A production account of sound changes affecting diphthongs and triphthongs in Romance*

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This paper is an investigation of processes of sound change (i.e., assimilations, dissimilations, elisions) affecting diphthongs and triphthongs derived from Latin mid low vowels in Romance. This analysis is carried out with reference to the Degree of Articulatory Constraint model of coarticulation according to which adaptation effects between consecutive segments in the speech chain, as well as their regressive or progressive direction, are determined by the requirements imposed by speakers upon the articulatory structures. Several findings are consistent with this theoretical framework, namely, assimilatory vowel raising in diphthongs and triphthongs appear to be facilitated by a homorganic onglide in accordance with the prominence of the carryover effects associated with the articulatory gestures for /j/ and /w/, and dissimilatory vowel lowering is not prone to be implemented in rising diphthongs with a (mid) high front vowel perhaps since the production of these diphthongs involves high articulatory demands.

Keywords: Regressive and progressive segmental adaptation, articulatory constraint, diphthongization, assimilation, rising and falling diphthongs, triphthongs, dissimilation, segmental absorption

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I. Introduction

1. Research goal: Sound change mechanisms in diphthongs and triphthongs

This paper is a study of the phonetic evolution of diphthongs and triphthongs and a contribution to modelling sound change in context. While predictions about vowel inventories out of context are quite accurate (Liljecrants & Lindblom 1972, Schwartz, Boë, Vallée & Abry 1997), contextual factors need to be taken into account in attempts to model the historical evolution of vocalic segments (de Boer 2001). For that purpose, the present study carries out an investigation of those processes affecting the vowel nucleus and the glides in vocalic sequences resulting from conditioned and spontaneous diphthongization of stressed vowels in Romance.

Several processes may be identified in this respect, i.e., the substitution of the vowel nucleus or the glide through assimilatory and dissimilatory mechanisms, and the simplification of vocalic sequences through glide elision or absorption by the vowel.

Assimilatory and dissimilatory changes contribute to a greater phonetic proximity and differentiation between segments which are adjacent (such as the vowel nucleus and the glides in diphthongs and triphthongs) or else located further away from each other in the speech chain. Both processes make explicit reference to context in such a way that the final phonetic outcome will turn out being more similar or more dissimilar with respect to the triggering contextual segment than the target segment subjected to change.

A widespread view is that segmental assimilation conveys a gain in articulatory economy, i.e., more facility of movement and economy of effort (Heffner 1950) and a reduction of the distance between two articulatory targets through minimization of energy expenditure (Lindblom 1983). It has also been proposed that assimilatory processes may be accounted for on perceptual grounds according to the following assumptions: they affect those consonant classes which are least distinctive perceptually (Hura, Lindblom & Diehl 1992) and may be motivated by hypocorrection when the listener fails to blame the triggering contextual segment for a coarticulatory distortion in the target phoneme (Ohala 1981).

Traditionally, dissimilations have been viewed as separate processes from assimilations in so far as they are perceptually driven and more asystematic. Their implementation is based on the need to achieve maximal perceptual distinctiveness (Labov 1994, Millardet 1910) or else on hypercorrection when the listener assumes erronously that a given sound has been distorted by context (Ohala 1981). Other authors have hypothesized that articulatory and phonological constraints also play a role in dissimilatory processes. Thus, according to Posner (1961), consonants more prone to replace other consonants are also 'stronger' and thus, more easily produced and/or perceived and often more familar in the phonemic system of a language, e.g., dentals vs. labials, and /l/ and /r/ vs. /d/.

Of much relevance to the assimilatory and dissimilatory forces acting in the evolution of diphthongs are those articulatory, acoustic and auditory factors which help to shape their phonetic structure. It has been stated in this respect that diphthongs are favored according to the degree of sonority of their nuclei, which is correlated with F1 and oral opening degree; indeed, variation along the height dimension would explain why diphthongs with low vowels occur more frequently than those with mid vowels and why sequences such as /uj/ and /iw/ are so rare in the languages of the world (Lindblom 1986). Moreover, Donegan has claimed that phonetic optimization in diphthongs is also achieved through other mechanisms such as (de)palatalization, (de)labialization and tensing (Donegan 1978). Some of these changes involve fronting and ought to be associated with F2 trajectories linking the vowel nucleus and the glide (Fox 1983, Ren 1986).

Sound changes affecting vocalic sequences may also yield the elimination of the glide component through absorption or elision depending on whether the vowel nucleus and the glide share all basic articulatory properties or not. Both processes are in accordance with glides being shorter and more transient than vowels and may be accounted for within a production framework such as Articulatory Phonology (Browman & Goldstein 1989, 1992a). Within this framework, segmental absorption results from complete overlap between two realizations of the same gesture differing in relative amplitude (e.g., /ow/ > *o*); elision, on the other hand, may be viewed as the natural consequence of maximal gestural reduction.

2. Theoretical framework

2.1 Articulatory modelling

A problem with the accounts of segmental adaptation and differentiation presented so far is that they cannot predict very well which sequences are more prone to undergo assimilation or dissimilation. Failure to make such predictions may be partly due to the generality of concepts such as ease of articulation, perceptibility gain, phonemic strength, and so on. Moreover the fact that diphthongs may undergo assimilatory raising and exhibit (mid) high vowel nuclei renders a pure perceptual account problematic. Trajectories connecting the glide and the vowel may be often short, i.e., for /ej/ and /ow/, which is not consistent with the notion that speakers attempt to maximize distinctiveness when uttering diphthongs (Maddieson 1984). A related objection is that the propensity of segmental sequences to undergo dissimilation or not may depend on production requirements rather than on specific perceptual strategies; thus, as pointed out in the *Discussion* section, the failure of vowel nuclei to become more different from the preceding glide in some rising diphthongs but not in others (e.g., in the case of /je/ vs. /jɛ/) may be conditioned by the degrees of articulatory constraint involved.

For all these reasons, it is hypothesized that articulatory factors may play a role in assimilatory and dissimilatory changes affecting diphthongs and triphthongs which calls for a joint interpretation of both types of processes within a general production framework. According to this approach, speakers would assimilate or dissimilate consecutive phonetic segments so as to facilitate their realization if they are too distant or too similar, respectively. It has been suggested that the size and form of CV inventories is governed by an analogous principle (Lindblom et al. 1995, Lindblom, MacNeilage & Studdert-Kennedy 1983): perceptually distinctive sequences will only be selected as optimal if easier to produce at acceptable articulatory costs, e.g., syllables such as /ɟi/ and /gu/ are preferable to /ɟu/ and /gi/ since the former exhibit shorter movements than the latter.

In our view, an articulatory investigation of those two classes of sound change processes ought to be conducted with reference to the predictions of the DAC ('degree of articulatory constraint') coarticulation model (Recasens, Pallarès & Fontdevila 1997, Recasens 1999). According to this model, vowels and glides (other consonants are not relevant to the present investigation) may be characterized as more or less constrained depending on the articulatory requirements involved in their production. Regarding vowels, the DAC value should be high for /i/ and decrease in the progression /i/ > /e/ > /ɛ/ since forming a palatal constriction prevents a raised and fronted tongue dorsum from adapting to the adjacent phonetic segments to a large extent; on the other hand, a relatively inactive tongue front for labiovelar /u/, upper pharyngeals /o/ and /ɔ/ and lower pharyngeal /a/ explains why these vowels turn out to be less constrained at the tongue predorsum than palatal vowels and may coarticulate with consonants at this tongue region; finally, /ə/ is specified for a minimal DAC value and is highly sensitive to coarticulatory effects since it involves little or no tongue body activation (see however Browman & Goldstein 1992b). Differences in lip protrusion for labial vs. nonlabial vowels cause the former to be more constrained than the latter at the lips, and a narrower constriction for /j/ and /w/ than for /i/ and /u/ renders the two glides more constrained and more resistant to coarticulatory effects than their vowel correlates (Lehiste 1964, Recasens 1985).

A basic prediction is that segments which are less constrained ought to assimilate to or be absorbed by those which are more constrained. Thus, e.g., since high vowels and glides are more constrained than lower vowels, the former ought to resist lowering to a larger extent than the latter resist raising. Also, glides ought to influence vowel nuclei rather than vice versa in line with differences in DAC degree between glides and vowels sharing the same place of articulation (see above) and with the fact that C-to-V coarticulatory effects are generally larger and more extensive than V-to-C effects (Recasens 1985). Vowel dissimilation in diphthongs and triphthongs could also be conditioned by an analogous principle, supposing that the high articulatory demands associated with /j/ and /w/ prevent the vowel nucleus from becoming too different from the glides. Articulatory overshoot, i.e., the intensification of a given articulatory property during one or more successive phonetic segments (e.g., palatality in the VCV sequence /iɲi/ or in the triphthong /uei/, Recasens 1984, Ren 1986), should also play a relevant role in assimilations and dissimilations to the extent that it causes an increase in degree of articulatory constraint to occur.

Moreover, a detailed characterization of the sound changes in question will allow us to formulate valid hypotheses about those articulatory structures which render segmental adaptation possible. Thus, while vowel raising in homorganic sequences may be attributed to tongue body and lip activity (e.g., *jɛj* > *jej*, *wɔw* > *wow*), the finding that front vowels may raise in the context of /w/ while back rounded vowels may do so in the adjacency of /j/ is in support of the possibility that vowel raising is largely determined by the jaw (see Keating et al. 1994). Otherwise, /j/-dependent tongue body fronting should cause back rounded vowels to front rather than to raise, and /w/-dependent labialization and tongue postdorsum raising should cause front unrounded vowels not to raise but to round and back (or to lower, given that /w/ has a very low F2 frequency locus).

Within this articulatory framework, another important issue is the phonetic outcome of sequences composed of vocalic segments implemented through antagonistic and highly constrained gestures, such as /w/ followed by a front unrounded vowel or by an open vowel or else /j/ before a back rounded vowel. The prediction is that speakers will favor the simplification of the vocalic sequence rather than the adaptation of one segment to the next in this case (i.e., *we* > *e*).

2.2 Directionality patterns

Another objection to theories dealing with segmental adaptation processes is that they make no explicit claims about whether such processes should favor the regressive or progressive direction. Extensive data from the literature reveal that assimilations and dissimilations do not always proceed from right to left in anticipation of the upcoming phonemes in the speech chain. Indeed, they may also be progressive, proceeding from left to right, which has been traditionally associated with gestural carryover and articulatory inertia. Modelling of directionality patterns should also apply to instances of glide absorption by the vowel nucleus to the extent that they are related to V-to-C coarticulation as well.

An important component of the DAC model is that it deals with the regularities underlying the regressive or progressive direction of sound change processes based on information about the gestural constraints for consecutive segments and the coarticulatory effects associated with them. Two main directionality trends are expected to hold in diphthongs and triphthongs. On the one hand, /j/ and high front vowels should cause more progressive than regressive sound changes to occur, or else equally salient progressive and regressive substitutions and absorptions, in view of extensive data from the literature showing that the articulatory activity associated with the tongue dorsum raising and fronting gesture for palatal consonants extends a great deal onto the two adjacent vowels but mostly so onto the following one (Recasens 1999). On the other hand, the glide /w/ and back rounded vowels should favor regressive over progressive changes given that coarticulatory effects associated with lip rounding are typically anticipatory (Farnetani 1999).

