# North East Linguistics Society

# Optimality Theory and Sound Change

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## 1.    Introduction

Since Kiparsky (1968) it is a standard practice in generative phonology to account for sound change by means of rule addition, rule simplification, rule reordering and rule loss. Given that the phonologiocal rule as such no longer exists in recently proposed constraint-based theories of phonology, such as Optimality Theory (cf. Prince and Smolensky (1993), McCarthy and Prince (1993a and b), the question arises how sound change must be accounted for in these theories.

In this paper we will address this issue. It will be claimed that in Optimality Theory, sound change can straightforwardly be accounted for by constraint reranking. This will be illustrated by two examples of sound change in the historical phonology of French. The first example involves a change in the syllable structure conditions that occurred between Gallo-Romance (5th-9th century) and Old French (11th/12th century), the second example involves the loss of the possibility to phonologically encliticize an unstressed object pronoun to a preceding stressed element (phonological enclisis). The formal account of both cases relies on a reordering of Alignment constraints.

This paper purports to show not only that sound change can be analyzed as constraint-reranking (an expected result), but also that the analyses proposed are not thwarted by the same drawbacks of previous derivational nonlinear accounts. Finally,

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we will raise the issue of how to account for markedness and unmarkedness in sound change.

This article is organized as follows. In section 2, we will discuss the first example, the change in syllable structure conditions. After that, we will point out some of the problematic aspects of previous accounts. Section 3 discusses the second example, the loss of phonological enclisis, alignment constraints. It will be argued that this sound change can be more adequately accounted for by constraint-reranking. In section 4, we will return to the issue of syllable structure and show how the changes observed can be described in terms of constraint-reranking. Finally, in section 5, we will summarize and discuss the main results of the proposed analyses.

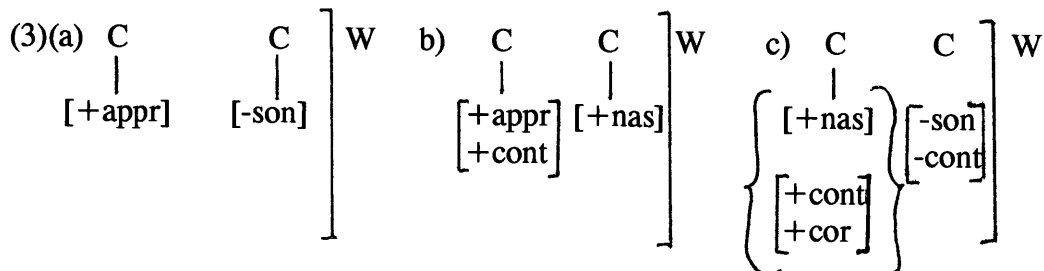## 2.    Segment extrametricality and syllable structure conditons

In Gallo-Romance and Old French, word-final obstruents could surface, as illustrated by the forms in (1).

(1)    drap    [p]    'blanket'
       net     [t]    'clear'
       sac     [k]    'bag'
       chef    [f]    'head'

Voiced obstruents in word-final position were devoiced. Compare, for instance, *sordre* 'to spring up,' to *sort* 'to spring up (pres.ind. 1/3p.)' and *servir* 'to serve,' to *serf* 'to serve (pres.ind. 1p.). Nominal forms, such as the ones in (1) added an *-s* in the nominative singular and the oblique plural case, hence such forms as, *sacs*, *chefs*, *draps*, etc. However, syllable-final consonant clusters only surfaced in word-final position, but not in word-internal position, as illustrated by the forms in (2).

