

Sonority Principle in French Nominal Loanwords into Moroccan Arabic: An Optimality-theoretic Analysis

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ABSTRACT

This paper examines the adaptation of French nominal loans into Moroccan Arabic by adopting the framework of optimality theory. The focus is to unveil the phonological and morphological repair strategies enforced by the phonotactic constraints of the borrowing language to resolve sonority principle in complex codas. The investigated phonological strategy is schwa and a high vowel epenthesis. Schwa epenthesis is triggered to split final biconsonantal codas that violate sonority principle. In three consonantal coda clusters, schwa insertion is conditioned by the sonority value of the consonants, where it is consistently epenthesized before the most sonorous segment. A high vowel behaves differently; it is epenthesized in the final position without splitting the coda cluster, and enforces the cluster to be syllabified as an onset instead of a coda, and as such sonority principle is satisfied. It is also argued that the addition of the morphological marker {-a}, which is primarily morphologically driven, indirectly satisfies sonority principle; by doing so, it blocks the application of schwa or a high vowel epenthesis, which points to the fact that such phonological and morphological strategies conspire to satisfy sonority principle. The study also provides further support for the phonological stance on loanword adaptation.

1. Introduction

Thanks to language contact, languages borrow linguistic items from one another. Moroccan Arabic (MA), in turn, has borrowed from a number of languages including, for example, French, Spanish, and Amazigh. Although in some cases loans are borrowed with no significant change, they are often governed by linguistic changes whereby the borrowing language adapts loans to conform to the phonotactic constraints of the native speakers' language system. To get deep insights into this issue, this paper examines the adaptation of French noun loanwords into MA, especially words with complex codas involving sonority principle violation. It also unveils the repair strategies triggered by MA to resolve sonority sequencing principle (henceforth, SSP).

This paper also contributes to the controversial issue on whether loanwords' adaptation is phonetic or phonological. Proponents of phonetic adaptations (e.g. Peperkamp & Dupoux (2003) and Peperkamp (2005)) contend that monolingual speakers rely on phonetic approximation when they do not have access to L2 phonological system. In other words, speakers' adaptations of loans depend on how foreign sounds are phonetically closest to the native language sound inventory. In contrast, adaptations may be phonologically guided. Such strategy is claimed to be used by bilingual speakers who have some phonological competence in L1 and L2. Reflecting on their phonological competence, MA speakers, for instance, may resort to epenthesis and deletion as two universally common phonological repair strategies to resolve ill-formed structures in loan phonology (see Louriz, 2004, for further details on epenthesis and deletion as repair strategies). Likewise, the present paper attempts to provide further evidence for the phonological stance on loan adaptations.



To account for SSP violation in complex codas, the paper is framed within optimality theory (henceforth, OT) (Prince & Smolensky, 1993). The adoption of OT stems from the fact that French noun loans to MA are replete with coda clusters wherein a number of constraints compete to generate the optimal candidate, the one that satisfies higher-ranked constraints and may incur minimal violations. Reference will be also made to the study conducted by Boudlal (2001) since it has implemented OT on SSP in Casablanca Moroccan Arabic and determined the hierarchy relationship between competing constraints (e.g. sonority constraints). The author will adopt some of the relevant constraints and decide whether their ranking applies to French noun loans into MA and generate other constraints to account for the specifications of the data.

The remainder of this paper is organized as follows: Section 2 provides a brief review of the studies conducted on French loanwords into MA. Section 3 defines the concept of sonority principle and explicates complex syllabic structures in MA. Section 4 deals with sonority principle within the framework of OT with special focus on the study carried out by Boudlal (2001). The relevant data will be presented and analyzed in section 5, which consists of three subsections, each of which is devoted to a repair strategy. Section 6 reflects on whether loanword adaptation is phonetic or phonological. Then we conclude.