Jaw coarticulation effects do not appear to show clearcut directionality trends (Fletcher & Harrington 1999). Some insight into patterns in C-to-V jaw coarticulatory direction may be obtained from contextual variation in F1 frequency which is correlated with jaw height and oral opening degree (Lindblom 1971, Wood 1982). These coarticulatory patterns suggest that mandibular effects on low vowels as a function of most consonants (as well as effects on high vowels as a function of consonants involving a high jaw — alveolars, palatals) may favor the carryover direction. This may happen in line with the massive nature and slow dynamics of the jaw; on the other hand, effects on high vowels appear to be anticipatory rather than carryover if associated with consonants produced with a lower jaw (dark /l/, velars, bilabials) (Recasens & Pallarès 2000).

3. Material to be analyzed

An evaluation of the relevant patterns of segmental assimilation, dissimilation, absorption and elision will be carried out for vocalic sequences generated by conditioned and spontaneous diphthongization in Romance.

Conditioned diphthongization in Romance is a regressive process which has yielded the rising diphthongs *jɛ/e* and *wɔ/o* from stressed /ɛ/ and /ɔ/ in open and checked syllables. It is associated with an immediately following palatal consonant in several dialectal areas (French, dialects of N. Italy, Occitan, Francoprovençal and Romansh, and presumably Catalan, Leonés and Aragonés) and with a following bilabiovelar consonant in a subset of them (Occitan, French). It may be claimed that tongue raising or labialization for the production of these contextual segments has caused a premature inflection at the onset of the stressed mid low vowel and, thus, a high glide to show up at this specific temporal point. Conditioned rising diphthongization of stressed /ɛ/ and /ɔ/ has also been triggered through regressive metaphony by a word-final high vowel in Rhaetoromance and in dialects of N./S. Italy, and also by a word-final open vowel in Romanian.

Spontaneous diphthongization in Romance may give rise to rising and falling diphthongs from any vowel. Rising diphthongs correspond to original nonhigh vowels (i.e., /e/ > *je*, /ɛ/ > *jɛ*, /o/ > *wo*, /ɔ/ > *wɔ*, /a/ > *j/wa*) and, if derived from /ɛ/ and /ɔ/, occur in open and checked syllables in Spanish, Vegliote, Wallon and Friulian, or just in open syllables in N./C. Italian, Ladin, French and Francoprovençal. On the other hand, falling diphthongs may go back to any original vowel (i.e., /i/ > *ij*, /u/ > *uw*, /e/ > *ej*, /ɛ/ > *ɛj*, /o/ > *ow*, /ɔ/ > *ɔw*, /a/ > *aj*, *ɛw*), and occur most frequently in open syllables whether derived from /e/ and /o/ in French, Rhaetoromance, Vegliote, N./S. Italian and Francoprovençal, or from /i/ and /u/ in S. Italian, Romansh and Vegliote.

The fact that the spontaneous rising diphthongization of /ɛ/ and /ɔ/ is found in Spain, France and Italy suggests that it originated in Late Latin already (Pope 1934). Moreover, mid high vowel diphthongization in General French and in other territories where Germanic influence was strong (N. Italy, Rhaetoromance dialects) parallels an analogous process in English where lengthened stressed vowels have led to vowel offset closing. However, according to Schürr (1970), spontaneous diphthongization could be reminiscent of an ancient, generalized situation of conditioned diphthongization through vowel metaphony in at least some Romance areas, e.g., in the Italian Peninsula where the process may have started in open syllables in the context of high vowels and extended to closed syllables later on (Maiden 1995). It is also possible that the articulatory characteristics of the preceding consonant have contributed significantly to the generation of an onglide from /ɛ/ and /ɔ/ (and a similar rationale may account for the presumed influence of a following consonant in the generation of offglides). Thus, for instance, falling F2 vowel transitions resulting from an increase in labial or dorsovelar constriction narrowing at vowel onset or from tongue dorsum lowering and retraction before /l/ and /rr/ at vowel offset may account for phonetic variants such as *pwónte*, *kwónde* in Portuguese from Porto (Schürr 1970: 101) and *pjɛlo*, *pjálo* PILA *téa̯rra*, *tjárro* TERRA in Occitan (Ronjat 1930: 135, 157).[1]

An interesting issue is the relationship between rising diphthongs and falling diphthongs with a more open glide than the vowel nucleus (e.g., S. Italian, Francoprovençal *ie̯/ə̯*, *uo̯/ə̯*, Leonés *íe/a*, *úe/a*, Rhaetoromance *ɛə̯*, *ɔə̯*). The most accepted view is that rising diphthongs evolved from their falling counterparts through gradual raising of the vowel nucleus, e.g., /æ/ > *ɛːə* > *eːə* > *iːə* > *je* (Labov 1994), and /ɛ/ > *eɛ̯* > *iɛ̯* > *iə̯* > *je* and /ɔ/ > *oɔ̯* > *uɔ̯* > *uə̯* > *uɛ̯* > *we* (Donegan 1978 for Spanish). This belief is based on the argument that, while tense or higher vowels are prone to turn into upgliding or outgliding diphthongs, lower or lax vowels are most susceptible to ingliding or downgliding. Dialectal data showing mid low vowel breaking into falling diphthongs may be adduced in support of this hypothesis (e.g., Romagnol *nɔ*^{a}*ster*, *kɔ*^{a}*l*, *me*^{ə}*l*, *e*^{ə}*rba*, Schürr 1971: 127, 129, 147, Straka 1959). The alternative view is that falling diphthongs with an open glide derive from rising diphthongs, whether because the latter came into place first through metaphony (Schürr 1970) or because they were spontanously generated in favorable prosodic or contextual conditions (e.g., Occitan from Ariège *defwɔra*, *mwɔrt*, Séguy 1954, Walsh 1975).

1. A following palatal element may have blocked the spontaneous diphthongization of a mid low vowel perhaps because the vowel was too close to undergo diphthongization. This action may be extensively illustrated in Spanish (Menéndez Pidal 1968), e.g., before original /ʎ/ (*réxa* REGULA, *óxa* FOLIA), /j/ (*poléo* PULEGIU, *pójo* PODIU), /tʃ/ (*létʃo* LECTU, *nótʃe* NOCTE).

4. Linguistic implications

While much effort has been devoted to the phonetic and phonological constraints shaping universal vowel systems (Liljencrants & Lindblom 1972, de Boer 2001), less attention has been paid to the role of production and perception strategies in sound change processes affecting vocalic sequences. There is much need for such research since human speech consists of syllables and segmental sequences, and sound changes occur because speech sounds appear in context (see de Boer 2001: 135–136 regarding these claims). Partial exceptions are Donegan (1978) and Labov (1994), where processes affecting vocalic sequences are accounted for based mostly on the inherent properties of vowel systems as well as on the feature specifications and the perceptual characteristics of vowels. Within this framework, this paper attempts to reconstruct the stages in the evolution of diphthongs and triphthongs from early to present-day Romance, and to find out whether the regularities underlying sound changes in vocalic sequences conform to the predictions of the degree of articulatory constraint model.

While using data for Romance, the present study is a contribution to the knowledge of those sound change mechanisms affecting vocalic sequences in other language families, and ought to be of use to phonologists and to psychologists working on the acquisition of phonology. The rationale for this interest lies in the fact that our analysis of sound change patterns is carried out on a large set of data from different Romance dialects. Thus, while individual examples could be idiosyncrasies of the informants or misperceptions by investigators, it is believed that the large data sample used in the present paper point consistently to certain general trends of universal validity. On the other hand, those patterns are evaluated against a model of production constraints which suggests that frequent assimilations, dissimilations and elisions in our database should correspond to natural processes of sound change.

II. Data

1. Methodological issues

The analysis presented in the *Discussion* section is based on the derivations listed in Section II.2. These derivations are by no means exhaustive, and have been reconstructed from available data in the literature and information from

Romance philologists. All sound changes appearing in Sections I.1, II.1 and II.2 have been proposed by specialists in the field who are referred to within parentheses at the relevant places; thus, for example, the evolution *jɛj* > *jej* and *jej* > *i* in the first paragraph of Section II.2.1.1 have been suggested by Nauton, Duraffour, Pope and Lausberg for different Romance languages or dialects. Phonetic symbols from other sources have been adapted to IPA symbols.[2] Preference is given to phonetic variants from specific dialectal domains, namely, Occitan in the case of vocalic sequences resulting from conditioned diphthongization and Italo-Romance in the case of vocalic sequences generated by spontaneous diphthongization.

Diphthongs with an open glide and instances of conditioned diphthongization induced by a high vocalic element through regressive metaphony will not be taken into consideration. Conditioned diphthongs in Latin words ending in -CUM have been included, however, partly because of the similarity of their derivations with those triggered by contextual /w/ but also in view of the uncertainty of the contextual trigger itself (i.e., either U after the loss of word-final M, or otherwise a transitional glide *w* inserted between the stressed vowel and the following velar consonant as in **fówgo* FOCU > **fwówgo* > *fwógo*; see Bouvier 1976: 317).

Regarding conditioned diphthongization, it is assumed that /j/ has been present as an independent segment in the triggering palatal consonant and therefore that vowel breaking has taken place in syllables checked by the glide. It may be the case however that this consonant involved a single articulatory gesture at the time that vowel inflection still existed. Thus, for example, Latin sequences where the palatal glide was adjacent to /n/ or /l/ may have been realized *ɲ* and *ʎ* before vowel diphthongization took place in line with the fact that they have left no traces of *j* in the Romance languages (e.g., Lombard *vjetʃ* VECLU, Cat.[3] *áɲə* suffix -ANEA, Rohlfs 1966: 115, Badia 1951: 205). On the other hand, the phonetic outcomes of KT and KS may still keep the onglide *j*, which

2. Rhotics are transcribed with the symbol *r* for the simple correlate and with *rr* for the trill. The so called French "*e* muet" has been adapted as a mid high, mid low or mid high-mid low rounded vowel depending on the case.

3. Several language and dialect abbreviations are used throughout the paper: Cat. (Catalan), Fr. (French), Francoprov. (Francoprovençal), Friul. (Friulian), Gasc. (Gascon), It. (Italian), Lad. (Ladin), Leng. (Lengadocian), Occ. (Occitan), Pic. (Picard), Port. (Portuguese), Rhaet. (Rhaetoromance), Rom. (Romanian), Rosh. (Romansh), Sard. (Sardinian), Sp. (Spanish), Vegl. (Vegliote), Wal. (Wallon).

may be taken to support the presence of this vocalic element at earlier evolutionary stages (i.e., W. Cat. *ʎɛjt* LACTE, *ejʃ* AXE, Badia 1951: 127, 195).

