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LA PHONÉTIQUE HISTORIQUE DU GALLO-ROMAN

État des lieux et perspectives

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1. Une discipline sinistrée

À la fin du XIX^e^ siècle, dans le décisif élan rationaliste dont l'école allemande et, singulièrement, les néogrammairiens sont le symbole, la phonétique historique du français a connu un développement remarquable : c'est dans cette dynamique qu'ont œuvré notamment Arsène Darmesteter (1846-1888), puis Édouard Bourciez (1854-1946) – la première édition du *Précis* date de 1889. Et c'est sur ce socle et sur les apports au siècle suivant du *REW* de Wilhelm Meyer-Lübke et du *FEW* de Walther von Wartburg qui ont rendu accessibles les données pertinentes à un niveau de détail et de précision inégalé, que Pierre Fouché (1891-1967), puis Georges Straka (1910-1993) en particulier, ont développé le savoir qui nous est parvenu et qui constitue, depuis la dernière guerre, le corps de doctrine qui fonde l'enseignement de la discipline comme les exigences des concours.

De cette dynamique, aujourd'hui, il ne reste rien ou presque : la phonétique historique semble une discipline en sommeil. Elle semble achever de s'éteindre, lentement, sans bruit, au fil des départs à la retraite, des postes universitaires non renouvelés faute de candidats compétents – l'Université se contentant d'enregistrer cette disparition. Mais, en réalité, cette absence de candidats et l'image affaiblie de la discipline ne sont pas la cause de son effondrement sur elle-même : ils en sont l'effet. Le

savoir dans ce domaine ne s'est simplement pas renouvelé et il est désormais transmis de façon sclérosée dans l'enseignement par des professeurs qui ne sont presque jamais des spécialistes. Dans les universités, la phonétique historique est le plus souvent considérée comme une corvée (au même titre que les techniques d'expression) à laquelle on astreint la dernière recrue, laquelle répète ce qu'elle a entendu dans les cours préparant aux concours qu'elle a passés mais ne cherche qu'à se débarrasser de cette charge sans rapport avec ses recherches. Ce qui était un savoir vivant est devenu une *doxa* que les manuels répètent.

La discipline a eu devant elle, dans la période récente, deux développements majeurs : l'évolution technologique – les possibilités ouvertes par l'informatique – d'un côté, les avancées sur le plan théorique de la linguistique de l'autre. Si l'étymologie, la dialectologie, ont su dans une large mesure mettre à profit au moins les moyens technologiques nouveaux (TLFi, DMF, extensions du *FEW*…), la phonétique historique a ignoré ces deux développements majeurs. Et l'on peut voir là la cause essentielle de son marasme actuel.

2. Des perspectives ?

C'est ainsi un constat bien déprimant que l'on est contraint, sauf à se payer de mots, de dresser lorsque l'on considère l'état actuel de la phonétique historique. Et évidemment, l'une des options est d'en prendre acte et d'attendre, avec les gémissements de circonstance, que cette page d'histoire se referme définitivement, que la discipline disparaisse un jour des programmes des concours, dernier retranchement où elle se tient…

Mais on peut aussi penser que cette phase sombre n'est pas définitive. Toute sinistrée qu'elle soit présentement, la phonétique historique a d'abord un patrimoine immense et très précieux qu'il importe et de préserver et de transmettre. Ensuite et surtout, la phonétique historique est bien loin d'avoir tout dit. Quiconque considère avec un peu de recul et d'esprit critique le corps de doctrine actuel de la discipline, en arrive très vite à

penser qu'il demeure quantité de points à préciser, à clarifier, et à terme à expliquer : à *comprendre*. Or, nous l'avons dit, des outils nouveaux sont disponibles, en théorie phonologique et en ressources (corpus recherchables), la connaissance de la variation dialectale ainsi que de la situation typologique s'est significativement améliorée, etc. En d'autres termes, pour peu qu'elle ne tourne pas le dos aux diverses avancées récentes, la phonétique historique pourrait tout à fait trouver un second souffle.

Nous sommes des linguistes – spécialisés en phonologie, non des romanistes au sens classique du terme, ni des philologues. Mais les linguistes que nous sommes ne méprisent ni ne mésestiment, en aucune façon, les travaux des romanistes et des philologues et sont depuis longtemps passionnés par les questions que soulève la diachronie du français. Si l'ensemble complexe de processus qui constitue cette diachronie est en effet définitoire de la langue et de son identité, ces processus ne sont pas, en eux-mêmes, propres au français : ils se retrouvent à l'identique dans beaucoup d'autres langues, aussi bien génétiquement liées au français que sans le moindre lien. Or c'est ce constat du caractère potentiellement universel des processus phonologiques qui fonde les recherches des écoles contemporaines – très diverses au demeurant – de phonologie. Et nous sommes convaincus pour notre part que c'est seulement en reconsidérant les données de la diachronie du français – recensées et traitées si complètement maintenant par les romanistes et les philologues, précisément – dans la perspective des avancées et des propositions nouvelles de la phonologie, que l'on pourra relancer la discipline de la phonétique historique. C'est dans ce cadre seulement que de jeunes chercheurs pourront s'intéresser à la phonétique historique, se passionner pour elle et en faire leur spécialité – à charge pour l'institution universitaire de les accueillir lorsqu'ils se présenteront.

Lorsque Olivier Soutet nous a proposé d'organiser ce numéro de *Diachroniques* sur la phonétique historique, c'est dans cette optique et sur cette conviction que nous avons répondu présents.

L'état des lieux mentionné dans le titre du numéro ne se veut donc pas un résumé avant fermeture de la boutique, mais vise à rassembler quelques exemples significatifs des pistes qui s'offrent à la discipline, dans des perspectives diverses, pour peu qu'elle sache, après avoir lucidement fait les constats négatifs qui s'imposent, se vouloir de nouveau un avenir. En somme, nous cherchons à donner une idée de ce que la phonétique historique pourrait être si elle était pratiquée de manière active, à montrer que la sclérose qui l'affecte actuellement n'est pas une fatalité et qu'il existe une phonétique historique au-delà des concours, passionnante en soi et plus encore si elle est en prise avec les théories, ressources et techniques modernes.

3. Constitution du numéro

Les contributions que nous avons sollicitées – souvent en dehors des limites de l'Hexagone – et rassemblées dans ce numéro concernent des questions très diverses et s'inscrivent dans des approches tout aussi variées.

Disciple de Georges Straka, Christiane Marchello-Nizia s'est orientée depuis longtemps vers la morphologie et la syntaxe ; elle revient ici à ses premiers intérêts en enquêtant sur les conditions et la chronologie de l'élision du pronom sujet JE (qui n'est attestée que depuis la première moitié du XII^{e} siècle). Cette question est intimement liée avec la cliticisation de JE : est-ce que celle-ci est la conséquence de l'affaiblissement phonétique de JE, ou au contraire cet affaiblissement du pronom est-il dû à sa perte d'autonomie syntaxique ? Une question phonologique que l'on ne pose jamais en français moderne mais qui est soulevée par la perspective diachronique est celle de savoir pourquoi parmi tous les pronoms sujets à finale vocalique (JE, TU, NOUS, VOUS) seul JE développe l'élision (l'élision dans TU, fréquente en français contemporain, est récente et demeure encore une simple variante). D'autant que les pronoms régime s'élident tous, en ancien français (LE, LA, LI) comme en français moderne (LE, LA), et ce en suivant une chronologie très différente par rapport à l'élision de JE : dès les plus anciens

textes tous les pronoms au cas régime s'élident sans aucune hésitation ou variation.

L'article de Chr. Marchello-Nizia est basé sur le corpus électronique de la GGHF (*Grande grammaire historique du français*, actuellement en gestation) qu'elle co-édite, corpus qui rassemble des textes représentatifs pour chaque siècle. Sa contribution illustre ainsi ce qu'il est possible de faire en alliant savoir classique, questionnements nouveaux et recours aux moyens technologiques actuels.

Roland Noske résume ce que nous savons de la nature de l'accent en gallo-roman. On trouve encore aujourd'hui dans les manuels l'affirmation, fausse, que l'accent mélodique (de hauteur, *pitch accent*) du latin classique se serait transformé en accent d'intensité (ou expiratoire) en gallo-roman. Cette intensité particulière de la voyelle tonique serait aussi le fait du francique, qui lui aurait donné un « surcroît de vigueur » (Gaston Zink). R. Noske montre d'abord, un argumentaire détaillé à l'appui, que l'accent du francique n'a en aucune façon influencé le système accentuel gallo-roman. Les études typologiques montrent que les emprunts d'accentuation sont rares, voire inexistants dans les langues du monde. Ensuite le francique, dans la période en question, avait probablement encore l'accent initial du germanique commun : en cas d'emprunt, c'est un accent de ce type qui aurait été transféré au gallo-roman. Or ce n'est pas le cas. Enfin, on met sur le compte de l'intensité empruntée au francique une série de processus observés en gallo-roman, au premier chef desquels la réduction / syncope des voyelles atones. Or le francique lui-même ne connaissait ni réduction ni syncope dans la période où l'emprunt est censé avoir eu lieu (vers le Ve siècle) : ces processus en francique ne surviennent que bien plus tard (après le IXe siècle). Comment alors l'accent d'intensité aurait-il pu causer la diminution des voyelles atones dans la langue qui l'aurait emprunté, quand la langue à laquelle il serait emprunté ne montre aucune trace d'un phénomène semblable ?