|  | Classical Latin | | Gallo-Romance | | Old French | | |
|---|---|---|---|---|---|---|---|
| (2a) | dormitorium | > | *[dɔrmtorju] | > | [dortojr] | dortoir | 'bedroom' |
| | computare | > | *[kɔmptarɛ] | > | [kɔmter] | conter | 'to count' |
| | civitatem | > | *[tsivtatɛ] | > | [tsittɛt] | citet | 'city' |
| | galbinum | > | *[džalbnu] | > | [džalnɛ] | jalne | 'yellow' |
| | fortimentum | > | *[fɔrtmɛntu] | > | [fɔrmɛnt] | forment | 'strongly' |
| | hospitalem | > | *[ɔsptal] | > | [ɔstɛl] | ostel | 'residence' |
| | | | | | | | |
| (2b) | diurnum | > | *[džɔrnu] | > | [džɔrn] | jorn | 'day' |
| | campum | > | *[tsampu] | > | [tšamp] | champ | 'field' |
| | debet | > | *[devɛt] | > | [deift] | deit | 'he must' |
| | colapum | > | *[kolpu] | > | [kɔlp] | colp | 'blow' |
| | partem | > | *[partɛ] | > | [part] | part | 'share' |
| | crispum | > | *[krespu] | > | [krɛsp] | cresp | 'crisp' |

The forms in (2) show that consonant clusters, such as *-rm*, *-mp*, *-lb*, *-rt*, and *-sp*, which were not allowed to surface in syllable-final position wordinternally, were allowed to do so in syllable-final position wordfinally. The possible combinations can be summarized by the constraints in (3).

$$
\text{(3)(a)}
\left[\begin{array}{cc}
\underset{[+\text{appr}]}{\overset{\text{C}}{|}} & \underset{[-\text{son}]}{\overset{\text{C}}{|}}
\end{array}\right] W
\quad \text{b)}
\left[\begin{array}{cc}
\underset{\left[\begin{array}{c}+\text{appr}\\+\text{cont}\end{array}\right]}{\overset{\text{C}}{|}} & \underset{[+\text{nas}]}{\overset{\text{C}}{|}}
\end{array}\right] W
\quad \text{c)}
\left[\begin{array}{cc}
\overset{\text{C}}{\left\{\begin{array}{c}[+\text{nas}]\\[+\text{cont}\\+\text{cor}]\end{array}\right\}} & \overset{\text{C}}{\left[\begin{array}{c}-\text{son}\\-\text{cont}\end{array}\right]}
\end{array}\right] W
$$

Consonant combinations not allowed by the constraints in (3) surfaced in Old French with an epenthetic schwa-like vowel, which is traditionally termed "voyelle d'appui." For instance, in a word like *jalne* 'yellow' (cf. (2a) above), the word-final *-ln* cluster, which resulted from apocope, is not a permissible combination according to any of the constraints in (3), and, consequently, an epenthetic schwa is added.
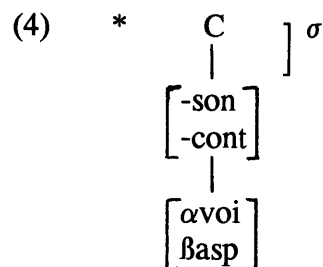
Nominal forms in (2) ending in a cluster also added an inflectional *-s* in the nominative singular case and the oblique plural case. Hence, the existence of forms with three consonants in word-final position, such as, for example, *corps* 'body (nom.sg.; obl.pl.),' *colps* 'blow with the fist (nom.sg; obl.pl.),' *cerfs* 'deer (nom. sg.; obl.pl.),' etc.

In the evolution from Gallo-Romance to Old French (11th and 12th century) some changes occurred that altered the clustering possibilities described above. In 12th century Old French, word-final consonants and consonant clusters were still permitted to surface. What changed, however, was the fact that word-final obstruents could only surface if they were not followed by an inflectional *s* or *t*. This gave rise to nominal and verbal alternations such as *corp* 'body (obl.sg.; nom.pl.) *cors* 'body (-nom.sg.; obl.pl), *clef* 'key (obl.sg/nom.pl)' *cles* 'key (nom.sg/obl.pl.)' and *dorm* 'I sleep' *dors* 'you (sg.) sleep, *dort* 'he sleeps,' *deif* 'I must' *deit* 'he must.'

Interestingly, Attic Greek is, in this respect, the exact mirror image of Old French. Stem-final obstruents were permitted to surface, but only if they were followed by an inflectional ending. The following data, taken from Itô (1986), illustrate this. In the nominative case, γυνη 'woman', for instance, surfaces without the stem-final *-κ* that shows up in, among other cases, the genitive case γυναικος and the dative case γυναικι.