The consonants immediately preceding or following the target vowel may also have intervened in the diphthongization process, either causing the simplification of a diphthong or else preventing diphthongization or diphthong simplification from occurring. Regarding the former option, /n/ and /l/ may have undergone palatalization before a palatal onglide (Leng. *ɲɔtʃ* NOCTE, *ʎɛj* LECTU, Ronjat 1930: 386). As for the latter, /ɔ/ may have stayed rather than yielding *wɔ* after word initial /pl/ or may have regressed to the original vowel through the stages /ɔ/ > *wɔ* > *ɔ* in the same contextual conditions (Occ. *plɔjo* PLOIA, Ronjat 1930: 184, Bouvier 1976: 328). On the other hand, *we* may have failed to undergo regular monophthongization after a velar or a labial (Lad. *kwéjsa* COXA as opposed to *féʎa* FOLIA, *eʎ* OCLU, Leccese *mwej* '*muovi*', *bwénu* '*buono*' as opposed to *ʃéki* '*giuochi*', *déli* '*duoli*', Guarnerio 1918: 249, 255). The action of the adjacent consonants on the evolution of onglides and offglides will not be addressed in the present paper; thus, for example, the loss of *j* or *w* will be attributed to straight elision or absorption by the vowel nucleus if the glide and the vowel happen to share basic articulatory properties.

Only those phonetic variants which developed from previous diphthongs or triphthongs will be dealt with. Thus, e.g., the rising diphthong *wo* derived from /o/ (San Fratello in Sicily *bwóka* BUCCA, Rohlfs 1966: 96) does not show up in Section II.2 since it does not appear to have undergone any changes, and the outcome *aj* from /a/ (Pugliese *krájpə* CAPRA, Rohlfs 1966: 42) has not been included in Section II.2.2.2 for the same reason. Nor will reference be made to contextual phonetic forms which have come to exist after conditioned or spontaneous diphthongization has applied, e.g., in Friulian, where *jɛ*, *wɛ* developed spontaneously from /ɛ/ and /ɔ/ have yielded *ja*, *wa* before a contextual rhotic (Friul. *fjár* FERRU, *fwart* FORTE, Iliescu 1972: 36, 38).

The phonetic variants appearing in the derivations are usually exemplified with lexical forms from Romance languages and dialects to which the Latin source is usually appended. A given vowel, diphthong or triphthong may appear more than once in the same derivation, e.g., *ø* in the derivation of Section II.2.1.3. Mid high and mid low vowels are often found in alternation, e.g., *ɛ/e* and *ɔ/o* alone or in diphthongs in the derivation of Section II.2.1.3; in many of these alternations, one of the vowels may be considered to be derived from the other one, generally *e*, *o* from *ɛ*, *ɔ*.

2. Derivations

2.1 Conditioned diphthongization (triggering closing consonant)

2.1.1 *Mid low front vowel before a palatal*

jɛ/ej	>	ej, i						
	>	jaj	>	jɛj	>	jɛ		
			>	jɔj	>	jøj	>	jø
			>	ja				
	>	ɛj	>	aj	>	oj		
	>	je	>	e				
	>	jɛ						

The original triphthong (Occ. *ljɛjt* LECTU, Ronjat 1930: 154) may change its nucleus into a higher or a lower vowel. Two consecutive vowel raising processes, i.e., *jɛj* > *jej* and *jej* > *i*, have been suggested for Occitan (see Nauton 1974: 96–98, e.g., *sjejs* SEX, *serízo* CERESIA in Haute Loire), Francoprovençal (see Duraffour 1932: 177–178, e.g., *si* SEX in Bas-Valais), Old French (see Pope 1934: 162–163, e.g., *lit* LECTU), and Romansh and Catalan (see Lausberg 1970: 255–257, e.g., *sis* SEX). Vowel lowering followed by raising towards a back rounded vowel, i.e., *jɛj* > *jaj* > *jɔj* and *ɛj* > *aj* > *oj*, has also been proposed for Occitan (see Nauton 1974: 96–98, e.g., Haute Loire *laj*, *loj* LECTU), as well as for Francoprovençal where *jaj* may also raise to *jɛj* and *jɔj* may front to *jøj* (see Duraffour 1932: 177, e.g., Vaux *mjaj*, *mjɔj*, *mjɛ*, *mjø* MEDIU).

Onglide and offglide absorption may yield several final outcomes: *ɛ/ej*, *jɛ/e* from *jɛj* and *e* from *je* in Occitan (see Nauton 1974: 96–97 and Bouvier 1976: 319–321, e.g., Haute Loire *lej*, *lje*, *ljɛtʃ* LECTU and Drôme *mje*, *me* MEDIU, *sɛj*, *se* SEX), *jɛ*, *ja* and *jø* from *jɛj*, *jaj* and *jøj*, respectively, in Francoprovençal (see Duraffour 1932: 177, e.g., Vaux *mja*, *mjɛ*, *mjø* MEDIU).

2.1.2 *Mid low front vowel before /w/*

jɛ/ew	>	iw	>	ju		
	>	jɛ/eɥ	>	jɛ/ej	>	i
			>	jœ/øɥ	>	jœ/ø
	>	jøw	>	jø		
	>	jow	>	jo		
	>	jaw	>	jɔ/ow	>	jɔ/o

Literature sources document the raising, rounding and lowering of the vowel nucleus in the original triphthong *jɛw* (Drôme *mjɛw* MEU, Bouvier 1976: 313).

Vowel raising yields *jew* (Occ., Gasc. *mjew* MEU, Lausberg 1970: 250, Rohlfs 1970: 118). An additional raising process may cause *jew* to become *iw*, *ju* in Occitan (see Nauton 1974: 83 and Bouvier 1976: 313, e.g., *diw*, *dju* DEU) and Sutselvan Romansh (see Luzi 1904, e.g., *miw* MEU, *ju* EGO), and *iw* in N. French and Gascon (see Pope 1934: 488, Goosen 1970: 55–57, Rohlfs 1970: 118). Otherwise, there may be offglide fronting (e.g., Basse Auvergne *jɛɥ* > *jɛj* EGO, Dauzat 1938: 90) followed by vowel nucleus raising and triphthong simplification into *i* (see Nauton 1974: 83–84, as in Haute Loire *djej* > *dʲi* DEU).

Mid front vowel rounding and subsequent offglide absorption may occur after offglide fronting in Occitan, i.e., *jɛ/ew* > *jɛ/eɥ* > *jœ/øɥ* > *jœ/ø* (see Nauton 1974: 84 and Ronjat 1930: 373 as for *jøɥ* EGO in Ambertois, and Dauzat 1938: 89–90 as for *dʲœɥ* DEU in Vinzelles and *jœ* EGO in Puy-de-Dôme). In French, however, mid front vowel rounding appears to have taken place through the evolution *jew* > *jøw* > *jø* (see Pope 1934: 201, e.g., *djø* DEU). Moreover, in Basse Auvergne, the mid front vowel has undergone backing/rounding and thus yielded a mid back rounded vowel along the route *jew* > *jow* > *jo* (see Dauzat 1938: 89, e.g., *jow*, *jo* EGO).

The vowel lowering process *jɛw* > *jaw* appears to have taken place in Sutselvan Romansh (see Luzi 1904, e.g., *jaw* EGO) as well as in Occitan where the resulting triphthong *jaw* may have been affected by vowel rounding and offglide absorption later (see Ronjat 1930: 371–377, e.g., *djaw*, *djɔw* DEU, *mjɔ/o* MEU).

2.1.3 *Mid low back vowel before a palatal*

wɔ/oj	>	uj	>	yj	>	y		
			>	u				
	>	ɔ/oj	>	ɔ/o				
			>	øj	>	ø		
	>	wɔ/o	>	ɔ/o				
			>	ɥɔ/o	>	ɥø	>	ø
					>	jɔ/o		
	>	waj	>	wɛj	>	ɛj		
					>	wɛ/e	>	wi
			>	wa, aj				
	>	wɛ/ej	>	wɛ/e	>	ɛ/e		
					>	wœ/ø	>	œ/ø

	>	ɛ/ej	>	ɛ/e		
(> ɥɔ/oj)	>	ɥɛ/ej	>	ɥi	>	y
			>	ɛ/ej, ɥɛ/e	>	ɛ/e
			>	ɥœ/øj	>	jœ/øj > jœ/ø, œ/øj> œ/ø
					>	œj, ɥø
					>	ɥœ/øɥ > jœɥ > œɥ
			>	jɛ/ej	>	ɛ/ej, jɛ/e

The original sequence *wɔj* is still maintained in Occitan and the variant *woj* is documented in Gascon (Leng. *trwɔjɔ* *TROIA, Gasc. *gwojt* OCTO, Ronjat 1930: 173, 178). In Gascon, *woj* may have raised and possibly fronted its vowel nucleus followed by offglide elision or absorption, i.e., *woj* > *uj* > *u*, *y(j)* (see Coromines 1990: 22–23, Rohlfs 1970: 120–121, e.g., *trújo*, *trýje* TROIA, *hýʎe* FOLIA, *kuʎ* COLLIGIT). Vowel raising to *uj*, *u* has also taken place in Catalan (see Coromines 1974: 249, e.g., *bujt* VOCITU, *fúʎə* FOLIA) and Sutselvan Romansh (see Luzi 1904: 787, e.g., *kújsa* COXA).

Another possible change involves the simplification of the triphthongs *wɔj* and *woj* through onglide absorption or offglide elision. Onglide absorption has applied to diphthongs with a palatal offglide in Occitan and Francoprovençal (see Bouvier 1976: 327–329 and Gardette 1941: 243–244, as for Occ. *plɔjo*, *plo* PLOIA, Francoprov. *nɔj*, *nɔ*^{e} NOCTE). Subsequently, the assimilatory action of the offglide may have caused the resulting vowel to front (see Pignon 1960: 151–161, e.g., Poitevin *nø* NOCTE). Offglide elision, on the other hand, appears to have taken place before a palatal consonant (Gasc. *hwóʎe* FOLIA, Ronjat 1930: 178) and may precede other replacements: onglide absorption in Occitan and Fassa Ladin (see Bouvier 1976: 325–329 and Elwert 1943: 48–49, e.g., Occ. *fɔ/óʎo* FOLIA, Lad. *fwója*, *fó(j)a* FOLIA); onglide fronting followed by either *ɥ* unrounding (see Ronjat 1930: 171–172 and Rohlfs 1966: 139, as for Occ. *fjɔʎo* FOLIA, *njɔ* NOCTE, Liguria *kjótu* COCTU) or else vowel fronting and *ɥ* absorption in dialects of N. Italy and in French (see Parry 1997: 238, Rohlfs 1966: 13, 140 and Pope 1934: 202, e.g., Piedmont *øt* OCTO, Old Fr. *føʎə* FOLIA).

Francoprovençal shows the dissimilatory process *wɔj* > *waj*, and subsequent vowel nucleus raising and glide deletion or absorption (see Gardette 1941: 243–244, and Duraffour 1932: 67, 164, 168). Illustrative examples are *kwɔ/aj*, *kwɛ/e* COCTU, *pa/ɛj* PODIU (Gardette), *wa*, *waj* HODIE, *fwaj*, *fwe*, *fwi* FOLIU (Duraffour).

