 2006).

Sometime after that, in the decade of the 2010's another points gave meaning to the PT as known by Chierchia. That is the kind of PT we are going to consider in this thesis. That *other* PT was made by Alber & Prince (2016, 2017), Alber, DelBusso & Prince (2016) and continued by other authors like DelBusso (2018).

PT is a theory of typological structure in OT (DelBusso 2018) where each language and its own grammar can be identified by their own property values (Merchant & Krämer 2018). To accomplish a property analysis, we need first to introduce three items: a set of properties, ranking conditions, and binary values. Those elements are important in the sense of, to accomplish a property analysis, we need to be able to identify the ranking of the constraints to distinguish the grammars of the typology, where the languages that share property values will also share extensional traits (Merchant & Krämer 2018: 1). Properties are antagonized sets of constraints stated in the form X <> Y -where X and Y are the two binary values of a property- and in which languages of the typology have to decide those binary values (DelBusso 2018; Merchant & Prince 2017, Merchant & Krämer 2018).

Some examples of properties can be found in (McManus 2016; Prince 2017; Alber & Prince 2016, 2017; among others). Besides, to exemplify some properties we will illustrate them with foot form properties in the language. Languages can have foot types Iambic (-uX-) or Trochee (-Xu-)[16] and whether they chose iambic or trochee (the binary

[16] In a footed syllable, "X" stands for the head of foot, while "u" stands for the non-headed foot. In this cases, iambic syllables are finally-headed, while trochee syllables are initially-headed (McManus 2016, Alan & Prince 2017).

values of foot form) depends on each languages' choices. Another commented example is the alignment of the foot: Foot can be left- or right-aligned (AFL or AFR respectively), that means that the stressed syllable can be found in the beginning of the prosodic word (AFL) or in the end of the prosodic word (AFR). The value of the foot alignment -left or right- depends, again, on the choices of every language. Within those 2 properties and their respectively 4 possible combinations (iamb-AFL, iamb-AFR, tr-AFL, tr-AFR) we can state for 4 distinctive and unique languages. Some examples of languages with those combinations could be: iamb-AFL: Greek (Martin & Johnson 2002); iamb-AFR: Tashlhiyt Berber (Gordon & Nafi 2012); tr-AFL: Finnish (Karvonen 2008); and, finally, tr-AFR: Turkish Kabardian (Gordon & Applebaum 2010) (McManus 2016; Alber & Prince 2017, Alber, DelBusso & Prince2016).

If we continue with a property analysis, each property value generates an ERC[17] set (*Elementary Ranking Condition*, Prince 2002; Merchant & Riggle 2016), where, afterwards, those binary values need to be evaluated in competition (DelBusso 2018; Merchant & Prince 2017). For that binary competition of ERCs, we need to take two competitor outputs and assign them a value of W (winner), L (loser) or *e* (equal)per ranking (W states for the constraint that favours the first competitor; L indicates that the constraint is in favour of the second of the competitors; and *e* "indicates that the constraint does not distinguish them by virtue of assigning both the same value") (Merchant & Prince 2017: 9; also, DelBusso 2018). The resulting grammar of a language needs to be the result of the binary choices within a particular constraint ranking chosen by the language (Merchant & Krämer 2018: 4).

If we exemplify ERCs, we will need, at least, a pair of candidates, in this case we will use three constraints and we will call them A and B, and, also at least, two constraints: X and Y. This would result in a simple ERC where, for each candidate and constraint we need to value their binary values and assign W, L or *e* depending on the competition of each candidate and constraint:

[17] In addition, we need to comment, as DelBusso (2018: 4) or Prince (2017: 15) remarked, the appearance of *leg*s: for each ERC set there exists "a single total linear order or a set of such orders. Each such order is a *l*inear *e*xtension of a *g*rammar, a *leg*, λ.", as say, a *leg* represents a single ordering of the ERCs constraints rather than their evaluation as violation between the pairs.

(11) ERC simplified exemplification

	X	Y
A ~ B	W	L

Here, we can observe that candidate A wins over candidate B in evaluation in constraint X, while in constraint Y, candidate A is worse than candidate B after the evaluation.

Finally, if we exemplify with another tableau and ERC for the properties we referred previously (Iambic, Trochee, AFL and AFR) we can generate a more detailed exemplification on how ERCs work. In this case we will use four constraints and, for example, three candidates (A, B, C) in competition to evaluate (as Prince 2017: 15) does. We will follow now his example with some modifications:

(12) ERC foot example

	Trochee	Iamb	AFL	AFR
A ~ B	W	L	*e*	*e*
A ~ C	*e*	*e*	W	L
B ~ C	*e*	W	W	*e*

In this case, we can observe that candidate A is better than candidate B in the Trochee constraint, that both are equal in AFL and AFR, and that candidate A is worse than candidate B in the constraint Iamb. In the second case, we can observe that candidate A is better than candidate C in AFL, but worse in AFR, while they are both equal in Trochee and Iambic. Finally, candidate B is better than candidate C in Iamb and AFL, but both are equal in Trochee and AFR. If we would like to continue our property analysis with this example, we could get three languages, depending on the ordering and values of each

constraint. Language1 should rank Tr >> Ia, Language2 should rank AFL >> AFR, and Language3 should rank Ia,AFL.dom.[18]

Now, we need to remark -and also introduce a new term- that with this analysis, we can obtain different possible optima for the grammar we are analysing, that is called the *typology* (Alber, DelBusso & Prince 2016; DelBusso 2018; Merchant & Prince 2017; Prince & Smolensky 1993/2004). For Prince & Smolensky (1993/2004: 92) or Merchant & Prince (2017: 9) a typology is "the collection of all the languages of a system. Since each language has a unique grammar associated with it, a typology may also be understood as the collection of all grammars of a system".

That collection of languages would work for us to take in account cross-linguistic and dialectal variation among languages because the grammar that a typology creates shows all the different combinations that can be found in language variation (DelBusso 2018: 1; Alber, DelBusso & Prince 2016), therefore those differences of grammar corresponding to the different languages -or variations of a language- can be described in a minimal way as the smallest property value that changes between that language variation (Alber & Meneguzzo 2016: 26). However, we need to assume that the set of constraints we would take in account for the analysis is finite and fully discoverable (Iosad 2018: 14).

When we introduce typologies in the OT analysis, we receive what is called a *factorial typology* (Alber, DelBusso & Prince 2016). As DelBusso (2018: 1-2) described it,

> an OT factorial typology of a given system is all possible permutations (rankings) of a set of universal constraints on linguistic forms that give rise to distinct sets of optima (languages). While all permutations of constraints are possible ranking hierarchies, in many typologies several hierarchies result in the same extensional language [but] not all constraints conflict and are crucially ranked in all grammars. A *property analysis* discerns the crucial rankings that classify a typology: those necessary and sufficient to define every grammar. PT explicated the link between these *intensional* rankings and the *extensional* traits exhibited in the languages they generate (Alber, DelBusso & Prince 2016).

In summary, as Alber, DelBusso & Prince (2016: 88) remarked, "a *factorial typology* is a set of grammars", and as Merchant & Prince (2017: 6-7), we create a factorial typology

[18] The operators *.dom* or *.sub* work by marking if any constraint should be ranked the highest (*.dom*) or the lowest (*.sub*) within a linear order (Alber & Prince 2016).

when we generate in an OT system a set of constraints and candidates for different inputs and we while showing how those constraints should evaluate the candidates would give us the information of the languages of our typology.

A practical case of typology is what we are going to make of in our analysis (section 3). We will need to develop an OT property analysis using the program OTWorkplace (Prince, Tesar & Merchant 2018)) -that program in format of an Excel Office document, permits us develop several OT analysis fastest than if we should make them by hand[19]- in which the expected results of the evaluation of the constraints -in this case properties- and candidates must be each different ranking and resulting grammar (and language) for each of the varieties of the language case of study, Catalan. With this result we will be able to differentiate which relevant values of properties differ from one to another variety of Catalan.

2.3.3. Vowel Reduction

As we introduced previously, in this section we present different approaches to vowel reduction following three authors: Crosswhite, Walker and DeLacy. Their different approaches to vowel reduction and their discussion are useful for us and it lets us demonstrate the characteristics of vowel reduction and, afterwards, it permits us produce our own analysis for Catalan vowel reduction. Each author presents and analyses vowel reduction following different constraints and different theoretical approaches, that is why we present them in the following sub-sections. Finally, we finish with a discussion, and we position ourselves with one of the analysis to follow for our own work.

2.3.3.1. Crosswhite

Crosswhite's understanding of vowel reduction or vowel neutralization depends on stress. She claims for two types of vowel reduction: 1) Contrast-Enhancing and 2) Prominence-Reducing. In addition, she claims that a two-pattern system for vowel reduction exists, a "moderate" one and an "extreme" one (see section 2.2.1 where this was already introduced).

[19] We will develop and explain in more detail how OTWorkplace works in section 3.

The data Crosswhite uses for her analysis of vowel reduction is, mainly, Russian, in concrete the Contemporary Standard Russian and some other Russian dialects. While she presents the data for her analysis, she notes all kind of vowel reduction patterns in Russian (Crosswhite 1999, chapter 3).

Her predictions are that "extreme" reduction will pertain to nonmoraic unstressed syllables, so the two-pattern system for vowel reduction will occur when the Prominence-Reduction constraints outrank the Contrast-Enhancing constraints, which produce "moderate" neutralization. As a consequence, she also predicts that "moderate" reduction will occur when both sets of constraints are in complementation, while "extreme" reduction will occur in the intersection of the sets of constraints (Crosswhite 1999: 104).

The two main constraints she uses for reduction are, first, for "extreme" reduction in equivalence with Prominence-Reduction the constraint that permits this kind of reduction is *Nonmoraic/-high (Crosswhite 1999: 110). In the case of "moderate" or Contrast-Enhancing[20], the main constraint that Crosswhite presents is Lic-Nonperiph/Stress (Crosswhite: 1999: 121). The first constraint claims that nonmoraic vowels cannot have more sonority than [i], while the second one defends that a nonperipheral vowel ([ɛ, e, ɔ, o]) cannot occur in the outputs unless if it is in a stressed position (Crosswhite 1999: 110, 121).

Some examples of the analysis for both "moderate" and "extreme" reduction are illustrated by her in her thesis. There she shows the constraints to give in account the reduction of /o/ to [a]. For that, she uses the following constraints in the following ranking: *Nonmoraic/-high >> Lic-Nonperiph/Stress >> Max[+fr] >> Max[-hi] >> C^{j}/[+fr] >> Dep[+hi]. In the case of other reduction patterns, for example to [i], she re-ranks C^{j}/[+fr] >> Max[-hi], and in cases of reduction to [e], the constraint Licnonperiph/Stress is ranked lower than C^{j}/[+fr] >> Max[-hi] (see Crosswhite 1999: 126-131 to see the violation tableaux of the reduction patterns). She concludes with a generalization: "the extreme vowel reduction patterns differ from the moderate vowel reduction patterns in disallowing certain sonorous reduction vowels, such as [a] or [e]" (Crosswhite 1999: 136). Afterwards, when she compares her results for the vowel

[20] The type of constraints Crosswhite is going to use for the Contrast-Enhancing type of reduction are the Licensing ones. For her, Licensing constraints should have an environment that "improves the likelihood for correct perception of the feature or feature combination in question" (Crosswhite 1999: 68).

inventories for Southern and Central Russian dialects she can observe that in moraic unstressed syllables she can find [i, u, a], while in nonmoraic unstressed syllables she finds [i, u, ə] and, with that results, she claims that what happens is not preservation of fewer contrasts in "extreme" reduction but what would seem a completely different type of vowel reduction system for each one of the types (Crosswhite 1999: 136).

Finally, she produces a factorial typology to investigate the relative rankings of both markedness (specifically for vowel reduction) and faithfulness constraints to give account for vowel reduction as she claims that patterns do not seem predictable. She investigates all 5 and 7 vowel languages that suffer from vowel reduction. For that, she proposes in addition of the already presented constraints Lic-Nonperiph and *Unstressed/-high, the new constraints Lic[F] and Lic[MidLax], where the first one tends to the elimination of all vowel contrasts (everything reduces to [ə]), while the second one benefits the appearance of [ɛ] and [ɔ] in stressed positions. In addition, she adds too all the possible combinations of faithfulness constraints: Dep[+/-high, +/-low, +/-front, round] and Max[+/-high, +/-low, +/-front, round] (Crosswhite 1999: 157, 159). The result of the factorial typology is a total of 235 predicted patterns, from which only 27 are attested in her empirical database.

She concludes that with her factorial typology, she could predict all attested 5- and 7-vowel reduction systems (and in relation to the unattested systems, they can be accidental gaps either because there is no attested language yet for the patterns or because of their similarities to other patterns can be indirect attested). Even with this, the factorial typology permits asymmetrical vowel reduction patterns with empirical support, that means not just all vowels raising or lowering, but some raising, lowering, centralizations, etc. at the same variety of pattern (Crosswhite 1999: 180).

2.3.3.2. Walker

Walker works vowel reduction following two main aspects: the position of the vowels in the words and how perception and production can affect vowels. For that, she understands vocalic patterns in terms of licensing and divides them between 1) Indirect Licensing, 2) Identity Licensing and 3) Direct licensing. Moreover, afterwards, she also adds a fourth type of licensing 4) Maximal Licensing. Vowel reduction would be included in the third

type, Direct Licensing, where features are wholly preserved just in positions that are prominent (stressed, initial and final syllables, and morphological roots or stems).

The data Walker uses for her analysis is, mainly, examples from Romance languages, in concrete, Spanish and Standard Italian, and from Germanic languages, like Modern Standard German or Old High German (Walker 2011, chapters 5, 6 and 7).

Her predictions are, in sum, that non-ambiguous material that is more marked could be restrictively chosen in prominence-based licensing, that means that the values of a feature of the vowels are penalized when they are not in a licensed position; whereas less marked material is subject to restriction from the licensing, as say, strong asymmetrically vowels will not be chosen for a licensing restriction. In the case of markedness properties that vary between languages, the value for variation is also open in prominence-based licensing patterns (Walker 2011: 32-35).

The main constraints she uses for her analysis are the License-type constraints (Walker 2011: 45-48) -following Crosswhite's Licensing constraints-, Ident constraints (Walker 2011: 46), *Duplicate (which claims to "assign a violation mark to pairs of corresponding elements within an output", Walker 2011: 54) and CrispEdge (which "penzalizes both indirect and identity licensing configurations", Walker 2011: 58). In addition, she uses two Ident-IO faithfulness constraints: Ident-IO-'σ(F) and Ident-IO-σ_{Final}(F), the first one demands a correspondent feature between input and output in stressed syllables, while the second one demands that in final syllables (Walker 2011: 65).

Some examples of her analysis can be found in Walker (2011: 56-58). For Veneto, she proposes an Indirect Licensing analysis in the case of /ordeni/ > [úrdini]. Here she uses and ranks the constraints the following way: License([+high]/$\sigma_{post\text{-}tonic}$,'σ) >> *Duplicate(F) >> Ident-IO(high). For Ascrea, she adds an Identity Licensing based analysis for the word /toreuu/ > [túreuu]. In this case, the constraints and rankings chosen are Lic([Height]/[+hi],'σ) >> Ident-IO(high) >> *Duplicate(F). Finally, she exemplifies an analysis of Direct Licensing with Ola Lamut for the word /olok/ > [olək]. The used constraints and ranking in this case are License([+round]/[-high],$\sigma_{initial}$) >> CrispEdge([round],σ) >> Ident-IO(round). As this last example is the one that most matters to us, as long as it is the one that represents vowel reduction, we would like to remark that any analysis of vowel neutralization she proposes in Chapter 7 follows a

ranking of Licensed/Markedness constraints over Faithfulness constraints: Lic,Marked >> Faith.

Finally, she proposes a factorial typology for both disyllabic and trisyllabic forms. For that the proposed constraints are: License([+F],'σ), License([+/-F],'σ), *Duplicate(+/-F), CrispEdge([+/-F],σ), Ident-IO(+/-F), Ident-IO-'σ(+/-F) and Ident-IO-σ_{Final}(+/-F) (Walker 2011: 65). For disyllabic structures, she found a total of 6 relevant different vocalic patterns, in this case she recognises one faithfulness pattern, fours patterns for Indirect Licensing, and a pattern for Direct Licensing. Secondly, for trisyllabic forms she got a total of 35 different vocalic patterns, but only 22 with different values for features (Walker 2011: 71). Last, she generated a factorial typology for what she called "non-local effects" (Walker 2011: 75-76) which are trisyllabic words formed within a disyllabic word plus an affix. The results here showed a total of 16 patterns from which only 9 were feature-value relevant.

