Lenition and Optimality Theory

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1. Introduction

Since Kiparsky (1968) generative historical phonology has relied primarily on the following means in accounting for sound change: rule addition, rule simplification, rule loss and rule reordering. Given that the phonological rule as such no longer exists in the recently proposed framework of Optimality theory (cf. Prince and Smolensky 1993), the question arises how sound change can be accounted for in this theory.

Prince and Smolensky (1993) contains mainly applications of the theory to non-segmental phonology (that is, stress and syllable structure), whereas the segmental phonology is only briefly (the segmental inventory of Yidiny) touched upon.

In this paper, we will present and discuss an account of consonantal weakening processes within the framework of Optimality theory. We will concentrate on lenition in the historical phonology of French, but take into account synchronic allophonic lenition processes as well. This paper purports to demonstrate not only that segmental phonology can straightforwardly be dealt with in optimality theory, but, moreover, that an optimality-based account of lenition is not thwarted by the drawbacks of previous proposals.

This paper is organized as follows. In section 2, we will present the main facts of lenition in the historical phonology of French. After that, section 3 briefly discusses previous analyses of this phenomenon, mainly concentrating on their problematic aspects. Section 4 considers the possibilities of accounting for lenition in Optimality theory. Finally, in section 5 the main results of the present paper are summarized.

2. Lenition in the historical phonology of French

Lenition, from an historical perspective, is traditionally assumed to comprise the following set of interconnected changes: degemination, the voicing of single (nongeminate) intervocalic obstruents, the spirantization of single intervocalic voiced stops, and eventually, the weakening of voiced fricatives into glides or complete deletion of the fricatives (cf. Bichakjian 1972 and 1977). Some examples that illustrate these changes in the historical phonology of French are listed in (1).

(1a)	habere	>*[aβere]	>	avoir		'to have'
	nudum	>*[nuδu]	>	nu		'naked'
	negare	>*[neγare]	>	nier		'to deny'
	librum	>*[liβru]	>	livre		'book'
	nigrum	>*[niγru]	>	noir		'black'
	barbam		>	barbe		'beard'
	tardus		>	tard		'late'
	largus		>	large		'large'

(1b)	ripam	>*[riba]>[riβa]	>	rive	'bank'
	locare	>*[logare]>[loγare]	>	louer	'to rent'
	pesare	>*[pezare]	>	peser	'to weigh'
	vitam	>*[vida]>[viδa] >		vie	'life'
	fratrem	>*[fradre]>[fraδre]	>	frère	'brother'
	aprilem	>*[abrile]>[aβrile]	>	avril	'april'
	rumpere		>	rompre	'to break'
	circulum		>	cercle	'circle'

(1c)	abbam		>	abbé	'abbot'
	cessare		>	cesser	'to cease'
	guttam		>	goutte	'drop'

The examples in (1a) show that the spirantization of voiced stops took place if the voiced stop was preceded by a vowel and followed by either a vowel or a sonorant, but failed to take place when the obstruent was the second member of an intervocalic consonant sequence.

The data in (1b) show that the contexts in which voicing took place exactly match the environments where spirantization applied. The data in (1b) also show that voiceless plosives became spirantized after being voiced. Finally, the data in (1c) show that degeminated consonants did neither undergo voicing nor spirantization.

The following relative chronology is traditionally assumed (cf. among others, Pope 1956). Lenition started by the spirantization of voiced stops between the 2nd and 3th century, followed by the voicing of voiceless obstruents between the 5th and 6th century. After that, a second round of spirantization occurred (which affected the Classic Latin voiceless stops that were made voiced by the voicing process) between the 5th and 6th century. Finally, degemination took place between the 7th and the 8th century. In (2) this chronology is schematically given for the coronal consonants only.

(2)   tt   t   d   ss   s

2-3th   ð

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4-6th   d   z

5-6th   ð

7-8th   t   s

In this section we have presented the main facts of lenition in the historical phonology of French and provided the traditionally assumed chronology of the lenition processes. In the next section we will discuss previous analyses of French lenition.