The original triphthong may also undergo vowel fronting/unrounding (Rosh. *kwéjsa* COXA, Old Fr. *fwéʎə* FOLIA, Guarnerio 1918: 249, Pope 1934: 162).[4] This process may have been followed by onglide elision either through *wε/ej* > *wε/e* > *ε/e* in Occitan and Gascon (see Bouvier 1976: 328–329, Rohlfs 1970: 120–121 and Ronjat 1930: 177, e.g., Occ. *kwεsa* COXA, *plεva* PLOIA, Gasc. *trwεjo* TROIA, *plwéjo* PLOIA, *εʎ*, *weʎ* OCULU, *nwεt*, *nε/et* NOCTE, *wet*, *wejt* OCTO), or through *wε/ej* > *ε/ej* > *ε/e* in Gascon and Poitevin (see Millardet 1910: 204–205, Rohlfs 1970: 120–121, Bec 1968: 107 and Pignon 1960: 161, as in Gasc. *nε/ejt* NOCTE, *kεjso* COXA). The back rounded glide may also cause vowel rounding to occur in Ladin and Romansh along the path *wε/e* > *wœ/ø* > *œ/ø* after which the output rounded vowel may unround again (see Elwert 1943: 48, Gartner 1910: 174 and Haiman & Benincà 1992: 50–52, e.g., *fwεja*, *fø/œa*, *féja*, *fi/eʎ* FOLIA).

A final series of changes affects the triphthong *ɥε/ej* (Occ. *plɥεjo* *PLOIA, *kɥéjso* COXA, Bouvier 1976: 323, 328) evolved from *wɔ/oj* through the developments *wɔ/oj* > *ɥɔ/oj* > *ɥε/ej* or *wɔ/oj* > *wε/ej* > *ɥε/ej* proposed by Ronjat (1930: 184) and Bouvier (1976: 328), respectively. They may be summarized as follows:

a. Vowel raising to *ɥi* in Old French (see Pope 1934: 163, e.g., *nɥit* NOCTE) as well as in Occitan where *ɥi* may have yielded *y* through stress shift (see Bouvier 1976: 323, e.g., *vɥi*, *vy* OCTO). Other derivations have been proposed for French, e.g., *wɔj* > *uj* > *yj* > *ɥi* (see Posner 1996: 289 and Pignon 1960: 161).
b. Glide absorption, which in Occitan accounts for the changes *ε/ej* > *e* (see Bouvier 1976: 325, 328, e.g., Trièves *kεjso* COXA, *kej*, *ke* COCTU) and *ɥε/e* > *ε/e* (see Ronjat 1930: 176, e.g., *nɥε/e*, *nε/e* NOCTE, *fεʎo* FOLIA).
c. Vowel nucleus rounding and subsequent substitutions involving one or both glides. Several evolutions of this sort are documented, namely, *ɥεj* > *ɥœj* > *œj* in Limousin (see Pignon 1960: 161), *ɥej* > *ɥøj* > *ɥø* in Vaucluse (*nɥø* NOCTE, Ronjat 1930: 176), *ɥε/ej* > *ɥœ/øj* > *jœ/øj* > *jœ/ø*, *œ/øj* > *œ/ø* in Drôme and Haute Loire (see Bouvier 1976: 323, 328, e.g., *fjœjo* FOLIA, *køso* COXA, and Nauton 1974: 89–90, e.g., *nɥœ/øjt*, *njœ/ø*, *nœ/øj* NOCTE), and *ɥœj* > *ɥœɥ* > *jœɥ* > *œɥ* in Basse Auvergne (see Dauzat 1938: 98–99, e.g., Vin-

4. It is commonly agreed upon that the mid front vowel has arisen from its mid back round counterpart in this case (Lausberg 1970: 250, 255, Grandgent 1905: 23). See also Sections II.2.1.4 and II.2.1.5.

zelles *vœɥ* OCTO, *dɛjœɥ* Fr. "dix-huit"). An analogous evolutionary path appears to have generated lexical forms such as *nø*, *nøj* NOCTE, *fjøj*, *fœ/øj* FOLIA in Northern France (Bruneau 1913: 186, Bloch 1917: 9, *ALW* 1953: 157).

d. Onglide delabialization followed by glide absorption, i.e., *ɥɛ/ej > jɛ/ej > jɛ/e*, *ɛ/ej*, in Occitan (see Nauton 1974: 90, e.g., *njejt*, *nje*, *nej* NOCTE, and Ronjat 1930: 175–176, e.g., *kɛjso* COXA, *fjɛjo* FOLIA, *njɛtʃ* NOCTE).

2.1.4 *Mid low back vowel before /w/*

wɔ/ow	>	wɛ/ew	>	ɛ/ew, jɛ/ew				
			>	(wœ/øw)	>	jœ/øw		
	>	uw	>	yw				
	>	ɔw	>	o				
	>	ɥɔ/ow	>	ɥu				
			>	jɔ/ow	>	jɔ/o	>	ju
					>	yw	>	jy
					>	jaw		
	(>	ɥɔ/ow)	>	ɥɛ/ew	>	ɛ/ew		
					>	ɥɛ/eɥ	>	ɛ/eɥ > œ/øɥ > œ/ø
								> ej
							>	jɛ/eɥ > jœ/øɥ, jɛj
					>	jɛ/ew	>	iw
							>	ɛ/ew > eɥ > øɥ > øj
							>	jɛ/eɥ > jɛ/ej > ji
								> jœ/øɥ > jœ/ø

In Gascon, the original triphthong may close or front/unround its vowel nucleus (e.g., *gwɔw*, *yw*, *wɛ/ew* OVU, *byw* BOVE, Ronjat 1930: 165, Millardet 1910: 208, Rohlfs 1970: 122). The latter substitution may be followed by onglide elision and unrounding both in sequences with a front unrounded vowel and in those with its rounded counterpart which is the typical realization of stressed /e/ in an area of W. Gascon (see Millardet 1910: 208, e.g., *wɛ/ew*, *wœ/øw*, *ɛ/ew* OVU, *bjɛ/ew*, *bjœ/øw* BOVE).

In Occitan, *wɔ/ow* may have regressed to a single back rounded vowel through glide absorption (see Bouvier 1976: 319, as in *bo* BOVE). Also, there may have been onglide fronting (*bɥɔw* BOVE, Ronjat 1930: 164, Bouvier 1976: 317) followed by other processes: vowel nucleus raising (see Bouvier 1976: 317, e.g., *bɥu* BOVE); onglide unrounding and subsequent offglide absorption and changes in vowel height, e.g., *bjɔ/ow*, *bjɔ/o*, *bjaw*, *bju*, *byw*, *bjy* BOVE (see Bouvier

1976: 319, Ronjat 1930: 164, Lafont 1983: 30).

Whether it applies before or after onglide fronting (i.e., *wɔ/ow* > *wɛ/ew* > *ɥɛ/ew* or *ɥɔ/ow* > *ɥɛ/ew*), vowel fronting/unrounding may give rise to several substitutions affecting both the glide and the vowel components:

a. Onglide absorption yielding *ɛ/ew* (see Ronjat 1930: 164–165, e.g., Leng. *bɛ/ew*).
b. Offglide fronting yielding *ɥɛ/eɥ* followed by vowel nucleus rounding and glide absorption or unrounding in Basse Auvergne (see Dauzat 1938: 92–94, e.g., *bɥeɥ*, *beɥ*, *bej*, *bœ/øɥ*, *bœ/ø*, *bjœ/øɥ*, *bjɛj* BOVE).
c. Onglide unrounding yielding *ɥɛ/ew* > *jɛ/ew*, followed by other changes to the vowel and the glide in Haute Loire and in other Occitan zones (see Nauton 1974: 85–86, e.g., *bjew*, *biw*, *bew*, *bøj*, *bjø*, *bjøɥ*, *bjej*, *bji*, and Ronjat 1930: 164–165, e.g., *bjɛw*, *bɛw*, *bjɛj*). This same evolutionary process appears to account for the forms *bjø* in the Vosges region (Bloch 1917: 11) and *bjeɥ*, *bjœ* in the Ardennes and Wallon (Bruneau 1913: 138, 198, 200, *ALW* 1953: 81).

2.1.5 *Mid low back vowel before -CU*

wɔ/o	>	u					
	>	ɥɔ/o	>	jɔ/o	>	ju	
	>	wɛ/e	>	wø	>	ø	
		(>ɥɔ/o)	>	ɥɛ/e	>	ɥi	> y
					>	ɥœ/ø	> jø, œ/ø
					>	ɛ/e	
wɔ/ow	>	wɛ/ew	>				
		(> ɥɔ/ow)	>	ɥɛ/ew	>	ɛ/ew	> œ/ø
					>	ɥœ/øw	> jøw > jø
							> ɥœ/øɥ > œ/øɥ > œ/ø(j)
					>	jew	> iw, ew, ju
					>	ɥiw	> y

The original diphthong is found in Occitan (*ʒwɔk* IOCU, Ronjat 1930: 169) and may undergo vowel raising in Gascon through an intermediate mid high back rounded vowel realization (*fuk*, Coromines 1990: 24). Onglide fronting gives rise to a front rounded glide which may then unround and cause the vowel nucleus to raise to *u* (see Ronjat 1930: 169–170 and Bouvier 1976: 317–319, e.g., *fɥɔk*, *fɥo*, *fjɔ/o*, *fju*). Another option is vowel fronting/unrounding (Gasc. *hwɛ/ek*, Rohlfs 1970: 121), after which the vowel nucleus may round in Ladin (see Haiman & Benincà 1992: 50 and Elwert 1943: 48, e.g., *føk*, *fek*, *fy*) and the onglide may front in Occitan (see Pignon 1960: 165 and Meyer-Lübke 1974: 191, e.g., *fwe*, *fɥe*). The outcome *ɥε/e* may be followed by changes affecting the glide and the vowel nucleus: vowel raising in Gascon presumably through *ɥi* (*hyk* FOCU, *dʒɥik* IOCU, Coromines 1990: 24, Rohlfs 1970: 121, Ronjat 1930: 169–170), onglide absorption in Occitan (see Meyer-Lübke 1974: 191, Bouvier 1976: 317, e.g., *fε/e* FOCU), vowel rounding and subsequent onglide unrounding or absorption in Occitan and Poitevin (*fœ*, *fɥœk* FOCU, *dʒœ*, *jɥøk*, *dʒjø* IOCU in Ronjat 1930: 169–170, *fjø*, *fø* in Pignon 1960: 163).