Later, she proposes other interactions and some other faithfulness constraints to give an explanation for Direct Licensing processes (as known, neutralization) that show variation and she summarizes them (Walker 2011: 79, table 18). Some of the faithfulness constraints are Max-IO(segment) (it penalizes segments that are present in the input but not in the output, it claims not to delete segments form the input, Walker 2011: 79) for Northern dialects of Modern Greek, and Uniformity-IO (which defends that no elements of the output have multiple correspondents in the input, Walker 2011: 214) or Morph-O-Contiguity (where to tokens of phonological structure affiliated with a given morpheme in the output belong to a contiguous string of syllables, Walker 2011: 220) for dialects of Liguria.

The results from the factorial typology let her explain that "what unites prominence-based licensing phenomena is […] preventing distinctive information from being expressed solely in a non-prominent position. This shared characteristic exists despite the plurality of processes and patterns" (Walker 2011: 80).

2.3.3.3. DeLacy

DeLacy understands vowel reduction in the context of two structural elements in relation to Markedness constraints: The Designated Terminal Elements (DTE) and the non-DTE. He understands DTE following Liberman & Prince (1977) and describes it similar as how

we understand a prosodic head, that means that a stressed position would be a DTE element, while the rest of the position would be understood as non-DTE elements (DeLacy 2006: 63). In the case of vowel reduction, then, we should be talking about the non-DTE structural parts.

The data he uses in his work comes from a vast variety of resources and different languages, for example, more common languages like Central Catalan or Sri Lankan Portuguese and less common ones like Maga Rukai or Maori (DeLacy 2006, chapter 7).

He claims in his predictions that there does not exist a single "unmarked segment" but that markedness structures and hierarchies vary and conflict, and depending on how we order the structure and which element of the hierarchy dominate over the others some elements are going to be assigned as less marked in a language. In the case of vowels, they appear to be less marked, that is the reason why we find phenomena like epenthesis or neutralization. Finally, variation in the vowel reduction patterns depend on the conflicting elements in the hierarchy and the overlapping of their position in the prosodic structure (DTE vs non-DTE or stressed vs unstressed positions) (DeLacy 2006: 286).

The main constraints he uses for his analysis are markedness constraints, as he assumes that "only markedness can influence vowel quality" (DeLacy 2006: 288) so they will always be ranked higher than faithfulness constraints. Those markedness constraints then have the type of: *Δσ≤{V[21]} (violated by a DTE syllable) and *-Δω≥{V} (violated by a non-DTE syllable).

Some examples of his analysis to vowel reduction can be found in his section 7.3 (DeLacy 2006: 306). In the concrete case of neutralization in non-DTE syllables he uses Central Catalan; he analyses the reduction process of /kɔzɛ-tə/ > [ku'zɛtə] or /pɛl-ut/ > [pə'lut]. For that he uses and ranks the constraints the following way: *-Δω≥{e, o} >> ID[+/-round] >> ID[+/-high]. It is important that the constraint *-Δω≥{e, o} is ranked higher than the constraints than prohibit low sonority vowels because that would block neutralization to schwa ([ə]) (DeLacy 2006: 311-312).

[21] The hierarchical order for marked sonority in DTE syllables is the following one: [ɨ, ʉ <> ə <> i, u <> e, o <> ɛ, ɔ <> a], in where low vowels are least marked for sonority, and high central vowels are least marked for the non-DTE syllables (DeLacy 2006: 288).

Moreover, the variation among other languages' vowel reduction process can also work following this structure, the difference is that the importance would just recall in the ordering of the markedness constraints among themselves. For example, in Siuslawan should first encounter *-Δω≥{a}, in Sri Lankan Portuguese it must be *-Δω≥{ɔ,ɛ} and, lastly, in New Zealand English it should be *-Δω≥{i,u} (DeLacy 2006: 312). Finally, variation also shows different dispersed inventories, they can contain both low and high vowels in unstressed positions. For example, in Luiseño we can find an unstressed system of three vowels ([i,u,a]), for example /tʃokatʃkaʃ/ > [tʃu'katʃkaʃ]. In this case he claims that some faithfulness constraints, in concrete Ident[low], must be ranked in a higher position than the markedness ones: Ident[+/-low] >> *-Δω≥{e,o}[22]. (DeLacy 2006: 314-315). That would mean, as he remarks (DeLacy 2006: 325) that vowel reduction is a process that can be found in both ways, increasing or decreasing of the sonority of the vowel.

To finish with, he concludes that as long as neutralization can work in both direction regarding vowel sonority it is not easy to establish a solid conclusion about markedness hierarchies just with this phenomenon. That means that, as he claimed, there is no evidence for just one unmarked segment or unmarked vowel, but markedness is important in taking in account the effects of sonority in vowels (DeLacy 2006: 332).

2.3.3.4. Discussion

Once we presented every author's approach, we test our candidates with the authors' constraints. With that, we want to check if what they predict for their analysis would work in other investigations. For that we use our inputs, which are all the vowels we can find in the Catalan vocalic system: /a, ɛ, e, i, ɔ, o, u, ə/. For inputs /a, ɛ, e, i, ə/, the outputs are [a, ɛ, e, i, ə], and for inputs /ɔ, o, u/ the outputs we take in consideration are [ɔ, o, u][23]. Finally, we develop the analysis using the OTWorkplace program.

[22] He does not do a factorial typology, as Crosswhite and Walker did, but this ordering observations can be understood as a factorial typology which result in the realization of different results in different languages.

[23] As we will explain in the analysis in the following section (section 3) we assume that backness and roundness are always high-ranked and that means that vowels do not change in backness and roundness when reduced, that is why we do not find outputs the kind of [o] for the input /a/ or outputs like [e] for inputs like /o/, for example.

First, for Crosswhite, we selected the main constraints we need to take in consideration for our analysis, those are some Licensing constraints: Lic-Nonperiph (which forbids the non-peripheral vowels [ɛ, e, ɔ, o, ə]), Lic-LaxMid (which bans mid-lax vowels [ɛ, ɔ]) and Lic-[F] (which prohibits all but schwas [a, ɛ, e, i, ɔ, o, u]); we will also use a Markedness constraint: *Unstressed/-high (which prevents [-high] vowels [a, ɛ, e, ɔ, o, ə] in unstressed positions); and some Faithfulness constraints: Dep[+/- high, +/-low, +/-ATR] and Max [+/-high, +/-low, +/-ART]. If we realize a factorial typology with OTWorkplace with those candidates and constraints, we get a total of 40 languages. Among those languages, we can find some of our main varieties: Algherese, Central, Northern and Majorcan but we miss the North-Western & Valencian one and the Faithfulness variety. Other problems we can find is the missing output [e] for the input /a/, found in some transitional varieties, and the outputs [ɛ] and [e] for the input /ɛ/, the first one found in the Faithfulness variety and the second one found in the Western varieties and other transitional ones.

In second place, we examined Walker's relevant constraints. In this case we have three relevant Licensing constraints: License[high], License[low] and License[ATR] (that forbit those features in Licensing positions); three Faithfulness constraints: ID-IO[high], ID-IO[low] and ID-IO[ATR] (that prevent any changes between output-input of the selected feature); and two Markedness constraints: *σ/a,e·o (which forbids unstressed syllables that contain a low or mid vowel [a, ɛ, e, ɔ, o]) and *σ/a,ɛ·ɔ (which prevents unstressed syllables with vowels with sonority greater or equal than [ɛ] and [ɔ]: [a, ɛ, ɔ]). After a factorial typology with those constraints we got a total of 26 languages. Around those languages we can successfully find the North-Western & Valencian, the Majorcan, the Northern and the Central variety, but we miss the Algherese and Faithfulness ones. Some other problems we can find is the absence of the output [ɛ] for the input /ɛ/, found in the Faithfulness variety, and some impossible realizations like [a] for the input /i/.

Finally, if we check DeLacy's constraints we can find four Faithfulness constraints: ID-IO[high], ID-IO[low], ID-IO[ATR] and ID-V (which penalizes every vowel that changes its form from the input to the output); then, we can find five Markedness constraints, that follow a sonority scale, as we could appreciate in the previous section: *-Δω≥{a}, *-Δω≥{ɛ, ɔ}, *-Δω≥{e, o}, *-Δω≥{i, u}, *-Δω≥{ə} (respectively, the will prohibit [a], [a, ɛ, ɔ], [a, ɛ, ɔ, e, o], [a, ɛ, ɔ, e, o, i, u] and [a, ɛ, ɔ, e, o, i, u, ə]). Once have done the factorial typology, we find a total of 28 languages. Through those languages we could appreciate the Faithful variety, the Majorcan, the Central and the Northern one, but we missed the

Algherese and the North-Western & Valencian one. In addition, we also missed the output [e] for the inputs /a/ and /ɛ/, the first one in some transitional varieties and the second one in the Western and transitional varieties, and for the inputs /ɛ/ and /e/ we missed the output [a], found in Algherese or, the second one, in transition varieties. Another main problem we found is the presence of the output [ə] for the input /i/.

Here in this thesis we follow Crosswhite's approach. Even though her analysis left out some important varieties for Catalan, that can be solved if we modify some of the constraints, her analysis is the one that permits us more successfully account for the dialectal variation in Catalan. We dismissed Walker's approach because most of her constraints take in account contextual information, while in Catalan we do not need those details in vowel reduction, and we dismissed DeLacy's approach because Licensing constraints will help us a lot for the analysis. Then, we can say that we will use the three kinds of constraints she presents: Licensing, Markedness and Faithfulness, as those are the ones that will permit us the variation results. In the following section we present and explain the constraints we use for our study, we develop the investigation and we extract the properties that we need to divide each variety.

3. Analysis

3.1. Defining the Candidates and Constraint sets

This section is about the analysis of the Catalan data and, as we present previously, we follow Crosswhite's works for considering our analysis.

Firs of all, we compilated the data from different literature resources, some of them are Adam (2006, Bonet & Lloret (1998), Cubells (2009), Gómez Durán (2002), IEC (2007), Mascaró (1978, 2002), Montoya-Abat (1999), Navarro (1999), Palmada (1994), Prieto (2001, 2004), Recasens (1996), Veny & Pons i Griera (2001, 2013), Veny & Massanell (2015), Veny (2007), Wheeler (2005). Among these resources we could find basic vocalic Catalan descriptions, descriptions of the main areas of Catalan and even more concrete regions, like the transitional areas.

Once we had all the data we needed, we made a selection of the processes of vowel reduction in the different varieties we could find. In this thesis we understand vowel reduction as all reduction patterns that affect the underlying vowels /a/, /ɛ/, /e/, /ɔ/, /o/ and /ə/. As we could appreciate in previous sections (section 2.1.), vowels /i/ and /u/ do not suffer from vowel reduction.

To prepare the analysis, then, we present the inputs and candidates we need. The different inputs we take in considerations are all the vowels in the Catalan system: /a/, /ɛ/, /e/, /i/, /ɔ/, /o/, /u/ and /ə/. Now, before we present the candidate selection, we have to make one assumption that comes from the observation of the data, that is that vowels never suffer changes in roundness and backness, we understand then that the features [round] and [back] are all high ranked in the constraints ranking and that is the reason we do not include them in the constraints for our analysis. That means that /a/ is does not reduce to [o] or /u/ is does not reduce neither to [e], for example. Acknowledging that, we make two groups of inputs-candidates, the front ones and the back ones: for the first group of inputs we can find /a/, /ɛ/, /e/, /ə/ and /i/, and their candidates are going to be all [a], [ɛ], [e], [ə] and [i] for each vowel of the input; in the second case we will find the candidates [ɔ], [o] and [u] all three for every input /ɔ/, /o/ and /u/.

Next, some other assumptions we need to consider are regarding the features of the vowels, in particular, /a/ and /ə/, which are not specified for the feature [ATR] (that claim is also made by Crosswhite 1999, 2001), while /ɛ/ and /ɔ/ have the value [-ATR] and /e/,

/i/, /o/ and /u/ are specified by the value [+ATR]. Secondly, we need to take in account the underlying form /ə/ and its respective candidates only in the Majorcan variety, for the rest of the analysis we exclude it claiming that, as we could observe previously (section 2.1.2.), the expected evolution of the obsolete underlying /ə/ is to end up becoming /ɛ/, and for that reason, we treat it the same way as if it would be /ɛ/, resulting of the complete process of natural evolution. Third, we assume that the underlying schwa is not the same vowel as the schwa resulting from the process of reduction (which was also claimed by Oostendrop (1998) for Dutch). On one hand, the first one is a full vowel with all its features like the rest of the vowels and it can occupy a prominent position in the word, in this case the stressed syllable; on the other hand, the second schwa is a featureless vowel that cannot occupy a prominent position and it can only be found in unstressed positions (Oostendorp 1995, 1998, 2000; Crosswhite 2001; Eychenne 2014; Oostendorp, Ewen, Hume & Rice 2011; Barnes 2006; Parker 2011; Flemming 2010, among many others).

Finally, we present the constraints we use for our analysis. As we claimed before, we follow Crosswhite's analysis and that means we utilize some of the constraints from her method. First, we apply three Faithful constraints: ID[high], which penalized the change of the feature [high] between input and output; ID[high,low], which penalizes changes in the value of the features [high] or [low] in an input-output relation, for example in the case of /a/ reducing to [e] it would be violated once as the feature [low] changes from [+low] to [-low], but if /a/ would reduce to [i] it would be violated twice as both are modified: [+low] becomes [-low] and [-high] becomes [+high]; and ID[high,low,ATR], which penalizes the modification of the value of the three features [high], [low] or [ATR]. Next, two Licensing constraints: Lic-Nonperiphery, which bans the non-peripheral vowels [ɛ, e, ɔ, o, ə], and Lic[MidLax], which bans the two mid-lax vowels [ɛ] and [ɔ] in non-Licensing positions, in this case unstressed syllables. Finally, three Markedness constraints: *Unstressed/-high, which prohibits the vowels with sonority greater than [i] and [u], in this case [a, ɛ, e, ɔ, o], in unstressed positions (note that as Crosswhite (1999: 139) remarks, [ə] is not more sonorous than [i] and [u], so this constraint is not going to be violated by schwa); *Unstressed/low, which prohibits low vowels in unstressed positions, here [a] (both "*Unstressed/X" constraints are taken from Crosswhite 1999, 2001); and NoSchwa which will go against the featureless schwa.

As a summary we compilate the inputs and candidates (13) on one hand, and the constraints and penalizations (14) on the other, right below:

(13) Inputs and Candidates

Input	Candidates	Input	Candidates
/a/	[a], [ɛ], [e], [ə], [i]	/i/	[a], [ɛ], [e], [ə], [i]
/ɛ/	[a], [ɛ], [e], [ə], [i]	/ɔ/	[ɔ], [o], [u]
/e/	[a], [ɛ], [e], [ə], [i]	/o/	[ɔ], [o], [u]
/ə/	[a], [ɛ], [e], [ə], [i]	/u/	[ɔ], [o], [u]

(14) Constraints and penalizations

Constraint	Penalization	Constraint	Penalization
ID[high]	≠ [high]	*Unstressed/-high	*a, ɛ, e, ɔ, o
ID[high,low]	≠ [high] or [low]	*Unstressed/low	*a
ID[high,low,ATR]	≠ [high] or [low] or [ATR]	NoSchwa	*ə
Lic-Nonperiph	*ɛ, e, ɔ, o, ə	Lic[MidLax]	*ɛ ɔ

3.2. Factorial Typology and Elementary Ranking Conditions

Once we have all inputs, candidates and constraints defined and clarified, we develop our OT analysis, for that we use of the program OTWorkplace (Prince, Tesar & Merchant 2018). This program is made of an Excel page and it permits us, once the inputs, outputs and constraints are introduced, to realize an automatic OT analysis and a factorial typology. As we do so, we can see that the program realizes a total of 33 languages (in this case, Catalan varieties) in the factorial typology. We illustrate below the violation tableau with inputs, outputs and constraints (15), and the factorial typology resulting from it (16).