L'auteur rappelle ensuite que la phonétique expérimentale a depuis les années 1950 réfuté l'idée même qu'il puisse y avoir

un accent expiratoire, ou d'intensité, qui ait quelque pertinence que ce soit pour l'évolution des langues ou leur grammaire. La conception de l'accent d'intensité est née au XIX^e siècle par introspection et en l'absence de mesures fiables. On sait aujourd'hui que l'accent, dans toutes les langues, se manifeste par un mélange de trois caractéristiques : 1° la hauteur (mesurée en Hertz), 2° la durée (mesurée en millisecondes) et 3° l'intensité (mesurée en décibels). La phonétique expérimentale montre que cette dernière est marginale dans les langues, et surtout que les locuteurs ne la perçoivent pas ou mal.

Dans la seconde partie de l'article, l'auteur montre que les diverses évolutions observées en gallo-roman et en germanique occidental font sens lorsqu'on les conçoit en deux blocs, chacun suivant sa logique propre et cohérente et illustrant les deux grands types de langues mis en évidence par l'école allemande de Peter Auer, Susanne Uhmann et Renata Szczepaniak : les langues qui comptent les syllabes et les langues qui comptent les mots. Une langue donnée peut être placée sur une échelle qui a pour extrémités ces deux types au moyen de dix critères typologiques. R. Noske montre que le gallo-roman et l'ancien français sont des langues de mots, alors que le français moderne est une langue syllabique. Du côté germanique, la situation est l'inverse : le vieux haut-allemand et l'ancien néerlandais, langues largement syllabiques, évoluent vers des langues de mots dans leurs aboutissements modernes, l'allemand et le néerlandais actuels.

Haike Jacobs propose une contribution qui illustre ce qu'une recherche vivante peut apporter au fonctionnement des concours. On enseigne (et écrit) depuis toujours que la consonification des voyelles hautes et moyennes en hiatus (trisyllabe *fílium* → bisyllabe *filju* « fils ») ne concerne que les voyelles atones : les voyelles toniques demeureraient (*grúem* → *grue*). Or Jacobs montre qu'il s'agit d'une illusion d'optique, *i.e.* que les auteurs classiques sont passés à côté d'une généralisation : le *u* de *grúem* (ainsi que les autres voyelles toniques dans la même situation) échappe à la consonification non pas parce qu'il est tonique, mais parce qu'il se trouve dans un mot bisyllabique. Le

résultat d'une consonification dans un bisyllabe serait en effet une forme oxytone, dont nous savons indépendamment qu'elle est rejetée dans la période précoce en question (Ier, IIe siècles). Ainsi ce que l'approche classique doit admettre comme contre-exemples (*mulíerem* → afr. *moillier*, *filíolum* → *filleul*) revient à la régularité : il s'agit de quadrisyllabes qui ne rencontrent aucun obstacle en devenant trisyllabes suite à la consonification de leur voyelle tonique.

Jacobs conclut que la consonification n'a aucun rapport avec l'accent, si ce n'est de façon indirecte. Sur cette base empirique il propose une analyse dans le cadre de la théorie de l'optimalité en montrant qu'une version plus récente de cette approche, qui réintroduit des éléments de sérialité, le sérialisme harmonique de John McCarthy, permet de rendre compte des faits là où la théorie classique, basée sur une computation strictement parallèle, échoue.

Tobias Scheer et Philippe Ségéral examinent les évolutions vocaliques en syllabe fermée du latin vulgaire à l'ancien français, lesquelles, mentionnées évidemment dans tous les manuels, n'ont – assez bizarrement – pas été l'objet d'études systématiques. On constate que les voyelles en syllabe fermée, observables dans des positions limitées – tonique, prétoniques(s), initiale seulement – se comportent de façon strictement commune : tout d'abord elles ignorent tout processus de syncope, à la tonique comme dans les deux positions atones (initiale et prétonique[s]), et ensuite évoluent de façon exactement identique. Pour l'essentiel sans aucun changement. Et lorsqu'il y a une modification du timbre, celle-ci est imputable à un processus unique : la résolution de la consonne en coda en ses constituants vocaliques, lesquels se reportent sur la voyelle – et même en ce cas, les résultats sont identiques quelle que soit la position (atone / tonique) où figure la voyelle. Ceci concerne l, les nasales (n, m) et enfin yod. Les processus qui impliquent ce dernier sont particulièrement complexes, mais les auteurs montrent que ses effets sur les voyelles se ramènent au modèle posé de résolution vocalique de la consonne en coda. Enfin, on constate que, tout comme

la syncope, la centralisation (vers schwa) n'existe pas pour les voyelles en syllabe fermée – tonique comme atones.

Les auteurs tirent argument de cela pour infirmer la primauté de l'accent sur les évolutions vocaliques et montrent que c'est en réalité la structure de la syllabe où se trouve la voyelle considérée qui est fondamentale, la présence ou l'absence de l'accent n'étant qu'une opposition secondaire, qui ne concerne que la syllabe ouverte. Dans ce cadre, les processus affectant les voyelles, à savoir 1° en syllabe fermée, le maintien sans changement et 2° en syllabe ouverte, l'allongement (d'où les diphtongaisons) sous l'accent et la centralisation / syncope en position atone, retrouvent une lisibilité simple. Dans la dernière partie de l'article, les auteurs proposent une interprétation dans le cadre d'une théorie phonologique qu'ils présentent brièvement, de cette distribution des processus qui ont affecté les voyelles.

Andrea Calabrese examine deux questions classiques de la diachronie gallo-romane : l'abaissement des voyelles hautes relâchées [ɪ, ʊ] (lat. i, u) qui deviennent [e, o] (en se confondant avec [e, o] < lat. ē, ō) et l'antériorisation spontanée de [u] en [y]. Ces deux phénomènes sont appréciés d'une part à la lumière de la théorie des contraintes et réparations dans laquelle l'auteur travaille, d'autre part dans le contexte de processus similaires ou identiques que l'on relève dans d'autres langues, romanes mais surtout au-delà de cette famille et des limites de l'indo-européen. Calabrese ainsi fertilise pour l'étude de la diachronie du français deux innovations porteuses qui ont été mentionnées *supra* : la confrontation aux théories phonologiques modernes et le témoignage de langues sans rapport génétique mais illustrant les mêmes processus.

L'auteur pense avoir trouvé dans le concept de P-map développé par Donca Steriade une explication pour l'évolution gallo-romane [ɪ, ʊ] > [e, o] : P-map modélise le savoir des locuteurs concernant la similarité acoustique des voyelles et consonnes. Les voyelles les plus proches de [ɪ, ʊ] selon ce calcul sont précisément [e, o]. Or si cela donne le résultat observé en gallo-

roman, Calabrese montre que d'autres langues, lorsqu'elles font évoluer [ɪ, ʊ], aboutissent à d'autres résultats, notamment [i, u] et [ɛ, ɔ]. L'auteur veut cela pour preuve que le seul paramètre acoustique ne suffit pas pour rendre compte de la variation typologique. Il introduit un générateur de variation phonologique basé sur ce qui peut arriver aux deux traits binaires [haut] et [tendu] qui dans son analyse sont constitutifs de [ɪ, ʊ] sous la forme [+haut, -tendu]. Ils peuvent d'une part être « excisés », *i.e.* dépouillés de leurs valeurs +/-. L'absence de ces valeurs est alors réparée par le P-map sur base acoustique, et le résultat est [e, o] comme en gallo-roman.

Mais il y a encore une autre façon pour une langue de se débarrasser de [+haut, -tendu]: en supprimant un trait distinctif. Ainsi on obtient [+haut] seul ou [-tendu] seul. Une telle configuration est universellement illicite (puisque la spécification d'un trait manque) et réparée par l'insertion de la valeur par défaut du trait absent. C'est ainsi que l'on obtient [+haut, +tendu] (à partir de [+haut] en ajoutant la valeur non-marquée [+tendu]) et [-haut, -tendu] (en partant de [-tendu] en complétant avec la valeur non-marquée [-haut]). Les deux résultats correspondent aux deux systèmes attestés : [ɪ, ʊ] > [i, u] ([+haut, +tendu]) et [ɪ, ʊ] > [ɛ, ɔ] ([-haut, -tendu]).

Au sein de la famille romane, Calabrese fait valoir un certain nombre de dialectes sardes et corses qui illustrent la dernière option : ces systèmes confondent lat. ē, ō et lat. ĕ, ŏ en [e, o], alors que lat. i, u = [ɪ, ʊ] aboutissent à [ɛ, ɔ].

Markedness effects in the Gallo-Romance vowel system

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1. Introduction[1]

Although changes in the sound shape of a language may actually be due to a wide variety of reasons, including language contact, mistaken perceptual parsing, reanalysis, and so on, a good number of them can be analyzed as involving "markedness" effects whereby a phonological configuration that is "marked", *i.e.* problematic from a phonological point of view (see section 3.4), is simplified. In the terminology adopted later, this marked configuration is repaired. In this article I will focus on two context-free changes that characterized the development of common Gallo-Romance, including French and Occitan, from Latin: the merger of the short high vowels with the long mid vowels into the mid close [e] and [o], and the fronting of Latin long [u:] into [ü], with the subsequent raising of [o] to [u]. I show that they are best accounted for as changes determined by markedness considerations in which, as we will see, certain problematic vocalic configurations are repaired.

On the pages below, I first briefly discuss some of the basic facts concerning these changes and show that traditional analyses – analyses that are still regularly used today – are unable to account for them (section 2). I then provide a basic outline of a model that

1. I am deeply indebted to Tobias Scheer whose insightful comments and suggestions on an earlier draft of this paper were of great help to me. All remaining faults are just mine.

provides a simple way to account for the changes under discussion (section 3) and proceed to an analysis of the facts (section 4).