According to Pope (1934: 204), Goosen (1970: 78) and Guarnerio (1918: 250), French underwent the changes *wew* > *ɥew* > *ew* > *ø* (*fø*, *ʒø* FOCU, IOCU) or else *wew* > *ɥew* > *ɥøw* > *jøw* > *jø* (*ljø* LOCU). Phonetic derivations in N. French, i.e., *wew* > *ɥew* > *jew* > *iw*, *ew*, *ju* or else *wew* > *ɥew* > *ɥiw* > *y*, involve essentially vowel raising (see Pope 1934: 204 and Goosen 1970: 78 for *liw* LOCU, *few* FOCU in Old Picard, and Bruneau 1913: 206 for *fy*, *fœ* FOCU, *ljy* LOCU in the Ardennes). The former evolution also accounts for several outcomes of FOCU in Romansh, i.e., *fjewk*, *fewk*, *fiwk*, *fjuk* (Guarnerio 1918: 251, Meyer-Lübke 1974: 191–192, Haiman & Benincà 1992: 50–52). On the other hand, the phonetic variants *fœ/ø*, *fœ/øj* in the Vosges region must have been preceded by the intermediate form *ɥœ/øɥ* through offglide fronting (see Bloch 1917: 11).

2.2 Spontaneous diphthongization

2.2.1 *High offset (front vowels)*

i	>	ij	>	ej	>	e								
					>	εj	>	ɔj, aj						
					>	oj	>	uj	>	yj	>	y		
					>	øj	>	ø						
e	>	ε/ej	>	øj	>	ø								
			>	ε, e, i										
			>	œj	>	œ								
			>	aj	>	a								
			>	ɔ/oj	>	oɛ̯	>	wε	>	wa	>	wɔ	>	ɔ
									>	wo	>	o, u		
									>	wø	>	ø		
									>	ε				
					>	o								

ɛ	>	ɛj	>	aj	>	a
			>	øj	>	ø
			>	oj		

The front vowels *i*, *e* and *ɛ* in falling diphthongs with a palatal offglide may lower through the stages *ej*, *ɛj* and *aj*, e.g., S. E.It. *faréjnə* FARINA, *fɛjlu* FILU, *marájtə* MARITU, *prɛ/ájtə* PETRA, N. It. *kandéjla* CANDELA, *stɛjla* *STELA, *pajl* PILU (see Papa 1981: 85, Rohlfs 1966: 54, 79, 130). This evolution applies not only to dialects of Italy but also to Francoprovençal, Romansh and Vegliote (see Meyer-Lübke 1974: 61, 94, Haiman & Benincà 1992: 43–46).

Mid front vowel realizations of different origins may have undergone rounding or backing/rounding (see Papa 1981: 85, 139, Meyer-Lübke 1974: 61, 102). This has been so for *ej* derived from /i, e, ɛ/ and for *ɛj* derived from /e/, e.g., S. It. *vó/øjtə* VITA, *døtə* DIGITU, *fo/øjlə* FIDELE, Romagnol *tɔjla* TELA, Rosh. *durmójr* DORMIRE, *nɔjf* NIVE, *fɔj* FIDE (Rohlfs 1966: 54, 79, 130, Papa 1981: 235, Guarnerio 1918: 140, Lutta 1923: 65, 88). Vowel raising may apply to *ej* (Lad. *pil* PILU, E. Francoprov. *kri* from *krej* CREDIT, Meyer-Lübke 1974: 101–102, Jeanjaquet 1931: 40) and accounts for the outcome *y* of /i/ though the stages *ej* > *oj* > *uj* in Matera (see Rohlfs 1966: 54–55, e.g., *amýk* AMICU).

Other changes affect the glide component and, more specifically, involve absorption or elision of the offglide *j*. Those processes may have operated on Friulian *ej* (*nef* NIVE, Guarnerio 1918: 194, Iliescu 1972: 40–41), Francoprovençal *ɛj*, *aj* (*nɛ* NIGRU, *kra* CREDIT, *fávra* FEBRE, Meyer-Lübke 1974: 100–101, Jeanjaquet 1931: 40), S. Italian *aj*, *øj*, *yj* (*tsára* CIRA, *døtə* DIGITU, *amýk* AMICU, Papa 1981: 235, Rohlfs 1966: 55, Meyer-Lübke 1974: 94), Picard *oj* (*fro* FRIGIDU, Goosen 1970: 67), Vosges *oj*, *aj* (*sɔ* SITE, *dra* DIRECTU, Bloch 1917: 90–91), and Wallon *œj*, *oj* and Ardenne *aj* (*sœ*, *so* SITI, *da* DIGITU, *ALW* 1953: 255, Bruneau 1913: 141).

The falling diphthong *ej* derived from /e/ has also changed to *wɛ* through the dissimilated variant *oj* (Wal. *setwɛl* *STELA, Franche Comté *dwɛ* DIGITU, *swɛ* SITE, *ALW* 1953: 255, Bloch 1917: 92). Later on, *wɛ* may have given rise to other realizations involving vowel nucleus lowering, rounding or backing/rounding and subsequent onglide elision or absorption, i.e., *wa*, *ɛ* in French (*vwaʀ* VIDERE, *monɛ* MONETA, see Lausberg 1970: 224–225), *ɛ*, *ø* in N. and N. E. France (Vosges, Ardenne *sɛ* SITE, Franche Comté *etør* *STELA, Bloch 1917: 90, Bruneau 1913: 141, Dondaine 1972: 287) and *ɔ*, *wa*, *o*, *u*, *ø* in the Ardennes and Wallon (see Bruneau 1913: 141, 229, e.g., *tɔl*, *twal* TELA, *do*, *du*, *dø* DIGITU).

2.2.2 *High offset (back vowels)*

a			>	e	>	ej	>	ɛj	>	aj		
ɔ			>	ɔw	>	o						
					>	ɛw						
					>	aw	>	a				
o			>	ow	>	u						
					>	ɔw	>	aw	>	a		
					>	ew	>	øw	>	ø		
u	>	uw	>	o/ɔw	>	ɛ/ew, øw, aw						
				yw	>	iw	>	ju	>	jy	>	y, i
	>	y	>	øj	>	oj	>	o				

Mid back vowels in falling diphthongs with the offglide *w* may undergo raising, e.g., *ow* derived from /o/ in N. Italian (see Rohlfs 1966: 93–94, e.g., *fjur* FLORE) and E. Francoprovençal (*ówra*, *úra* HORA, Jeanjaquet 1931: 40). The change *ɔw* > *ow* followed by later replacements may occur in sequences with original /ɔ/ in S. Italian zones such as Abruzzo where the two mid back vowels merge into a mid high realization (Rohlfs 1966: 156).

Dissimilatory vowel lowering may apply to word-final diphthongs with a mid front vowel derived from /a/ in Ardenne, i.e., *nej* NASU yields *nɛj* and then *naj* (Bruneau 1913: 110, 132–133). Diphthongs derived from /u/ and /o/ may also undergo vowel lowering in dialects of Italy through the stages *ow*, *ɔw* and *aw*, e.g., C. It. *sɔwlo* SOLE, S. It. *fáwrnu* FURNU, *fó/áwsə*, *fɔwse* FUSU (see Papa 1981: 85, Rohlfs 1966: 62, 93, 97, Grassi, Sobrero & Telmon 1997: 103). A similar evolution affects /ɔ/ in S. Italian regions where this vowel has merged with /o/ (see Rohlfs 1966: 156, e.g., *bɔwnə* BONA, *váwvə* BOVE), as well as /y/ in Vegliote where the front rounded vowel has yielded *oj* presumably through *øj* (e.g., *ʒojn* UNU, Lausberg 1970: 236, Sánchez Miret 1998: 153). Lowering of *ow* (/o/) is also found in Francoprovençal zones (*áw/ɥra* HORA; Meyer-Lübke 1974: 136).

Other vowel substitutions involve rounding. Fronting/unrounding affects mid back rounded vowels in falling diphthongs whether derived from /o/ (Francoprov. from Val Soana *vews* VOCE, S. It. *séwlə* SOLE, Guarnerio 1918: 211, Rohlfs 1966: 99), /ɔ/ (S. It. *vɛwna* BONA, Friul. from Erto *nɛwf* NOVU, Rohlfs 1966: 156, Papa 1981: 220, 225, Haiman & Benincà 1992: 49) or /u/ (S. It. *féwsə* FUSU, *mɛwlə* MULA; Rohlfs 1966: 62, Papa 1981: 85, 132). It may also apply to *uw* which arose from /u/ and which has yielded *iw*, *jy*, *i* or *y* presumably through *yw* in Matera and other S. Italian areas (see Meyer-Lübke 1974: 78–79, Guarnerio 1918: 273, Rohlfs 1966: 61–63, Papa 1981: 230, e.g., *fýwmə* FUMU, *fíwsə* FUSU, *línə* LUNA, *venjúte*, *viníyt* VENUTU, *njyd* NULLU). Whether derived from /o/ or /u/, mid high front *e* may also undergo assimilatory rounding in the diphthong *ew*, i.e., *ew* > *øw* (Old Fr. *søl* SOLU, S. It. *føwsə* FUSU, Pope 1934: 201, Rohlfs 1966: 62).

Other changes affect the glide component. Thus, glides may drop or be absorbed by the vowel nucleus in diphthongs derived from /ɔ/ (Lad. *so* SOROR, Tagliavini 1926: 40–41), /o/ (Francoprov. *ára* HORA in Guarnerio 1918: 211, as well as Old Fr. *søl* SOLU reported above) and /u/ (Vegl. *tʃol* CULU in Lausberg 1970: 236, and S. It. *línə* LUNA mentioned above).

2.2.3 *High onset*

ε	>	jε/e	>	ε, e, i, ja				
ɔ	>	wɔ/o	>	u				
			>	ɥo	>	jo		
					>	ɥø	>	jø, ø
			>	wε/e	>	wø	>	ø
			>	wa				

The rising diphthongs *jε* and *wɔ* generated spontaneously from /ε/ and /ɔ/ (e.g., Tuscan *mjεle* MELE, It. *nwɔvo* NOVU, Rohlfs 1966: 104, 133) may undergo raising to *je*, *wo* (e.g., Drôme *pje* PEDE, Bouvier 1976: 309). The mid high version of this rising diphthong is also found in Spanish, French, Friulian and N. Italian (/ε/), and in Old Spanish and Old French (/ɔ/). Further raising of the vowel nucleus through a progressive assimilatory action yields the vowel outcomes *i*, *u*, e.g., N. It., Wal. *pi* PEDE, Friul. *piːt* PEDE, *pruːf* PROPE, Vegl. *pítra* PETRA, *nuf* NOVU, S. It. *kur* CHOR (Rohlfs 1966: 116–117, 147, *ALW* 1953: 219, Bruneau 1913: 137, Haiman & Benincà 1992: 48, Lausberg 1970: 226–232). In the light of these data, it seems to us that the changes *e* (/ε/) > *i* and *o* (/ɔ/) > *u* do not need to be implemented through intermediate falling diphthongs with an open glide (Duraffour 1932: 79, 97–98, Pope 1934: 488, Sánchez Miret 1998) or through more complex derivations (i.e., *jeː* > *jej* > *jəj* > *iː* and *weː* > *wew* > *wəw* > *uː* in Friulian, according to Francescato 1966: 136).