(15) Violation tableau

Cat_vr	VT.ini					*E,e,O,o,s	*a,E,e,O,o	*E,O	*a	*x
input	output	opt	ID[high]	ID[high,low]	ID[high,low,ATR]	Lic-Nonperiph	*Unstressed/-high	Lic[MidLax]	*Unstressed/low	NoSchwa
a	a		0	0	0	0	1	0	1	0
	E		0	1	1	1	1	1	0	0
	e		0	1	1	1	1	0	0	0
	x		0	0	0	0	0	0	0	1
	i		1	2	2	0	0	0	0	0
E	a		0	1	1	0	1	0	1	0
	E		0	0	0	1	1	1	0	0
	e		0	0	1	1	1	0	0	0
	x		0	0	0	0	0	0	0	1
	i		1	1	2	0	0	0	0	0
e	a		0	1	1	0	1	0	1	0
	E		0	0	1	1	1	1	0	0
	e		0	0	0	1	1	0	0	0
	x		0	0	0	0	0	0	0	1
	i		1	1	1	0	0	0	0	0
s	a		0	1	1	0	1	0	1	0
	E		0	0	0	1	1	1	0	0
	e		0	0	0	1	1	0	0	0
	s		0	0	0	1	0	0	0	0
	i		1	1	1	0	0	0	0	0
i	a		1	2	2	0	1	0	1	0
	E		1	1	2	1	1	1	0	0
	e		1	1	1	1	1	0	0	0
	x		0	0	0	0	0	0	0	1
	i		0	0	0	0	0	0	0	0
O	O		0	0	0	1	1	1	0	0
	o		0	0	1	1	1	0	0	0
	u		1	1	2	0	0	0	0	0
o	O		0	0	1	1	1	1	0	0
	o		0	0	0	1	1	0	0	0
	u		1	1	1	0	0	0	0	0
u	O		1	1	2	1	1	1	0	0
	o		1	1	1	1	1	0	0	0
	u		0	0	0	0	0	0	0	0

While observing the violation tableau and the factorial typology, the reader can notice that regarding the notation system, OTWorkplace does not understand IPA symbols, so we replaced the symbols of 'ɛ' and 'ɔ' to 'E' and 'O', respectively. In addition, as we claim that schwa as underlying vowel is different than the schwa resulting from the process of vowel reduction, we notated the full-vowel schwa as 's', found in the Majorcan variety, and the featureless schwa from the outputs of the other varieties as 'x'.

(16) Factorial typology

Cat_vr	FacTyp							
Inputs->	a	E	e	s	i	O	o	u
L1	a	a	a	a	i	O	o	u
L2	a	a	a	a	i	o	o	u
L3	a	a	a	a	i	u	u	u
L4	a	a	a	s	i	O	o	u
L5	a	a	a	s	i	o	o	u
L6	a	a	e	s	i	o	o	u
L7	a	a	i	i	i	u	u	u
L8	a	E	e	s	i	O	o	u
L9	a	e	e	s	i	o	o	u
L10	a	x	e	s	i	O	o	u
L11	a	x	e	s	i	o	o	u
L12	a	x	x	a	i	O	o	u
L13	a	x	x	a	i	o	o	u
L14	a	x	x	a	i	u	u	u
L15	a	x	x	s	i	O	o	u
L16	a	x	x	s	i	o	o	u
L17	a	x	x	i	i	u	u	u
L18	a	i	i	i	i	u	u	u
L19	e	E	e	s	i	O	o	u
L20	e	e	e	s	i	o	o	u
L21	x	E	e	s	i	O	o	u
L22	x	e	e	s	i	o	o	u
L23	x	x	e	s	i	O	o	u
L24	x	x	e	s	i	o	o	u
L25	x	x	x	a	i	O	o	u
L26	x	x	x	a	i	o	o	u
L27	x	x	x	a	i	u	u	u
L28	x	x	x	s	i	O	o	u
L29	x	x	x	s	i	o	o	u
L30	x	x	x	s	i	u	u	u
L31	x	x	x	i	i	u	u	u
L32	i	i	i	s	i	u	u	u
L33	i	i	i	i	i	u	u	u

If we realize a first approach to the factorial typology, we are able to observe the five main varieties of Catalan and a Faithful one, theoretically predicted here. The Faithful variety corresponds to language 8 (L8, in the typology), while the different varieties can be observed in L3 (Algherese), L9 (North-Western & Valencian), L29 (Majorcan) and L30 (Central and Northern). We will focus in the transitional varieties later in this section,

as they need more precise details of variation. Before continuing, if we pay attention to both /i/-[i] and /u/-[u] maps in all the languages we can appreciate that they are universally bounded, that means that regardless the order of the constraints, those two candidates are always going to be the optimal ones for those two respective inputs. The same case happens to be in the Majorcan variety for the map /s/-[s], as in all cases, the optimal output for the input /s/ is going to be [s] over the rest of the candidates.

Another useful tool that OTWorkplace facilitates us, is to be able to see the detailed information of each language. For that it shows us the ERCs for each language and the corresponding diagrams. As we observe the ERC equivalent to the five varieties, we can appreciate all the different rankings that each variety has.

3.2.1. Faithful variety

To start with, we illustrate the ERC tableau from OTWorkplace corresponding to L8, the Faithful variety:

(17) Faithful, L8 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low
1.1>5	a	a	i	W	W	W			L		L
4.4>5	s	s	i	W	W	W		L			
3.3>5	e	e	i	W	W	W		L	L		
7.2>3	o	o	u	W	W	W		L	L		
2.2>5	E	E	i	W	W	W		L	L	L	
6.1>3	O	O	u	W	W	W		L	L	L	
1.1>3	a	a	e		W	W		W			L
4.4>1	s	s	a		W	W		L	W		W
3.3>1	e	e	a		W	W		L			W
2.2>1	E	E	a		W	W		L		L	W
2.2>3	E	E	e			W				L	
6.1>2	O	O	o			W				L	
1.1>4	a	a	x				W		L		L
3.3>4	e	e	x				W	L	L		
2.2>4	E	E	x				W	L	L	L	

Here we can observe that, the ranking for the Faithful variety looks like: ID[high], ID[high,low], ID[high,low,ATR], NoSchwa >> Lic-Nonperiph, *Unstressed/-high, Lic[MidLax], *Unstressed/low. So, first, the high-ranked constraints are the Faithful ones, followed by the NoSchwa constraint. Those four constraints are the ones that let us obtain the Faithful result in the typology, as Faithfulness wants to preserve the output as it is presented in the input. The rest of the constraints, the lower-ranked, are the ones that

penalize the appearance of different vowels in the output, the Licensing and the Markedness constraints. So, the result for this variety is going to be the following one: /a/-[a], /ɛ/-[ɛ], /e/-[e], /ə/-[ə], /i/-[i], /ɔ/-[ɔ], /o/-[o] and /u/-[u].

3.2.2. Main varieties

Now, we present and describe the five main varieties of Catalan (note that we explain and illustrate just four ERCs as long as the Central and Northern varieties behave the same way, so they will be grouped together in the same ERC).

First, we start by describing the Algherese variety, corresponding to L3 in the factorial typology:

(18) Algherese, L3 ERC

WL Pairs												
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	8:NoSchwa	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low
2.1>2	E	a	E	W	W			L	L		L
6.3>1	O	u	O	W	W		L	L	L	W	
1.1>3	a	a	e	W				W	W		L
2.1>3	E	a	e	W				L			L
3.1>3	e	a	e	W				L	L		L
4.1>4	s	a	s	W				L	L	L	L
6.3>2	O	u	o	W			L	L	L	W	
7.3>2	o	u	o	W			L	L	L	W	
1.1>4	a	a	x			W				L	L
2.1>4	E	a	x			W		L	L	L	L
3.1>4	e	a	x			W		L	L	L	L
1.1>5	a	a	i				W	W	W	L	L
2.1>5	E	a	i				W		W	L	L
3.1>5	e	a	i				W			L	L
4.1>5	s	a	i				W			L	L

The ranking for the Algherese variety looks the following way: first, the two Licensing constraints followed by the NoSchwa prohibition, in a second level of the ranking, we find the Faithfulness constraints and, finally, the lowest ranked ones would be the two remaining Markedness constraints, *Unstressed/-high and *Unstressed/low. The result for this variety, then, is that /ɛ/ and /e/ reduce by lowering to [a], and /ɔ/ and /o/ reduce by raising to [u] because non-peripheral and lax-mid vowels are banned, and they do not reduce to schwa as the NoSchwa constraint is ranked in a high position. Finally, front vowels do not rise to [i] the same way back vowels do, because the constraints that ban the modification of the [high] feature, the Faithful constraints, are ranked higher than the one than ban the lowering to [a], *Unstressed/low.

In second place, we talk about the North-Western & Valencian variety, which corresponds to L9 in the factorial typology:

(19) North-Western & Valencian, L9 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	8:NoSchwa	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W	W			W		L	L
4.4>5	s	s	i	W	W			W	L		
2.3>5	E	e	i	W	W			W	L	L	
3.3>5	e	e	i	W	W			W	L	L	
6.2>3	O	o	u	W	W			W	L	L	
7.2>3	o	o	u	W	W			W	L	L	
1.1>3	a	a	e		W			W	W		L
4.4>1	s	s	a		W			W	L	W	W
3.3>1	e	e	a		W			W	L		W
2.3>1	E	e	a		W				L		W
2.3>2	E	e	E			W		L			
6.2>1	O	o	O			W		L			
1.1>4	a	a	x				W			L	L
3.3>4	e	e	x				W		L	L	
2.3>4	E	e	x				W	L	L	L	

In this case the ranking for this variety is, first, two of the Faithfulness constraints, ID[high] and ID[high,low], which prohibits the reduction process to follow a rising in the case of the front vowels, as say, front vowels will not become [i]; next, the Licensing constraint Lic[MidLax] bans the appearance of those mid laxed vowels, so /ɛ/ and /ɔ/ reduce to [e] and [o] respectively; it follows the NoSchwa constraint, as in this variety none of the vowels reduce to schwa. As we go low in the ranking, we encounter the ID[high,low,ATR] constraint, which needs to be lower ranked as the change of ATR is present in the mid vowels. Finally, the last ranked constraints are the second Licensing and the other two Markedness ones, which maintain the peripheral character of [a], but at the same time it avoids the lowering of the front vowels to [a]. The result of this variety is the reduction of /ɛ/ to [e] and /ɔ/ to [o].

Third, we pay attention to the Central and Northern varieties, L30 in the factorial typology:

(20) Central and Northern, L30 ERC

WL Pairs											
ERC#	Input	Winner	Loser	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	8:NoSchwa
2.4>2	E	x	E	W	W					W	L
6.3>1	O	u	O	W	W		L	L	L	W	
2.4>1	E	x	a	W		W		W	W		L
3.4>1	e	x	a	W		W		W	W		L
4.4>1	s	s	a	W		W		W	W	L	
1.4>1	a	x	a	W		W					L
1.4>3	a	x	e	W				W	W	W	L
2.4>3	E	x	e	W					W	W	L
3.4>3	e	x	e	W						W	L
6.3>2	O	u	o	W			L	L	L	W	
7.3>2	o	u	o	W			L	L	L	W	
1.4>5	a	x	i				W	W	W		L
2.4>5	E	x	i				W	W	W		L
3.4>5	e	x	i				W	W	W		L
4.4>5	s	s	i				W	W	W	L	

The ranking shown in this varieties is, first, two Markedness constraints and a Licensing one. *Unstressed/-high prohibits everything with sonority greater than /i/, /u/ and /ə/, Lic[MidLax] bans mid lax vowels (not applicable for the Northern variety, as it does not make any distinction between mid-vowels), and *Unstressed/low avoids outputs to lower to [a] in the case of the front vowels. Next, we encounter the Faithfulness constraints, which avoids the front vowels to raise to [i], and finally, the second Licensing constraint, Lic-Nonperiph, and the last Markedness constraint, NoSchwa, cause almost everything to reduce to schwa. The result of the reduction process, then, is in both varieties reduction of /a/ and /e/ to schwa by becoming featureless, and reduction of /o/ to [u] by raising. In addition, in the case of the Central variety, /ɛ/ and /ɔ/ reduce to schwa and [u], respectively.

Fourth, and the last variety of this first approach, the Majorcan variety, L29 in the factorial typology:

(21) Majorcan, L29 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	7:*Unstressed/low	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high	8:NoSchwa
1.4>5	a	x	i	W	W			W			L
2.4>5	E	x	i	W	W			W			L
3.4>5	e	x	i	W	W			W			L
4.4>5	s	s	i	W	W			W	L		
6.2>3	O	o	u	W	W			W	L	L	
7.2>3	o	o	u	W	W			W	L	L	
2.4>1	E	x	a		W		W	W		W	L
3.4>1	e	x	a		W		W	W		W	L
4.4>1	s	s	a		W		W	W	L	W	
1.4>3	a	x	e		W			W	W	W	L
2.4>2	E	x	E			W			W	W	L
6.2>1	O	o	O			W		L			
1.4>1	a	x	a				W			W	L
2.4>3	E	x	e					W	W	W	L
3.4>3	e	x	e						W	W	L

Before we start the analysis, we need to remember that this variety is the only one that presents contrastive schwa (/s/ in the OTWorplace notation). In this case, we can appreciate higher ranked two of the Faithfulness constraint, ID[high] and ID[high,low], which ban all vowels to rise to [i] or [u], or front vowels to lower to [a]; next, the Licensing constraint Lic[MidLax] falls against maintaining the mid laxed vowels and the Markedness constraint, *Unstressed/low, supports the prohibition of lowering the front vowels to [a]. In a second row of the ranking, we can find the last Faithful constraint, ID[high,low,ATR], the second Licensing, Lic-Nonperiph, and a second Markedness constraint, *Unstressed/-high. Those constraints facilitate reduction to schwa in the case of the front vowels. Finally, the lowest ranked constraint is NoSchwa, as in this variety we can find reduction to schwa. The result of the reduction process in this variety, then, will be reduction of /a/, /ɛ/ and /e/ to the featureless schwa (while the underlying schwa stays intact as a full vowel) and reduction of /ɔ/ to [o].

3.2.3. Transitional varieties

Once we observed the different ERCs for the first set of varieties, the *main* ones, we focus now our attention to the different transitional area. In this case, the languages representing each variety in the factorial typology are not as simple as in the previous varieties, where

one single language was equivalent for one variety. The interesting fact of the transitional varieties is that they present variation in how they apply vowel reduction. That is the reason why different and several languages from the factorial typology represent the same transitional variety. In this case, we present the three transitional varieties and we point out the different ERCs that can result in that variety (sometimes the same language from the factorial typology corresponds to more than one transitional area, as they sometimes share the reduction pattern too). For an easy comprehension, then, we group the common results among the different transitional varieties, so, if, for example, the Central-Septentrional and the Tortosan varieties present same patterns of reduction (like it is the case of reduction of /e/ to [a], which is not present in the Tarragonian variety) we illustrate them together with the same languages and ERCs from the typology. The grouping we realize for the transitional areas is as follows: First, the three varieties together, Central-Septentrional, Tarragonian and Tortosan, as the three present same reduction processes; and secondly, groups of two varieties, Central-Septentrional and Tarragonian, Central-Septentrional and Tortosan, and Tarragonian and Tortosan, as long as two varieties also present same reduction patterns.

For the first group, compound by the three transitional varieties (Central-Septentrional, Tarragonian and Tortosan) we find that we can correlate the three varieties with several languages from the factorial typology: L1, L2, L4, L5, L6, L21, L22, L23 and L24 (see Appendix, Images 4-12 for the ERCs).

As we pointed out previously, if we exclude the varieties with contrastive schwa claiming that they behave like /ɛ/, we can appreciate that languages L1 and L2 are equivalent with L4 and L5, respectively. In that case, L1 and L4, and L2 and L5 will remain the same and, even if we did not exclude the schwa from this varieties, we could claim that this could be the case of indirectly attested varieties, like Crosswhite (1999) claims for some of her results) due to the feature proximity between the realization of /s/ like both [a] and [ə].

Now, if we pay attention to the analysis, OTWorkplace permits us to join several ERCs from the languages to get the information in the same ERC. If we do that, we can appreciate that in the case of these languages we are taking in account now, the common ranking of constraints is to have Lic-Nonperiph and *Unstressed/-high the lowest ranked of all the constraints.

(22) Joined L1, L2, L4, L5, L6, L21, L22, L23, L24 ERCs

SKB of Join								
JOIN	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high
jnERC.1	W					W	L	
jnERC.2	W			W	W		L	L
jnERC.3	W		W		W		L	L
jnERC.4	W	W	W				L	L
jnERC.5						W		L

Finally, is we observe the different results in the factorial typology, we can appreciate that each language lets us identify different variation processes in each variety. Starting with L1 and L4 we can observe how all the front non-high vowels reduce by lowering to [a], while /i/ is maintained like [i], and the same case happens to be for L2 and L5, as all those three varieties permit reduction by lowering of /a/, /ɛ/ and /e/ to [a]. The difference recalls in the reduction of the back vowels. In the case of L1 and L4, there is no reduction in the case of /ɔ/ and /o/, and in L2 and L5 /ɔ/ reduces to [o]. Both combinations are possible in this varieties as, like we saw in the previous section (section 2.2.2.), it is completely possible to just have reduction in some parts of the vocalic schema, this is one of the basic definitions we saw for transitional areas; secondly, in the case of presenting reduction, we could observe how all transitional areas can reduce /ɔ/ to either [o] or [u], being in this case to [o], but this is the same phenomenon present in the varieties L21 and L23, and L22 and L24, where they can either not reduce, like in the first pair, or reduce to [o], like in the second pair. So, if we pay attention at the reduction processes of the languages L21, L22, L23 and L24, we can appreciate that all of them present reduction of /a/ to [ə], while /e/ maintains its same underlying characterization as [e]. The case of L22 presents too reduction of /ɛ/ to [e], while in L21 /ɛ/ is maintained without suffering neutralization. Finally, as we can observe with /ɔ/ not reducing, the case of /ɛ/ not reducing can be explained by the same criteria; vowel reduction in transition areas is not always unified.