In the latter two forms, the stem-final *κ* surfaces, according to Itô, because of the presence of the inflectional *-ι* and *-ος*. In the nominative case, however, due to the absence of an inflectional ending, the stem-final *-κ* does not surface. In contrast, stem-final *-π* and *-κ* in the nominative cases of words, such as, for instance, φλεψ 'vein (φλεβος gen.)' and θωραξ 'chest (θωρακος gen.)' do surface because of the presence of the inflectional ς.

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Itô's (1986) analysis of Attic Greek is as follows: A laryngeal feature assimilation rule is assumed which spreads the laryngeal features of a coronal obstruent to a preceding consonant. A coda condition is postulated which excludes coda stops that have a singly linked laryngeal feature, as in (4). Furthermore, word-level extraposodicity for ς is assumed.
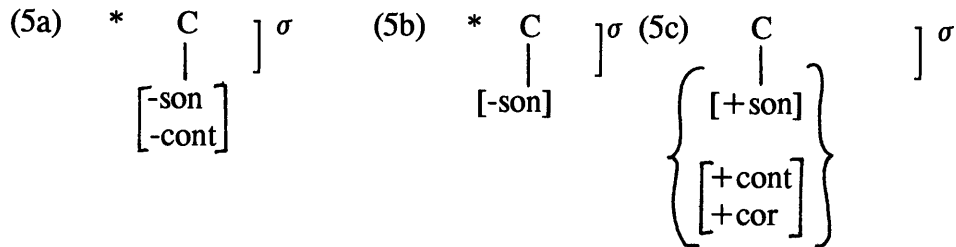
(4)     *     C      $]^{\sigma}$
              |
           ⌈ -son ⌉
           ⌊ -cont ⌋
              |
           ⌈ αvoi ⌉
           ⌊ ßasp ⌋

The analysis of Itô runs as follows. On the first cycle of /γυναικ/ the final κ is extraprosodic, and it appears as an onset-consonant at the surface when vowel-initial suffixes are added, such as -ι and -oς, as in γυναικι and γυναικoς. If the form enters the word-level without a suffix, final κ is no longer extraprosodic, because only ς is allowed to be extraprosodic at word-level in Attic Greek. Given that Structure Preservation holds at the word-level, and that segments must be licenced by Prosodic Licensing, final κ will be eliminated by Stray Erasure.

In the case of /θωραξ [k+s]/, stem-final κ is extraprosodic on the first cycle, but when nominative ς is added, loses its extraprosodic status. However, as a result of the laryngeal feature assimilation, κ shares its laryngeal features with ς. Now, given that Itô (1986) assumes that the Linking Constraint (cf. Hayes (1986)) also governs conditions like the ones in (4), κ is not excluded by the coda condition in (4), but can be syllabified as a coda. The word-final ς is post-lexically adjoined to the sylable, because post-lexically Structure Preservation no longer holds. Summarizing, the surfacing of κ before ς, but deletion of κ not followed by ς is thus explained as a result of the laryngeal feature assimilation rule.

The analysis of Attic Greek cannot readily be extended to Old French, contrary to what one would expect given the voice-assimilation facts discussed above. On the contrary, for Old French explicit mention of linked laryngeal features has to be avoided in the formulation of the coda condition, in order to account for the non-surfacing of obstruents before *s*.

The 12th century Old French coda condition can neither be the negative one in (5a) nor the one in (5b), but has to be the positive one in (5c)[1].