2. The Latin vowel system and its development

2.1. Basic Facts

Phonemically, Classical Latin had a typical basic five vowel system: two high vowels (one front unrounded and the other back, rounded), two mid vowels (one front unrounded and the other back rounded), and one central unrounded low vowel[2]. Each vowel could be contrastively short or long. The system of Classical Latin was therefore that in (1) with the featural assignments in (2). The feature [tense] is used to distinguish tense and lax vowels in this paper (see section 4.2 for further discussion).

(1) Classical Latin vowel system (phonemic)

i		u		i:	u:
ɛ		ɔ		ɛ:	ɔ:
	a			a:	

(2) Classical Latin vowel system (featural)

	i	ɛ	a	ɔ	u
high	+	-	-	-	+
low	-	-	+	-	-
back	-	-	+	+	+
round	-	-	-	+	+
tense	+	-	-	-	+

In Calabrese (2003), to which I refer the reader, I provide evidence that, contrary to the common opinion among Romance linguists (*e.g.* Loporcaro 2010b for a recent example), no distinctions in [tense] values were associated with length distinctions in the Classical Latin vowel system. Hence the high vowels were [+tense] and the mid vowels [-tense], regardless of their length, as expected in typical five vowel systems.

2. In addition to the Latin vowels in (1), the Classical vowel system included the diphthongs /ae/ and /au/.

The quality of the Latin vowels is preserved in the Sardinian and Southern Lucanian system which are simply characterized by the loss of phonemic quantity distinctions. I will not discuss this change here (Weinrich 1958, see also Calabrese 2003 and more recently Loporcaro 2010a, among others). It is enough to say – simplifying a little bit – that short vowels lengthened in open syllables and long vowels shortened in closed syllables so that length became predictable from syllable structure and was no longer contrastive. Therefore, Sardinian and Southern Lucanian have a five vowel system where each vowel preserves the Latin quality.

(3) Sardinian and Southern Lucanian vowel system

i		u	+high, +tense
ɛ		ɔ	-high, -tense
	a		+low, -tense

In all other Romance varieties, probably starting around the I[st] century A.D. (see Calabrese 2003 for arguments and references), a series of further changes affected the Latin vowel system before the loss of contrastive quantity, which led to the replacement of quantity distinctions by quality distinctions. Here I follow the traditional reconstruction by Weinrich (1958, see also Loporcaro 2010a), although interpreting it in more contemporary terms. The first step of the development associated [tense] values with contrastive length (as under (4) below, where (4)a applies first because of the Elsewhere Principle[3]). The association of the feature specifications [+tense] and [-tense] to long and short vowels, respectively, is a common phonological process, which occurred in the history of many languages, for example in Middle English (see Chomsky and Halle 1968: 253).

(4) association of tense values with contrastive length

a. [-cons] → [+tense] / x x

b. [-cons] → [-tense]

3. The Elsewhere Principle (Kiparsky 1973) requires that in a set of rules where the structural description of one contains the structural descriptions of the others, the more specific rule ((4)a in (4)) always applies first.

After the application of the process in (4), the superficial vocalic system of Latin differed from that of Classical Latin as in (5). The feature [+tense] was not assigned to long [aː]. I assume that this is a case of blocking by an independently needed constraint against [+low, +tense] vowels. This aspect of the change will not be discussed here.

(5) vowel system (after association of tense values to contrastive length)

ɪ	ʊ	iː	uː
ɛ	ɔ	eː	oː
a		aː	

The other crucial development is the replacement of the [+high, -tense] vowels [ɪ, ʊ] (the "open" high vowels in traditional terminology) with the [-high, +tense] vowels [e, o] (the "close" mid vowels in traditional terminology). The process describing this change is shown in (6). After the application of (6) the system in (7) arises.

(6) [+high, -tense] → [-high, +tense]

that is, [ɪ, ʊ] → [e, o]

(7) vowel system (after [ɪ, ʊ] → [e, o])

ɪ e	ʊ o	iː	uː
ɛ	ɔ	eː	oː
a		aː	

The final step was the loss of contrastive length oppositions mentioned above, which transformed the system in (7) into the one shown under (8) which is the common system at the basis of most of Romance varieties, and in particular of Gallo-Romance[4].

4. A further development of the system in (8) is characteristic of many Southern Italian varieties, like Sicilian or Central and Southern Salentino. Here mid and high +tense vowels merge (i), which results in the system in (ii).

(i) [+tense] → [+high]

(ii)

i	u
ɛ	ɔ
a	

The development of the Latin system that is observed in Romanian is discussed in note 11.

(8) vowel system (after loss of contrastive length)

i		u
e		o
ɛ		ɔ
	a	

2.2. Merger of [+high, -tense] and [-high, +tense] vowels

A central issue for any account of the development of the Latin vowel system is why the [+high, -tense] vowels (ɪ, ʊ) merged with [-high, +tense] vowels (e, o). A restatement of traditional accounts of this merger can be found in Loporcaro (2010b: 110):

> Latin long /eː/ realized as [eː], was closer to short /i/ (probably realized as [ɪ]) in the acoustic-articulatory space than it was to short /e/ (pronounced [ɛ]). This phonetic circumstance must have favored a tendency for long /eː/ (*e.g.* in CĒNA "dinner") and short /i/ (*e.g.*, PĬPER "pepper") to be treated at some point as member of a binary length contrast, a tendency reinforced by the fact that monophthongization of /AE/ (< archaic /AI/) had provided a new long counterpart /ɛː/ (*e.g.* in CAELUM) "sky") to short (and phonetically lax) /ɛ/ (as in VĔNIT "come 3SG.PRS. IND"), which could at this point be reanalyzed as /ɛ/, contrasting with both long /ɛː/ < /AE/ and short /e/ (</i/). A symmetrical tendency must have obtained on the velar side of the vowel system, with short /u/ (phonetically [ʊ] tending to be reanalyzed as the short counterpart of long /oː/, rather than /uː/.

This account combines i) the traditional idea that one of the triggers of the merger between the [+high, -tense] and the [-high, +tense] vowels was the "closeness in acoustic-articulatory space" between the two sets of vowels (Weinrich 1958) with ii) the structuralist idea that the merger was influenced by the presence of a structural gap in the Late Latin system (see (14)-(15)): there was no short [-high, +tense] [e] as a counterpart to the long [eː], while there was an opposition between a short [-high, -tense] [ɛ] and a long [ɛː] which had been created by the monophthongization of the diphthong *ae*. This gap, according to this analysis, had to be avoided and filled, thus leading to the lowering of [ɪ] to [e] (Lüdtke 1956).

Both ideas are problematic.

Observe, first of all, that a merger between [+high -tense] vowels and [-high +tense] vowels is quite common across the languages of the world. Let us consider a few cases.

The proto-language of the Kwa family (Niger Congo, Stewart 1972) is reconstructed as having the ten vowel system under (9) below, with a [+/- tense] opposition for each vowel (where capital [A] is a [+tense] low vowel)[5].

(9) Proto-Kwa

-tense		+tense	
ɪ	ʊ	i	u
ɛ	ɔ	e	o
a		A	

However, only a few of the modern Kwa languages have a vocalic system of that kind. Stewart shows that the [+tense] low vowel and the [-tense] high vowels are most commonly eliminated by the context-free changes under (10). The change that is of particular importance for us is the one under (10)b3.

(10) evolutions affecting Proto-Kwa

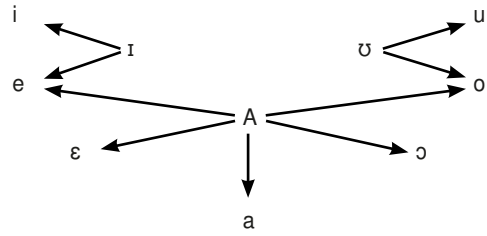
a. 1. A → a
i.e. [+low, +tense] → [+low, -tense]
2. A → e
i.e. [+low, +tense] → [-low, +tense]
3. A → ɛ
i.e. [+low, +tense] → [-low, -tense]

b. 1. ɪ, ʊ → i, u
i.e. [+high, -tense] → [+high, +tense]
2. ɪ, ʊ → ɛ, ɔ
i.e. [+high, -tense] → [-high, -tense]
3. ɪ, ʊ → e, o
i.e. [+high, -tense] → [-high, +tense]

5. The feature [ATR] should be used to describe this system and that of Proto-Edoid below. I use the feature [tense] for the sake of expository simplicity. On the relation between [tense] and [ATR] see section 4.2.

Elugbe (1982) observes the same type of reductions that we see in the Kwa languages in another African language, Proto-Edoid (Niger Congo), where we have the developments under (11).

(11) Proto-Edoid and subsequent evolutions



Observe that the vowels eliminated from the proto-language were [+high, -tense] [ɪ, ʊ] and [+low, +tense] [A]. The different reflexes of these vowels are similar to those that we find in the development of the Kwa languages. The same changes are also found in the Sudanic and Tungusic languages (Vaux 1996). Further, the change [ɪ, ʊ] → [e, o] is found in vowel harmony systems (see the so-called "Umbrian" metaphony) after the raising of mid [-tense] vowels to high (see Calabrese 1999).

The change [ɪ, ʊ] → [e, o] also accounts for the lowering of short lax vowels in Chinautla (a dialect of Pokoman, a Quichean language): *ʊk'* → *ok'* "louse", *pɪš* → *peš* "tomato" (Campbell 1977, Donegan 1978).

In Southern and Western Swedish, beginning in the 15th century, short [i] and [u] (arguably [ɪ] and [ʊ]) were lowered to [e] and [ø], thus *esk* "fish", *møkke* "much" corresponds to Central Swedish *fɪsk*, *mʊkke* (Haugen 1976, Donegan 1978).