2. Literature review

The study of the adaptation of French loanwords into MA has received an in-depth investigation. In this respect, Heath (1989) finds out that French vowels are commonly adapted into MA vowel inventory. To cite few illustrative examples, Heath (p.75) notes that the vowel [ɔ] is adapted as [o], [a] is generally borrowed into MA as [ɑ], especially in the phonetic environment of emphatic sounds, while the vowels [e] and [ɛ] are generally adapted into MA as [i]. The absence of nasalized vowels in MA also enforces the adaptation of French nasalized vowels as plain vowels when borrowed into MA.

Similarly, Kenstowicz and Louriz (2009) have analyzed the adaptation of French vowels into MA vowel system considering the emphatic adaptation in monosyllabic and disyllabic words. They particularly consider the behavior of vowels in the contexts of emphatic harmony, plain harmony, and disharmony. They conclude that French vowels are adapted into “the closest MA vowels within the auditory space” (p.56). For example, French [i, y, e] are adapted into MA vowel [i] (see Louriz, 2008, for detailed information on how French [y] is adapted to MA as [i]) since it is “the closest vowel in auditory space” (p.55), and French [a] is borrowed as the emphatic vowel [ɑ] as it is closer to MA vowel [ɑ] than to MA [a] (Kenstowicz & Louriz, 2009). Such an adaptation is accompanied with the propagation of pharyngealization on neighboring consonants (see Zellou, 2011, for similar findings, and Bensoukas, El Hamdi & Ziani, 2017, pp.3-4, for more information on how an emphatic sound affects the integration of French loan infinitives into MA and Moroccan Amazigh), a phenomenon which, according to the authors, systematically applies to the French back vowels [a, ă, o, ɔ, ɔ̃] but it does not with front vowels [e, ɛ] (pp. 72-73) and therefore should be better studied in terms of auditory space rather than contrasting the phonological features of the two languages. This claim is in line with Peperkamp & Dupoux (2003) and Peperkamp (2005) who argue that in the process of loanwords non-native sound features are approximated into the phonetically closest sound inventory of the native language.

In addition to the adaptation of French vowels, French consonants undergo phonological integration when borrowed into MA. In this respect, Lharouchi (2019) has analyzed French rhotic adaptation into MA and Berber and concluded that French uvular fricatives [ʁ] and [χ] are systematically adapted into Arabic as a coronal tap, a process he attributes to phonological factors rather than phonetic ones.

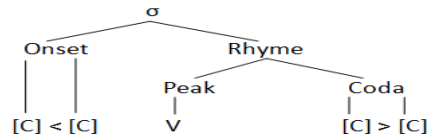
The morphological aspect of French loanwords into MA has also been investigated. Of interest is the study conducted on the adaptation of French loan-infinitives into Moroccan Amazigh and MA (Bensoukas, El Hamdi & Ziani, 2017). The authors analyze the case of vowel ablaut exhibited in weak verbs. As far as MA is concerned, French loan infinitives, after being phonologically integrated, are morphologically subject to a vowel ablaut process to adjust to the perfective morphology of MA. For example, the French final mid-vowel [e] in [frɛne] ‘brake’ first undergoes a phonological process of raising into a high vowel [i] and then realized morphologically as [frani] or [frana] in MA depending on person (p.9).

In sum, these studies (among others) have interestingly unveiled theoretical and empirical issues in loan phonology and brought more insights into the phonetic and phonological hypotheses on loanword adaptation. However, to our knowledge the analysis of SSP of French loanwords into MA remains under-researched. With the aim to contribute to the previous studies in the literature of loanword adaptation, the present paper is therefore devoted to an exclusive analysis of the violation of SSP in French noun loans into MA. Before elaborating on this issue, a word on SSP and complex syllabic structures in MA is in order.

2.1 Sonority Sequencing Principle and Complex Syllabic Structures in MA

SSP aims to organize the structure of a syllable based on sonority values of segments. It states that a vowel, which constitutes the peak of a syllable, is the most sonorous segment and the surrounding sequence of consonants (coda and onset segments) must increase in sonority scale toward the peak. In other words, the coda and onset consonants at the edges must be less sonorous than those closer to the peak, as shown in figure (1) (where > means *greater than* in sonority).