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[1]     The coda condition (5a) would incorrectly exclude *s* in *s*-stop clusters, such as, for instance *feste* (Modern French *fête*) 'feast, party' and *escole* (Modern French *école*) 'school' from surfacing. The coda condition in (5b), although correctly allowing for *s*-stop clusters, incorrectly allows *f* to surface before inflectional -*s* and -*t*, yielding incorrect \**clefs* and \**beift* (cf. Jacobs (1989) for a

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(5a)  *  C  ]σ    (5b)  *  C  ]σ  (5c)    C    ]σ
         |                 |                |
      ⎡-son ⎤           [-son]        ⎧ [+son]  ⎫
      ⎣-cont⎦                         ⎪         ⎪
                                      ⎨ ⎡+cont⎤ ⎬
                                      ⎪ ⎣+cor ⎦ ⎪
                                      ⎩         ⎭

The possible word-final consonant clusters (2b) can now be described as being extrametrical, and, if the conditions in (3) are reformulated as syllable affiliation rules (cf. Clements and Keyser (1983)), be incorporated by them into syllable structure in word-final position only (cf. Jacobs (1989).

The comparison between Attic Greek and Old French, in which similar structural conditions exist (the laryngeal assimilation facts), but in which nevertheless different distributional consonant clustering properties obtain, makes it hard to accept Itô's explanation for Attic Greek.

In this section, we have discussed the first of the two sound changes mentioned above. It has been shown that previous nonlinear, derivational accounts are successful in describing the facts, but that a close comparison between Attic Greek and Old French casts some doubt on the explinatory adequacy of the analyses discussed. In the next section, we will discuss Optimality Theory and the second of the two sound changes mentioned above.

## 3.    Optimality theory: Alignment and the loss of phonological enclisis

In Optimality theory (Prince and Smolensky (1993)) phonology is thought of as a universal set of constraints which are hierarchically ranked on a language-specific basis. The relation between input and output is accounted for by two functions, GEN and H-EVAL, which respectively generate for each input all possible outputs and evaluate which output is optimal (cf. Prince and Smolensky (1993) for a more detailed account). Thus in Optimality theory the phonological rule as such no longer exists. Rather, starting from an input **all** possible outputs are generated and evaluated against the constraint-ranking of the language until the optimal output is found.

Phonological alternations are no longer accounted for by phonological rules, but, rather, are the result of the interaction of constraints (with different ranking possibilities in different languages) in the grammar.

One type of constraint, motivated extensively in McCarthy and Prince (1993b), which we will crucially use, is a constraint called ALIGNMENT. A constraint of this type basically demands that two categories begin or end at the same time by requiring that an edge (R/L) of a prosodic or morphological constituent must coincide with an edge (R/L) of another prosodic or morphological constituent.

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more detailed account).

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In order to clarify how Alignment works, let us consider next the loss of the phonological enclisis in the evolution from Old to Middle French. In Old French, monosyllabic unstressed function words could be pronounced either as part of the word that preceded them (enclisis[2]; for instance, *jol vi* 'I saw him') or as part of the word that followed them (proclisis; for instance, *jo l'aim* 'I love him/her'). In the evolution from Gallo-Romance to later Old French, the possibility of encliticizing disappeared[3].

Traditionally (cf.Kukenheim (1971)), this has been accounted for as being caused by a change in the rhythmic structure of the language. Classical Latin had initial stress and a descending rhythm, which was replaced by an ascending rhythm and final stress in the evolution from Gallo-Romance to Old French. This insight can be formalized (cf. Jacobs (1993)) as a case of parameter-resetting in the Edge-based theory of Selkirk and Shen (1990), which we will briefly discuss.
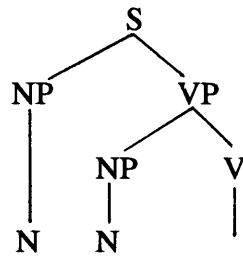
Selkirk and Shen (1990) propose a theory of the syntax-phonology mapping which allows for the construction of two prosodic constituents: the Prosodic Word (PW) and the Major Phrase. The relation between syntactic structure and prosodic structure is defined by a mapping of syntactic structure to prosodic structure according to a parameter that specifies whether the right- or the left-edge of syntactic categories is used in the syntax-phonology mapping. If, for the Gallo-Romance syntax-phonology mapping rule constructing Prosodic Words, the left-edge of syntactic categories is chosen, one obtains domains in which the preverbal clitic object pronoun is separated from the verb although syntactically being dependent on it. The object pronoun is thus phonologically enclitic, but syntactically proclitic.