In all of these cases, in addition to those encountered in Romance, we observe the context-free process in (12) which merges [-tense] high vowels with [+tense] mid vowels:

(12) [+high, -tense] → [-high, +tense]

I first consider the idea that the merger in (12) is based on the acoustic similarity/closeness between the [+high, -tense] vowels and the [-high, +tense] ones. As was mentioned above, given this similarity, these two classes of vowels are held to

be unable to establish an efficient phonological contrast, and therefore merge (Weinrich 1958). A number of objections can be leveled against this proposal. For one thing, it is unclear why acoustic closeness should result in lack of an efficient contrast in the case of these two sets of vowels. In fact, despite this closeness, a contrast between them is preserved in many languages for centuries. English and German are good examples. Similarity in itself does not explain the merger. Some other factor must be playing a role. On the other hand, the proposal that the merger in (12) is due to acoustic closeness does not explain why the merger affects the [+high, -tense] vowels [ɪ, ʊ] in such a way that they become [-high, +tense] [e, o], rather than turning the [-high, +tense] vowels [e, o] into [+high, -tense] [ɪ, ʊ]. That is, the proposal simply fails to account for the direction of the change. Furthermore, if acoustic similarity indeed plays a role in the merger between [ɪ, ʊ] and [e, o], it is unclear why in the cases reviewed above [ɪ] and [ʊ] may also become [i] and [u], or [ɛ] and [ɔ]. Changes based on similarity should lead to a single outcome (the "similar" element), not to a variety of results, some of which, i.e., [ɛ] and [ɔ], are neither acoustically or articulatorily similar to the target of the change. The similarity hypothesis is unable to account for all of these facts alone. I will come back to acoustic similarity in my analysis below (section 4.1), but not as the trigger of the process.

Consider now the idea that short [+high, -tense] [ɪ] was changed to [-high, +tense] [e] in order to become the short counterpart of [eː], given the fact that short [ɛ] had become the short counterpart to the long [ɛː] from the diphthong *ae*. Observe first of all that this analysis requires that the merger occurred when length was still contrastive in the Latin vowel system: [ɪ] changes to become the "short" counterpart of "long" [eː]. Therefore it assumes that the Late Latin vowel system had the structure in (13).

(13) structural gaps in the Late Latin vowel system after the application of (5) and the monophthongization of *ae* to [ɛː]

iː	ɪ		ʊ	uː
eː	ɛ		ɔ	oː
ɛː				
		aː	a	

The relevant changes (only considering front vowels) are given below.

(14) reanalysis of [ɛ] as structural counterpart of /ɛː/

iː	ɪ	→	iː	ɪ
eː	ɛ		eː	
	↓			
ɛː			ɛː	ɛ

(15) lowering of ɪ

iː	ɪ	→	iː	
	↓			
eː			eː	e
ɛː	ɛ		ɛː	ɛ

Now notice that the change in (15) leads to a structural gap: after having applied, there is no longer a short counterpart to long [iː]. It is unclear why the absence of a short counterpart to [eː] is more problematic than the absence of a short counterpart to the high vowels. Moreover it is also unclear why the problem of the absence of a short counterpart to [eː] is not simply solved by tensing short [ɛ], since in any case the resulting system would have been asymmetric.

Furthermore, one wonders why under such an analysis short [+high, -tense] back [ʊ] has lowered to [-high, +tense] [o], since in this case no gain in the structural symmetry of the system is achieved.

(16) lowering of ʊ

uː	ʊ	→	uː	
	↓			
oː			oː	o
	ɔ			ɔ

The conclusion is that an adequate account of the merger of the short high and mid long vowels in early Romance cannot be found either by resorting simply to acoustic similarity or to structural asymmetries in the vowel system, or to a combination of both. Another solution is called for.

2.3. Fronting of [u]

We can now turn to the other crucial change leading to the Gallo-Romance vowel system, the fronting of the vowel that developed from Latin long [u:]. Given the discussion above, this vowel was a [+tense] [u]. The fronting of [u] in its system is depicted under (17).

(17) fronting of lat. u:

ɪ			u			ɪ	[ü]	
e			o		→	e		o
ɛ			ɔ			ɛ		ɔ
		a					a	

Haudricourt and Julliand (1949) call the fronting of Latin long [u:] one of the "thorniest" issues of Gallo-Romance phonology. Ascoli (1882) hypothesized that this change was due to the Celtic substratum of Gallo-Romance. Since then, this hypothesis was shown to be based on very slender grounds, to say the least. Namely, Ascoli grounds his view on the (later) changes observed in insular Celtic; however, it is established today that Gaulish does not display fronting of Proto-Indo-European [u:] (Eska 2004). On the other hand, u-fronting even in Gallo-Romance seems to be quite late (not earlier than the 7th century), *i.e.* at a time when Gaulish was already extinct (see Jackson 1953).

Furthermore, it is to be observed that context-free systematic u-fronting occurred spontaneously in many other languages quite independently of any contact with [ü] containing languages. As Samuels (2006), observes, this change occurred in São Miguel Portuguese, Old Scandinavian and Classical Greek; we also find similar shifts in Armenian (Vaux 1992), Somali (Antell *et al.* 1973), Swiss French, Yiddish, Lithuanian, Albanian, West Syriac, Akha (Lolo-Burmese) (Labov *et al.* 1972), in "almost all dialects of American English" (Labov *et al.* 1997) and Norwich English (U.K.,

Labov 1994), as well as in Scots, South African, New Zealand, and southern British dialects (Lass 1988). Dressler (1974) identifies numerous other instances of context-free u-fronting, both with and without associated o-fronting. Among the languages he mentions are Oscan, Umbrian, some Iranian dialects, Irish Gaelic dialects, Brithonic, Mingrelian (Caucasian), Xopic (Caucasian), Holoholo (Bantu), Albanian, Frisian and Parači (Indo-Iranian). Calabrese (2000) adds the cases of Apulian dialects (see section 4.2).

Martinet (1952) proposed that u-fronting is due to the so-called "asymmetry of the articulators", *i.e.* the assumption that more vocalic oppositions are allowed in the front area of the mouth than in the back area. According to this idea, u-fronting occurs when the number of vowel phonemes increases in the back area of the mouth. Given the lesser articulatory space in this area, [u] is fronted in order to free space that can be used by [+tense] [o] (see (17) for Gallo-Romance).

Martinet's account requires four distinctions of height among the back vowels: /u, o, ɔ, a/. However, not all of the languages listed above have four degrees of height in the back area. In particular, Labov *et al.* (1997) show that American West English varieties display u-fronting despite the fact that they exhibit a three-height distinction in the back area owing to the merger of the vowels in *caught* and *cot*. Furthermore, as Samuels (2006) observes, seven-vowel systems with three height distinctions among front (i, e, ɛ) and four among back vowels (u, o, ɔ, a) happen to be one of the two most common seven-vowel systems across languages (Crothers 1978). Thus, u-fronting cannot be simply motivated by vocalic overcrowding in the back series.

Another possible account for back vowel fronting involves possible misanalysis during language acquisition (Harrington 2012). This solution is based on Ohala's (1993) hypothesis that a sound change can come about when a listener fails to adequately compensate for coarticulation in perception. This leads to an across-the-board reinterpretation in which a feature

is systematically attributed to the underlying representation of the coarticulated segment, or to some other articulatory mechanism, rather than to coarticulation. Consider a high back u after a coronal segment such as a /t/ (/tuC/). In this context the vowel /u/ is slightly fronted due to coarticulation ([tüC]). The idea is that listeners who used to filter out the effects of coarticulation from this vowel (and thereby analyze it perceptually as [u], *i.e.* as underlying /tuC/) no longer do so: that is, they misanalyze it as underlying /tüt/ by erroneously assigning the feature [-back] to the underlying representation of the rounded vowel. The actual sound change comes about when this mistaken attribution of the feature [-back] is extended to all high rounded vowels, therefore also in non-fronting contexts such as after labials or velars (Harrington 2012). The obvious problem here has to do with the reasons for this extension: why should learners ever arrive at a systematically erroneous analysis of the language they are exposed to (Kiparsky 2014)? What could impose such an erroneous analysis? In absence of a reasonable answer, this scenario is severely undermined.

I am not aware of any other adequate account of the systematic, context-free fronting of [u] that is observed in the systems mentioned above, Gallo-Romance included.

Alternative accounts for the merger between [+high, -tense] and [-high, +tense] vowels and for the fronting of [u] will be proposed in section 4. The following section prepares the theoretical grounds for the solutions suggested.

3. Theoretical Assumptions

3.1. A Realistic Approach to Language

The analysis of the two changes discussed will be cast in a recent revision of my way of seeing phonology, which combines an internal forward system of production/perception (Calabrese 2009b, 2012) with the constraint-based model of Calabrese (2005). To understand my analysis, it is necessary to outline the basic features of this theory. I would like to point out, however,

that the analyses proposed do not require my own particular theoretical idiom and could be easily translated into other models that interpret sound changes in terms of markedness effects, such as OT.

I begin by mentioning that the theory developed here assumes the realistic approach to language advocated by Bromberger and Halle (1992, 1997, 2000) (see also Halle 2002, Calabrese 2005, 2012). According to this approach, "phonology is about concrete mental events and states that occur in real time, real space, have causes, have effects, are finite in number" (Bromberger and Halle 2000: 21). In the realistic approach, the reality of language involves our concrete acts of speech performed by our limited bodies and brains, and the theory of phonology – and linguistics – must be built on this reality. Linguistic computation must be executed in the brain in real time (see Calabrese 2012 for further discussion).

Linguistic theory under this view investigates the system of knowledge that allows concrete occurrences of real time computational steps that convert conceptual structures into sound waves and vice versa. This knowledge involves representations and computations that have concrete spatio-temporal occurrences and stem from the workings of an actual brain with all its limitations. "Competence" is therefore the actual system of knowledge that allows the production/perception of speech events and is distinct from "performance" which involves the contingencies of this production/perception (see Bromberger and Halle 2000: 35). Here I will consider some aspects of this competence system.