(1)



Though languages seem to differ to some extent in sonority hierarchy scale depending on the phonotactic constraints of the language, the following sonority scale (Zsiga, p. 334) is widely adopted in the literature, wherein low vowels are the most sonorous segments while plosives the least sonorous ones:

(2)

low vowels > mid vowels > high vowels and glides > rhotics > laterals > nasals > fricatives > plosives

To explain how SSP outlines the structure of a syllable, consider onset and coda consonants in the word ‘smart’. The first consonant in the onset cluster [s], a fricative sound, is lower in the sonority scale than the second onset consonant [m], which is closer to the peak; similarly the final coda consonant [t], a stop sound, is less sonorous than the liquid [r]. Thus, sonority decreases toward the onset and coda edges and increases toward the peak of the syllable. However, there are exceptional cases in which SSP is not satisfied (e.g. in MA the sequence *ms* in [mʂaʔi] ‘crazy’ violates SSP). Whenever such a situation arises, a language, which ranks SSP high, may make appeal to certain phonological repair strategies, such as insertion and deletion, or assign one consonant to a higher prosodic unit as is the case in MA complex onsets and codas (see discussion below).

SSP can also explain why certain consonantal sequences are not permissible in the phonological system of a language. The reason why, for example, the word ‘smart’ is an existing English word while *‘msatr’ is not lies in the violation of SSP. The initial phoneme sequence *ms* is not allowed by the phonotactic constraints of English language.

SSP also proves particularly crucial in syllabification. With regard to MA, one of the areas where the concept of SSP has been brought into discussion is nominal schwa syllabification. Since MA does not accept complex syllabic structures, it allows the insertion of a schwa to break CCC sequence as CCəC or CəCC. Following Benhallam’s Syllable Structure Assignment Algorithm (SSAA) (1990), every CCC sequence is syllabified as CCəC, as exemplified below:

(3)

Root	Stem	Gloss
ktb	ktəb	‘write’
sbʕ	sbəʕ	‘lion’
ħmɾ	ħməɾ	‘red’

Although this algorithm seems to syllabify a large number of non-derived trisegmental verbs, nouns, and adjectives, it is not exempted from criticism as it fails to capture some words. In this respect, Boudlal (2001) has shown that Benhallam’s SSAA fails to account for the syllabification of the words that require schwa epenthesis after the first consonant in CCC syllabic structure, including geminated words (e.g. [sədd] ‘close’) and some nouns (e.g. [dərɓ] ‘hitting’, [dənb] ‘sin’). Such words cannot be syllabified by SSAA since schwa is epenthesized between the first and second consonants rather than before the third. To solve this problem, Benhallam (1980) proposes that the words with CəCC syllable structure and those with CCəC pattern have a different underlying syllable template, a claim that is challenged by Boudlal (2001).

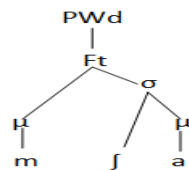
What concerns us in such a debated issue on the syllabification of CCC sequence is the consonantal cluster that involves SSP. In the same line of thought, Al Ghadi (1990) proposes a solution based on SSP. He claims that the syllabification of non-derived trisegmental nouns is largely dependent on the sonority of the second and third consonants. In other words, he states that schwa is placed before the second consonant if it is more sonorous than the third sound (as in a. below) and before the third consonant in two cases: if the third sound is more sonorous than the second sound (as in b.) or if they have the same sonority (as in c. below where according to Al Ghadi (1990) nasals and liquids are assumed to have the same sonority value).