Changes affecting *jε* and *wɔ* involve other mechanisms. Those vowel sequences may undergo onglide absorption (e.g., *jε* > *ε* after a palatal consonant in the case of Italian *tʃεlo* CAELU, Sánchez Miret 1998: 78) and vowel lowering yielding *ja* and *wa* (Francoprov. *pja* PEDE, Vegl. *fjásta* FESTA, *dwármi* DORMIT, Occ. *kwa*, *kwɔl* COLLU, Duraffour 1932: 72, Lausberg 1970: 226–231, Bouvier 1976: 508). Also, the output *ø* may derive from *wɔ/o* by two different evolutions: onglide fronting followed by assimilatory vowel fronting and onglide unrounding and absorption (see Rohlfs 1966: 139–140 for N. It. *skjóra* SCHOLA, *prøva* PROVA, and Gardette 1941: 226 and Duraffour 1932: 98–99 for Francoprov. *sɥ/jø* SOROR, *nø* NOVU), vowel fronting/unrounding followed by vowel labialization and onglide absorption (Friul. *rwéde* ROTA, Sp. *nwéβo* NOVU, Leonés *pwørta* PORTA, Fr. *pø* POTET, Lad. *swe*, *sø* SOROR, Haiman & Benincà 1992: 52, Zamora Vicente 1989: 91–92, Menéndez Pidal 1986: 126, Pope 1934: 202, Tagliavini 1926: 40–41).

III. Discussion

1. Vowel height

1.1 General trends

(a) The derivations presented in Section II.2 show that the vowel nuclei in Romance diphthongs and triphthongs with /j/ and /w/ (also /ɥ/) may undergo two-way changes along the height dimension, i.e., they may lower if high (*i* > *e*; *u* > *o*; *y* > *ø*), raise if low (*a* > ɛ, ɔ), and lower or raise if mid (*e*, *o* > ɛ, ɔ > *a*; ɛ, ɔ > *e*, *o* > *u*, *i*). These substitutions conform to two basic patterns, i.e., vowel lowering is basically dissimilatory while vowel raising is assimilatory. Also, Middle English diphthongs with a high glide favor dissimilatory vowel lowering (*ii* > *e/əj* > *ɛj* > *aj*; *uw* > *o/əw* > *ɔw* > *aw*) and assimilatory vowel raising (*ja* > *jɛ* > *je/ə* > *ju*; *wa* > *wɛ*; *aw* > *ɛw*) (Ogura 1990). Therefore, there appears to be a trend to avoid two successive segments when they are high, and to assimilate a lower segment to a higher one rather than viceversa. This causes a decrease rather than a gain in vowel perceptibility in all cases. Both strategies are consistent with the notion that high vowels are specified for stricter tongue dorsum requirements and more coarticulatory resistance than low vowels, and may thus be accounted for by the DAC model.

The fact that changes along the height dimension affect the vowel nucleus rather than the glides (see also Donegan 1978) also support a production-based interpretation. Indeed, F2 coarticulation data in the literature show that both /j/ and /w/ allow little V-to-C coarticulation while exerting much C-to-V coarticulation, e.g., /j/ on low and back vowels and /w/ on front vowels (see *Introduction*). Data on jaw coarticulation also reveal that consonants involving a high jaw such as /j/ are least affected by jaw position for the adjacent vowels

(Keating et al. 1994); moreover, vowel-dependent effects in jaw height on /w/ should have little perceptual salience since this glide is produced with a fixed labial constriction irrespective of vowel context.

1.2 Assimilation

1.2.1 *Diphthongs*

a. According to data in Section II.2, assimilatory vowel raising takes place in diphthongs with a low or a mid vowel nucleus as a function of /j/, /w/ and the onglide /ɥ/, and may be regressive (*ɛj* > *ej* > *i*; *aj* > *ɔj* > *oj* > *uj*; *ow* > *u*) and progressive (*j/w/ɥɛ* > *j/w/ɥe* > *(j)/w/ɥi*; *wa* > *wɔ*; *w/jɔ* > *w/jo* > *(w)/ju*).[5]

Both the mandibular subsystem and the tongue and the lips can be made responsible for vowel raising in those diphthongs in which the glide and the vowel nucleus are homorganic, i.e., in vocalic sequences with /j/ and front vowels and in those with /w/ and back rounded vowels. This should be so since tongue dorsum height and lip constriction narrowing are to a large extent correlated with jaw height for the production of front vowels and of back rounded vowels; namely, raising the lower jaw causes tongue dorsum raising and lip constriction narrowing to occur. It is however the case that the vowel and the glide are not required to be homorganic for assimilatory raising to take place, i.e., rising and falling diphthongs may undergo front vowel raising adjacent to /w/ and back rounded vowel raising adjacent to /j/. This finding suggests that vowel height in diphthongs is largely ruled by jaw height and therefore that changes in F1 associated with oral opening degree probably play a crucial role in diphthong perception (see *Introduction*).

The summary presented above also suggests that height assimilations as a function of /w/ are more prone to affect mid vowels than low vowels perhaps since lip rounding for the glide is less prominent in the adjacency of the latter vs. the former (again, see also Donegan 1978). Indeed, assimilatory changes in the derivations of Section II.2 do not include the vowel shifts *w/ɥa* > *w/ɥɛ* (though *wa* may raise to *wɔ*, see II.2.2.1), *aj* > *ɛj* and *aw* > *ɔw*. Some of these substitutions may take place in vowel sequences of a different origin, e.g., *wa* > *wɔ* (Abruzzo

5. These strings of phonetic forms do not correspond necessarily to true derivations but may represent series of consecutive changes as they appear in Section II.2. Thus, for example, while the string *ɛj* > *ej* > *i* does not show up in Section II.2, the partial changes *ɛj* > *ej* and *ej* > *i* may be found in Section II.2.2.1. In some cases the entire string may operate all at once, e.g., *jɛ* > *je* > *(j)i* in the derivation of Section II.2.2.3.

ru kwónə '*il cane*', Tuttle 1985), *aj* > *ɛj* (Sp. *merino* MAJORINU, Menéndez Pidal 1968: 68), *aw* > *ɔw* (Fr. *autre* ALTERU, Cat. *poc* PAUCU, Lausberg 1970: 264, 277).

b. As indicated above, it appears that assimilatory vowel height in diphthongs may occur in both regressive and progressive directions. Vocalic sequences which did not arise from vowel diphthongization may also allow assimilatory raising along the two directions, i.e., regressive in the case of *ɛ/a/ɔj* > *e/ɛ/oj* (e.g., Sp. *seis* SEX, *mesón* MASIONE, Port. *noite* NOCTE, Menéndez Pidal 1968: 58, 68, Williams 1938: 36) and *ɛ/ɔw* > *e/ow* (e.g., Gasc. *hew* FEL, Fr. *moudre* MULGERE, Ronjat 1930: 149, Pope 1934: 202), and progressive in the case of *je* > *i* (e.g., Sp. *castillo* CASTELLU, *víspera* VESPERA possibly with the assistance of the following palatal or palatalizing consonant, Lloyd 1987: 505) and *ia* > *ie*, *ua* > *ue* (e.g., Mirandés *die*, *rue* for *día*, *rua*, Zamora Vicente 1989: 116).

If changes in vowel height in diphthongs are associated with mandibular variation, the directionality trends in assimilatory direction just described should conform to the existence of prominent C-to-V carryover and anticipatory effects in jaw height. Though scarce, available data on jaw and F1 coarticulation do not disconfirm this possibility (see *Introduction*). Regarding /j/, those patterns in assimilatory directionality are also consistent with the role of the tongue dorsum given that effects in tongue dorsum raising/fronting turn out to be prominent at the anticipatory and carryover levels. In principle, the fact that assimilatory vowel rounding in vocalic sequences with /w/ also takes place in both regressive and progressive directions is not in agreement with data on lip rounding coarticulation in the literature suggesting that carryover effects are shorter and more variable than anticipatory effects (see *Introduction*). Evidence from other sound changes is however in support of the progressive action of labial consonants and vowels and suggests that highly constricted realizations of /w/ may indeed exert prominent carryover effects, i.e., glide insertions (Judeo-Spanish *pwádre* PATRE, N. Port. from Sátão *vwĩɲo* VINU, Zamora Vicente 1989: 357, Leite 1987: 83), vowel assimilations (Rom. *fátə* FETA, Calabrese *fuscella* for *fiscella*, Lausberg 1970: 275, Rohlfs 1966: 169), and consonant insertions and absorptions (dial. Cat. *ków/və* CAUDA, *pow/v/βál* PUTEALE, *awrí* for *awβrí* OPERIRE, Recasens 1996: 199, 201, 302).

1.2.2 *Triphthongs*

Assimilatory raising also affects triphthongs with mid vowels independently of whether the two glides agree in fronting with the vowel nucleus or just one of them does. Regarding the former group, we find both changes *j/ɥɛj* > *j/ɥej* > *j/ɥi* and *wɔw* > *wow* > *wu*. Regarding the latter, raising affects triphthongs with a front onglide (*jɔw* > *jow* > *yw*; *ɥɔw* > *ɥow* > *ɥu*; *j/ɥɛw* > *j/ɥew* > *(j)/ɥiw)* rather than those with a back onglide (*wɔj* > *woj* > *uj* only). Triphthongs with a low vowel nucleus undergo raising if the vowel is flanked exclusively by /j/ (*jaj* > *jɛj*, *jɔj*) and in the case of *jaw* (*jaw* > *jɔw*).

These patterns of assimilatory raising appear to be mostly associated with a homorganic onglide. Data show that vowel raising occurs mostly after /j/ and /ɥ/ in triphthongs with mid front and low vowels in line with the salience of the carryover component associated with tongue dorsum and jaw raising for front glides, and after /w/ in triphthongs with mid back vowels in line with prominent carryover effects associated with a highly constricted lip rounding gesture (see Section III.1.2.1). Assimilatory raising is not prone to occur in triphthongs in which the mid front vowel is preceded by an antagonistic glide, i.e., in sequences in which two distant gestures need to be executed in a short period of time, namely, predorsum fronting/raising with possible unrounding just after the formation of /w/ or backing/rounding after /j/ (*we/ɛ/ø/œw*, *we/ɛ/ø/œj*, *jo/ɔj*, *ɥo/ɔj*, though *jo/ɔw* and *ɥo/ɔw* may undergo raising). Vowel raising does not take place in formations starting with *jø/œ*, *ɥø/œ* and *wa* either (see Section III.1.2.1 regarding arguments as to why raising does not easily apply to *wa*).