3. Previous analyses

It will come as no surprise that lenition, one of the major distinctions between Western and Eastern Romance languages, has been well-studied and described in virtually every theoretical framework in the history of romance linguistics. One of the most insigthful accounts (a structuralist one) has been given by Martinet (1955). Martinet considered lenition to be a set of interconnected changes conceived of as a chain reaction caused by the tendency for geminates to simplify (cf. also Bichakjian 1972 and 1977)

The spirantization of voiced stops did not lead to the loss of contrast given that no voiced fricatives existed in Latin. The phonological space left vacant as a result of spirantization permitted voiceless obstruents to become voiced without loss of phonological distinctness. After the spirantization of original voiceless stops, the geminates could be degeminated without loss of phonological distinctness.

However, given that lenition can occur in languages that not only lack voiced fricatives, but that also lack geminates, as in Castillian Spanish, the key-trigger for lenition seems to be the absence of voiced fricatives. It is only in systems lacking voiced fricatives that voiced stops can become fricatives without loss of phonological distinctness.

In Jacobs and Wetzels (1988) an underspecification account of lenition is proposed which essentially aims at formally characterizing lenition as an integrated sound shift. Adopting Steriade's (1987) principles of underspecification, Jacobs and Wetzels (1988) describe the set of sound changes making up lenition as essentially involving a redefinition of predictable feature values. Each single step in the lenition process is shown to affect a feature whose phonetic realization has become predictable by an R-rule in the sense of Steriade (1987), that is, a redundant rule that introduces a non-underlying feature value within the class of segments for which that feature value is predictable and non-distinctive. Steriade (1987) shows convincingly that only R-values can be left out in the underlying representation, whereas the unmarked case for distinctive feature values is to be present underlyingly.

Given the fact that Latin had no voiced fricatives (*z* and *v*), the underlying representation of the Latin consonant inventory in line with Steriade's theory of underspecification is the one in (3).[1]

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[1]   In (3) only R-values are left out in UR. It is for reasons of space only that we do not include the labial and dorsal subparts of the Latin consonant inventory.

(3)   t   d   s

voice   -   +   0

cont   -   0   +

strid   0

It goes without saying that the feature value [-continuant] can underlyingly be left unspecified for voiced stops only because of the absence of voiced fricatives. If voiced fricatives would have existed in Latin, the feature 'continuant' would be distinctive for the class of voiced obstruents.

The first step in the lenition process can now be represented as the R-rule (4b) which replaces the R-rule (4a) within the context in which lenition occurred.[2]

(4a)   [0cont] --->   [-cont] / $\begin{bmatrix} - \\ -son \\ +voice \end{bmatrix}$ Elsewhere

$\begin{bmatrix} - \\ -son \\ +voice \end{bmatrix}$

|

(4b)   [0cont] --->   [+cont] /   X1   X2   (X1 adjacent to X2)

|

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After the application of spirantization, formalized as (4b), a new underlying system of feature values is set up according to a principle proposed in Jacobs and Wetzels (1988) which has the effect of making the feature value 'voice' predictable

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[2]   The adjacency condition stipulated for (4b) will block the rule's application to geminates according to Schein and Steriade's (1986) Uniform Applicability Condition.

by R-rules for voiceless obstruents. It is essentially along these lines that the different steps of lenition are described.[3]

There are, however, a number of problematical aspects in the underspecification analysis of lenition.

First of all, spirantization most certainly must have been optional for some time. This optionality is hard to describe in terms of the rules in (4) as this would require the possibility of both (4a) and (4b) being active in one and the same environment.

Second, once rule (4b) becomes operative, it cannot function as an R-rule. This is so beacuse it introduces a distinctive feature value [+continuant] within the class of voiced obstruents. At this period in the language voiced obstruents will be [+cont] within the lenition context, but [-cont] elsewhere, that is in postconsonantal position.

In order to circumvent these problems, Jacobs and Wetzels propose that as long as spirantization was optional it functioned as a feature-spreading rule (involving the assimilation of the feature [+cont] from the vowel to the adjacent voiced stop), and assume that different systems of underlying feature representation can occur in different contexts. It is questionable, however, that vowels need to be specified for the fetaures 'continuant' and 'voice.' Furthermore, although undeniably in different contexts, different features are predictable, it seems undesirable to enrich underspecification theory in such a way that different underlying systems of feature values have to be learned for different contexts.