If for Later Old French the parameter is reset to right-edges, one obtains a domain in which the preverbal clitic object pronoun is no longer separated from the verb, but together with a preceding non-lexical item incorporated within the same domain as the verb. The different prosodic constituent structures made possible by the different parameter settings are illustrated in (6).

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[2]   Enclisis was optional in Old French. In Modern French only a few lexicalized remnants can be observed, such as, the contraction of *de + le > du, de + les > des, à + le > au* and *à + les > aux*. These forms can be analyzed along the lines of Zwicky (1987) as syntactic allomorphy or along the lines of Hayes (1990) as precompiled phrasal allomorphy. The optional character of Old French enclisis seems to exclude such an analysis. The reader is referred to Jacobs (1993) for a more detailed account and to Evers (1994) for a partially lexicalized approach.

[3]   Clitics are considered, following Garde (1968:70-72), as basically stressless and therefore have to be integrated into prosodic words. A distinction has to be made between phonological and syntactical proclisis and enclisis. An unstressed object pronoun in preverbal position can syntactically be proclitic on the verb, but phonologically be enclitic on a preceding stressed element. This is most clearly shown by cases such as Old French *jot vi* 'I saw you', where the phonological enclisis is clear by the reduction and integration of the object pronoun into the preceding stressed subject pronoun, but where syntactically the object pronoun is proclitic on the verb.
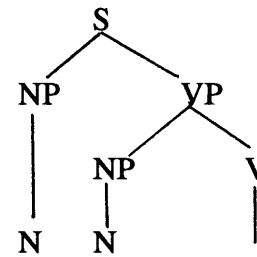
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(6a) Parameter is set to LEFT                    (6b) Parameter is set to RIGHT