3.2. Interactions between Speech Production and Perception: Analysis-by-Synthesis and Internal Forward Models of Speech Production

A sentence, when uttered, is only a stream of sound. That stream of sound, however, is associated with a certain meaning. In producing an utterance, a speaker converts a determined conceptual structure into a stream of sound. In perceiving

an utterance, a listener converts a stream of sound into a conceptual structure.

For the purpose of this article, it is important to consider how production and perception interact. We will see that in order to understand this interaction, we need an internal forward system. This system will be crucial to understand aspects of the two diachronic changes discussed in this paper.

The speakers' and listeners' linguistic knowledge of a given language must contain information that is able to account for how sound and meaning of the sentences of his language are correlated, and how conversions between sound and meaning proceed.

It is commonly assumed that knowledge of words, or more precisely of the vocabulary of the language, is a fundamental part of this knowledge. Words, in turn, are commonly composed of smaller pieces, morphemes. And it is the morphemes – in addition to words – that make up the vocabulary of the speakers of a language. Each vocabulary item is composed of a phonetic index, a sequence of phonemes, encoded in distinctive features – what I call an exponent – and an associated meaning, *i.e.* a conceptual unit or a combination of conceptual units. It is self-evident that the knowledge of exponents must be stored in the long term memory of speakers/listeners: we are not born with this knowledge, but must learn it, *i.e.* commit exponents to memory one by one.

In production, by means of exponents, hierarchically organized structures composed of grammatical and semantic features generated by a syntactic computation – what we can loosely call conceptual structures – are converted into phonological representations. This is done by associating the exponents to the relevant morphological pieces in these structures – a process referred to as the insertion of exponents (or vocabulary insertion, Halle and Marantz 1993). Processes in the phonological component then convert the underlying phonological representations generated by the insertion of exponents into surface phonological representations that may

be radically different from the underlying ones. Further phonetic processes convert these representations into articulatory representations that are then implemented in patterns of muscular activation/articulatory gestures. At this point streams of sounds are produced.

In perception, the goal of the listener is to access the meaning – the conceptual structures mentioned above – conveyed by the stream of sounds that are heard. The meaning of an utterance is accessed through the identification of the exponents of the vocabulary items (morphemes/words) used in it and the recognition of how they are structurally organized. The identification of exponents may only be achieved by parsing away the effect of phonological processes that may sometimes render them unrecognizable.

There is evidence that perception is not direct, but mediated by grammatical/linguistic knowledge that involves active hypothesizing by the listener (Garnes and Bond 1980). This is required to account for the misperceptions and/or illusory perceptions that listeners have not only in their experience of non-native, foreign sounds, but also of the sounds of their own language (see Calabrese 2012 for more discussion and references).

Recent work on speech perception (Poeppel *et al.* 2008, see also Calabrese 2012 for further references) has suggested that the most adequate way to account for the aforementioned "active hypothesizing on the part of the listener", *i.e.* for the effects of grammatical computations and in general for the interaction of top-down and bottom-up processes in speech perception, is to assume that perceptual representations of speech are constructed through an analysis by synthesis of the signal (Halle and Stevens 1962). Analysis by synthesis requires an active access to grammatical knowledge and elaboration of perceptual targets through grammatical derivations.

In analysis by synthesis, the listener analyzes the acoustic input by deriving how it is generated by the speaker, synthesizes a virtual acoustic signal based on the output of this derivation

and matches the virtual with the actual signal[6]. The first step is the generation of a hypothetical phonological representation underlying the acoustic target representation. This hypothetical representation is then submitted to a computation that generates the virtual acoustic representation that can be compared with the target. A successful perceptual act occurs when the acoustic shape of the phonological representation derived by this perceptual computation matches the acoustic input in auditory memory. In this way, the listener makes sure that the exponents identified in the input signal correspond to those intended by the speaker who produced the signal. The need for this certainty is referred to as the parity requirement (Liberman 1996, Liberman and Whalen 2000).

Analysis by synthesis crucially requires an internal forward model that is able to calculate the acoustic/auditory consequences of phonological representations. An internal forward model is a cognitive system that predicts the consequences of actions. It is based on an influential idea in neuro-cognitive sciences: during sensorimotor control "the brain predicts the consequences of action by simulating the dynamic responses of our body and environment to the outgoing motor control" (Wolpert and Flanagan 2009: 274).

An internal forward system that is able to predict the fine motor and sensory consequences of phonological representations (specifically their acoustic and auditory consequences) is also a fundamental part of speech production (Guenther 1995, 2006). Tian and Poeppel (2010) show that while planning to speak, speakers activate the hearing part of the brain before the actual production of the word. That is, the brain is predicting what the word will sound like[7]. Thus, phonological representation must

6. During the analytic process characterizing analysis by synthesis, any type of knowledge can be accessed. In particular, the listener's ability to access the knowledge of the speech production apparatus can explain how the articulatory configurations behind the signal are properly identified, as proposed by the motor theory of speech perception (Liberman and Mattingly 1985, 1989; see also Liberman *et al.* 1967).

7. Probably this is due to the fact that the achievement of parity is also required during production insofar as the speaker wants to be certain to communicate what he

be converted into virtual acoustic and auditory representations and vice versa. The presence of a phonological internal forward system is crucial to understand some aspects of the historical changes under examination in this paper.

3.3. Distinctive Features

Another crucial assumption of the theory presented here is that the representations of exponents of the morphemes and words stored in long-term memory involve phonological distinctive features. Features are the fundamental units forming speech units (phones or phonemes). Since Chomsky and Halle (1968), linguists overwhelmingly assume that features have an articulatory basis. Phonological analysis of language after language shows that classes of sounds appear to be organized in terms of the articulatory correlates of features (see Halle 2002, Halle *et al.* 2000 for recent arguments).

The role of articulatory features in production is obvious. The issue is how representations based on such articulatory features are recovered in perception. These representations cannot be directly extracted from the acoustic signal (Diehl *et al.* 2004, Ladefoged *et al.* 1972, among others). This problem can be solved only by assuming that the listener has access to knowledge of the basic correlations between motor speech action and acoustic/auditory patterns, top down, through an internal forward system of speech perception. Therefore, an internal forward system is also necessary to account for the relations between features and the acoustic information contained in the signal (see Stevens 1972, 1989, 1998 on the basic "quantal" correlations between acoustic and articulatory patterns).

3.4. The Phonological Component

In my own view (Calabrese 2005, 2009a), the phonological system of a language produces a complex set of output phonological representations derived from underlying representations of exponents by phonological operations, some of which are

intends to.

of a language-specific historical origin and others due to Universal Grammar (UG). Phonological theory must have an architecture such that processes involving universal markedness considerations and purely language-specific processes interact with each other smoothly and efficiently.

One component of the architecture proposed here is the Instruction Module, which contains the instructions governing the sound shape of a language. The instructions contained in the instruction system may be both positive (18) and negative (19).

(18) Instruction Module: positive instruction

if αF, then βG / [_ , γZ]

from now on: αF → βG / [_, γZ]

(19) Instruction Module: negative instruction

*[αF, -βG] / [_ , γZ]

Positive instructions require that configurations with the same structural description undergo the same structural change. These are called rules. Negative instructions mark certain configurations as illicit. They are called filters. Filters typically govern the structures of inventories. If an input contains an illicit configuration it may be removed by different structural changes. It follows that in the case of filters the same structural description may undergo different structural changes (*i.e.* a conspiracy, see Calabrese 2005 on the differences between rules and filters and the need to assume both).

Both rules and filters can be idiosyncratic and language-specific as well as universal. Universal rules and filters are included in the Markedness Module (MM). The MM is the repository of all interface properties that characterize the phonology and the motor/sensory processes external to phonology proper. The Instruction Module also contains a component with language-specific rules and filters, to handle the wide range of phonological phenomena that cannot plausibly be analyzed as the activity of markedness considerations. In this article we are not dealing with language-specific processes, so I will restrict my attention to universal filters and rules.

As mentioned above, the Markedness Module includes universal filters and universal rules. There are two types of universal filters: *prohibitions* and *marking statements*. Prohibitions identify configurations that are never possible for articulatory and/or acoustic/perceptual reasons, *e.g.* the configuration *[+high, +low]. Marking statements identify phonologically complex configurations that may be found in some but not all phonological inventories. They can be active or deactivated. If a marking statement is deactivated in a given language, the relevant complex configuration appears in the language. Otherwise, they are naturally active, and the relevant complex configuration is missing. Marking statements are ranked in UG, to the effect that certain statements can only be inactive if others are also made inactive.

Universal rules include *natural rules*, which account for processes that tend to be recurrent across languages, like final obstruent devoicing, or a process such as that in (4). They can also be active or deactivated. As in the case of marking statements, I assume that they are naturally active and that they must be deactivated – suppressed like the natural processes of Donegan and Stampe (1979) – in the acquisition process.

The input representation is checked by both filters and rules in the Checking Component. If the input does not contain any configuration that dissatisfies instructions, it passes and goes on to further modules. However, if the input representation does contain this kind of configuration, it is marked as needing a change, *i.e.* a repair, and the input is sent to the Repair Component, along with information as to which instruction is dissatisfied. The Repair Component consists of a number of Repair Sets, one for each instruction (I refer the reader to Calabrese 2005, 2009a for discussion of how these repair sets work).