The second group we describe now is the one composed by Central-Septentrional and Tarragonian. We can find the following varieties in the factorial typology that represent those two dialects: L12, L13, L14, L15, L16, L17, L25, L26, L27, L28 and L31 (see Appendix, Images 13-23, for the ERCs).

Again, if we exclude the results for the contrastive schwa, we can observe some equivalent pairs of language varieties. L12 is equivalent to L15, L13 is to L16, and L14

is equivalent to L17; and in the second group of languages, we can appreciate that the languages L25 and L28 are equivalent, L26 can be equivalent to the main variety L29 (for Majorcan), and L28 and L31 can be equivalent to the main variety L30 (for Central and Northern Catalan).

This time, if we join again the selected languages, we can observe how OTWorkplace gives us as a result NoSchwa as the lowest ranked constraint.

(23) Joined L12, L13, L14, L15, L16, L17, L25, L26, L27, L28, L31 ERCs

SKB of Join								
JOIN	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa
jnERC.1	W	W	W					L
jnERC.2		W	W		W		W	L
jnERC.3				W	W			L

Next, if we observe the results we obtained, we can appreciate alternation between the reduction or non-reduction of /ɔ/ and /o/. First, we can observe that reduction is not present in neither of both vowels in the languages L12, L15, L25 and L28; reduction of only /ɔ/ to [o] in the languages L13, L16 and L26; and total reduction of both /ɔ/ and /o/ to [u] in the languages L14, L17, L27 and L31. Secondly, in the case of the front vowels, we can observe than from L12 to L17, all varieties preserve /a/ as [a], so there is no reduction process ongoing in the low vowel, while in the case of the mid vowels, we can observe that both /ɛ/ and /e/ reduce to schwa; next, in the varieties from L25 to L28 and L31, all non-high front vowels reduce to schwa, while /i/ remains unreduced. In this case, the Tortosan variety is excluded from those languages because it is impossible to find reduction of /e/ to schwa, that is why these languages just pertain to the Central-Septentrional and Tarragonian varieties.

The third group of varieties we analyse is the one formed by the Central-Septentrional and Tortosan variety, divided in the factorial typology by the languages L18, L32 and L33 (see Appendix, Images 24-26 for the ERCs).

In this case, if we exclude the result for the underlying schwa, we can observe that both L32 and L33 can be equivalent. In addition, if we join the languages in OTWorkplace, we can observe that the lowest ranked constraints are the Faithful ones.

(24) Joined L18, L32, L33 ERCs

SKB of Join								
JOIN	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]
jnERC.1	W	W				L	L	L
jnERC.2		W		W		L		L
jnERC.3					W	L	L	L

Here, if we observe the results we got from the analysis in OTWorkplace, we can appreciate that in all the languages or varieties the reduction of the back vowels is the same, both /ɔ/ and /o/ reduce to [u]; next, in the case of the non-high front vowels we can observe that reduction is not present in /a/, which is maintained like [a] in L18, while in the case of the other front vowels of this variety, and in the other two languages too (L32 and L33), all vowels reduce by raising to [i], and, of course, /i/ is maintained as [i]. This alternation of the non-high vowels with [i] is only present in the Central-Septentrional and Tortosan variety, that is the reason that the Tarragonian variety is excluded from this group.

The fourth group we want to detail is the one for the Tarragonian and Tortosan dialects, found in the factorial typology in L19 and L20 (see Appendix, Images 27-28 for the ERCs).

If we join the languages with OTWorkplace, we can observe that Lic-Nonperiph and *Unstressed/-high are the lowest ranked and that means we can establish the function {Lic/Nonperiph,*Unstressed/-high}.sub for these two varieties. In addition, though, we can observe how ID[high,low] and ID[high,low,ATR] are ranked lower in two of the joined ERCs (jn.ERC.2 and jn.ERC.3) while in the first one (jn.ERC.1), the Faithfulness constraints should be ranked higher.

(25) Joined L19, L20 ERCs

SKB of Join								
JOIN	1:ID[high]	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high
jnERC.1	W				W	W	L	L
jnERC.2			W		L	L	L	
jnERC.3				W	L	L	L	L

This time, we can appreciate that the back vowels can either not reduce (in L19) or just /ɔ/ reduces to [o] (L20). In the case of the front vowels, we can observe that either all reduce to [e], and /e/ stays the same too (in L20), or a partially reduction in the case of /a/ to [e], while /ɛ/ and /e/ stay unreduced (in L19). In this case, the distinct characterization of these two languages of the Tarragonian and Tortosan variety is because they admit for /a/ to reduce to [e], while that is not possible for the Central-Transitional variety.

Finally, we want to remark three residual languages that remain unattested in the factorial typology: L7, L10 and L11 (see Appendix, Images 29-31 for the ERCs).

Those languages are unattested in none of the varieties of Catalan because we have no data of reduction of /ɛ/ to [a] and /e/ to [i] simultaneously, like we can observe in L7, and we do not have any attested data for only reduction of the mid vowel /ɛ/ to schwa, while all the other front vowels maintain their unreduced nature, which we can appreciate in both L10 and L11. Even though, if we join the varieties, we can appreciate that all of them follow the same ranking when talking about the lowest constraints. All of them rank lower the Markedness constraints *Unstressed/-high and Unstressed/low.

(26) Joined L7, L10, L11 ERCs

SKB of Join								
JOIN	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	6:Lic[MidLax]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
jnERC.1			W				L	L
jnERC.2				W	W		L	L
jnERC.3						W	L	L

This can show us that, even though we do not have them attested in our varieties of the Catalan system, they could, maybe, be present in other languages aside from Catalan, or in varieties not studied yet or for which we do not have the data.

To finish with, if we compare now our results with the attested patterns from Crosswhite (1999, 2001) we can observe that there is correlation with our variations and the ones Crosswhite observes. For our Faithful pattern, we can observe her output pattern #44, which she describes as common (Crosswhite 1999: 321). In the case of the main varieties, for Central Catalan she obtains the output pattern #148 (Crosswhite 1999: 329), for the North-Western & Valencian variety, she obtains the output pattern #47, for her, also the same as the Standard Italian variety (Crosswhite 1999: 321), she also obtains the

Algherese variety in the output pattern #117 (Crosswhite 1999: 327), the Northern Catalan in the output pattern #19 (Crosswhite 1999: 296) and the Majorcan variety which corresponds to her output pattern #104 (Crosswhite 1999: 326). Finally, we want also to comment that she points out another kind of pattern for the Balear variety as a different one from Central Catalan and Majorcan, the output pattern for which is her #103 and the difference between it and the previous one, Majorcan, and with the Central Catalan is that back vowels /ɔ/ and /o/ do not suffer from any kind of vowel reduction (Crosswhite 1999: 326). Even though we did not find evidence for this Balear variety and we do not take it in account for our analysis, we can claim out that our factorial typology also gives evidence of it in the language that corresponds to L28.

In the case of the transitional varieties we can observe that languages L1 and L4 are attested in output pattern #87, which is the same as the Russian e-reduction (#22) and the Balear (in #103) (Crosswhite 1999: 324); for L2 and L5 we can observe the pattern #88, which she also equivales it to the pattern #104 for Majorcan (Crosswhite 1999: 324). The variety that corresponds to L6 can be seen in her pattern #48 for Trigrad, and also related to #161 for Bulgarian (Crosswhite 1999: 321). Next, the varieties L13 and L16 are attested in #100 which directly corresponds to #98 (#100 is an indirect attested pattern because of the existence of #98) and at the same time, #98 (which correspond to Sadzhava Ukranian) is attested in languages L12 and L15 (Crosswhite 1999: 325); L14 and L17 correspond to the unattested pattern #144 (Crosswhite 1999: 329); and L18 is observed in #122 which corresponds to Neapolitan Italian (Crosswhite 1999: 327). Surprisingly, our varieties L19 and L20 are not even illustrated in Crosswhite's work, in none of the patterns described by Crosswhite we can observe a reduction process that goes from /a/ to [e], which we find in these two of our varieties. Languages L21, L23, L22 and L24 correspond to the patterns #56 (which she describes as questionable even though it is quite common but under-reported), #57 (equivalent to Russian e-reduction from #22), #58 (equivalent to Standard Italian from #47) and #59 (equivalent to Majorcan in #109) respectively (Crosswhite 1999: 322). We can continue with the varieties corresponding to L25 and L28, which can be observed in pattern #103 for Balear Catalan, L26 which corresponds to #104 for Majorcan Catalan, and varieties L27 and L31 correspond to #148 for Central Catalan (Crosswhite 1999: 326, 329). Next, the last varieties we can observe in our typology, L32 and L33, can be observed in Crosswhite's work as unattested patterns, which correspond to #132 (Crosswhite 1999: 328). To finish with, we would

like to observe our unattested Catalan varieties to prove if they can exist in other languages or are for real unattested. Varieties L7 and L11 correspond to the unattested patterns #123 and #49 respectively; while L10 corresponds to the pattern #46 for Pavlikianski (Crosswhite 1999: 327, 321).

If we compilate the differences in the data we could observe, the inexistent patterns for Crosswhite and our attested ones (L19 and L20), we can find a gap of a process of reduction, maybe because Crosswhite did not take in consideration the possibility of reduction from /a/ to [e], which we can appreciate in the Tarragonian and Tortosan varieties. In the case of her unattested patterns and our attested varieties (L14 and L17) we could defend that probably microvariation offers more degree of divergence between patterns that standard languages or main varieties and taking a deeper look at sub-varieties we can appreciate other patterns of variation, like is the case of these languages corresponding to Central-Septentrional and Tarragonian varieties. In the other way around, attested patterns for her but unattested for us, the possibility is, as sounds logical, that Catalan does not follow all existing vocalic patterns which can be present in other languages, that is the reason why we can find attested patterns in some languages that are not attested in Catalan. Finally, in the case of unattested patterns for both of us and Crosswhite, we could claim that are patterns that can possibly exist, perhaps in small varieties or in sub-varieties from which we do not have data yet because they are not still studied.

3.3. Property Analysis

Now that we have illustrated all ERC's, we can proceed to the property analysis. As we are taking in account variation and microvariation, we have all different kinds of variation among properties too. The main division we do for now is going to be between the faithfulness constraints. We have seen that we work with three types of faithfulness constraints, ID[high], ID[high,low] and ID[high,low,ATR], and, as we can observe they are subdivisions of the a bigger one in the sense that, where we have ID[high,low,ATR] we are always going to find the other two, where we have ID[high,low] we are going to find ID[high] too, but not necessary ID[high,low,ATR], and where we find ID[high] it is not necessary at all that we can observe the other two constraints. For that reason, we start dividing the properties in those that select the three faithfulness constraints, the ones that

select two and the ones that just select one. Also, we must note that property 1 needs to work also with the markedness constraint NoSchwa. In that way, property 1 is ID[high,low,ATR]&NoSchwa <> Markedness; property 2 is ID[high,low] <> Markedness, and property 3 is ID[high] <> Markedness. The markedness properties we use correlate with the constraints we saw previously this section but we state them in property format: Lic-Nonperiph is m.*P, Lic[MidLax] is m.*M, *Unstressed/low and *Unstressed/-high are represented like m.*L and m.*-H respectively, and, finally, NoSchwa looks like m.*S. Next, we divide each property in its own sub-properties to be able to account for the micro variation.

3.3.1. Property 1

As we presented before, property 1 looks like (27):

(27) P1: {f.IdHLA, m.*S}.sub <> {m.*P, m.*M, m.*L, m.*-H}

a. {f.IdHLA, m.*S}.sub > {m.*P, m.*M, m.*L, m.*-H}

b. {m.*P, m.*M, m.*L, m.*-H} > {f.IdHLA, m.*S}.sub

This property is wide scope, that means that all faithfulness constraint and NoSchwa always outrank all the rest of the markedness ones. In addition, the constraint NoSchwa needs to be always outranking the rest of the markedness constraint. If one of the other markedness constraints outranks NoSchwa, we have, then, an unfaithful variety (value b). This permits us distinguish between the properties that not neutralize from the ones that neutralize, that is L8 (P1a) from the other languages (P1b).

As P1a is already finished, being the faithful variety, we need now to pay attention to the micro-variation among the varieties that present reduction, P1b. For that, the next micro-step needs to be now, the faithfulness constraints against the markedness constraints. That is P1|2 in (28):

(28) P1|2: f.IdHLA <> {m.*P, m.*M, m.*L, m.*-H, m.*S}

a. f.IdHLA > {m.*P,M,L,-H,S}

b. {m.*P,M,L,-H,S} > f.IdHLA

Now, we can observe and compare other varieties with ID[high,low,ATR] higher ranked than the markedness constraints. The difference, though, is in the ranking of the markedness constraints among themselves, as NoSchwa is not outranking all the other markedness ones. That resultes in the first step of microvariation. If value a, we observe L10, L15, L21, L23 and L28, which present minimal variation from the faithful one, as they maintain all, or mostly all, ATR values invariable but present other kinds of variation. If value b, we observe the varieties where at least one of the markedness constraint outranks all the faithfulness ones.

If we pay attention first to the micro-variation under value a, we can appreciate variation only in the markedness constraints, presented in property P1|2|1 under the value a of P1|2a, as all faithfulness constraints still outrank the markedness ones, illustrated in (29):

(29) P1|2|1: m.*L <> {m.*P, m.*M, m.*-H, m.*S}

a. m.*L > {m.*P,M,-H,S}

b. {m.*P,M,-H,S} > m.*L

Here the markedness constraint *Unstressed/low needs to be either the highest ranked, if value a, or the lowest ranked, if value b, of the markedness constraints. The corresponding languages to the result P1|2|1a are L21, L23 and L28, as the three of them ranked *Unstressed/low the highest one, that means that the outputs do not present a low vowels; while P1|2|1b corresponds to languages L10 and L15, as it is the lowest one, we can appreciate the appearance of low vowels in the output. The next micro-step now is the one about the respective ranking between NoSchwa and the two Licensing constraints under the dominance of *Unstressed/low (value a), P1|2|1|1 is illustrated that in (30):

(30) P1|2|1|1: {m.*P, m.*M} <> m.*S

a. {m.*P,M} > m.*S

b. m.*S > {m.*P,M}

In this case, if we pick value a, the result is language L28, where faithfulness constraints outrank the markedness ones (P1|2a), where *Unstressed/low is ranked the highest of the markedness (P1|2|1a) and where the Licensing constraints are both ranked higher than NoSchwa (P1|2|1|1a), that results in the presence of schwa in the outputs. If it happens to be value b, we can find languages L21 and L23, and, then, we need another micro-step. Here, we split the Licensing constraints to check which of both is ranked higher than NoSchwa. This is illustrated in P1|1|1|1|1 in (31):

(31) P1|1|1|1|1: m.*M <> m.*S

a. m.*M > m.*S

b. m.*S > m.*M

Here, if we observe the respective ranking of Lic[MidLax] against NoSchwa, we can appreciate that, is value a, where Lic[MidLax] is ranked higher than NoSchwa we obtain language L23, where schwa wins over mid-lax vowels; but if value b, where NoSchwa is ranked higher than Lic[MidLax], we obtain now language L21, where schwas are less present. Once we got to this step, as all possible languages for this property have been identified, we can close this leg of properties, which consisted in the structure of value a for P1|2.

Taking a look back to P1|2|1, we can observe that, with value b, the result was languages L10 and L15 with the constraint *Unstressed/low ranked the lowest. Now, again, if we compare the position of the Licensing constraint with the NoSchwa one, we can directly jump to the micro-step of the relative ranking of just Lic-Nonperiph and NoSchwa, as those two are the relevant ones for establishing a different re-ranking. This is illustrated in P1|2|1|2 in (32):

(32) P1|2|1|2: m.*P <> m.*S

a. m.*P > m.*S

b. m.*S > m.*P

In this case, if value a, we obtain language L15, where Lic-Nonperiph is ranked higher than NoSchwa, which lets us observe the presence of schwas in the output; while if we pick value b, we will obtain language L10, as, in this time, NoSchwa is ranked higher than Lic-NonPeriph, and schwas are less present.