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            S                                              S
          /   \                                          /   \
       NP      VP                                     NP      VP
        |     /  \                                     |     /  \
        |   NP    V                                    |   NP    V
        |    |    |                                    |    |    |
        N    N                                         N    N
```

PW-Left        [                          PW-Right                        ]
            (  )  (  )                              (                      )

         jo  le  vi                              jo    le        vi

Selkirk and Shen (1990) allow a variation in the syntax-phonology mapping according to which all syntactic categories or only lexical syntactic categories count for purposes of domain construction. Given that pronouns are functional and not lexical instances of syntactic categories, whether D or N[4], the same prosodic constituents as in (6) will result as long as we specify that lexical X0's are chosen for the PW-rules.

If the parameter setting (6a) is considered to yield the correct prosodic constituent structure for Gallo-Romance and (6b) the correct one for Old French, then, the evolution from enclisis to proclisis can straightforwardly be described as a change in the edge-parameter setting for the construction of Prosodic Words. In (6a), the parameter setting LEFT automatically induces a PW boundary at the beginning of the utterance, hence the domains (*jo le*) and (*vi*). *Jo* and *vi* being the heads of different PW's both receive stress and, therefore, *le* is able to encliticize on the preceding stressed subject pronoun. Given that stress is final in structure (6b), the subject pronoun is no longer stressed and consequently a following clitic (unstressed) object pronoun can no longer cliticize onto it. Moreover, given that the edges that are relevant for the syntax-phonology mapping correspond to the location of word and phrasal stress (final in Old and Modern French; initial in Classical Latin), it seems logical to try and connect these facts in a more principled way. Jacobs (1993) proposes the principle in (7).

(7)    *The syntax-phonology mapping parameter is set to RIGHT in a language with final and to LEFT in a language with initial stress.*

The edge-based theory of the syntax-phonology mapping thus seems to provide a straightforward explanation for the loss of enclisis. The change from a descending

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[4]The syntactic representation in (6) is greatly simplified for ease of exposition. Subject and object pronouns have been represented as NP's. Current syntactic practice probably would consider them DP's. However, this does not crucially alter the prosodic constituent structure.

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rhythm to an ascending rhythm (from Classical Latin phrase initial stress to Gallo-Romance and Old French phrase final stress) can formally be described as a change in the edge-parameter setting for the construction of Prosodic Words. The different prosodic constituent structure that resulted from this switch can be claimed to be responsible for the loss of enclisis.

The analysis proposed above has a number of problems. First, the analysis aseems to imply that proclisis was not possible until the edge-parameter was reset from LEFT to RIGHT. This is so because the Gallo-Romance parameter setting (6a) ({Lex0,Left}) will always induce a word boundary between a proclitic word and a following lexical X0. Therefore, the intermediate stage of the language where both enclisis and proclisis are possible (an example of this is given in (8) cf. Evers, 1994:15) is hard to describe.

(8) Enclisis and proclisis in Old French (12th century *Chanson de Roland*)

> *Fors s'en eissirent li Sarrazins dedenz*
> *Sis cumbatirent al bon vassal Rolant*

> The Sarrasins who were inside went outside
> and fought with the good knight Roland

One either has to assume that the two different rules of prosodic word construction (6a) and (6b) coexisted for some time or that after the switch from LEFT to RIGHT ((6a) to (6b)), initial stress subsisted for some time (cf. Jacobs, 1993). Given that this period must have lasted four centuries, since enclisis and proclisis coexisted from the earliest Old French documents on, neither assumption is very attractive. Hence, although the derivational edge-based account proposed above to some extent provides a possible answer for the evolutionary change from enclisis to proclisis, it faces problems in defining the correct domains for the application of both proclisis and enclisis at the same time in the Old French period.

Second, the analysis relying on the edge-based theory predicts that enclisis can occur in languages that have initial stress, but cannot occur in languages that have final stress if we assume (7). In Jacobs (1994) this prediction is examined by comparing European Portuguese to Brazilian Portuguese, where it is claimed that a strong link between initial stress and the existence of enclisis in a language is hard to sustain.

Let us now return to the Alignment theory, in order to illustrate how Alignment permits us to solve the problems discussed above. Alignment constraints are formulated according to the general scheme in (9), taken from McCarthy and Prince (1993b).

(9)      General schema for ALIGN

In ALIGN (GCat, GEdge, PCat, PEdge), the GEdge of any GCat
must coincide with PEdge of some PCat.
(Where GCat = Grammatical Category, among which are the morphological