Since we are dealing with vowel markedness in this article, I will focus only on this area in the illustration of how the Markedness Module works. It is assumed that marking statements govern the structure of phonemic, in our case vocalic systems. The absence of the configuration [-back, +round] in a

language, *i.e.* of front rounded vowels [ü, ö, œ], is formalized in terms of the marking statement *[-back, +round], which makes sure that this combination is illicit in the language. Languages vary in what feature combinations are allowed in their inventory. Calabrese (2005) argues that the set of marking statements under (20) accounts for the varying structure of vowel systems across languages.

(20) marking statements responsible for vocalic inventories

a. *[-low, -high]

b. *[-high, +tense]

c. *[+low, -back]

d. *[-back, +round]

e. *[+high, -tense]

f. *[+back, -round] / [_ , -low]

g. *[+low, +round]

h. *[+low, +tense]

A language in which no marking statement is deactivated will thus have the vowel system /i, u, a/. Arabic is a language of this type. If a language deactivates the marking statement (20) c, it will have the vowel system /i, u, æ, a/. Latvian is a case in point. If instead of (20)c, a language deactivates the marking statement (20)a, it will have the vowel system /i, u, ɛ, ɔ, a/ which is found in Modern Greek, Spanish, Hawaiian, and many other languages. If in addition to the marking statement (20) a a language also deactivates the marking statement (20)b, it will have the vowel system /i, u, e, ɛ, o, ɔ, a/, which is found in standard Italian. If, instead, it deactivates the marking statements (20)c and (20)d, it will have the vowel system /i, y, u, ɛ, œ, ɔ, æ, a/, which is found in Finnish. The structure of other vowel systems can be accounted for in similar ways by marking statement deactivation.

It was mentioned that if a marking statement is active in a language, the configuration marked by this statement is illicit in this language. Thus, in a language with the vowel system

/i, u, ɛ, ɔ, a/, the vowel [æ] is illicit because it is excluded by the active marking statement *[+low, -back]. Illicit configurations are fixed by phonological repairs. A common repair adjusting illicit featural configurations involves deleting one of the illicit feature specifications and replacing it with the opposite specification (switch of the plus/minus value). For example, consider Italian speakers. The Italian vowel system does not have the [+low, -back] vowel [æ] of the English word *cat* /kæt/ and Italians replace this vowel either by [ɛ] or by [a]. This can be explained as follows. The illicit configuration [+low, -back] of the vowel [æ] may be repaired by replacing [+low] with [-low] ([+low, -back] → [-low, -back]), or by replacing [-back] with [+back] ([+low, -back] → [+low, +back]). In the first case, the illicit vowel [æ] is replaced by the vowel [ɛ], and in the second case, by the vowel [a].

In Calabrese (1988, 1995, 2005), segmental repairs are implemented by three different procedures: delinking, fission and excision, each involving a different set of instructions. These three types of repair rules can be reduced to the basic operations of non-linear phonology: insertion and deletion. Delinking involves deletion of a feature value; fission involves insertion (excision also involves deletion but targets the entire illicit configuration, on which more below). The grammar selects the basic operation that repairs the illicit featural configuration. All other aspects of the repair follow from the intrinsic design of language as well as from the requirements of economy and time pressure.

Here I will only show how delinking works formally. Excision will be discussed in section 4.1 (see Calabrese 1995, 2005 on fission). Consider the marking statement in (21).

(21) *[+low, -back] (*æ)

If this constraint is active, the configuration [+low, -back] must be repaired. This is done by the application of the basic operations of deletion. The two possibilities under (22) are encountered.

(22) REPAIR of *[+low, -back]

a. Operation: Deletion
   Target: [-back]

b. Operation: Deletion
   Target: [+low]

Given (22)a and (22)b, either the feature [-back] or the feature [+low] is deleted in the illicit configuration in (23), yielding the output in (24)a or (24)b, respectively.

(23) [+low, -back] ([æ])

(24) a. [+low, ___]

b. [___, -back]

Since the model does not allow for featural underspecification (features must always be specified), the value for [back] in (24)a and for [round] in (24)b needs to be determined. Values compatible with the active marking statement (21) are inserted, which produces the output under (25).

(25) a. [+low, +back] ([æ] is replaced by [a])

b. [-low, -back] ([æ] is replaced by [ɛ])

3.5. Sound Change

Each sound change involves three parts (Labov 2001): an innovation implemented by an individual speaker, the transmission of this innovation from this speaker to other speakers in a linguistic community, and finally the adoption of this innovative feature in the grammar of the community. Only the first part is properly linguistic; the other two parts are controlled by sociolinguistic or fully social factors. Here I am interested only in the first part of a linguistic change: the innovation implemented by the individual speaker.

In the framework assumed, sound changes that are due to markedness effects are accounted for by postulating the activation of marking statements or natural rules. When this kind of activation goes into effect, a repair adjusts the representations

that have thus become disallowed. Under this interpretation, a sound change of this type is an innovative repair.

Changes due to markedness effects may lead to what is called the *emergence of the unmarked* in the recent literature (McCarthy and Prince 1994): a marked item is replaced by a less marked, or unmarked configuration. It is important to point out, however, that there are also sound changes that are difficult to categorize as involving the emergence of the unmarked. A classical case in point is the context-free fronting of rounded back vowels discussed in section 2.3 and further analyzed in section 4.2. Changes of this type appear to involve the opposite phenomenon: an *emergence of the marked* (see Calabrese 2005: 47-52). Cases of this type are by no means rare: for example, syncope gives rise to complex syllabic structures; vowel assimilation such as umlaut produces marked vowels like [ü, ö, ä]; vowel/consonant interactions (e.g. palatalization) create marked consonants such as palato-alveolar affricates and so on. All these cases are of the same type: they involve a conflict between a natural rule/marking statement and another marking statement disallowing a highly marked configuration. The historical change leading to the emergence of the marked involves the activation of the rule/marking statement that leads to a violation of another marking statement.

The crucial issue in all of these cases – including back vowel fronting discussed – is that the violated marking statement is deactivated instead of being repaired. The fact is that when a phonological operation generates a configuration of features that is normally not admitted in a language (*i.e.* illicit because of a marking statement), the language has two options: either 1) the disallowed configuration is simplified by applying a repair; or 2) the relevant marking statement is deactivated, thereby admitting the previously excluded configuration of features. By implementing the latter option, the language accepts paying

the cost of deactivating the relevant marking statement and enlarging its inventory[8].

The obvious question now is why in some cases languages accept paying the cost of deactivating the relevant marking statement while at other times they do not and resort to repairs instead. I believe that there is no way to answer this question. As discussed in Calabrese (2005), we are dealing with the idiosyncrasies of history, and a parallelism between sound change and cultural change is relevant in this case. In fact, there cannot be a real answer to the question of why a certain cultural custom is adopted instead of another. For example, consider why piercing or tattooing has become popular in a segment of our society. We can explain why these customs spread in certain groups as a sign of identity or rebellion, but not why they were adopted in the first place by the individuals that started piercing or tattooing themselves. Many different factors can play a role in this, some totally irrelevant such as simple chance. I submit that linguistic change works along these lines and, in particular, has the two options mentioned. What is important in the case of linguistic change is that there is a limited number of possibilities, for example, the option of deactivating or not deactivating a given marking statement when it is violated. But an account for why a certain possibility, or option, was adopted instead of another, cannot be pursued, at least given our current understanding of how the mind works.

8. This must obviously be possible, given the fact that allophones are allowed and that phonological inventories may change by phonemicizing these allophones. Allophones, in fact, are introduced into a language by phonological operations – implemented by rules or repairs – that create feature configurations disallowed by some active marking statements. These marking statements are obviously deactivated in this case. At the same time, phonological inventories can be changed by acquiring new foreign segments through borrowing. In this case we are also dealing with configurations of features mentioned in marking statements that were previously active in those inventories. If marking statements could never be deactivated, the existence of allophones and innovation in phonological inventories could not be accounted for. That is, languages would always remain the same.

4. Analysis of the two changes ɪ, ʊ → e, o and u → ü

4.1. The Merger of [+high, -tense] and [-high, +tense] in Romance

Evidence shows that [+high, -tense] vowels are phonologically complex, *i.e.* marked. First of all, vowels of this type tend to be historically eliminated from vowel systems as we have seen in section 2.2. At the same time, the presence of [+high, -tense] vowels in a vowel system tend to imply the presence of [+high, +tense] (i, u), [-high, +tense] (e, o) and [-high, -tense] (ɛ, ɔ) vowels (Calabrese 1988, Maddieson 1984). This clearly indicates the hierarchical positioning of the configuration representing ɪ, ʊ as more complex than the others. It can be argued that the reason for the complexity of the [+high, -tense] vowels is that they are not acoustically optimal in so far as tongue root retraction does not enhance the acoustic effects produced by the raised tongue position (see Stevens *et al.* 1986). Calabrese (1988, 1995) proposes that [+high, -tense] vowels are excluded by the marking statement in (26).

(26) *[+high, -tense]

If this constraint is active, ɪ, ʊ must be repaired. If we look back at the examples discussed in section 2.2, it appears that they are repaired in the following way.

(27) repairs of *[+high, -tense] found cross-linguistically

a. [+high-tense] → [+high, +tense] deletion of [-tense] (ɪ, ʊ → i, u)

b. [+high, -tense] → [-high, -tense] deletion of [+high] (ɪ, ʊ → ɛ, ɔ)

c. [+high, -tense] → [-high, +tense] ? (ɪ, ʊ → e, o)

The changes in (27) a,b involve delinking (Deletion) as shown below.