Finally, synchronic allophonic lenition processes, in which the historical steps are realized in one swoop, such as the ones discussed for Danish (Clements and Keyser 1983) or Malayalam (Mohanan 1993) require a quite complicated derivation, in which the underlying feature system has to be adjusted after the application of each R-rule in order for the next R-rule to take place.

Summarizing, the underspecification analysis faces a number of problems: different sets of underlying feature values have to be assumed for different contexts, the optional stages of each process have to be described as feature-spreading, and, synchronic allophonic lenition processes, in which voicing and spirantization take place simultaneously, are very complicated to account for.

In the next section, we will present an optimality-based account which is not thwarted by these problems.

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[3]   For a more detailed account the reader is referred to Jacobs and Wetzels (1988).

4. Optimality theory

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.

As mentioned above, Prince and Smolensky (1993) mainly discuss applications of the theory to non-segmental phonology. In chapter 9, they briefly discuss the segmental inventory of Yidiny. We will briefly recapitulate their analysis of Yidiny, which, on the one hand, will serve to briefly introduce the theoretical notions of Optimality theory, and, on the other hand, will form the starting point for the optimality-theoretic analysis of lenition.

Yidiny has a consonant inventory in which secondary articulation only occurs on coronal consonants. The secondary articulation is palatal. In other words, only palatalized coronals exist, but no palatalized velars or labials occur in Yidiny. The way in which Prince and Smolensky account for this state of affairs is as follows. They assume the harmony scale in (5a) according to which the association of an articulator Coronal to a place node is more harmonic than any other articulator, for instance, Labial. The harmony scale (5a) translates into the constraint hierachy (5b) which expresses the unmarkedness of coronal articulations.

(5a)   Coronal Unmarkedness: Harmony scale: PL/COR ≻ PL/LAB

(5b)   Coronal Unmarkedness: Dominance Hierarchy: *PL/LAB » *PL/COR

The constraints in (5b) are termed anti-association constraints and are to be interpreted as follows:

do not associate a coronal articulator to a place node, and, do not associate a labial articulator to a place node.

Three more constraints are needed which are given in (6).

(6)   PARSE (feature): An input feature must be parsed

        FILL (place): A Place node must not be empty

        *[fʲ   :fʲ (secondary articulator) is not parsed as the primary one

The constraints in (5) and (6) can be violated and will lead to different outputs depending on the way they are hierarchically ranked.

In (7) we have given some relevant examples in a so-called constraint tableau. The ☞ points to the optimal candidate, the * means a violation of a constraint, and the ! points to crucial constraint satisfaction failure.

(7)	FILL (place)	*PL/LAB	PARSE(feat)	*PL/COR	*[fʲ
{PL,cor,cor'}					
☞ [cor cor']				* *	
[cor' cor]				* *	*!
[cor] <cor'>			*!	*	
[cor']<cor>			*!	*	*
[]<cor cor'>	*!		* *		

In (7), the first row represents the Yidiny constraint hierarchy, with the dominancy order from left to right. The input is given in the second row, and possible candidates are listed in rows that follow.

Angled brackets refer to unparsed underlying material, whereas square brackets are to be interpreted in the following way. The first possible candidate, that is the one in the third row, has a primary articulator associated to the C-place and the secondary to the V-place. For the candidate in the fourth row the association has taken place in the opposite order: the secondary articulator is associated as a primary articulation, hence incurring a violation of the lowest ranked constraint. The first two candidates violate twice the anti-association constraint (5b) forbidding associaton of a COR articulator to a place node. However, given the higher ranking of the constraints PARSE and FILL, (7) shows that it is

better to violate the anti-association constraint for COR than to violate the PARSE or FILL constraints.

Because the anti-association constraint for LAB (5b) dominates the constraint PARSE, a labialized labial cannot occur in Yidiny as shown in (8) (cf. Prince and Smolensky 1993 for a more detailed account).