Mid vowel raising in rising triphthongs and diphthongs with /ɛ/ and /ɔ/ and the homorganic glides /j/ and /w/ may be seen as a two-step process yielding a mid high vowel in the first place and a high vowel later on, e.g., *jɛj* > *jej* > *(j)i* (analogously to Fr. *gît* < **jieist* IACET, Lausberg 1970: 263), *wɔw* > *wow* > *(w)u*, *jɛ* > *je* > (*j*)*i* and *wɔ* > *wo* > (*w*)*u*. Raising may also apply to the falling diphthongs *ej* and *ow*, but less so to *ɛj* and *ɔw* which do not undergo the two-step raising evolutions *ɛj* > *ej* > *i* and *ɔw* > *ow* > *u* while allowing the dissimilatory vowel changes *ɛj* > *aj* and *ɔw* > *aw* to occur (see Sections II.2.2.1 and II.2.2.2). These data are in agreement with the relevance of the carryover coarticulatory effects associated with /j/ and /w/, and endorse the claim that /ɛ/ and /ɔ/ changed into *i* and *u* in Old Catalan forms such as *pit* PECTU and *fúʎə* FOLIA through the conditioned diphthongization processes *jɛj* > *jej* > *i* and *wɔw* > *wow* > *u* rather than through the evolutions *ɛj* > *ej* > *i* and *ɔw* > *ow* > *u* (see Coromines 1974 and Badia 1951, for the two opposing views).[6]

6. To our knowledge, the complete evolution /ɛj/ > *ej* > *i* is not documented in Romance. Thus, /ɛ/ before a palatal glide may raise to *e* but not to *i* in Wallon and in the Ardennes, e.g., *lɛ(j)* LECTU > *le(j)* in addition to *lɛ(j)* > *laj* > *lɔ/oj* (*ALW* 1953: 183, Bruneau 1913: 128).

1.3 Dissimilation

a. While assimilatory raising applies to most diphthongs, derivations in Section II reveal that vowel dissimilatory lowering is subject to important restrictions. The process in question has been found to apply to homorganic diphthongs with front and back glides except for rising diphthongs exhibiting a (mid) high vowel nucleus, and may thus be regressive rather than progressive. Indeed, dissimilatory lowering accounts for the changes *ij > ej > ɛj > aj*, *uw > ow > ɔw > aw*, *yj > øj* and *jɛ > ja*, and does not operate on the sequences *j/ɥi*, *j/ɥe* and *wu/o/ɔ*. Regarding heterorganic diphthongs, dissimilatory lowering may apply to the rising sequence *wɛ* (*wɛ > wa*) while there appear to be no instances of the dissimilatory developments *wi > we > wɛ*, *iw > ew > ɛw > aw*, *j/ɥu > j/ɥo > j/ɥɔ > j/ɥa* or *uj > oj > ɔj > aj*.

Two aspects of these dissimilatory changes deserve mention. In the first place, the fact that dissimilatory lowering operates better on homorganic sequences than on heterorganic sequences. This is compatible with a production-based account of dissimilation. In the second place, vowel dissimilation is not prone to be implemented in rising diphthongs with (mid) high front vowels. Theories attributing dissimilation to a need to increase the perceptibility degree may easily account for the implementation of vowel dissimilation in Romance falling diphthongs (also if these vocalic sequences have not been the result of vowel diphthongization, e.g., *ɛw* stays rather than closing to the expected outcome *ew* in Piedmontese *lɛwra* LEPORE and *ɔw* may become *aw* in dial. Cat. *aw* OVU, Rohlfs 1966: 113, Recasens 1996: 132). The failure of rising diphthongs with high and mid high front vowels to undergo dissimilatory lowering is however problematic for these theories, since the acoustic similarity between the vowel and the glides should render these vocalic sequences especially favorable to differentiation. Instead, the sound change patterns reported in Section II.2 suggest strongly that mid high vowels tend to raise and mid low vowels tend to lower adjacent to /j/ and /w/, recalling Donegan's statement that vowels which are more susceptible to increase of a given property are the ones already possessing that property to a higher degree (Donegan 1978).[7]

7. The change *je > jɛ* in words like *hier*, *fiel*, *piege* and *siege* in Middle French is not exceptional in this respect. Indeed, this specific instance of vowel lowering appears to have been contextually conditioned by the opening influence of the following consonant and by the presence of a following free syllable in the same word (Pope 1934: 187, 192, 210, Lausberg 1970: 238).

Within the framework of the present investigation, the failure of rising diphthongs with (mid) high vowels to lower may be interpreted in terms of coarticulatory resistance. Stricter articulatory requirements for rising vs. falling diphthongs with those vowels may account for why dissimilation is more prone to apply regressively than progressively. Regarding rising diphthongs with /j/ and front vowels, high articulatory requirements for /e/ may be related to the prominence of the carryover effects associated with tongue dorsum and jaw raising for /j/ and to articulatory overshoot in strings composed of two consecutive palatal segments (see *Introduction*). Production requirements also appear to play a relevant role in sequences composed of the onglide /w/ and back rounded vowels, i.e., the fact that lip protrusion and jaw height for highly constricted /w/ may be more salient in rising diphthongs than in falling diphthongs may explain why dissimilatory lowering takes place in the former class of diphthongs rather than in the latter.

b. Trends in dissimilatory lowering for triphthongs parallel those operating on diphthongs to a large extent, i.e., lowering applies to the mid low vowel nucleus of *jɛj*, *jɛ/ɔw* and *wɔj* thus yielding *jaj*, *jaw* and *waj*, respectively (but not so to the triphthongs *jɔj*, *wɛ/ɔw* and *wɛj*). On the other hand, triphthongs with mid high vowels (i.e., *wej/w*, *woj/w*, *jej/w*, *jo/jw*) are not affected by the process at hand while most of them may undergo assimilatory raising (all but for the strings *wew* and *joj* composed of vowels and glides involving antagonistic articulatory gestures). As pointed out for the diphthong formations in Section III.1.3 (a), this finding is consistent with predictions of the DAC model rather than with theories that base dissimilation on perceptual optimization.

2. Vowel nucleus fronting and rounding

a. According to our database, mid vowel nuclei in Romance diphthongs and triphthongs may undergo two-way changes along the fronting/rounding dimension, i.e., they may both back/round (*e*, *ɛ* > *o*, *ɔ*) and, less often, front/unround (*o*, *ɔ* > *e*, *ɛ*). High vowels do not undergo backing/rounding (*i* > *u*) or fronting/unrounding (*u* > *i*) which is in accordance with their high degree of coarticulatory resistance. Changes involving separate fronting or rounding do not appear to be reversible: while front unrounded and, less so, back rounded vowels may yield front rounded realizations (*i/u*, *e/o*, *ɛ/ɔ* > *y*, *ø*, *œ*), front rounded vowels do not usually unround or back (*y* > *i*; *ø* > *o*).

b. Vowel changes along the fronting and rounding dimensions may be assimilatory and dissimilatory, and conform to specific directionality patterns. Regarding diphthongs, front vowel rounding may be regressive or progressive if resulting from the assimilatory action of the adjacent glide (i.e., *ew/ɥ > øw/ɥ*; *we/ɛ > wø*; *ɥi/e/ɛ > ɥy/ø/œ*) and, less so, regressive if developed by a dissimilatory action (*e/ɛj > ø/œj*). According to our database, front vowel unrounding occurs only for *yw > iw* (through regressive dissimilation) and perhaps *jy > (j)i* (through progressive assimilation). On the other hand, while back vowel fronting/unrounding is essentially dissimilatory and may proceed in either a regressive or progressive direction (*o/ɔw > e/ɛw*; *wo/ɔ > we/ɛ*), front vowel backing/rounding may be implemented through a regressive dissimilatory process rather than through progressive assimilation (*wɛ > wo*; *e/ɛj > o/ɔj*). Finally, back vowel fronting may be associated with a regressive or progressive assimilation (*o/ɔ/uj > ø/yj*; *ju > jy*; *ɥo/u > ɥø/y*) and, less so, with a regressive dissimilation (*uw > yw*), while the only instance of front vowel backing in our database is dissimilatory and regressive (i.e., *øj > oj*).

While some of the dissimilatory sound changes presented so far may contribute to improving the perceptual salience of the vocalic sequence (e.g., vowel fronting/unrounding in the case of substitutions such as *ow > ew* and *wo > we*), other vowel quality changes are better accounted for with reference to the articulatory constraints involved in diphthong production. Thus, the fact that changes along the fronting and rounding dimensions do not favor the regressive or progressive direction is in support of the salience of the anticipatory and carryover components associated with tongue dorsum raising and fronting for /j/ and with the lip rounding gesture for labial glides. Analogous changes induced by /w/ in vocalic sequences of a different origin may favor the regressive direction which is in line with the prominence of the lip rounding anticipatory component, namely, assimilatory vowel rounding (e.g., *ew > øw*, *jɛw > jɔw*, as in Fr. *cheveux* CAPILLOS, Occ. *riou* RIVU, Pope 1934: 201, Ronjat 1930: 373) and dissimilatory vowel fronting/unrounding (e.g., *o/yw > e/iw*, as in Cat. *veu* VOCE, Gasc. *líwə* LUNA, Coromines 1974: 251, Millardet 1910: 60).

c. Analogous to the diphthongs, the front vowel rounding process *e*, *ɛ > ø*, *œ* in triphthongs is mostly assimilatory and does not appear to favor any specific direction in asymmetrical sequences (symmetrical sequences: *we/ɛw > wø/œw*, regressive direction: *je/ɛɥ > jø/œɥ*, *je/ɛw > jøw*; progressive direction: *ɥi/e/ɛw > ɥy/ø/œw*, *ɥe/ɛj > ɥø/œj*). On the other hand, back vowel fronting may be associated with a dissimilatory action (*wo/ɔw > we/ɛw*), an assimilatory action (*jo/ɔj* > *jø/œj*) or both (*ɥo/ɔw* > *ɥe/ɛw*; *wo/ɔj* > *we/ɛj*; *ɥo/ɔj* > *ɥe/ɛj*). Analogous to changes in vowel height, large articulatory differences between the front palatal glide and back rounded vowels may account for the absence of the replacements *joj* > *jej* (assimilatory) and *jej* > *joj* (dissimaltory).

3. Other changes

a. Glide substitutions affect rounded glides rather than /j/ presumably in line with differences in articulatory complexity between the two sets of segments, and cause *w* to front (> *ɥ*) and *ɥ* to unround (> *j*). Changes affect onglides in diphthongs and triphthongs (*we/ɛ/o/ɔ* > *ɥe/ɛ/o/ɔ*; *ɥe/ɛ/o/ɔ/ø/œ* > *je/ɛ/o/ɔ/ø/œ*) and, less often, offglides (*e/ɛ/ø/œw* > *e/ɛ/ø/œɥ*; *e/ɛ/ø/œɥ* > *e/ɛ/ø/œj*). When conditioned by the following vowel and thus regressive, those glide changes may be dissimilatory (*w* > *ɥ* before *o/ɔ* and *ɥ* > *j* before *o/ɔ/ø/œ*) and, less often, assimilatory (*w* > *ɥ* and *ɥ* > *j* before *e/ɛ*). When taking place progressively, they are assimilatory rather than dissimilatory and mostly associated with a mid front unrounded vowel.