- (4)
- $C_1\emptyset C_2C_3$, if $|C_2| > |C_3|$, e.g. [səlk] ‘cable’
 - $C_1C_2\emptyset C_3$, if $|C_3| > |C_2|$, e.g. [təbən] ‘hay’
 - $C_1C_2\emptyset C_3$, if $|C_2| = |C_3|$, e.g. [ħmə] ‘he carried’

The examples provided above also indicate that schwa epenthesis is conditioned by the syntactic category of the word. In MA nouns, which is our concern, the placement of schwa is determined by the sonority of the neighboring consonants (Al Ghadi, 1990; Boudlal, 1993), whereas in verbs and adjectives it is conditioned by Benhallam’s SSAA. However, there are certain nouns that do not abide by the SSP. Benhallam (1980) provides a list of these nouns and Boudlal (2001, p. 50) shows that such exceptional nouns consist of a pharyngeal sound as in [ħmə] ‘sleep’, [ħəbs] ‘jail’, and [ħnə] ‘snake’.

It should be noted that MA does not always opt for schwa epenthesis to resolve sonority violation. For instance, no phonological repair strategy, such as epenthesis, is employed to prevent sonority violation in initial consonantal clusters. Instead it is assumed that the first member of the cluster is syllabified as a degenerate syllable (Selkirk, 1981) while the second member is branched as an onset of the main syllable². Consider the representation of the verb [mʃa] ‘he left’:

- (5) Semisyllable licensing (Kiparsky, 2003)



Following Roca and Johnson (1999), and Selkirk (1980) such a syllabification violates Strict Layer Hypothesis (SLH), which demands that every prosodic element should be contained within its superordinate unit; the mora should be dominated by the syllable, which is, in turn, dominated by foot, and the foot should be dominated by the prosodic word (PWd). With reference to the example above, the initial member of the cluster [m] violates this constraint for the sake of satisfying SSP, which is in this case higher-ranked than SLH. Therefore, MA prefers to sacrifice the violation of SLH instead of SSP. This idea of competing constraints as regards SSP in MA words is further analyzed within the framework of optimality theory, which is the concern of the next section.

2.2 Sonority Principle within Optimality Theory

One of the interesting previous accounts that apply OT on the study of SSP in MA is the one conducted by Boudlal (2001). In his study of Casablanca Moroccan Arabic, Boudlal has analyzed the syllabification of non-derived nouns by incorporating OT. Similar to Al Ghadi (1990), he specifically demonstrates how schwa insertion is conditioned by the sonority of the second and third consonants of a root. To account for this behavior of schwa, Boudlal (2001, p. 90) adopts the following sonority ranking, where S refers to stops, F to fricatives, N to nasals, L to liquids, and G to glides (>> means higher ranked than):

- (6)
-

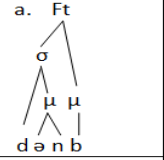
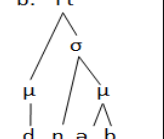
In addition to the sonority constraints above, he adopts the alignment constraint, ALIGN-R-σ' (the right edge of the stem should coincide with the right edge of the prominent syllable (the syllable that is liable to bear stress) to indicate the directionality of schwa syllabification.

In his analysis of trisegmental nouns, Boudlal (2001) focuses on the three cases referred to by Al Ghadi (1990) in (4) above, in which schwa insertion is conditioned by SSP. The sonority constraints stated in (6) above along with ALIGN-R-σ' are used to assess the first case of the nouns on the pattern CəCC, where the alignment constraint is low in the ranking since priority is

² The same thing applies to consonantal clusters in the coda position where the final consonant is syllabified as a degenerate syllable (see Al Ghadi, 1994, for more details).

given to sonority over the right alignment of the prominent syllable. Consider the parses of the input /dnb/N given in (7) below³(where the symbol ☞ refers to the optimal candidate).

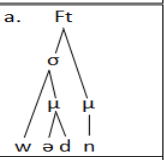
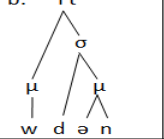
(7)

/dnb/N	*μ ə S	*μ ə N	ALIGN-R-σ'
☞ a. Ft 		*	*
b. Ft 	*!		

The ranking above accounts for schwa insertion in nouns on the pattern of CəCC. Thus, sonority constraints and ALIGN-R-σ' are capable of predicting the insertion of schwa before the second consonant, which is more sonorous than the third consonant.