categories MCat = Root, Stem, Morphological Word, Prefix, Suffix, etc.
PCat = Prosodic Category = $\mu$, $\sigma$, Ft, PrWd, PhPhrase, etc.
GEdge, PEdge = Left, Right)

The general schema for Alignment can be understood, according to McCarthy and Prince (1993b:32) as defining part of the Morphology-Phonology interface. Similarly, the syntax-phonology mapping parameter can be defined in terms of Alignment, which allows us to define the Syntax-Phonology interface in a similar way as the Morphology-Phonology interface.

For Gallo-Romance, the Prosodic Word rule (6a) can be defined in terms of an Alignment constraint, as in (10).

(10)      Align-Lex0-LEFT:  Align (Lex0, L, PrWd, L)

According to the constraint in (10) any left-edge of a Lex0 should coincide with the left-edge of a Prosodic Word. The problem that we have discussed above, i.e. the difficulty in accounting for both enclisis and proclisis at the same time, can now easily be solved. As a constraint, (10) can be violated depending on the ranking of other constraints. The cases where it is violated in Old French are precisely the cases where we have proclisis. Referring for a more detailed account to Jacobs (1994), it can suffice here to state that in order to enforce proclisis, we need a constraint ranking that in the case of a vowel hiatus, will ensure the non-surfacing of the vowel of the unstressed object pronoun rather than the insertion of an epenthetic consonant. The syllable structure constraints needed to guarantee this are motivated in Prince and Smolensky (1993:85-96), and include ONS (syllables must have onsets), PARSE (underlying segments must be parsed) and FILL (syllable positions must be filled with underlying segments). In order to be effective these constraints must dominate the constraint in (10). The constraint ranking we will assume is given in (11) and motivated in more detail in Jacobs (1994).

(11)      ONS > > FILL > > PARSE > > ALIGN-Lex0-LEFT.

The change from proclisis to enclisis, or rather the loss of phonological enclisis can be described as a constraint-reranking of Align-Lex0-Left and Align-Lex0-Right. The necessary existence of both contradictory constraints (the essence of Optimality Theory) can be demonstrated on the basis of Brazilian/European Portuguese (cf. Jacobs (1994).

In this section, we have argued that the problems of the earlier derivational prosodic account to define the domains of application for enclisis and proclisis can be solved in Optimality theory, precisely because the syntax/phonology mapping defined

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in terms of alignment is less **rigid** in the sense that the constraints defining it can be violated by higher-ranked constraints, viz. the syllable structure constraints in the case of Old French. Thus we claim that it is not only possible to account for sound change by constraint-reranking, but, moreover, that a constraint-based account yields a more adequate description of the facts. In the next section, we will return to the changes that occurred in the syllable structure conditions, and, show how these can be accounted for as a reranking of Alignment constraints.

## 4.    Optimality Theory: Alignment and the evolution of the French syllable

Prince and Smolensky (1993) and McCarthy and Prince (1993a) argue for a constraint forbidding codas: -COD. If this constraint is undominated in a language, and, hence, never violated, only open syllables are possible. To allow codas at all, this constraint has to be dominated by PARSE (stating that underlying segments must be parsed) and FILL (syllable positions must be filled with underlying segments), as illustrated in the constraint tableau (12) for an input CVC (cf. Prince and Smolensky 1993:92-93).

| (12)          | PARSE | FILL | -COD |
|---------------|-------|------|------|
| ☞ .CVC.       |       |      | *    |
| .CV<C>.       | *!    |      |      |
| .CV.C□.       |       | *!   |      |

In (12), the ☞ points to the optimal candidate, the * means a violation of a constraint, and the ! points to crucial constraint satisfaction failure. The reader can chech for himself that a ranking PARSE>>-COD>>FILL will lead to epenthesis, and, a ranking FILL>>-COD>>PARSE to deletion.

For Gallo-Romance and Early Old French, we need certain consonants to be deleted in coda position, but not the sonorants or *s*. Possible codas can be expressed in Optimality Theory as encapsulated association hierarchies, defined as sets of constraints forbidding the association of a segment to a position. The reader is referred to chapters 7 and 8 in Prince and Smolensky (1993) for a more elaborated account. Here it will suffice to assume that, given that the possible codas in Gallo-Romance and Old French (11th century) are sonorants and *s*, an appropriate ranking of the constraints -COD, PARSE and FILL in the associational hierarchy will lead to deletion (underparsing) of word-internal codas other than the sonorants or *s*.

If we assume now that the ALIGN constraint (cf.McCarthy and Prince (1994a: 36,40,fn.34) and Prince and Smolensky (1993:103)) given in (13) is higher-ranked than the constraints defining possible codas, this will lead to syllabification of the wordfinal consonants of (2b) above.

(13)    ALIGN  ]stem = ]σ  equivalently  ALIGN (Stem, R, σ, R)

The constraint in (13) demands that the stem-final edge corresponds to the final edge of a syllable. High-ranking of (13) accounts for the fact that in word-final position syllable-final clusters are allowed, but not word-internally, as illustrated in (15).

Furthermore, in order to account for the surfacing of the inflectional endings, we need the alignment-constraint in (14) which demands that the final edge of a Morphological Word corresponds to the edge of a syllable.