Before we continue with the other faithfulness groups, we want to make a summary of P1, with value a, and P1|2 with value a in (33) and (34) below.

(33) (Micro)variation P1 with value a

Property	Property values	Languages	Residual languages	Properties and values
P1: f.IdHLA <> {m.*P,M,L,-H,S}	P1a: f.IdHLA > {m.*P,M,L,-H,S}	L8		P1a

(34) (Micro)variation P1|2 with value a

Property	Property values	Languages	Residual languages	Properties and values
P1: f.IdHLA <> {m.*P,M,L,-H,S}	P1b: {m.*P,M,L,-H} > {f.IdHLA, m.*S}.sub		L3, L10, L14, L15, L21, L23, L27, L28, L30, L31, L32, L33	P1b
P1|2: f.IdHLA <> {m.*P,M,L,-H,S}	P1|2a: f.IdHLA > {m.*P,M,L,-H,S}		L10, L15, L21, L23, L28	P1b, P1|2a
	P1|2b: {m.*P,M,L,-H,S} > f.IdHLA		L3, L14, L27, L30, L31, L32, L33	P1b, P1|2b

P1|2|1: m.*L <> {m.*P,M,-H,S}	P1|2|1a: m.*L > {m.*P,M,-H,S}		L21, L23, L28	P1b, P1|2a, P1|2|1a
	P1|2|1b: m.*P,M,-H,S > m.*L		L10, L15	P1b, P1|2a, P1|2|1b
P1|2|1|2: m.*P <> m.*S	P1|2|1|2a: m.*P > m.*S	L15		P1b, P1|2a, P1|2|1b, P1|2|1|2a
	P1|2|1|2b: m.*S > m.*P	L10		P1b, P1|2a, P1|2|1b, P1|2|1|2b
P1|2|1|1: {m.*P,M} <> m.*S	P1|2|1|1a: {m.*P,M} > m.*S	L28		P1b, P1|2a, P1|2|1a, P1|2|1|1a
	P1|2|1|1b: m.*S > m.*P,M		L21, L23	P1b, P1|2a, P1|2|1a, P1|2|1|1b
P1|2|1|1|1: m.*M <> m.*S	P1|2|1|1|1a: m.*M > m.*S	L23		P1b, P1|2a, P1|2|1a, P1|2|1|1b, P1|2|1|1|1a
	P1|2|1|1|1b: m.*S > m.*M	L21		P1b, P1|2a, P1|2|1a, P1|2|1|1b, P1|2|1|1|1a

If we check now the value b of P1|2, we can appreciate some of the unfaithful varieties, like languages L3, L14, L27, L30, L31, L32 and L33. Let's remember P1|2 from (28) now here in (35):

(35) P1|2: f.IdHLA <> {m.*P, m.*M, m.*L, m.*-H, m.*S}

a. f.IdHLA > {m.*P,M,L,-H,S}

b. {m.*P,M,L,-H,S} > f.IdHLA

With value b, we can appreciate that in the case that all markedness constraints outrank all the faithfulness we can obtain language L33, the most marked one of the varieties. The microvariation, now, is established in which and how markedness constraints outrank the faithfulness ones. The first constraint to take in account now, is if whether NoSchwa is ranked higher or lower than the faithfulness ones. That is going to be P1|2|2 illustrated in (36):

(36) P1|2|2: m.*S <> f.IdHLA

a. m.*S > f.IdHLA

b. f.IdHLA > m.*S

If value a, NoSchwa outranks the faithfulness constraints, it givess us languages L3 and L32, where no schwas are present in the outputs. If value b, faithfulness are ranked higher than NoSchwa and that permits schwas in the output (L14, L27, L30, L31, L33). If we continue with the microvariation from value a, the following step we need to remark is if whether *Unstressed/low and *Unstressed/-high outrank or not the faithfulness, for that, we need P1|2|2|1, illustrated in (37):

(37) P1|2|2|1: {m.*L,-H} <> f.IdHLA

a. {m.*L,-H} > f.IdHLA

b. f.IdHLA > {m.*L,-H}

Here, we can appreciate that, if value a realizes, we obtain language L32, where NoSchwa outranks the faithfulness constraints (P1|2|2a), and, also *Unstressed/low and *Unstressed/-high outrank the faithfulness and NoSchwa (P1|2|2|1a), that results in a language with high vowels; while in L3, value b is chosen, as the faithfulness outranks *Unstressed/low and *Unstressed/-high (P1|2|2|1b) but not NoSchwa (P1|2|2a), that is the reason we do not find schwas in the output but we can observe low vowels in the front and high vowels in the back. If we remember, L3 corresponds to the Algherese main variety.

However, if value b is chosen in P1|2|2, faithfulness outranks NoSchwa (L14, L27, L30 and L31). Afterwards, we need to establish the microvariation for those languages, again in a parallel way, with the contrast between *Unstressed/low and *Unstressed/-high with the faithfulness constraints. In that way, P1|2|2|2 looks like P1|2|2|1, the difference is in the position of NoSchwa regarding the faithfulness constraint. So, if value a is chosen for P1|2|2|2 we obtain languages L30 and L31, meanwhile if value b, languages L14 and L27. In the case of the first ones, after value a, we need a new micro-step regarding faithfulness to distinguish between them, in this case, we re-rank Lic-Nonperiph over or above the faithfulness constraints. That is illustrated in (38) with P1|2|2|2|1:

(38) P1|2|2|2|1: m.*P <> f.IdHLA

a. m.*P > f.IdHLA

b. f.IdHLA > m.*P

Now, if we get value a, we obtain language L31, where Lic-Nonperiph is ranked higher than the faithfulness constraints, which bans non-peripheral vowels from the output; while if we pick value b, faithfulness is ranked higher than Lic-Nonperiph and, as a result, we get language L30, where schwa, in case we need to take it in account as underlying, maintains its nature. L30, as we can remember, is the main variety for Central and Northern Catalan.

However, if we pick value b for P1|2|2|2, we get, again faithfulness over markedness (languages L14 and L27). Here, now once more, the re-ranking needs to be done between markedness constraints. In this case, NoSchwa needs to be to re-rank over or above *Unstressed/low and *Unstressed/-high. This sub-property is P1|2|2|2|2 and we illustrate it in (39):

(39) P1|2|2|2|2: m.*S <> {m.*L,-H}

a. m.*S > {m.*L,-H}

b. {m.*L,-H} > m.*S

In this case, then, we can appreciate that, if NoSchwa is ranked higher than *Unstressed/low and *Unstressed/-high (value a) we obtain language L14, where there are no schwas in the output; but if it is the other way around, we obtain language L27 (value b), with schwas.

Below, we compilate and summarize the micro-steps for P1|2 with value b.

(40) (Micro)variation P1|2 with value b

Property	Property values	Languages	Residual languages	Properties and values
P1|2: f.IdHLA <> {m.*P,M,L,-H,S}	P1|2b: {m.*P,M,L,-H,S} > f.IdHLA	L33	L3, L14, L27, L30, L31, L32, L33	P1|2b
P1|2|2: m.*S <> f.IdHLA	P1|2|2a: m.*S > f.IdHLA		L3, L32	P1|2b, P1|2|2a
	P1|2|2b: f.IdHLA > m.*S		L14, L27, L30, L31	P1|2b, P1|2|2b
P1|2|2|1: {m.*L,-H} <> f.IdHLA	P1|2|2|1a: {m.*L,-H} > f.IdHLA	L32		P1|2b, P1|2|2a, P1|2|2|1a
	P1|2|2|1b: f.IdHLA > {m.*L,-H}	L3		P1|2b, P1|2|2a, P1|2|2|1a
P1|2|2|2: {m.*L,-H} <> f.IdHLA	P1|2|2|2a: {m.*L,-H} > f.IdHLA		L30, L31	P1|2b, P1|2|2b, P1|2|2|2a
	P1|2|2|2b: f.IdHLA > {m.*L,-H}		L14, L27	P1|2b, P1|2|2b, P1|2|2|2a
P1|2|2|2|1: m.*P <> f.IdHLA	P1|2|2|2|1a: m.*P > f.IdHLA	L31		P1|2b, P1|2|2b,

				P1|2|2|2a, P1|2|2|2|1a
	P1|2|2|2|1b: f.IdHLA > m.*P	L30		P1|2b, P1|2|2b, P1|2|2|2a, P1|2|2|2|1b
P1|2|2|2|2: m.*S <> {m.*L,-H}	P1|2|2|2|2a: m.*S > {m.*L,-H}	L14		P1|2b, P1|2|2b, P1|2|2|2a, P1|2|2|2|2a
	P1|2|2|2|2b: {m.*L,-H} > m.*S	L27		P1|2b, P1|2|2b, P1|2|2|2a, P1|2|2|2|2b

3.3.2. Property 2

Next, we pay attention to the second property. As we can appreciate, P2 is narrow scope, that means it just affects the languages that stayed out of P1 and not all markedness constraints outrank all the faithfulness ones. P2 is focuses on ID[high,low] and looks as follows:

(41) P2: f.IdHL <> {m.*P, m.*M, m.*L, m.*-H, m.*S}

a. f.IdHL > {m.*P,M,L,-H,S}

b. {m.*P,M,L,-H,S} > f.IdHL

If we pick value b, we can appreciate that none of our varieties follows this pattern, so it is dismissed. On the other hand, if we pick value a, we can appreciate several languages from the typology: L9, L11, L16, L22, L24 and L29. Continuing with that, we can appreciate minimal variation inside this group of languages, for that we need to pay attention to some more sub-properties. Next sub-property (P2|1) considers whether the

languages present or not schwa, for that we compare the rankings between the constraint NoSchwa ranked higher or lower than the faithfulness ones. In concrete, as we saw that the faithfulness constraints ID[high] and ID[high,low] are all ranked higher, we compare them with the faithfulness constraint that stayed out of the group, ID[high,low,ATR]. This is illustrated in (42):

(42) P2|1: f.IdHLA <> m.*S

a. f.IdHLA > m.*S

b. m.*S > f.IdHLA

If value a, we can appreciate languages where they do present minimal variation in appearance of schwa, like L11, L16, L24 and L29. While if value b, we can appreciate languages with no schwa at all or with a minimal presence of it, like languages L9 and L22. If we continue with the value a, we can appreciate, now, that the following micro-steps is regarding the position in the ranking of the markedness constraints. In P2|1|1 (43) we compare, again, the position of NoSchwa with some of the rest of the relevant markedness constraints, Lic-Nonperiph, *Unstressed/low and *Unstressed/-high:

(43) P2|1|1: m.*S <> {m.*P,L,-H}

a. m.*S > {m.*P,L,-H}

b. {m.*P,L,-H} > m.*S

Here, if the binary choice falls for value a, we find the languages L11, L16 and L24, while if it falls in the value b, we just encounter language L29, where the micro-variation of the constraints recalls in the lower ranking of NoSchwa, that is the reason why this language presents greater amount of schwa in the output. Also, we want to remark that this is the language of the Majorcan variety. On the other side, if we consider the languages in value a, we need to start making more detailed the position of schwa among the other markedness. For that we present in P2|1|1|1 (44) the comparison in the position of schwa only with the markedness constraint *Unstressed/low:

(44) P2|1|1|1: m.*S <> m.*L

a. m.*S > m.*L

b. m.*L > m.*S

In the case of value b, we can appreciate that the result is language L24 where low vowels are not permitted and, thus, we do not find [a] as an output. On the other hand, if we pick value a, we appreciate languages L11 and L16, where schwas are permitted. Next, we need another micro-step to differentiate between those two languages. In this case, continuing with the NoSchwa constraint, we evaluate its ranking with the other rmarkedness constraint, Lic-NonPeriph:

(45) P2|1|1|1|1: m.*S <> m.*P

a. m.*S > m.*P

b. m.*P > m.*S

In the first case, if value a is chosen, we obtain language L11, where non-peripheral vowels are banned from the output in favour of schwa, while if value b is resulting, we can appreciate that the outputs present more schwas than in the other languages, in this case, we obtain language L16.

To finish with, if we pick value b in P2|1, and continuing with a parallel analysis with which we have seen for value a, we need to re-rank the constraint NoSchwa with some other markedness constraints to be able to appreciate the micro-variation between languages L9 and L22. In this case the relevant markedness constraint is *Unstressed/low, illustrated in (46):

(46) P2|1|2: m.*S <> m.*L

a. m.*S > m.*L

b. m.*L > m.*S

The result of the evaluation of these constraints shows us, once more, the amount of possible schwas we can find in the output of the languages under evaluation. In the first case, if value a is chosen, we have NoSchwa in a higher position in the ranking, that is why the language resulting, L9 presents fewer schwas, none at all, in the output as its competitor with value b, language L22. As a reminder, we want like to say that L9 is the corresponding to the North-Western & Valencian variety.

Below, in (47), we present a summary of P2 -only with value a, as value b was dismissed with no languages:

(47) (Micro)variation P2 with value a

Property	Property values	Languages	Residual languages	Properties and values
P2: f.IdHL <> {m.*P,M,L,-H,S}	P2a: f.IdHL > {m.*P,M,L,-H,S}		L9, L11, L16, L22, L24, L29	P2a
P2|1: f.IdHL <> m.*S	P2|1a: f.IdHL > m.*S		L11, L16, L24, L29	P2a, P2|1a
	P2|1b: m.*S > f.IdHL		L9, L22	P2a, P2|1b
P|2|1|2: m.*S <> m.*L	P2|1|2a: m.*S > m.*L	L9		P2a, P2|1b, P2|1|2a
	P2|1|2b: m.*L > m.*S	L22		P2a, P2|1b, P2|1|2b
P2|1|1: m.*S <> {m.*P,L,-H}	P2|1|1a: m.*S > {m.*P,L,-h}		L11, L16, L24	P2a, P2|1a, P2|1|1a
	P2|1|1b: {m.*P,L,-H} > m.*S	L29		P2a, P2|1a, P2|1|1b
P2|1|1|1: m.*S <> m.*L	P2|1|1|1a: m.*S > m.*L		L11, L16	P2a, P2|1a, P2|1|1a, P2|1|1|1a

	P2|1|1|1b: m.*L > m.*S	L24		P2a, P2|1a, P2|1|1a, P2|1|1|1b
P2|1|1|1|1: m.*S <> m.*P	P2|1|1|1|1a: m.*S > m.*P	L11		P2a, P2|1a, P2|1|1a, P2|1|1|1a, P2|1|1|1|1a
	P2|1|1|1|1b: m.*P > m.*S	L16		P2a, P2|1a, P2|1|1a, P2|1|1|1a, P2|1|1|1|1b

3.3.3. Property 3

Finally, we analyse P3, which just includes the faithfulness constraint ID[high]. Again, as a narrow scope property, markedness constraints may outranks some or all of the faithfulness constraint, we pay attention to that in the following part below. First, we present P3, again parallel to P1 and P2, in (48):

(48) P3: f.IdH <> {m.*P, m.*M, m.*L, m.*-H, m.*S}

a. f.IdH > {m.*P,M,L,-H,S}

b. {m.*P,M,L,-H,S} > f.IdH

Here, in the first case, if we pick value a, we appreciate more marked languages, like it is the case of L1, L2, L4, L5, L6, L12, L13, L19, L20, L25 and L26. Note that this is the biggest variety and with that, it is the one that presents more micro-variation among the micro-steps of the property. Value b, on the other hand, accomplishes for languages L7, L17 and L18.

Next, if we take in account the sub-variation of value b. P3|2 is about re-ranking the NoSchwa constraint over or above the next faithfulness constraint, ID[high,low]. This is illustrated in (49):

(49) P3|2: f.IdHL <> m.*S

a. f.IdHL > m.*S
b. m.*S > f.IdHL

The micro-variation here is relative to the presence or absence of schwa. If value a is chosen, we can appreciate language L17, where schwa has some presence in the output, on the other hand, if value b if chosen, no schwa has representation in the output, which is the case of language L7 and L18.

The next step to take in account is if the second faithfulness constraint ID[high,low,ATR] is over or above the markedness ones *Unstressed/low and *Unstressed/-high. This is illustrated in (50) in P3|2|1:

(50) P3|2|1: f.IdHLA <> {m.*L, m.*-H}

a. f.IdHLA > {m.*L,-H}
b. {m.*L,-H} > f.IdHLA

In this case, we can appreciate that, if value a, the faithfulness constraint is ranked higher than the markedness ones, that results in low vowels in the output, which corresponds to L7; while if value b, high vowels win over low vowels in the output. That is appreciated in L18.

Next, we continue with value a of P3. The following micro-step we need to evaluate is parallel to the one we just saw, comparing the second faithfulness constraint with the NoSchwa constraint. That means that P3|1 looks like exactly like P3|2. In this case, if value a is chosen, we can appreciate languages that present some schwas in the outputs, that is the case for languages L12, L13, L25 and L26. In contrast, if value b is the chosen

one, we can appreciate that schwa is not present at all in the outputs. This can be observed in languages L1, L2, L4, L5, L6, L19 and L20.