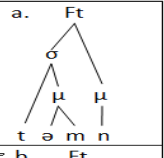
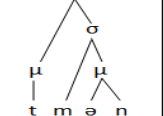
The same ranking is adopted by Boudlal (2001) to account for trisegmental nouns on the pattern CCəC, as shown in the parses of the input /wdn/N below:

(8)

/wdn/N	*μ ə S	*μ ə N	ALIGN-R-σ'
a. Ft 	*!		*
☞ b. Ft 		*	

Candidate (8b), with the pattern CCəC, emerges as the optimal one as it satisfies the higher-ranked constraint, which states that schwa is banned before stops. The same competing constraints stated above account for the last case of trisegmental nouns, where the second and third consonants are equal in sonority. The placement of schwa is between the second and third consonants, CCəC. Consider tableau (9) for the input /tmn/N :

(9)

/tmn/N	*μ ə N	ALIGN-R-σ'
a. Ft 	*	*!
☞ b. Ft 	*	

³We will adopt Kiparsky's representation of the minor syllable (2003) in which consonants in complex onsets or codas are licensed by the foot rather than a syllable as Boudlal (2001) claims. If a minor syllable is to be dominated by a syllable as Boudlal argues, then MA should not resort to epenthesis to break complex codas. However, Boudlal's representation could be incorporated to satisfy other constraints such as FootBin(arity).

The difference between the two candidates above is in their violation of ALIGN-R-σ'. The placement of schwa in such nouns is, therefore, determined by ALIGN-R-σ' although it is dominated by sonority.

As to quadrisegmental nouns on the pattern CCCC, although they are usually syllabified as CəC.CəC, Boudlal (2001) has shown that SSP is active in their syllabification. In other words, schwa is inserted before the second consonant of the root if it is more sonorous than the third consonant (e.g. [dərbala] 'dirty clothes', [təlfaza] 'Television') and before the third consonant in case it is more sonorous than the second one (e.g. [msəmna] 'a kind of bread'). To approach this type of nouns, Boudlal uses *COMPLEX constraint to rule out complex margins, and sonority and alignment constraints, as shown in tableau (10):

(10)

/msmn-a/ N	*COMPLEX	$\begin{matrix} *μ \\ \swarrow \searrow \\ ə \quad F \end{matrix}$	$\begin{matrix} *μ \\ \swarrow \searrow \\ ə \quad N \end{matrix}$	ALIGN-R-σ'
a. msəm.na	*!		*	*
b. m.səm.na			*	*
c. məs.mna	*!	*		*

Candidates (10a) and (10c) are ruled out by *COMPLEX, whereas candidate (10b) satisfies it. It does so because the initial phoneme of the onset cluster is licensed by the foot.

Having considered the interaction of different constraints related to SSP in MA nouns, let us now present and analyze the data.

3. Resolution of Sonority Violation Principle

In this section, I shed light on the different repair strategies employed by MA to resolve SSP in complex codas. I will start with a few words about the data, then present the phonological repair strategy, insertion of a schwa and a high vowel, and conclude with the morphological behavior of the feminine suffix {-a} in satisfying SSP.

3.1 The Data

The data to be analyzed are a corpus of French loans to MA that was collected from the spontaneous speech of more than 20 MA native speakers including myself, in the region of Kenitra. Although data were specifically collected from informants from the Gharb region, the selected loans are commonly used by all Moroccans regardless of their regional dialect and whether they speak French or not. At first, I compiled a large corpus of French loans, and then the relevant loan words with a cluster of consonants in the coda position wherein SSP is active were selected for analysis. Finally, the data were divided based on the involved phonological repair strategy.