(28) REPAIR of *[+high, -tense]

a.	Operation:	Deletion	
	Target:	[-tense]	
	Output:	[+high, __]	
	Automatic feature insertion:	[+high, +tense]	
	Output:	[+high, +tense]	[i, u]
b.	Operation:	Deletion	
	Target:	[+high]	
	Output:	[__, -tense]	
	Automatic feature insertion:	[-high, -tense]	
	Output:	[-high, -tense]	[ɛ, ɔ]

But what about (27)c? In Calabrese (1995) I hypothesize that this sound change involves one of the possible repairs triggered by the active marking statement in (26). In this paper I specifically propose that (27)c is an instance of simplifying negation, whose format is given in (29), and whose application to the configuration [+high, -tense] yields the derivation in (30). Note that negation changes feature values of features to their opposite.

(29) [αF, βG] → -([αF, βG]) → [-αF, -βG]

where [αF, βG] is a disallowed configuration

(30) [+high, -tense] → - ([+high, -tense]) → [-high, +tense]

In addition to (30), this repair is also needed in order to capture phenomena like the following (some of which were discussed in section 2.2).

(31) a. [+tense] A → ɛ/ɔ 1. in the diachronic changes from Proto-Kwa to the modern Kwa languages.
2. in several [+/-tense] harmony systems in which the [+tense] counterpart of [a] is either ɛ or ɔ.

b. ü, ö → ɨ, ə unconditioned sound change that occurred in the history of Mongolian (see Dressler 1974).
pronunciation of [ö] as [ɜ] by English speakers (*Gödel* pronounced as *girdle*), see Kiparsky (1973).

c. ə → ö pronunciation of English [ə] as [ö] by foreign speakers, see Jones (1964).

All processes in (31) involve a context-free reversal of the feature specifications of the input configurations. These are phonologically complex and governed by independently motivated marking statements as shown in (32). In earlier work I assumed that these processes are due to the repair operation in (29).

(32) a. [+low, +tense] → [-low, -tense] =(31)a *[+low, +tense]
b. [-back, +round] → [+back, -round] =(31)b *[-back, +round]
c. [+back, -round] → [-back, +round] =(31)c *[+back, -round]

In later work I tried to account for negation in a different way. In a segmental repair such as delinking, some features of the illicit input configuration are preserved in the output. In an operation such as negation, however, all aspects of the ill-formed input configuration are changed. Nothing is preserved. The peculiarity of negation then is that it is radical. It is the most drastic measure to undertake against a disallowed feature configuration: total removal. It is as if both features of a marked configuration were marked as "bad" and needed to be removed. Thus in Calabrese (2005), I propose that, among the repair operations allowed in the repair component, there is also the removal of the entire

disallowed configuration, an operation that I dub *excision*. I also assume that after excision of the disallowed configuration, the opposite values of the deleted features are inserted to satisfy full specification, thus capturing feature reversal as in (29). This double insertion of features, however, has always bothered me.

Here I would like to explore another way of conceiving the filling of the excised configuration, and assume that acoustic similarity plays a role in this operation. As will be seen below, this allows us to capture the traditional idea that acoustic similarity between [+high, -tense] and [-high, +tense] vowels plays a role in the merger of these vowels (see section 2.2).

The idea pursued includes some aspects of the P-map theory of Steriade (1999). Steriade argues that the knowledge of the relative acoustic similarity between segments is a fundamental part of the linguistic knowledge of a language. The P-map includes statements such as that in (33).

(33) The pair of segments x-y is more similar than the pair of segments w-z.

According to Steriade, the primary function of a P-map is to guide the speaker in search of the minimal input deformation that can solve the problems posed by a linguistic constraint. In our case we would have a statement such as that in (34).

(34) A vowel involving the features [+high, -tense] (ɪ, ʊ) is more similar to a vowel involving the features [-high, +tense] (e, o) than to any other vowel.

To account for the change of [+high, -tense] to [-high, +tense] vowels and given (34), we can then assume a constraint against [+high, -tense] vowels, as proposed before.

(35) *[+high, -tense]

If this constraint is active, ɪ, ʊ must be repaired. If we assume that speakers follow the P-map in this repair and replace a disallowed segment with a segment that is acoustically minimally different from the target segment, we have an account for the change in (27)c, repeated here as (36).

(36) [+high, -tense] → [-high, +tense]

The problem with statements such as those in (33) and (34), however, is that they must obviously be universal, rather than language-specific. They predict the existence of only one possible repair, *e.g.* the one in (36) given (34). However, as may be seen from the discussion in section 2.2 and many other cases, the elimination of [+high, -tense] vowels does not always lead to [e] and [o]: it may also produce the [+high, +tense] vowels [i] and [u], as well as the [-high, -tense] vowels [ɛ] and [ɔ]. This is entirely unexpected in Steriade's theory where such dialectal variation should not occur.

Note that Steriade's idea requires an internal forward system, although she is not explicit on that. Crucially, the speaker must compute the auditory consequences of the feature complexes selected in the repairs in order to evaluate them in terms of the statements in (33) or (34).

I would like to suggest a way of capturing the P-map hypothesis in terms of the internal forward system described in section 3.2, while following the theory of repairs presented, thus directly accounting for variation.

Recall that excision deletes the entire disallowed feature configuration. When this occurs, the specifications of the excised features must be filled to satisfy full specification. I assume that the internal forward system is responsible for this operation. In particular, this system looks for specifications of the excised features, which together with the other features of the affected segment lead to a segment that is auditorily similar to the disallowed segment. As discussed above, the internal forward system in perception is able to compute the acoustic/auditory consequences of featural configurations. The same can be assumed for production. Thus, when high [-tense] vowels are repaired by excision, the internal forward system looks for a featural configuration involving the features [high] and [tense] which, in conjunction with the other features of the affected vowel, generates a vowel that is auditorily close to the

disallowed [+high, -tense] vowel. This search will prompt the feature configuration [-high, +tense], *i.e.* [e, o].

The same analysis can be extended to the repairs in (31). In the case of the repair of [+low, +tense] A, the internal forward system looks for a featural configuration that is auditorily similar to that of A in terms of F1 values, *i.e.* that of the vowels [ɛ] or [ɔ]. In the case of the repair of [ü, ö, ə] which, recall from (31)b,c, may be replaced by [ɨ, ə, ö,], respectively, the internal forward system selects the featural configuration of vowels of the same height that are auditorily similar to the illicit target vowels in being less peripheral in the acoustic space (in terms of less extreme F2 values).

We now also have an account of what happens in the case of (27)c: we are facing excision followed by the insertion of a featural configuration selected through the search for a segment that is auditorily similar to the illicit target. Note that, crucially in the analysis proposed here and in contrast to Steriade's P-map, excision is not the only possible repair. Delinking may also apply to ɪ, ʊ. as in (28)a-b. Thus, the output of the repair can also be [i], [u] or [ɛ], [ɔ] (in addition to [e], [o]). We thus not only have an account of the merger of [+high, -tense] and [-high, +tense] vowels due to excision, but also of the variation that is found when [+high, -tense] vowels are repaired (see section 2.2), which owes to the availability of the delinking operations in (28).

In the case of Romance, this approach predicts that Latin short [i, u] should also be able to have an outcome different from that of the Latin [iː, uː] and [ɛː, ɔː]. Possible evidence for such an alternative result is provided by a small number of Sardinian and Corsican dialects (Loporcaro 2010b: 119) where [i, u] are kept distinct from both the reflexes of Latin [iː, uː] and [ɛː, ɔː].

(37)

iː	i	ɛː	ɛ	aː	a	ɔ	ɔː	u	uː
|	|	\	/	\	/	\	/	|	|
i	e		ɛ		a		ɔ	o	u

4.2. Fronting of High Tense [u]

Let us now turn to the other context-free vocalic change affecting Gallo-Romance: the fronting of the high tense [u] that developed from Latin long [uː].

In Calabrese (2000) I dealt with a similar process of vowel fronting that occurs in some Apulian dialects. A crucial aspect of this process is that it affects the back vowels as shown in (38).

(38) fronting in Apulian dialects

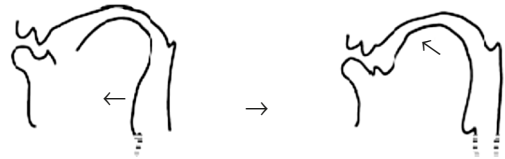
u → ü

o → ö

ɔ

My analysis in that paper assumes the feature [Advanced Tongue Root (ATR)] instead of [tense] so that [+tense] vowels are instead [+ATR], and [-tense] vowels [-ATR]. Observe that the vowels which are fronted in (38) are those that are [+ATR]. If we assume the feature [ATR], there is a natural motivation for the fronting process in (38) due to the mechanics of tongue root movement. In fact Lindau (1978) observes that advancing the tongue root tends to push the tongue body up and forward (see also Archangeli and Pulleyblank 1994), as schematized in (39) (adapted from Vaux 1992).

(39) [+ATR] → fronting and raising



Therefore, in pronouncing [+ATR] back vowels, speakers need to suppress the natural tendency to front them. The need for this suppression makes the configuration [+ATR, +back] articulatorily complex, and therefore phonologically marked. The marking statement in (40) expresses this complexity.

(40) *[+back, +ATR]

As proposed earlier, a segment is disallowed when a marking statement is active. Disallowed segments must be repaired. Hence we can say that the marking statement in (40) was active in the Apulian varieties displaying fronting, and that the fronting process that changes the [+ATR] vowels [u] and [o] into [ü] and [ö] involves the repair in (41) – deletion of [+back] –, which eliminates the configuration disallowed by (40).

(41) [+back] → [-back] / [__, +ATR]

Evidence for (41) is provided by historical developments in languages with clear [ATR] distinctions. In these languages, [+ATR] back vowels are fronted so that from a proto-system with [ATR] oppositions as in (42)a we get the system in (42)b where the [+ATR] vowels are also fronted (see Vaux 1992, 1996).