Now, continuing with the development of the micro-steps for P3|1 we can appreciate more micro-steps. If value a is chosen, we need to know the re-ranking for the NoSchwa constraint among the makedness ones. In this case, we compare it to the constraints *Unstressed/low and *Unstressed/-high:

(51) P3|1|1: m.*S <> {m.*L,-H}

a. m.*S > {m.*L,-H}

b. {m.*L,-H} > m.*S

In this step we compare the amount of presence of schwa in the outputs. If we pick value a, corresponding to languages L12 and L13, we appreciate a smaller number of schwas than with value b, which corresponds to languages L25 and L26.

The following micro-step is regarding the re-ranking of a faithfulness constraint with the Lic[MidLax] markedness constraint. This step is parallel for whether we have value a or b. Illustrated in (52), then, it represents both P3|1|1|1 and P3|1|2:

(52) P3|1|1/P3|1|2: f.IdHL <> m.*M

a. f.IdHL > m.*M

b. m.*M > f.IdHL

First, in the case of P3|1|1, if value a is chosen, we can appreciate language L12, where the mid-lax back vowel is present in the output, while if value b, language L13 is not going to present the mid-lax one in favour to the mid-tense back vowel. The equivalent case is for P3|1|2. If we pick value a, we have a language with mid-lax back vowels in the output, language L25, whereas if value b, we do not be able to appreciate mid-lax, but mid-tense back vowels, which is the case of language L26.

We present a summary, of P3b and P3|1a below in (53) and (54), respectively:

(53) (Micro)variation P3 with value b

Property	Property values	Languages	Residual languages	Properties and values
P3: f.IdH <> {m.*P,M,L,-H,S}	P3a: f.IdHL > {m.*P,M,L,-H,S}		L1, L2, L4, L5, L6, L12, L13, L19, L20, L25, L26	P3a
	P3b: {m.*P,M,L,-H,S} > f.IdH		L7, L17, L18	P3b
P3|2: f.IdHL <> m.*S	P3|2a: f.IdHL > m.*S	L17		P3b, P3|2a
	P3|2b: m.*S > f.IdHL		L7, L18	P3b, P3|2b
P3|2|1: f.IdHLA <> {m.*L,-H}	P3|2|1a: f.IdHLA > {m.*L,-H}	L7		P3b, P3|2b, P3|2|1a
	P3|2|1b: {m.*L,-H} > f.IdHLA	L18		P3b, P3|2b, P3|2|1b

(54) (Micro)variation P3|1 with value a

Property	Property values	Languages	Residual languages	Properties and values
P3|1: f.IdHL <> m.*S	P3|1a: f.IdHL > m.*S		L12, L13, L25, L26	P3a, P3|1a
	P3|1b: m.*S > f.IdHL		L1, L2, L4, L5, L6, L19, L20	P3a, P3|1b
P3|1|1: m.*S <> {m.*L,-H}	P3|1|1a: m.*S > {m.*L,-H}		L12, L13	P3a, P3|1a, P3|1|1a
	P3|1|1b: {m.*L,-H} > m.*S		L25, L26	P3a, P3|1a, P3|1|1b

P3|1|1|1: f.IdHL <> m.*M	P3|1|1|1a: f.IdHL > m.*M	L12		P3a, P3|1a, P3|1|1a, P3|1|1|1a
	P3|1|1|1b: m.*M > f.IdHL	L13		P3a, P3|1a, P3|1|1a, P3|1|1|1b
P3|1|1|2: f.IdHL <> m.*M	P3|1|1|2a: f.IdHL > m.*M	L25		P3a, P3|1a, P3|1|1b, P3|1|1|2a
	P3|1|1|2b: m.*M > f.IdHL	L26		P3a, P3|1a, P3|1|1b, P3|1|1|2b

Now, if we go back to P3|1 and we pay attention to value b, we can appreciate, once more, a parallel phenomenon regarding the steps we need to continue realizing for establishing micro-variation. In P3|1|2, though, we need make one more re-ranking of the faithfulness constraint ID[high,low]. First, only the comparison of *Unstressed/low is necessary between the markedness constraints and the faithfulness one:

(55) P3|1|2: f.IdHL <> m.*L

a. f.IdHL > m.*L

b. m.*L > f.IdHL

If we have value a, we appreciate the presence of low vowels in the output, which is the case of languages L1, L2, L4, L5 and L6, whereas, if value b, we do not observe low vowels in the output, this happens in languages L19 and L20.

Next, in both cases, either we follow value a or value b, we need to continue the micro-variation steps with a re-ranking of the constraint Lic[MidLax] over or above the faithful ID[high,low]. This is illustrated in (56) for both P3|1|2|1 and P3|1|2|2:

(56) P3|1|2|1/P3|1|2|2: f.IdHL <> m.*M

a. f.IdHL > m.*M

b. m.*M > f.IdHL

If we analyse first P3|1|2|2 we can appreciate that with value a, we obtain language L19 which will maintain mid-lax vowels, while in the case of value b, in language L20, mid-lax vowels fall in favour of the mid-tense ones. If we check now P3|1|2|1, we can appreciate the same phenomenon. In languages L1 and L4, value a is the chosen one, which makes them present mid-lax vowels in the output, while in the case of languages L2, L5 and L6, corresponding to value b, do not present mid-lax vowels but mid-tense ones.

The next relevant minimal step we need to follow now for both cases of value, in the following sub-properties, P3|1|2|1|1 and P3|1|2|1|2, is about considering the re-ranking of markedness constraint, in concrete, Lic-Nonperiph and *Unstressed/-high. This step is parallel for both properties, so we illustrate them together in (57):

(57) P3|1|2|1|1/P3|1|2|1|2: m.*P <> m.*-H

a. m.*P > m.*-H

b. m.*-H > m.*P

If we first pay attention to the property P3|1|2|1|1, resulting from the value a of the previous one. Here, we can appreciate that, if value a is chosen, we can observe that the non-peripheral constraint bans non-peripheral vowels in favour of the [-high] ones, which permits us peripheral vowels in the outputs, which is the case of language L1, while, if it is the other way around, we obtain language L4. In the case of P3|1|2|1|2, we can appreciate a parallel phenomenon. In the case of value a, we observe peripheral vowels in the output, which is the case of L2, while if value b is chosen, we obtain languages L5 and L6.

Next, the last micro-step we need to give consideration to is the re-ranking of Lic-Nonperiph in relation to the third faithfulness constraint, ID[high,low,ATR].

(58) P3|1|2|1|2|1: f.IdHLA <> m.*P

a. f.IdHLA > m.*P

b. m.*P > f.IdHLA

First, in the case of value a, we can appreciate that maintaining peripheral vowels in the output is higher ranked than avoiding peripheral vowels, that is the case of L6, finally, if it is re-ranked the other way around, with value b, we observe the language L5.

Finally, in (59), we present a summary of P3|1b:

(59) (Micro)variation P3|1 with value b

Property	Property values	Languages	Residual languages	Properties and values
P3|1: f.IdHL <> m.*S	P3|1a: f.IdHL > m.*S		L12, L13, L25, L26	P3a, P3|1a
	P3|1b: m.*S > f.IdHL		L1, L2, L4, L5, L6, L19, L20	P3a, P3|1b
P3|1|2: f.IdHL <> m.*L	P3|1|2a: f.IdHL > m.*L		L1, L2, L4, L5, L6	P3a, P3|1b, P3|1|2a
	P3|1|2bdHL: m.*L > f.I		L19, L20	P3a, P3|1b, P3|1|2b
P3|1|2|2: f.IdHL <> m.*M	P3|1|2|2a: f.IdHL > m.*M	L19		P3a, P3|1b, P3|1|2b, P3|1|2|2a
	P3|1|2|2b: m.*M > f.IdHL	L20		P3a, P3|1b, P3|1|2b, P3|1|2|2b
P3|1|2|1: f.IdHL <> m.*M	P3|1|2|1a: f.IdHL > m.*M		L1, L4	P3a, P3|1b, P3|1|2a, P3|1|2|1a

	P3|1|2|1b: m.*M > f.IdHL		L2, L5, L6	P3a, P3|1b, P3|1|2a, P3|1|2|1b
P3|1|2|1|1: m.*P <> m.*-H	P3|1|2|1|1a: m.*P > m.*-H	L1		P3a, P3|1b, P3|1|2a, P3|1|2|1a, P3|1|2|1|1a
	P3|1|2|1|1b: m.*-H > m.*P	L4		P3a, P3|1b, P3|1|2a, P3|1|2|1a, P3|1|2|1|1a
P3|1|2|1|2: m.*P <> m.*-H	P3|1|2|1|2a: m.*P > m.*-H	L2		P3a, P3|1b, P3|1|2a, P3|1|2|1b, P3|1|2|1|2a
	P3|1|2|1|2b: m.*-H > m.*P		L5, L6	P3a, P3|1b, P3|1|2a, P3|1|2|1b, P3|1|2|1|2a
P3|1|2|1|2|1: f.IdHLA <> m.*P	P3|1|2|1|2|1a: f.IdHLA > m.*P	L6		P3a, P3|1b, P3|1|2a, P3|1|2|1b, P3|1|2|1|2a, P3|1|2|1|2|1a
	P3|1|2|1|2|1b: m.*P > f.IdHLA	L5		P3a, P3|1b, P3|1|2a, P3|1|2|1b, P3|1|2|1|2a, P3|1|2|1|2|1b

3.4. Summary and discussion

To sum up, we can observe how the different rankings in the constraint structure modify the results of vowel reduction. Depending on if we rank higher any of the three groups of constraints we can find, Faithfulness, Markedness or Licensing, we can observe how the main varieties are shown in the output. In the detailed case of the transitional areas, we observe how the lower positions are more relevant for the results, as they represent areas where the possibility of combinations and resulting patterns increases for the phenomenon of vowel reduction, and, finally, and more important how one same area can have several rankings for several results. In PT we can appreciate how the main properties are three, depending on the faithfulness constraint they demand. P1 is selecting the widest faithfulness constraint, ID[high,low,ATR]&NoSchwa, P2 select the second one, ID[high,low], and, finally, P3 works on the last faithfulness constraint, ID[high]. The variation is established, for each property, in how they either rank or re-rank those faithfulness constraints and the markedness ones, even, how they re-rank markedness constraint between the faithfulness ones. This is shown in the micro-variation steps each property goes through in P1|… for example, and can gives us a simplified way of showing how and which constraints we need to re-rank to give in account micro-variation, in this case, among the varieties of one same language, Catalan.

4. Conclusions

In conclusion, this thesis explored a property analysis (Alber & Prince 2016, 2017; Alber, DelBusso & Prince 2017; DelBusso 2018) working on an OT typology. In concrete, the approach to analyse micro-variation in PT as a way of analysing the micro-steps properties need to follow when re-ranking constraints (Alber 2001, 2014a; Alber & Meneguzzo 2016). Most of the times when we approach dialectological variation, we focus on the ranking of faithfulness constraints over markedness but we need to pay attention too, once we established the order of markedness and faithfulness constraints, how markedness constraints themselves re-rank for showing variation, in that way we do not have to assume fixed rankings for those markedness constraints (Alber 2014b, 2015). As sometimes we do not know exactly which one is the markedness constraint we need to re-rank to show that micro-variation process (Alber & Meneguzzo 2016: 48), we proposed an itemization of each property showing those microparameters or re-rankings.

Talking about properties we focused first in three main properties that correlate to the three faithfulness constraints we found in the analysis. P1 works comparing ID[high,low,ATR]&NoSchwa with the other markedness constraints, P2 does it with ID[high,low], and P3 correlates to ID[high]. As we are talking about variation inside one same language it is important that we have to give in account for small changes among varieties. That is considered here with micro-variation for each property too. As we can find variation and micro-variation among the varieties, it makes sense that the same happens when we talk about properties too.

As we are dealing with a large typology, the holographic principle (Merchant & Krämer 2018) could help us dividing each set of properties in smaller ones to be able to accomplish for the micro-structure of each. In their work, Marchant & Krämer analyse the appearance of consonants in a syllable coda position making an equivalence with a simpler set. They work with several markedness constraints, in stringent sets, that make conflict with only one faithfulness constraint. That was a good idea to start approaching our analysis, however, here we are dealing with two conflicting stringent sets of constraints that, in addition, interact between each other and themselves. So, in this thesis what we need is to take in account not only the conflicting interactions among different sets of stringent constraints, but also, the different positions and re-ranking we can observe inside the same stringent set of constraints.

In this case, we need to have clear the difference between macro- and microparameters, we work in microvariation. Macroparameters are the constraints in the highest position of the hierarchy, while the microparameters are the other different positions in the hierarchy (DelBusso 2018). To establish the re-ranking of the constraints in the microparametrical positions, we need to take in account supersets, which are sets that include smaller sets, and the set of total orders in an ERC set (DelBusso 2018: 40). These two concepts permit us explore the combinations and re-ranking in an ERC set and how sets interact among the others. Here we started with a superset, which is each property (P1, P2 and P3), and we divided every superset in smaller sets that included as much constraints as possible until we defined all the ERCs corresponding to the languages of the typology.as we want to approach the minimal changes the appear between each variety (Alber & Meneguzzo 2016).

Focusing now on each property, while comparing the varieties that are included in P1 we could appreciate how each time we needed to follow a decreasing path, like a bottleneck. Once we had the languages from P1, we assigned values, a or b, depending if the order of the constraints was higher for the faithfulness or for the markedness. After that we proceeded to analyse the structures that had, for example, the faithfulness on top, in this case P1|2 with value a, for example, to get the information of the first micro-step, in this case, in whether P1|2|1, and so on. Once all the languages of this property had been considered we could appreciate the micro-structure that P1|2 had, with all its sub-variants and steps. The results we observed where P1a for L8, the only faithful variety, while P1b presented the rest of the unfaithful ones (where L33 is the main unfaithful one). In a second micro-step, we identified next re-rankings for each value of P1b (also P1|2), if value P1|2a, P1|2|1, if value P1|2b, P1|2|2. We continued re-ranking and dismissing constraints and rankings until we got to the end of the structure. For P1|2a, we identified languages L28 (P1|2|1|1a), L23 and L21 (P1|2|1|1|1a and b, respectively), and L15 and L18 (P1|2|1|2a and b, respectively). In the case of P1|2b, we could observe L32 and L3, the Algherese variety, (P1|2|2|1a and b, respectively), languages L31 and 30, the Central and Northern variety, (P1|2|2|2|1a and b, respectively), and L14 and L27 (P1|2|2|2|2a and b, respectively).

Afterwards, we proceeded to do the same with P2. We identified the languages that compound this group, where ID[high,low] is considered in the ranking as a starting point, and we did the same as in P1: identify and start dividing the properties in each of the

languages that forms P2. In this case we could appreciate that there are no languages under the sub-variation of P2b, so everything works under the specified value of P2a. here we could appreciate L29, the Majorcan variety, (P2|1|1b), L9, the North-Western & Valencian variety, and L22 (P2|1|2a and b) in a first level; following under the structure for P2|1|1a we could find languages L24 (P2|1|1|1b), L11 and L16 (P2|1|1|1|1a and b).

Finally, P3 was the biggest group as it was the one that contained more languages. Under the leg of P3b we could observe languages L17 and L18 (P3|2a and b). Next, under P3a we could appreciate L12 and L13 (P3|1|1|1a and b), and L25 and L26 (P3|1|1|2a and b). Next, following P3|1b, we could observe languages L1 and L4 (P3|1|2|1|1a and b), L2 (P3|1|2|1|2a), L6 and L5 (P3|1|2|1|2|1a and b), and languages L19 and L20 (P3|2|2a and b).

To finish with, this thesis permits us appreciate how dialectology can work better if we study it hand by hand with PT. If we observe the dialect division, we can appreciate that the main languages (L8, L3, L9, L29 and L30) are, first of all, under the first two properties (P1 or P2) and the realization of each language depends on the value of the property. For P1 we can appreciate value a for the faithfulness variety, L8, and value b for the Central, Northern and Algherese varieties, while in P2, value a gives us the two remaining dialects, North-Western & Valencian (L9) and Majorcan (L29). We can also observe other varieties inside those three groups and the output all groups have in common is in the form of the output of the back vowels, mainly, and the presence or absence of mid-front vowels.

In more detail, if we observe first P1|2a, it gives us all varieties that present faithful outputs for the back vowels (/ɔ/-[ɔ], /o/-[o], /u/-[u]) and we can observe either presence or absence of mid-front vowels from mid-front vowel inputs as faithful, partially reduced or reduced, while the low vowels is going to be either faithful or schwa.