3.2 Resolving Sonority Violation through Schwa Epenthesis: CəC and CCəC Patterns

One of the repair strategies employed by MA to resolve SSP is schwa epenthesis. Following Benhallam (1980, 1988, 1990) and Boudlal (2001), schwa is not part of the underlying representation but is argued to be epenthetic. In certain phonological contexts, such as a cluster of two consonants, MA makes recourse to schwa epenthesis to repair an ill-formed structure. Consider the following French loanwords into MA:

(a)

French	MA	Gloss
film	filəm	'film'
sykə	ʃukkər	'sugar'
rəʔtabl	burʔabəl	'cell phone'
kaɖə	kaɖər	'frame'
kaʔtabl	kaʔtabəl	'school bag'
livə	lifər	'book'
mœbl	mubəl	'furniture'
kaʔtɔ̃	krəʔən (pl.)	'cartons'

What motivates schwa epenthesis in these loanwords is the SSP. That is, epenthesis is triggered to avoid the violation of a universal markedness constraint dubbed sonority principle⁴. As such, sonority constraint must outrank faithfulness constraint DEP-ə to allow outputs with epenthetic schwa to surface. The insertion of schwa also suggests that MA does not tolerate complex syllabic structures⁵, and hence *COMPLEX constraint (militating against complex structures) is active and equally ranked with Son(ority) (henceforth, SON). In addition, since schwa syllable must have a coda, NoCoda constraint is dominated by DEP-ə and by transitivity is ranked below the higher constraints. The following tableau explains this interaction with regard to the input /film/:

(11) SON, *COMPLEX >> DEP-ə

/film/	SON	*COMPLEX	DEP-ə	NoCoda
ⵜⴰⴳⴷⵓⵏ a. fi.ləm			*	*
b. film	*!	*		**

Candidate (11a) emerges as the winner as it satisfies the higher-ranked constraints, SON and *COMPLEX at the expense of violating lower-ranked constraints. Candidate (11b) loses because it fatally violates the higher-ranked constraints.

What the tableau above does not include is a candidate like [fil.m], where the final coda consonant is unsyllabified, and another where it is parsed, [fil.m.]. To eliminate the former candidate, we suggest the adoption of PARSE-seg(ment) constraint, which requires every segment to be part of a syllable (Prince & Smolensky, 1993), and assume that it must be undominated as all segments of an input must be parsed into a syllable. As for the candidate with a parsed coda consonant, we adopt *P/C constraint, which prohibits consonants from occupying peak position (Prince & Smolensky, 1993), as shown in the following tableau:

(12)

/film/	SON	*P/C	PARSE-seg	*COMPLEX	DEP-ə	NoCoda
ⵜⴰⴳⴷⵓⵏ a. fi.ləm					*	*
b. film	*!			*		**
c. fil.m			*!			*
d. fil.m.		*!				*

In addition, a reasonable question to ask here is as follows: instead of epenthesis, why cannot MA resort to deletion to satisfy SSP since this phonological process has been reported in the literature as a repair strategy used in MA to adapt French words into the phonological system of MA (see Louriz, 2004, 2012)?⁶ The answer derives from the fact that MA does not delete any segments to satisfy the syllable structure (Boudlal, 2001)⁷. By the same reasoning, we assume that MA never makes appeal to deletion in order to satisfy SSP. To this end, MAX constraint (militating against deletion) should be undominated, too. The following tableau illustrates this interaction:

(13)

/film/	SON	MAX	*P/C	PARSE-seg	*COMPLEX	DEP-ə	NoCoda
ⵜⴰⴳⴷⵓⵏ a. fi.ləm						*	*
b. film	*!				*		**

⁴In this respect Boudlal (2001) claims that schwa epenthesis and hence the violation of DEP-IO is primarily enforced by a higher dominating constraint dubbed PARSE-Seg which demands the unsyllabified CC as in ‘CV.CC’ (cf. fi.lm) to be syllabified as CVC with schwa being the nucleus. In this paper and considering the data we are investigating, we claim that DEP-ə is enforced by sonority principle, instead.

⁵ MA allows neither complex codas nor complex onsets. In words such as [slam] ‘greeting’, where schwa epenthesis or deletion or any other phonological process is not allowed, the first sound of the cluster is syllabified as a degenerate syllable (see Boudlal, 2001; Selkirk, 1981).