Other glide replacements are *ø/œj* > *ø/œɥ* (rounding), *we/ɛ/ø/œ* > *je/ɛ/ø/œ* (fronting/unrounding), *o/ɔj* > *oɛ̯* (lowering) and *oɛ̯* > *wɛ* (raising).

b. Glide absorption in diphthongs or triphthongs is associated with a vowel nucleus sharing analogous articulatory characteristics. The absorption of front glides by a front vowel is mostly regressive in the case of /ɥ/ (*ɥy/e/ɛ/ø/œ* > *y/e/ɛ/ø/œ*, though *ø/œɥ* > *ø/œ* is also possible) and progressive but also regressive in the case of /j/ (*y/e/ɛ/œ/øj* > *y/e/ɛ/ø/œ*; *jy/e/ɛ/ø/œ* > *y/e/ɛ/ø/œ*). On the other hand, the absorption of /w/ by a rounded vowel may be both regressive and progressive (*o/ɔ/øw* > *o/ɔ/ø*; *wo/ɔ/ø/œ* > *o/ɔ/ø/œ*).

The fact that the absorption of /w/ favors the regressive and progressive directions is consistent with the prominence of the anticipatory and carryover coarticulatory effects associated with lip rounding for the rounded vowel nucleus. Moreover, the finding that /j/ absorption may favor the progressive direction is related presumably to prominent carryover effects associated with tongue dorsum raising and fronting for the front vowel nucleus. Sound changes occurring in vocalic sequences not resulting from vowel diphthongization reveal that *w* insertion and absorption may also be regressive and progressive (dial. Cat. *səwó* SATIONE, *kówə* CAUDA, S. Sard. *máu* < *máwu* MALU, Fr. *fløʀ* < *fløwr* < **flewr* < **flowr* FLORE, Recasens 1996: 302, Contini 1987: 422, Pope

1934:201), while *j* insertion happens to be mostly progressive and *j* absorption may be both regressive and progressive (Cat. *pəjéʎə* PATELLA, *idɛjə* IDEA, Sp. *maéstro* MAGISTRU, *peór* PEIOR, Recasens 1996:300, Menéndez Pidal 1968:133).

c. Glide elision occurs mostly in falling diphthongs in accordance with consonants undergoing syllable-final undershoot. Our data show that, while this is exclusively so for /j/ after low and back vowels, the elision of /w/ also takes place syllable initially before a front vowel (i.e., *we/ɛ* > *e/ɛ* in addition to *wa* > *a* and *aw* > *a*). The elision of /w/ in rising diphthongs or triphthongs with a front vowel nucleus appears to be due to the same factor preventing vowel height assimilation from taking place, i.e., the difficulty in fronting the tongue and unrounding the lips just after the formation of the antagonistic lingual and labial gestures for /w/ (Sections III.1.2 and III.1.3). The same rationale would explain why the Old Catalan lexical form *nujt* has yielded *nit* NOCTE presumably through *nwít* (Coromines 1974:250).

d. The instability of vocalic sequences composed of two high elements explains why these formations may undergo changes driving towards articulatory simplification in a good number of cases, i.e., replacement of falling diphthongs by rising diphthongs (*yw* > *jy*; *iw* > *ju*), vowel assimilation involving fronting, rounding or unrounding (*uj* > *yj*; *ju(w)* > *jy(w)*; *ɥi(w)* > *ɥy(w)*; *ɥu* > *ɥy*, *jy* > *(j)i*), vowel dissimilation involving fronting or unrounding (*uw* > *yw*; *yw* > *iw*), onglide or offglide absorption (*ɥy(w)* > *y(w)*; *jyw* > *yw*, *jy*), and onglide substitution (*ɥy* > *jy*).

IV. Conclusions

Data presented and reviewed in this paper provide evidence in support of the notion that speakers may use different production strategies in order to avoid complex or highly constrained segmental combinations. In doing so, they appear to reject vocalic sequences imposing high articulatory requirements and thus, a high articulatory cost. The need to avoid articulatory complexity accounts presumably for changes in fronting and rounding in the case of labial onglides and front rounded vowels (*w* > *ɥ*; *ɥ* > *j*; *ø*, *œ* > *e*, *ɛ*), and for the interruption of longlasting lip rounding through dissimilatory fronting/unrounding (*o/ɔw* > *e/ɛw*; *wo/ɔ* > *we/ɛ*). Articulatory incompatibility could also account for a trend to avoid the diphthong *wa* (i.e., *wo/ɔ* lowering is not favored in our database), for /w/ to delete before front vowels, and for vowels not to raise in specific triphthongs (i.e., if front after /w/ and if back rounded after /j/) and not to undergo quality changes yielding antagonistic segmental combinations (e.g., the change *jej* > *joj* is not documented in our derivations). Articulatory reduction accounts for the elision of /j/ after any nonfront vowel.

Assimilatory vowel raising effects in diphthongs could be attributed to variation in jaw height, as suggested by the action of /j/ on back rounded vowels and of /w/ on palatal vowels. However, the fact that those effects in triphthongs and diphthongs are mostly progressive and require homorganicity between the onglide and the vowel nucleus appears to be more in accordance with the role of the tongue and the lips than with that of the jaw.

Dissimilatory changes are based on perceptual factors (i.e., speakers trying to avoid contiguous vocalic elements from being too similar) but do seem to depend on articulatory requirements as well. Dissimilatory lowering in diphthongs was found to occur in homorganic vocalic sequences rather than in heterorganic ones and the same constraint applies to the initial CV component of triphthongs. Moreover, this action appears to be blocked by mid high vowels, if highly constrained by the progressive action of preceding /j/ and /w/. This latter finding could also be accounted for on acoustic and perceptual grounds; indeed, Schwartz et al. (1997) report a discrimination experiment in which patterns of greatest high formants convergence in the /e/ region were found to be more stable in short-term memory than those with less formant convergence.

To a large extent, the direction of sound change processes in vocalic sequences reported in the present paper are consistent with the DAC model of coarticulation. Prominent anticipatory and carryover effects for highly constricted /j/ and /w/ and for palatal and labial vowels may explain why several processes favor both the regressive and progressive directions, namely, assimilatory vowel raising as a function of both glides (e.g., *ej*, *je* > *i*), assimilatory front vowel rounding and dissimilatory back vowel fronting/unrounding as a function of *w* (*ew* > *øw*; *we* > *wø*; *ow* > *ew*; *wo* > *we*), assimilatory back vowel fronting as a function of j (*oj* > *øj*; *ɥo* > *ɥø*), and absorption of the two glides by a preceding and following vowel (*je*, *ej* > *e*, *wo*; *ow* > *o*). Moreover, the relevance of a specific coarticulatory direction may explain why several adaptation processes favor the progressive or regressive component only: the progressive component in the case of assimilatory vowel raising in homorganic rising diphthongs and in triphthongs starting with a homorganic CV sequence (e.g., *jɛ* > *je* > *i*; *wɔ* > *wo* > *u*; *jɛj/w* > *jej/w* > *ji(w)*; *wɔw/j* > *wow/j* > *wu*, *uj*) and perhaps /j/ absorption after front vowels (*y/e/ɛ/ø/œj* > *y/e/ɛ/ø/œ*); the regressive component in the case of dissimilatory vowel lowering and front vowel backing/

rounding in diphthongs (*ɛj > aj*; *ɔw > aw*; *ɛ/ej > ɔ/oj*), and of assimilatory vowel rounding in triphthongs (*jew > jøw*).

Diphthongs made up of high segments may be considered to be unstable in many respects, which explains why they are often undone by any of several strategies (assimilation, dissimilation, simplification). Resistance to contextual changes involving fronting and rounding in high vowel nuclei may be due to the fact that those segments are maximally constrained, whether because they are produced with two coordinated labial and lingual constrictions (for /y/ and /u/) or with a tongue dorsum raising and fronting gesture (for /i/). It has also been suggested in this respect that the acoustic and perceptual stability of the vowels /i/ and /y/ derives from their quantal nature at regions of maximal formant convergence, i.e., F2–F3 for /y/ and F3–F4 for /i/ (Schwartz et al. 1997). This pre-phonetic constraint would account for why languages prefer /y/ to /ø/ and /œ/ (also /ɯ/ as opposed to /ɤ/ and /ʌ/, Maddieson 1984) and for why /y/ acts as a true interior vowel while back unrounded /ɯ/ often replaces missing /u/ in languages of the world.

In the course of an analysis of the evolution of diphthongs and triphthongs in Romance, this study has sought to uncover a set of structural patterns occurring in segmental sequences. It is believed that production (as well as perceptual) constraints account for the cooccurrence of certain segmental combinations rather than others in the world's languages, and that theoretical approaches such as the degree of coarticulation model may help to uncover those syntagmatic patterns. Future research could test whether languages outside the Romance domain exhibit analogous patterns of behavior.

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Résumé

Ce travail étudie les processus de changement phonétique (assimilations, dissimilations, élisions) liés aux diphtongues et aux triphtongues dérivées des voyelles moyennes basses du latin dans le domaine roman. Cette analyse est réalisée dans le cadre du modèle de coarticulation 'degree of articulatory constraint', selon lequel les effets d'adaptation entre segments consécutifs dans la chaîne parlée, ainsi que la direction de ces effets (régressive/progressive), sont conditionnés par les contraintes imposées sur les structures articulatoires dans la production de la parole. Différents résultats apportent une confirmation à ce modèle. Le phénomène assimilatoire d'élévation vocalique dans les diphtongues et dans les triphtongues est facilité par la proéminence des effets de persévération associés aux gestes articulatoires pour /j/ et /w/. Le phénomène dissimilatoire d'abaissement vocalique est peu fréquent dans les diphtongues fermantes avec une voyelle (moyenne) haute antérieure, probablement parce que ces diphtongues exigent un effort articulatoire important.

Zusammenfassung

In diesem Beitrag werden die Lautprozesse Assimilation, Dissimilation, Elision untersucht, die den von lateinischen halbtiefen Vokalen abgeleiteten Diphthongen und Triphthongen in romanischen Sprachen entsprechen. Die Analyse erfolgt im Rahmen eines bestimmten Koartikulationsmodells, nämlich des 'Degree of Articulatory Constraint Model' (Modells des Grades der artikulatorischen Einschränkung). Laut diesem Modell werden Anpassungseffekte von aufeinanderfolgenden Äußerungssegmenten (einschließlich ihrer Richtung: progressiv vs. regressiv) durch diejenigen Erfordernisse bestimmt, die die Sprecher den artikularotischen Strukturen unterordnen. Folgende Ergebnisse sind im Einklang mit diesem theoretischen Rahmen: (1) Die assimilatorische Vokalanhebung in Diphthongen und Triphthongen wird durch einen homorganen Anglitt ('onglide') begünstigt, gemäss der Prominenz der perservatorischen Effekte, die mit den artikulatorischen Gesten für /j/ und /w/ verbunden sind. (2) Die dissimilatorische Absenkung des Vokals wird in ansteigenden Diphthongen mit mittelhohen und hohen vorderen Vokalen in der Regel vielleicht deshalb nicht implementiert, weil Sprecher versuchen, vokalische Sequenzen mit hohen artikulatorischen Anforderungen zu vermeiden.

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