(42) a. original ATR system

i	e	A	o	u	+ATR
ɪ	ɛ	a	ɔ	ʊ	-ATR

b. derived ATR/back system

i	e	æ	ö	ü	+ATR
ɪ	ɛ	a	ɔ	ʊ	-ATR

Somali provides an example of such a development. This language has two series of vowels contrasting in terms of the feature [ATR]. Interestingly, the [+ATR] vowels are also fronted, as shown by the [+ATR] [u] and [o] which surface as [ü] and [ö], respectively (Antell *et al.* 1973: 38). The same can be observed in Tungusic and Mongolian which have been shown to have ATR oppositions and feature an ATR harmony (Svantesson 1985, Rialland and Djamouri 1984). Crucially, [+ATR] vowels are also relatively front in both groups of languages.

Note that the context-free fronting of rounded back vowels discussed affects the unmarked vowels [u] and [o] and produces the vowels [ü] and [ö], respectively, which according to any markedness criteria are marked[9]. In the theory presented here, these vowels are disallowed by the marking statement in (43).

(43) *[-back, +round]

Thus in the case of this fronting process we have a change from the unmarked to the marked, *i.e.* an instance of the emergence of the marked discussed in section 3.5. Recall that the emergence of the marked occurs when there is a conflict between two marking statements, one of which excludes a more marked configuration. Also recall that using OT terminology (but not only, see in fact Calabrese 1988, 2005), marking statements are ranked. Thus, the case at hand involves a conflict between the marking statement *[+back, +ATR] and the higher ranked marking statement *[-back, +round]. Usually it is the former, lower ranked marking statement that is deactivated. However, in some languages it does not, and violations of it must be repaired. They are repaired by deleting [+back] and replacing it with [-back]. When this happens segments such as ü and ö are created, which violate *[-back, +round]. If the speakers of this language accept the degree of complexity of this segment, and *[-back, +round] is deactivated, front round vowels are introduced into the language, hence leading to the emergence of marked vowels. We thus have an analysis of the fronting of back vowels we observe in Gallo-Romance and the other languages mentioned.

Still there is a problem that needs to be addressed before going on. If [tense] is simply replaced by [ATR] and thus the constraint governing the marked high lax vowels is *[+high, -ATR], assuming the constraint *[+back, +ATR] leads us to expect vowel systems in which the high back vowels are missing. However, such systems are unattested. High back vowels tend always to

9. For example, i) their presence in a system presupposes the existence of their basic front unrounded and back unrounded counterparts, and ii) they are uncommon across phonological systems (see Maddieson 1984).

be present in vowel systems: [u] is typically considered to be an unmarked vowel together with [i] and [a] (Maddieson 1984). Furthermore only if [u] is present in a system can its more open, lax, counterpart be present, as expected by standard markedness implications. Thus, if we use the feature [ATR] to account for the contrast between close vs. open/lax high vowels, we should assign unmarked status to the configuration [+high, +back, +ATR] with respect to the configuration [+high, +back, -ATR]. This directly contradicts the assumption that the configuration [+back, +ATR] is marked.

A possible solution to this problem can be found by considering the findings by Calabrese and Grimaldi (forthcoming). This study deals, among other things, with the articulatory difference between mid close and mid open vowels in the Southern Salentino variety of Italo-Romance. These differences were investigated through ultra-sound imaging of the vocal tract. The study shows that in this variety, the articulatory difference between mid close and mid open vowels, where mid close vowels acoustically have a higher F1 and a less peripheral position for F2, does not simply involve tongue root advancement but a combination between tongue body displacement *and* tongue root advancement. The overarching generalization is that in mid close vowels general tongue shape is more convex. Crucially, the study shows that tongue shape convexity in back vowels may be achieved by some speakers merely through tongue body displacement without tongue root advancement. In contrast, mid close front vowels always display tongue root advancement across all speakers (while there is variation in tongue root position in back vowels – tongue root position is thus not fixed in this case).

Given this state of affairs, Calabrese and Grimaldi propose to use the feature [tense] to account for the contrast between mid open and close vowels in Italo-Romance where [+tense] vowels are characterized by an increased tongue convexity involving the tongue body, and also possibly the tongue root. However, introducing the feature [tense] in addition to [ATR] creates

an overgeneration problem: it would predict the existence of languages where the features [tense] and [ATR] can freely combine, leading to systems with four height distinctions in the high or mid vowels, which of course are not on record. Therefore Calabrese and Grimaldi propose that tongue root position cannot be used contrastively by itself. Tongue root advancement or non-advancement can instead be seen as a configuration enhancing the convexity requirements associated with vowel tensing (see Stevens *et al.* 1986). Specifically, the proposal is that the presence of the feature [ATR] is always governed by the enhancement rule in (44).

(44) [α tense] → [α ATR]

In languages clearly displaying ATR distinctions like Akan (see Lindau 1978) and the Niger-Congo Languages in (9) and (11), rule (44) is fully active. In other languages, however, it may interact with the constraint in (40). This constraint may block the application of (44) to the back vowels as is the case in Southern Salentino, or it may trigger the application of the fronting repair in (41).

This idea solves the problem mentioned above as follows. Vowel system structure is governed by the constraints in (20), which correctly predict that [i], [u] and [a] are the basic unmarked vowels and vowels such as lax [ɪ] and [ʊ] are instead marked. The constraint *[+back, +ATR] interacts locally only with the enhancement rule in (44) by blocking it or repairing the outcomes of its application, as in (41), which leads to fronting[10].

At this point we can come back to Gallo Romance, where [+tense] [u] that developed from Latin long [u:] is fronted. I want to propose that this fronting was due to the constraint in (40). The crucial change in Gallo-Romance then was the activation of

10. I assume that this analysis of fronting holds for all cases in which we observe what appears to be a spontaneous change from the unmarked [u, o] to the marked [ü, ö].

the rule in (44), which interacted with the active (40). The repair triggered by the constraint was the one shown in (45)[11,12].

(45) [+back] → [-back] / [__, +ATR, +high]

This led to the vowel system in (46).

(46) vowel system after u-fronting

i	ü			
e				o
ɛ				ɔ
		a		

Given this evolution, we still need to account for the raising of [o]. A peculiar feature of the surface system in (46) is that the position of the unmarked sound [u] is left unfilled. Suppose that such structural gaps are disfavored as assumed by Martinet (1955). A surface vowel system must contain unmarked vowels. An auditory principle governing surface representations such as that in (47) can be postulated at this point. This principle

11. Evidence for this analysis may also be provided by the evolution of the Latin vowel system in Romanian and central Lucanian. In these Romance varieties we observe a different evolution of the vowels in the front and back series: whereas a distinction between mid close and mid open vowels was created in the front area, no such distinction appeared in the back series.

(i)	Latin	i:		i	ɛ:	e	a:	a	ɔ	ɔ:	u	u:
		|	\	/	|	\	/	\	/	\	/
	R./L.	i		e	ɛ		a		ɔ		u	

Given the discussion in the text, we now have a possible account for what we see in Rumanian and Lucanian. Assuming that both (40) and (44) are active, (40) could have blocked the application of (4) to back vowels. After the loss of quantity and the merger of high [-tense] and mid [+tense] vowels (only in the front series), a new contrast is created in the front, but not in the back series.

This analysis predicts that the high tense back vowel of the resulting system in (i) must be [-ATR] as in Southern Salentino, at least in the early stages of its historical development. Future research will test this prediction for the modern varieties.

12. There is a complication insofar as one expects also fronting of the mid [+ATR] [o] as in the Apulian dialects in (38). The absence of this change seems to indicate that the constraint in (41) must actually be split into two independent constraints: one applying to high and one applying to non-high vowels. It is the constraint in (ia) below that is activated in Gallo-Romance. In the Apulian dialects, both constraints under (i) below are active. Ancient Greek and Old Swedish seem to behave like Gallo-Romance.

(i) a. *[+back, +ATR] / [__ +high]
b. *[+back, +ATR] / [__ -high]

essentially translates Martinet's insight into terms which are consistent with the framework adopted here.

(47) The vowel system of any language must contain unmarked vowels, where unmarked vowels are those not constrained by marking statements (*i.e.* [i, u, a]).

To fill in gaps that are illicit according to this principle requires access to the internal forward system. The internal forward system is able to check the featural representations of the other vowels in the system, select the vowel where minimal featural changes lead to the missing vowel and implement the changes on this vowel. In the system in (46), [-high, +ATR] [o] is the auditorily closest vowel to the missing [u]. This leads to the reanalysis of this vowel as [u] by the rule in (48)[13].

(48) [+back, +tense] → [+high]

5. Conclusions

In concluding this paper, I would like to stress the importance of re-examining linguistic history in the light of ever evolving linguistic theory, and to propose explanations of historical facts using current frameworks. The validity of such explanations, as in all sciences, is in their ability to reduce the phenomena under analysis to other known phenomena and to extend the proposed explanations to other independent facts.

The merger of [+high, -tense] (ɪ, ʊ) and [-high, +tense] vowels (e, o) as well as the fronting of [u] are two of the major developments characterizing the evolution of the Latin vowel system into Gallo-Romance. They are also among the most problematic ones. As discussed, traditional pre-generative analyses fail to provide an adequate account for them; still textbooks and other sources rely on them. In this article I hope to have shown how we can account for these developments in a simple and adequate alternative way. The diachronic events at hand are due to the marked status of the feature configurations [+high, -tense] and [+back, +ATR].

13. It remains to be seen whether this analysis can be extended to all cases of pull chains (Martinet 1952) of the kind that we see in Gallo-Romance.

Both merger and fronting can then be analyzed as involving repair operations that remove these marked configurations and replace them with less marked ones.

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