(8)	FILL (place)	*PL/LAB	PARSE(feat)	*PL/COR	*[f
{PL,lab,lab'}					
[lab lab']		* *!			
☞[lab]<lab'>		*	*		
[]<lab lab'>	*!				

The relative ranking of PARSE and anti-association constraints permits an account for the segmental inventory of Yidiny. It is obvious that the coronal unmarkedness dominance hierarchy plays an important role. However, coronal unmarkedness may be true for segmental inventories, but certainly not for preconsonantal position. Coronal-noncoronal stop sequences are typologically very marked (cf. among others, Sievers 1893, Blust 1979, Clements 1988, Wetzels 1989, and Jacobs 1992). It seems therefore that anti-association constraints should take into account the context in which the segment occurs. This then is precisely what we need in order to provide a constraint-based approach to lenition, to which we now turn.

In order to account for lenition we will assume that the markedness of certain consonants in certain positions can adequately be accounted for by contextually-determined anti-association constraints. Furthermore, we will assume that if, under compulsion of higher ranked constraints, nodes in the feature-geometry are left unfilled these nodes are at the surface provided with the unmarked feature value in that position. In their discussion of Latin, Prince and Smolensky (1993: 48-51) propose something similar when they state that unfilled morae are interpreted in the output as a "continuation of a tautosyllabic vowel." For our present purposes this means that unfilled 'cont' and unfilled 'voice' are interpreted as + in the context in which lenition occurs, that is in post-nuclear position.

The examples *núdus* 'naked' and *pedéster* 'on foot' in which the voiced stop is preceded and followed by a stressed vowel (excluding an ambisyllabic account) and which both underwent spirantization show that the context must be post-nuclear rather than syllable-final (cf. also Bichakjian 1972).

The anti-association constraints that at first sight seem necessary are the ones in (9).

(9a) Consonantal Unmarkedness: Harmony scale: Fricative > Voiced stop > Voiceless

(9b) Consonantal Unmarkedness: Constraints: *LE/[+vce,-cont]

                                                                              *LE/[-vce]

The anti-association constraints in (9b) must be understood as follows. Within LE, that is the lenition context, neither associate the underlying features [+voice, -cont] nor [-voice]. An alternative formulation and perhaps more in line with Prince and Smolensky (1993) would be PM (Peak Margin), instead of LE. The constraints would then read as follows: do not associate [+voice, -cont] to a Margin after a Peak, and, do not associate [-voice] to a Margin after a Peak.

If the constraint hierarchy in (10) is assumed, nothing will happen in the lenition context, given that a violation of the lower-ranked anti-association constraints is better than violations of the higher-ranked faithfulness constraints (PARSE).

(10) Parse (voice) » Parse (cont) » *LE/[+voice,-cont] » *LE/[-voice]

In (10) we have not included the constraints FILL for the relevant nodes where both 'voice' and 'continuant' are located in the feature-geometry. However, nothing crucial hinges upon this.

In order to account for the first step in the lenition process, we might propose the reranking as in (11).

(11) Parse (voice) » *LE/[+voice,-cont] » Parse (cont) » *LE/[-voice]

The constraint tableau in (12) shows that the optimal output candidate for underlying voiced stops is the one in which the feature [-cont] is left unparsed. Again a constraint FILL for the relevant node where 'continuant' is located in the feature tree could have been added, but again this is not crucial. Low ranking of this constraint would make it ineffective. Please recall that it is assumed that in the output the resulting candidate will be interpreted as [+continuant].

(12)	PARSE(vce)	*LE/[+vce,-cont]	PARSE(cont)	*LE/[-vce]
{+voice,-cont}				
☞[+vce]<-cont>		*	*	
<+vce>[-cont]	*!	*		
[+voice,-cont]		* *!		
<+voice,-cont>	*!		*	

Reranking the constraint hierarchy as in (12) accounts for the first step (spirantization of voiced stops) in the lenition process. However, if we want to account for the second step in the lenition process (voicing of voiceless obstruents), then we run into problems. On the one hand, we do need, in order to get spirantization, the underparsing of 'continuant,' but at the same time we want parsing of 'continuant' in order not to get fricatives out of voiceless stops. In other words, voiceless stops must become voiced stops and not voiced fricatives. It is therefore that we have to make a distinction between

'continuant' parsing for voiced (PAR(c)/+vce) and 'continuant' parsing for voiceless consonants (PAR(c)/-vce). The net effect of differentiating between these two kinds of 'continuant' parsing is that phonological distinctness is not lost in the lenition process. This is illustrated in the constraint-tableau in (13).