Secondly, P1|2b, on the other hand, gives us the result of total unfaithful (with reduction) output for the back vowels (/ɔ/-[u], /o/-[u], /u/-[u]), while front vowels avoid being mid either lowering to [a] (L3) or becoming the featureless schwa (L30). As we can observe, the two main varieties are either the one that realizes all front vowels as [a], Algherese, or the one that does them all as [ə], Central and Northern. The rest of the varieties we can find in P1|2b present some (more or less) micro-variation. In this group we can even find rising of all front vowels to [i] in the output.

The third case, P2a shows us a middle step between those two values of P1|2. In P2 we can observe partial reduction of the back vowels (/ɔ/-[o], /o/-[o], /u/-[u]), while mid-front vowel inputs can or not present mid-front vowels. Now, the mid-front vowel outputs for those same inputs in P1|2a and P2a can be either staying totally faithful, becoming mid-lax or becoming the featureless schwa, but never by lowering to [a]. The difference with P1|2a is that, in this case, we only find mid-tense-front vowels while in P1|2a we can find the possibility of mid-lax-front vowels in the output. In P2, then, we can identify the two main varieties as the one that realizes all mid-front vowels as mid-lax vowels, North-Western & Valencian (L9), or the one that realized all front vowels as schwa, Majorcan (L29). The rest of the varieties inside this group present micro-variation between those two dialects.

Finally, for P3 we need a bit more of details to take in consideration. First, for P3a, we can appreciate that the outputs for the back vowels can be both faithful or partially reduced. The distinction for this case is regarding the ranking of the faithfulness constraint that bans changing the value of [+/-ART]. If ATR is high-ranked among the markedness constraint, we obtain languages with outputs similar to P1|2a (/ɔ/-[ɔ], /o/-[o], /u/-[u]), while if it is lower-ranked, we observe outputs similar to the ones in P2a (/ɔ/-[o], /o/-[o], /u/-[u]). In the case of the front vowels, we can appreciate a bit of a mix of the previous properties (always with value a) plus some concrete new realizations. Similarly to P1|2a, we can appreciate both mid vowels in the output as faithful, but we can also appreciate partial reduction of the mid-lax to the mid-tense, or to both to schwa. The same case happens to be with the low vowel, as it can be faithful or reduced to schwa. Similar to P2a we can appreciate back vowels with partial reduction (/ɔ/-[o], /o/-[o], /u/-[u]), while mid-front vowels can become mid-lax or both to schwa. In addition, we can appreciate other combinations like the case of outputs that behave like P1|2a for front vowels but like P2a for back vowels or the other way around. Moreover, we can also find new outputs that we did not find in the previous properties, like the raisin of the lower vowel (/a/-[e]). Secondly, P3b presents, similarly to P1|2b, all back outputs reduced (/ɔ/-[u], /o/-[u], /u/-[u]). Front vowels can also follow the patterns of P1|2b in some cases. Mid-vowels can lower to [a], rise to [i] or become the featureless schwa, but not stay with their mid nature in the output (the predominance seems to be raising); however, the difference is that the low vowel never presents reduction.

In the eyes of dialectology and PT, then, we can re-establish the main dialectal areas of Catalan in a different way. In the literature we could find Eastern Catalan, where we include Central, Northern, Majorcan and Algherese, while in Western Catalan, we include North-Western & Valencian. If we follow the property analysis developed in this thesis, we can divide the main varieties of Catalan in some different ways. We can still have two main blocks. Main variety 1, which is represented by Central, Northern and Algherese, and main variety 2, which includes North-Western & Valencian and Majorcan. Instead of paying attention to the varieties that reduce all front-non-high vowels to schwa, which Algherese does not follow, so it should not be included in the traditional Eastern varieties, we can divide the main varieties in the ones that reduce both /ɔ/ and /o/ to [u] (Main variety 1, P1|2b), and the ones that only present reduction in /ɔ/ to [o] (P2a).

In addition, we can re-establish the transitional areas in a different way too compared on how we saw them presented for the literature. Focusing on vowel reduction, we can observe two main transitional area, corresponding to P1|2a and P3a. These transitional areas are the ones between the faithful variety and Central, Northern and Algherese; and the one between the faithful variety and the North-Western & Valencian and the Majorcan varieties. On the other hand, we are able to appreciate two secondary transitional varieties: The first one is between the Algherese variety and the Central and Northern varieties, P1|2b (in addition to P3b, as we can consider it is a smaller group of transitional areas that excludes outputs from P1|2b, so it could be integrated together); the second one we can appreciate is between the North-Western & Valencian and the Majorcan variety.

As a conclusion, we can defend that the approach of PT handing dialectology presented in this thesis can help understand dialectological variation in terms of properties, as the important variation resides in the re-ranking of the constraints in a minimal way that can present us minimal steps in the variation process. This way, we can understand better the relations between dialects and the transitional areas and we can group them in an easier way. We can do that by looking at the properties and minimal steps in the ranking of the constraints, rather than having in account the contexts in which alternation can be possible, as sometimes it can result in a huge list because the main characteristics claimed to treat them as so was that they present reduction but not everywhere, like the case of the main varieties. In the same way, as we could appreciate that the description of the transitional areas in section 2 (2.2.2.6-2.2.2.8) was quite long, in this way it permits us classify them in an easier way. We can even include more regional and concrete dialects,

sometimes the ones that include only a few cities, without having to establish a whole dialectal pattern just for them. In addition, this way we can understand why there are distant geographical regions that share similar reduction patters, for instance Tortosan (South of Catalonia) and Alicantinian (South of the Valencian Community), and it can even help understand other phenomena, a part from vowel reduction, and let us establish each variety in general terms of general phonological processes. This could be solved in more re-ranking or adding more micro-steps to the properties, to be even more concrete or to be able to include other phenomena, like the reduction pattern regarding diphthongs, or even not just vowel reduction, for example harmony.

Finally, we would like to suggest for future work, as a way to confirm is this proposal too, to study the other smaller varieties we could find for Catalan that were not included in the three main transitional areas: for example, Menorcan, Eivissan, Ribagorsan, Pallaresian in Catalonia, the sub-varieties of Valencian, and the areas in the border with Aragon. Also, another consideration to make for future work could be applying this proposal of property micro-variation for dialectal variation found in other Romance languages, for example, with Spanish or Italian.

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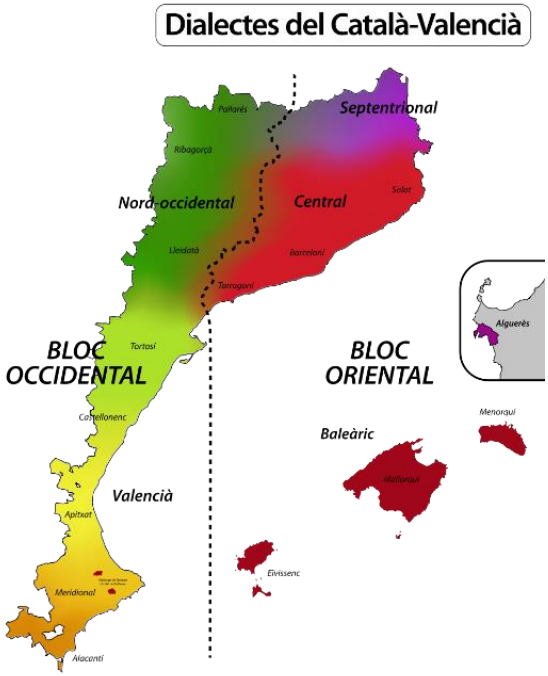
6. Appendix

Image 1. Catalan-Speaking Countries

(Image from: https://en.wikipedia.org/wiki/Catalan_Countries)

Image 2. Catalan Dialects



(Image from: https://ca.wikipedia.org/wiki/Dialectes_del_catal%C3%A0)

Image 3. Provinces and "Comarques" in Catalonia

(Image from: https://ca.wikipedia.org/wiki/Prov%C3%ADncies_de_Catalunya)

Image 4. Central-Septentrional, Tarragonian and Tortosan, L1 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	8:NoSchwa	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low	6:Lic[MidLax]
1.1>5	a	a	i	W			W	W	L	L	
2.1>5	E	a	i	W				W	L	L	
3.1>5	e	a	i	W					L	L	
4.1>5	s	a	i	W					L	L	
7.2>3	o	o	u	W		L	W	W	L		
6.1>3	O	O	u	W		L	W	W	L		L
1.1>4	a	a	x		W				L	L	
2.1>4	E	a	x		W		L	L	L	L	
3.1>4	e	a	x		W		L	L	L	L	
1.1>3	a	a	e			W	W	W		L	
2.1>3	E	a	e			W	L			L	
2.1>2	E	a	E			W	L	L		L	W
3.1>3	e	a	e			W	L	L		L	
4.1>4	s	a	s			W	L	L	L	L	
6.1>2	O	O	o					W			L

Image 5. Central-Septentrional, Tarragonian and Tortosan, L2 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	8:NoSchwa	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W				W	W	L	L
2.1>5	E	a	i	W					W	L	L
3.1>5	e	a	i	W						L	L
4.1>5	s	a	i	W						L	L
6.2>3	O	o	u	W			L	W	W	L	
7.2>3	o	o	u	W			L	W	W	L	
2.1>2	E	a	E		W		W	L	L		L
6.2>1	O	o	O		W				L		
1.1>4	a	a	x			W				L	L
2.1>4	E	a	x			W		L	L	L	L
3.1>4	e	a	x			W		L	L	L	L
1.1>3	a	a	e				W	W	W		L
2.1>3	E	a	e				W	L			L
3.1>3	e	a	e				W	L	L		L
4.1>4	s	a	s				W	L	L	L	L

Image 6. Central-Septentrional, Tarragonian and Tortosan, L4 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	8:NoSchwa	5:*Unstressed/-high	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	7:*Unstressed/low	6:Lic[MidLax]
4.4>5	s	s	i	W			L	W	W		
1.1>5	a	a	i	W		L		W	W	L	
2.1>5	E	a	i	W		L			W	L	
3.1>5	e	a	i	W		L				L	
7.2>3	o	o	u	W		L	L	W	W		
6.1>3	O	O	u	W		L	L	W	W		L
1.1>4	a	a	x		W	L				L	
2.1>4	E	a	x		W	L		L	L	L	
3.1>4	e	a	x		W	L		L	L	L	
4.4>1	s	s	a			W	L	W	W	W	
1.1>3	a	a	e				W	W	W	L	
2.1>3	E	a	e				W	L		L	
2.1>2	E	a	E				W	L	L	L	W
3.1>3	e	a	e				W	L	L	L	
6.1>2	O	O	o						W		L

Image 7. Central-Septentrional, Tarragonian and Tortosan, L5 ERC

WL Pairs										
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	8:NoSchwa	5:*Unstressed/-high	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	7:*Unstressed/low
4.4>5	s	s	i	W				L	W	W	
1.1>5	a	a	i	W			L		W	W	L
2.1>5	E	a	i	W			L			W	L
3.1>5	e	a	i	W			L				L
6.2>3	O	o	u	W			L	L	W	W	
7.2>3	o	o	u	W			L	L	W	W	
2.1>2	E	a	E		W			W	L	L	L
6.2>1	O	o	O		W					L	
1.1>4	a	a	x			W	L				L
2.1>4	E	a	x			W	L		L	L	L
3.1>4	e	a	x			W	L		L	L	L
4.4>1	s	s	a				W	L	W	W	W
1.1>3	a	a	e					W	W	W	L
2.1>3	E	a	e					W	L		L
3.1>3	e	a	e					W	L	L	L

Image 8. Central-Septentrional, Tarragonian and Tortosan, L6 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	8:NoSchwa	3:ID[high,low,ATR]	5:*Unstressed/-high	4:Lic-Nonperiph	2:ID[high,low]	7:*Unstressed/low
4.4>5	s	s	i	W			W		L	W	
1.1>5	a	a	i	W			W	L		W	L
2.1>5	E	a	i	W			W	L			L
3.3>5	e	e	i	W			W	L	L	W	
6.2>3	O	o	u	W			W	L	L	W	
7.2>3	o	o	u	W			W	L	L	W	
2.1>2	E	a	E		W		L		W	L	L
6.2>1	O	o	O		W		L				
1.1>4	a	a	x			W		L			L
3.3>4	e	e	x			W		L	L		
2.1>4	E	a	x			W	L	L		L	L
4.4>1	s	s	a				W	W	L	W	W
1.1>3	a	a	e				W		W	W	L
3.3>1	e	e	a				W		L	W	W
2.1>3	E	a	e						W	L	L

Image 9. Central-Septentrional, Tarragonian and Tortosan, L21 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	7:*Unstressed/low	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]
4.4>5	s	s	i	W	W	W			L		
3.3>5	e	e	i	W	W	W			L	L	
7.2>3	o	o	u	W	W	W			L	L	
2.2>5	E	E	i	W	W	W			L	L	L
6.1>3	O	O	u	W	W	W			L	L	L
1.4>5	a	x	i	W	W	W		L			
4.4>1	s	s	a		W	W	W		L	W	
3.3>1	e	e	a		W	W	W		L		
2.2>1	E	E	a		W	W	W		L		L
1.4>3	a	x	e		W	W		L	W	W	
2.2>3	E	E	e			W					L
6.1>2	O	O	o			W					L
1.4>1	a	x	a				W	L		W	
3.3>4	e	e	x					W	L	L	
2.2>4	E	E	x					W	L	L	L

Image 10. Central-Septentrional, Tarragonian and Tortosan, L22 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high
4.4>5	s	s	i	W	W				W	L	
2.3>5	E	e	i	W	W				W	L	L
3.3>5	e	e	i	W	W				W	L	L
6.2>3	O	o	u	W	W				W	L	L
7.2>3	o	o	u	W	W				W	L	L
1.4>5	a	x	i	W	W			L	W		
4.4>1	s	s	a		W		W		W	L	W
3.3>1	e	e	a		W		W		W	L	
2.3>1	E	e	a		W		W			L	
1.4>3	a	x	e		W			L	W	W	W
2.3>2	E	e	E			W			L		
6.2>1	O	o	O			W			L		
1.4>1	a	x	a				W	L			W
3.3>4	e	e	x					W		L	L
2.3>4	E	e	x					W	L	L	L

Image 11. Central-Septentrional, Tarragonian and Tortosan, L23 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	7:*Unstressed/low	6:Lic[MidLax]	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high
4.4>5	s	s	i	W	W	W				L	
3.3>5	e	e	i	W	W	W				L	L
7.2>3	o	o	u	W	W	W				L	L
1.4>5	a	x	i	W	W	W			L		
2.4>5	E	x	i	W	W	W			L		
6.1>3	O	O	u	W	W	W		L		L	L
4.4>1	s	s	a		W	W	W			L	W
3.3>1	e	e	a		W	W	W			L	
2.4>1	E	x	a		W	W	W		L		W
1.4>3	a	x	e		W	W			L	W	W
2.4>3	E	x	e			W			L	W	W
6.1>2	O	O	o			W		L			
1.4>1	a	x	a				W		L		W
2.4>2	E	x	E					W	L	W	W
3.3>4	e	e	x						W	L	L

Image 12. Central-Septentrional, Tarragonian and Tortosan, L24 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	7:*Unstressed/low	3:ID[high,low,ATR]	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high
4.4>5	s	s	i	W	W			W		L	
3.3>5	e	e	i	W	W			W		L	L
6.2>3	O	o	u	W	W			W		L	L
7.2>3	o	o	u	W	W			W		L	L
1.4>5	a	x	i	W	W			W	L		
2.4>5	E	x	i	W	W			W	L		
4.4>1	s	s	a		W		W	W		L	W
3.3>1	e	e	a		W		W	W		L	
2.4>1	E	x	a		W		W	W	L		W
1.4>3	a	x	e		W			W	L	W	W
2.4>2	E	x	E			W			L	W	W
6.2>1	O	o	O			W		L			
1.4>1	a	x	a				W		L		W
2.4>3	E	x	e					W	L	W	W
3.3>4	e	e	x						W	L	L

Image 13. Central-Septentrional and Tarragonian, L12 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	6:Lic[MidLax]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W		W	W			L	L
2.4>5	E	x	i	W		W	W		L		
3.4>5	e	x	i	W		W	W		L		
4.1>5	s	a	i	W						L	L
7.2>3	o	o	u	W	L	W	W			L	
6.1>3	O	O	u	W	L	W	W	L		L	
1.1>3	a	a	e		W	W	W				L
2.4>3	E	x	e		W		W		L	W	
2.4>2	E	x	E		W			W	L	W	
3.4>3	e	x	e		W				L	W	
4.1>4	s	a	s		W	L	L			L	L
2.4>1	E	x	a			W	W		L	W	W
3.4>1	e	x	a			W	W		L	W	W
6.1>2	O	O	o				W	L			
1.1>4	a	a	x						W	L	L