(14)    ALIGN (Word, R, $\sigma$, R)  or ]word = ]$\sigma$

The evolution from early Old to later Old French can now be described as the reranking of (13) below the constraints defining possible codas, as illustrated in the tableaus in (15) and (16).

| (15) /chefs/ | Align (14) | Align (13) | Fill | -COD | PARSE |
|---|---|---|---|---|---|
| f<s>. | *! | | | * | * |
| <f><s>. | *! | * | | | * * |
| <f>s. | | *! | | | * |
| ☞ fs. | | | | * | |

| (16)/chefs/ | Align (14) | Fill | -COD | PARSE | Align (13) |
|---|---|---|---|---|---|
| f<s>. | *! | | * | * | |
| <f><s>. | *! | | | * * | * |
| ☞ <f>s. | | | | * | * |
| fs. | | | *! | | |

The optimal candidate in (15) is the one that does not entail violations of either the Alignment constraint (13) or the one in (14). The last candidate, in which the stem-final edge corresponds to the syllable edge (by the syllabification of stem-final *f*) and in which the morhological edge corresponds to the syllable edge (by the syllabification of word-final *s*), is therefore the optimal candidate. All other possible candidates in (15) are ruled out as a result of violating either (14) or (13).

In (16), by the low-ranking of the Alignment constraint (13), the optimal candidate is the one that does not entail a violation of the high-ranked Alignment constraint (14) and which is best according to the other constraints. The third candidate, does not violate Align (14) nor the constraints FILL or -COD (*s* being a permissible coda). All other candidates in (16) are ruled out by violating the three high-ranked constraints.

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The constraint ranking in (15) is the one we will assume for Gallo-Romance and Early Old French, and the ranking in (16) the one we will assume for Old French of the 12th century. The evolution of the syllable structure can thus be straightforwardly accounted for by constraint reranking. It should be clear, however, that a more detailed and sophisticated account is necessary to describe the possibility in Gallo-Romance of, for instance, word-final -*rn* versus -*ln*.

In this section, we have described the sound change that has occurred in the evolution from Gallo-Romance to Old French as a case of constraint-reranking. Compared to the account (discussed in section 2) involving linked features and segment extrametricality or extraprosodicity, the description given here has the obvious advantage of being independent of the voicing assimilation facts, and hence that contrasts such as the ones between Old French and Attic Greek are to be expected.

## 5.     Summary and discussion: sound change and markedness

In this paper, we have discussed two examples of sound change in the historical phonology of French, where we have shown not only that Optimality Theory by constraint reranking can adequately account for sound change, but also that the proposed analyses are not thwarted by drawbacks of previous nonlinear derivational accounts.

There is, however, one aspect that needs to be briefly discussed. In section 3, in the discussion of the edge-based analysis of the loss of enclisis, we briefly came across the principle (7), in which a link was made between the edge relevant for the edge-parameter and the edge where phrasal stress is located. For the sake of the argumentation, we will side-step for the moment the empirical adequacy fo the principle in (7), and concentrate on the role of principles such as these in Optimality Theory. Until the advent of constraint-based theories, such as Optimality Theory, it has been a common practice among phonologists to add to the Theory of Markedness by formulating principles such as the one in (7). The obvious question that arises now, of course, is how such principles can translate into Optimality Theory. In other words, does Optimality Theory allow for a Theory of Markedness based on similar principles, or should the unmarked state of affairs in one way or another follow as a natural result from the hierarchy? The latter position seems unmotivated as there is nothing inherent in the formalism of constraint-hierarchies that would prefer one ranking above the other. Also, each constraint itself, because it is considered to be part of Universal Grammar, is already in a sense a statement about markedness. Nevertheless, one would like to be able to express more formally that some rankings are more natural or less marked than others. Therefore, for the case at hand, we could, if the first position is adopted, and, assuming that phrase-initial and phrase-final stress can be accounted for by edge-aligning feet with Prosodic Words, propose a principle like (17).

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(17)   *If, in a language, the constraint ALIGN (PrWd, L, Ft, L) is higher
       ranked than the constraint ALIGN (PrWd, R, Ft, R), then,
       the constraint ALIGN (LEX0, L, PrWd, L) is, in the unmarked case,
       higher ranked than the constraint ALIGN (LEX0, R, PrWd, R).*

It is, however, easy to see that this way of dealing with markedness can easily become very complicated. For instance, if we want to express the generalization (cf. Hayes (1993)) that certain languages (that is those that have iambic stress rules) tend to have quantitative rules such as rhythmic vowel lengthening, consonant gemination, vowel reduction and vowel deletion, whereas other languages (those having trochaic stress rules) do not, this would become, if expressed in a similar way as (17), very intricate. It is clear that especially in this area a lot of future research is needed.

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