(13)	PAR(c)/-vce	*LE/[-vce]	PAR(vce)	*LE/[+vce,-c]	PAR(c)/+vce
{p}{-c,-vce}					
[-c, -v]		*!		*	
☞ [-c] <-v>			*	*	
<-c, -v>	*!		*		
[-v] <-c>	*!	*			
{b}{-c,+vce}					
[-c, +v]				* *!	
[-c] <+v>			*!	*	
<+v, -c>			*!		*
☞ [+v] <-c>				*	*

The constraint ranking in (13) adequately accounts for the spirantization and voicing processes. The other steps in the lenition process can be accounted for in a similar way. For instance, an anti-association constraint that forbids the parsing of a root node into two skeletal slots will, if ranked appropriately with respect to the constraint that parses root nodes into skeletal slots, be able to account for the final step of lenition in the historical phonology of French: degemination.

Finally, after the sound changes have gone through, the principle of Lexicon Optimization (cf. Prince and Smolensky, 1993:192) will lead to inputs that are closer to the actual outputs in the lenition context.

After this discussion of lenition in the historical phonology of French, let us now turn to synchronic allophonic lenition processes.

A reranking from the constraint hierarchy in (10) to the one in (13) is also able to account for synchronic allophonic lenition processes in which spirantization and voicing take place at the same time. An example is Danish discussed in Clements and Keyser (1983), where in a lenition context the voiceless stops /p, t, k/ are realized as [b, d, g], and where in the same lenition context /d, g/ are realized as [δ, γ]. In a similar way, the allophonic lenition processes in Malayalam (cf. Mohanan 1993) might be accounted for. In Malayalam, the application of the processes depends on the various registers ranging from careful to fast colloquial. Each register could then be characterized by a specific constraint reranking.

5. Summary and discussion

In this paper we have proposed an optimality-based analysis of lenition, concentrating mainly on the historical phonology of French. It has been demonstrated that lenition can be accounted for by assuming contextually-determined anti-association constraints. Let us briefly summarize the main advantages of the proposed analysis in comparison to the underspecification analysis.

First of all, the problem of having different sets of underlying feature systems for different contexts has disappeared. There is only one underlying system of feature values, the correct outcome of which is regulated by the constraint hierarchy.

Second, there is no need to have the feature values [+voice] and [+continuant] underlyingly present for vowels, given that the optional stage, which characterized, at least in the historical phonology of French, the spirantization and voicing processes, can now be accounted for by assuming optional reranking for the period of time in which these processes were optional.

Third, synchronic allophonic lenition processes can be straightforwardly accounted for and do not require a complicated derivation.

There is, however, one aspect that needs to be discussed. In the underspecification analysis the key-trigger for the occurrence of spirantization in a language was claimed to be related to the absence of voiced fricatives. In order to formalize his, the principle in (14) was proposed in Jacobs and Wetzels (1988).

> (14)   A feature changing rule Rc that changes αF_i into $-\alpha F_i$ for a (class of) segment(s) Z in
>
>   the context W is a natural innovation in a grammar where the value of F_i is
>
>   predictable by an R-rule for Z in W

In the account we have provided in this paper, no such prediction is made. Logically a reranking along the lines of (13) is possible in any language, regardless of its consonantal inventory. How can we translate the insight expressed in (14), if empirically correct, into Optimality theory? In other words, how can we formulate lexical distributional patterns or regularities in the lexicon?

Prince and Smolensky (1993) do not discuss in great detail the consequences of the theory for the lexical representation of a language. It is clear that especially in this area further research is needed to strengthen the empirical foundations of the theory.[4]

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[4] A similar problem arises when accounting for idiosyncratically marked stress patterns in a language. A case in point would be Italian. For a discussion see Jacobs (1994).

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