Image 14. Central-Septentrional and Tarragonian, L13 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W			W	W		L	L
2.4>5	E	x	i	W			W	W	L		
3.4>5	e	x	i	W			W	W	L		
4.1>5	s	a	i	W						L	L
6.2>3	O	o	u	W		L	W	W		L	
7.2>3	o	o	u	W		L	W	W		L	
2.4>2	E	x	E		W	W			L	W	
6.2>1	O	o	O		W			L			
1.1>3	a	a	e			W	W	W			L
2.4>3	E	x	e			W		W	L	W	
3.4>3	e	x	e			W			L	W	
4.1>4	s	a	s			W	L	L		L	L
2.4>1	E	x	a				W	W	L	W	W
3.4>1	e	x	a				W	W	L	W	W
1.1>4	a	a	x						W	L	L

Image 15. Central-Septentrional and Tarragonian, L14 ERC

WL Pairs											
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
2.4>2	E	x	E	W	W				L	W	
6.3>1	O	u	O	W	W	L	L	L		W	
1.1>3	a	a	e	W			W	W			L
2.4>3	E	x	e	W				W	L	W	
3.4>3	e	x	e	W					L	W	
4.1>4	s	a	s	W			L	L		L	L
6.3>2	O	u	o	W		L	L	L		W	
7.3>2	o	u	o	W		L	L	L		W	
1.1>5	a	a	i			W	W	W		L	L
2.4>5	E	x	i			W	W	W	L		
3.4>5	e	x	i			W	W	W	L		
4.1>5	s	a	i			W				L	L
2.4>1	E	x	a				W	W	L	W	W
3.4>1	e	x	a				W	W	L	W	W
1.1>4	a	a	x						W	L	L

Image 16. Central-Septentrional and Tarragonian, L15 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	6:Lic[MidLax]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W	W	W				L	L
2.4>5	E	x	i	W	W	W			L		
3.4>5	e	x	i	W	W	W			L		
4.4>5	s	s	i	W	W	W	L				
7.2>3	o	o	u	W	W	W	L			L	
6.1>3	O	O	u	W	W	W	L	L		L	
1.1>3	a	a	e		W	W	W				L
2.4>1	E	x	a		W	W			L	W	W
3.4>1	e	x	a		W	W			L	W	W
4.4>1	s	s	a		W	W	L			W	W
2.4>3	E	x	e			W	W		L	W	
6.1>2	O	O	o			W		L			
2.4>2	E	x	E				W	W	L	W	
3.4>3	e	x	e				W		L	W	
1.1>4	a	a	x						W	L	L

Image 17. Central-Septentrional and Tarragonian, L16 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	3:ID[high,low,ATR]	4:Lic-Nonperiph	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W	W		W			L	L
2.4>5	E	x	i	W	W		W		L		
3.4>5	e	x	i	W	W		W		L		
4.4>5	s	s	i	W	W		W	L			
6.2>3	O	o	u	W	W		W	L		L	
7.2>3	o	o	u	W	W		W	L		L	
1.1>3	a	a	e		W		W	W			L
2.4>1	E	x	a		W		W		L	W	W
3.4>1	e	x	a		W		W		L	W	W
4.4>1	s	s	a		W		W	L		W	W
2.4>2	E	x	E			W		W	L	W	
6.2>1	O	o	O			W	L				
2.4>3	E	x	e				W	W	L	W	
3.4>3	e	x	e					W	L	W	
1.1>4	a	a	x						W	L	L

Image 18. Central-Septentrional and Tarragonian, L17 ERC

WL Pairs											
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	2:ID[high,low]	3:ID[high,low,ATR]	8:NoSchwa	5:*Unstressed/-high	7:*Unstressed/low	1:ID[high]
2.4>2	E	x	E	W	W			L	W		
6.3>1	O	u	O	W	W	L	L		W		L
1.1>3	a	a	e	W		W	W			L	
2.4>3	E	x	e	W			W	L	W		
3.4>3	e	x	e	W				L	W		
6.3>2	O	u	o	W		L	L		W		L
7.3>2	o	u	o	W		L	L		W		L
4.5>4	s	i	s	W		L	L				L
1.1>5	a	a	i			W	W		L	L	W
2.4>1	E	x	a			W	W	L	W	W	
3.4>1	e	x	a			W	W	L	W	W	
2.4>5	E	x	i			W	W	L			W
3.4>5	e	x	i			W	W	L			W
1.1>4	a	a	x					W	L	L	
4.5>1	s	i	a						W	W	L

Image 19. Central-Septentrional and Tarragonian, L25 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low	6:Lic[MidLax]	8:NoSchwa
1.4>5	a	x	i	W		W	W				L
2.4>5	E	x	i	W		W	W				L
3.4>5	e	x	i	W		W	W				L
4.1>5	s	a	i	W				L	L		
7.2>3	o	o	u	W	L	W	W	L			
6.1>3	O	O	u	W	L	W	W	L		L	
1.4>3	a	x	e		W	W	W	W			L
2.4>3	E	x	e		W		W	W			L
2.4>2	E	x	E		W			W		W	L
3.4>3	e	x	e		W			W			L
4.1>4	s	a	s		W	L	L	L	L		
2.4>1	E	x	a			W	W	W	W		L
3.4>1	e	x	a			W	W	W	W		L
6.1>2	O	O	o				W			L	
1.4>1	a	x	a					W	W		L

Image 20. Central-Septentrional and Tarragonian, L26 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	4:Lic-Nonperiph	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low	8:NoSchwa
1.4>5	a	x	i	W			W	W			L
2.4>5	E	x	i	W			W	W			L
3.4>5	e	x	i	W			W	W			L
4.1>5	s	a	i	W					L	L	
6.2>3	O	o	u	W		L	W	W	L		
7.2>3	o	o	u	W		L	W	W	L		
2.4>2	E	x	E		W	W			W		L
6.2>1	O	o	O		W			L			
1.4>3	a	x	e			W	W	W	W		L
2.4>3	E	x	e			W		W	W		L
3.4>3	e	x	e			W			W		L
4.1>4	s	a	s			W	L	L	L	L	
2.4>1	E	x	a				W	W	W	W	L
3.4>1	e	x	a				W	W	W	W	L
1.4>1	a	x	a						W	W	L

Image 21. Central-Septentrional and Tarragonian, L27 ERC

WL Pairs											
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low	8:NoSchwa
2.4>2	E	x	E	W	W				W		L
6.3>1	O	u	O	W	W	L	L	L	W		
1.4>3	a	x	e	W			W	W	W		L
2.4>3	E	x	e	W				W	W		L
3.4>3	e	x	e	W					W		L
4.1>4	s	a	s	W			L	L	L	L	
6.3>2	O	u	o	W		L	L	L	W		
7.3>2	o	u	o	W		L	L	L	W		
1.4>5	a	x	i			W	W	W			L
2.4>5	E	x	i			W	W	W			L
3.4>5	e	x	i			W	W	W			L
4.1>5	s	a	i			W			L	L	
2.4>1	E	x	a				W	W	W	W	L
3.4>1	e	x	a				W	W	W	W	L
1.4>1	a	x	a						W	W	L

Image 22. Central-Septentrional and Tarragonian, L28 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	7:*Unstressed/low	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	8:NoSchwa
1.4>5	a	x	i	W	W	W					L
2.4>5	E	x	i	W	W	W					L
3.4>5	e	x	i	W	W	W					L
4.4>5	s	s	i	W	W	W		L			
7.2>3	o	o	u	W	W	W		L	L		
6.1>3	O	O	u	W	W	W		L	L	L	
2.4>1	E	x	a		W	W	W		W		L
3.4>1	e	x	a		W	W	W		W		L
4.4>1	s	s	a		W	W	W	L	W		
1.4>3	a	x	e		W	W		W	W		L
2.4>3	E	x	e			W		W	W		L
6.1>2	O	O	o			W				L	
1.4>1	a	x	a				W		W		L
2.4>2	E	x	E					W	W	W	L
3.4>3	e	x	e					W	W		L

Image 23. Central-Septentrional and Tarragonian, L31 ERC

WL Pairs											
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	8:NoSchwa
2.4>2	E	x	E	W	W	W					L
6.3>1	O	u	O	W	W	W		L	L	L	
1.4>3	a	x	e	W	W				W	W	L
2.4>3	E	x	e	W	W					W	L
3.4>3	e	x	e	W	W						L
6.3>2	O	u	o	W	W			L	L	L	
7.3>2	o	u	o	W	W			L	L	L	
4.5>4	s	i	s	W				L	L	L	
2.4>1	E	x	a		W		W		W	W	L
3.4>1	e	x	a		W		W		W	W	L
1.4>1	a	x	a		W		W				L
4.5>1	s	i	a		W		W	L			
1.4>5	a	x	i					W	W	W	L
2.4>5	E	x	i					W	W	W	L
3.4>5	e	x	i					W	W	W	L

Image 24. Central-Septentrional and Tortosan, L18 ERC

WL Pairs											
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	8:NoSchwa	2:ID[high,low]	5:*Unstressed/-high	7:*Unstressed/low	1:ID[high]	3:ID[high,low,ATR]
2.5>2	E	i	E	W	W		L	W		L	L
6.3>1	O	u	O	W	W		L	W		L	L
1.1>3	a	a	e	W			W		L		W
2.5>3	E	i	e	W			L	W		L	L
3.5>3	e	i	e	W			L	W		L	L
6.3>2	O	u	o	W			L	W		L	L
7.3>2	o	u	o	W			L	W		L	L
4.5>4	s	i	s	W			L			L	L
1.1>4	a	a	x			W		L	L		
2.5>4	E	i	x			W	L			L	L
3.5>4	e	i	x			W	L			L	L
1.1>5	a	a	i				W	L	L	W	W
3.5>1	e	i	a					W	W	L	
4.5>1	s	i	a					W	W	L	
2.5>1	E	i	a					W	W	L	L

Image 25. Central-Septentrional and Tortosan, L32 ERC

WL Pairs											
ERC#	Input	Winner	Loser	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph
2.5>2	E	i	E	W	W			L	L	L	W
6.3>1	O	u	O	W	W			L	L	L	W
4.4>1	s	s	a	W		W			W	W	L
3.5>1	e	i	a	W		W		L			
2.5>1	E	i	a	W		W		L		L	
1.5>1	a	i	a	W		W		L	L	L	
1.5>3	a	i	e	W				L	L	L	W
2.5>3	E	i	e	W				L	L	L	W
3.5>3	e	i	e	W				L	L	L	W
6.3>2	O	u	o	W				L	L	L	W
7.3>2	o	u	o	W				L	L	L	W
1.5>4	a	i	x				W	L	L	L	
2.5>4	E	i	x				W	L	L	L	
3.5>4	e	i	x				W	L	L	L	
4.4>5	s	s	i					W	W	W	L

Image 26. Central-Septentrional and Tortosan, L33 ERC

WL Pairs												
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]
2.5>2	E	i	E	W	W	W			L	L	L
6.3>1	O	u	O	W	W	W			L	L	L
1.5>3	a	i	e	W	W				L	L	L
2.5>3	E	i	e	W	W				L	L	L
3.5>3	e	i	e	W	W				L	L	L
6.3>2	O	u	o	W	W				L	L	L
7.3>2	o	u	o	W	W				L	L	L
4.5>4	s	i	s	W					L	L	L
3.5>1	e	i	a		W		W		L		
4.5>1	s	i	a		W		W		L		
2.5>1	E	i	a		W		W		L		L
1.5>1	a	i	a		W		W		L	L	L
1.5>4	a	i	x					W	L	L	L
2.5>4	E	i	x					W	L	L	L
3.5>4	e	i	x					W	L	L	L

Image 27. Tarragonian and Tortosan, L19 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	7:*Unstressed/low	8:NoSchwa	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high	6:Lic[MidLax]
4.4>5	s	s	i	W			W	W	L		
1.3>5	a	e	i	W			W	W	L	L	
3.3>5	e	e	i	W			W	W	L	L	
7.2>3	o	o	u	W			W	W	L	L	
2.2>5	E	E	i	W			W	W	L	L	L
6.1>3	O	O	u	W			W	W	L	L	L
4.4>1	s	s	a		W		W	W	L	W	
3.3>1	e	e	a		W		W	W	L		
2.2>1	E	E	a		W		W	W	L		L
1.3>1	a	e	a		W		L	L	L		
3.3>4	e	e	x			W			L	L	
2.2>4	E	E	x			W			L	L	L
1.3>4	a	e	x			W	L	L	L	L	
2.2>3	E	E	e					W			L
6.1>2	O	O	o					W			L

Image 28. Tarragonian and Tortosan, L20 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	6:Lic[MidLax]	7:*Unstressed/low	8:NoSchwa	2:ID[high,low]	3:ID[high,low,ATR]	4:Lic-Nonperiph	5:*Unstressed/-high
4.4>5	s	s	i	W				W	W	L	
1.3>5	a	e	i	W				W	W	L	L
2.3>5	E	e	i	W				W	W	L	L
3.3>5	e	e	i	W				W	W	L	L
6.2>3	O	o	u	W				W	W	L	L
7.2>3	o	o	u	W				W	W	L	L
2.3>2	E	e	E		W				L		
6.2>1	O	o	O		W				L		
4.4>1	s	s	a			W		W	W	L	W
3.3>1	e	e	a			W		W	W	L	
2.3>1	E	e	a			W		W		L	
1.3>1	a	e	a			W		L	L	L	
3.3>4	e	e	x				W			L	L
2.3>4	E	e	x				W		L	L	L
1.3>4	a	e	x				W	L	L	L	L

Image 29. Unattested language, L7 ERC

WL Pairs												
ERC#	Input	Winner	Loser	4:Lic-Nonperiph	6:Lic[MidLax]	8:NoSchwa	2:ID[high,low]	3:ID[high,low,ATR]	5:*Unstressed/-high	7:*Unstressed/low	1:ID[high]
6.3>1	O	u	O	W	W		L	L	W		L
2.1>2	E	a	E	W	W		L	L		L	
1.1>3	a	a	e	W			W	W		L	
2.1>3	E	a	e	W			L			L	
3.5>3	e	i	e	W			L	L	W		L
6.3>2	O	u	o	W			L	L	W		L
7.3>2	o	u	o	W			L	L	W		L
4.5>4	s	i	s	W			L	L			L
1.1>4	a	a	x			W			L	L	
3.5>4	e	i	x			W	L	L			L
2.1>4	E	a	x			W	L	L	L	L	
1.1>5	a	a	i				W	W	L	L	W
2.1>5	E	a	i					W	L	L	W
3.5>1	e	i	a						W	W	L
4.5>1	s	i	a						W	W	L

Image 30. Unattested language, L10 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	3:ID[high,low,ATR]	6:Lic[MidLax]	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W	W	W				L	L
4.4>5	s	s	i	W	W	W			L		
3.3>5	e	e	i	W	W	W			L	L	
7.2>3	o	o	u	W	W	W			L	L	
2.4>5	E	x	i	W	W	W		L			
6.1>3	O	O	u	W	W	W	L		L	L	
1.1>3	a	a	e		W	W			W		L
4.4>1	s	s	a		W	W			L	W	W
3.3>1	e	e	a		W	W			L		W
2.4>1	E	x	a		W	W		L		W	W
2.4>3	E	x	e			W		L	W	W	
6.1>2	O	O	o			W	L				
2.4>2	E	x	E				W	L	W	W	
1.1>4	a	a	x					W		L	L
3.3>4	e	e	x					W	L	L	

Image 31. Unattested language, L11 ERC

WL Pairs											
ERC#	Input	Winner	Loser	1:ID[high]	2:ID[high,low]	6:Lic[MidLax]	3:ID[high,low,ATR]	8:NoSchwa	4:Lic-Nonperiph	5:*Unstressed/-high	7:*Unstressed/low
1.1>5	a	a	i	W	W		W			L	L
4.4>5	s	s	i	W	W		W		L		
3.3>5	e	e	i	W	W		W		L	L	
6.2>3	O	o	u	W	W		W		L	L	
7.2>3	o	o	u	W	W		W		L	L	
2.4>5	E	x	i	W	W		W	L			
1.1>3	a	a	e		W		W		W		L
4.4>1	s	s	a		W		W		L	W	W
3.3>1	e	e	a		W		W		L		W
2.4>1	E	x	a		W		W	L		W	W
2.4>2	E	x	E			W		L	W	W	
6.2>1	O	o	O			W	L				
2.4>3	E	x	e				W	L	W	W	
1.1>4	a	a	x					W		L	L
3.3>4	e	e	x					W	L	L	

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