⁶For example, the French word ‘automobile’ is borrowed into MA as [tomobil], with the deletion of the initial vowel since MA does not allow onsetless syllables.

⁷ Yet deletion can be used to satisfy other constraints such as Onset. (see Louriz, 2004, 2012, for further clarification).

c. fil.m				*!			*
d. fil.m.			*!				*
e. fil		*!					*

Note that deletion is blocked for two reasons: first in addition to the fact that deletion is aimed to satisfy sonority trivially by violating MAX, such a strategy is obviated because of the force of another higher-ranked constraint on the size of the loanwords. In this respect, Louriz (2012) states that MA enforces a constraint on the size of the loanwords from Amazigh Arabic in that it requires the minimal word to consist of at least two full syllables. She labeled it as: Minimality Adapt (Min Adapt), any output must contain at least two full syllables.

MA seems to act in the same way as to the constraint imposed on the minimal size of French loanwords in relation to SSP. Put differently, deletion that results in monosyllabic words is never used as a strategy to satisfy SSP. This suggests that Min Adapt constraint must be ranked high in order to exclude any ill-formed monosyllabic loanwords. Consider tableau (14) for the parses of the input /film/:

(14)

/film/	SON	Min Adapt	*P/C	PARSE-seg	*COMPLEX	DEP-ə	NoCoda
ⵜⴰⴳⴷⵓⵏ a. fi.ləm						*	*
b. film	*!				*		**
c. fil.m				*!			*
d. fil.m.			*!				*
e. fil		*!					*

As the tableau shows, candidate (14a) is the optimal one as it incurs no violation of the higher-ranked constraints, while candidates (14b), (14c), (14d), and (14e) lose in the competition as they fatally violate SON, PARSE-seg, *P/C, and *Min Adapt, respectively. The winner satisfies SON at the expense of violating the lower-ranked constraint DEP- ə. Candidate (14b) involves a fatal violation of SON in the sense that the sound [l], which is adjacent to the nucleus, is less sonorous than [m]. Candidate (14c) loses, for it contains one unparsed segment, and candidate (14d) is penalized for having a minor syllable. Candidates (14e) fatally violate Min Adapt (and undominated MAX) constraint, which points out to the fact that MA rules out any French loanwords to MA that derive from deletion, especially if this phonological process reduces a disyllabic or polysyllabic word into a monosyllabic one.

Now considering forms with complex onsets (e.g. [kɾa.ɬən]), *P/C should be demoted to a low ranking to allow outputs with consonantal peaks to surface. While it is not ranked with respect to NoCoda, *P/C must be dominated by DEP-ə to block outputs that resort to excessive epenthesis to resolve complex codas and onsets as is the case of candidate (15e) below. By transitivity, *P/C is dominated by the other higher-ranked constraints. Tableau (15) reflects this ranking:

(15)

/kɾɛn, {-a}/	Min Adapt	*COMPLEX	PARSE-seg	DEP-ə	*P/C	NoCoda
a. kɾa.ɬən		*!		*		*
ⵜⴰⴳⴷⵓⵏ b. .k.ɾa.ɬən				*	*	*
c. kɾa	*!	*				
d. k.ɾa.ɬən			*!	*		*
e. kə.ɾa.ɬən				**!		*

Thus, we assume that the constraints postulated so far are what triggers schwa epenthesis in biconsonantal codas. The following ranking is, then, generated:

- SON, Min Adapt, *COMPLEX, PARSE-seg, MAX >> DEP-ə >> *P/C, NoCoda

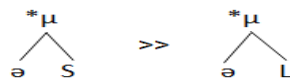
So far, we have seen the use of schwa epenthesis as a repair strategy in the phonological context of a sequence of two coda consonants differing in sonority hierarchy. Whenever a coda consonant that is adjacent to the nucleus is less sonorous than the following segment, schwa is inserted to resolve the violation of SSP. Another important phonological context of schwa epenthesis is a cluster of three coda consonants. Consider the following words:

(b)

French	MA	Gloss
ʃābɛ	ʃomɓəɾ	'room'
sātɣ	ʃonɗəɾ	'center'
ʃbɛ	lomɓəɾ	'shadow'
sɛptābɛ	sibɗomɓəɾ	'September'

The data above reveal that the absence of nasalized vowels in MA results in a sequence of three final consonants, where schwa is epenthesized to break it. Such epenthesis is governed by sonority. In other words, schwa is consistently epenthesized before the most sonorous segment, which happens to be the last one. This choice favors the pattern CCəC to CəCC. Accordingly, to obtain the correct outputs of the nouns on the pattern CVC.CəC, we adopt the following sonority ranking (see Boudlal, 2001):

(16)



Consider tableau (16) for the parses of the input /sātɣ/:

(17)

/sātɣ/	*μ ə S	*μ ə L	DEP-ə
a. ʃo.ɳəɗɾ	*!		*
☞ c. ʃon.ɗəɾ		*	*

The ranking above excludes the pattern CəCC exemplified by candidate (17a) and selects the pattern CCəC. This supports the argument that schwa must be inserted before the most sonorous sound in the context of three final coda consonants. However, this generated ranking does not eliminate a candidate like [ʃo.ɳəɗɾ], in which the nasal sound is syllabified as an onset of the ultimate syllable, as demonstrated in the tableau below:

(18)

/sātɣ/	*μ ə S	*μ ə L	DEP-ə
a. ʃo.ɳəɗɾ	*!		*
☞ b. ʃo.ɳəɗɾ		*	*
☞ c. ʃon.ɗəɾ		*	*

Note that based solely on sonority constraints and DEP-ə, the candidates (18b) and (18c) tie in everything and as such the optimal candidate can be determined by the adoption of the undominated *COMPLEX constraint:

(19)

/sātɣ/	*COMPLEX	*μ ə S	*μ ə L	DEP-ə
a. ʃo.ɳəɗɾ	*!	*		*
b. ʃo.ɳəɗɾ	*!		*	*
☞ c. ʃon.ɗəɾ			*	*

As tableau (19) shows, candidates (19b) and (19c) no longer tie as the former candidate now involves a fatal violation of *COMPLEX.

It is worthy to note that ALIGN-R-σ' constraint (Boudlal, 2001) can be also adopted to generate CCəC pattern. This constraint would rule out a candidate like [ʒo.ɲəʔ.r] on the basis that the degenerate syllable is not right aligned. *Min-σ constraint (Boudlal, 2001) or *P/C (Prince & Smolensky, 1993) would equally rule out [ʒo.ɲəʔ.r^u] in that the final syllable consists solely of a consonant.

The constraints we have generated so far are ranked below:

- SON, Min Adapt, *COMPLEX, PARSE-seg, MAX >> DEP-ə >> *Min-σ, NoCoda (For final biconsonantal loanwords)
- *COMPLEX, *μəS >> *μəL >> DEP-ə (for final three consonantal loanwords)

In addition to schwa insertion, MA makes recourse to high vowel epenthesis to satisfy SSP in French loanwords. The next section is devoted to this phonological repair strategy.

3.3 Resolving Sonority Violation through High Vowel Insertion

The following data contain some remarkable phonological processes to investigate but they will not be underlined as they are irrelevant to the present study. The focus is primarily on the contexts where SSP is involved.

(c)

French	MA	Gloss
mitɥ	mitru	'miter'
kabl	kaβli (or kaβəl)	'cable'
litɥ	jəʔro	'liter'
poʊv	bufri	'poor'
ʒɑdɑm	ʒɑdarmi	'interstate trooper'

The data above reveal that MA inserts a high vowel ([i] and [u] but most frequently [i])⁸ word finally to satisfy SSP. This vowel creates a new syllable in which it occupies the nucleus position (e.g. [mi.tru]). The data also show that both a high vowel and schwa epenthesis are sometimes interchangeably employed with no lexical change ([kaβli] or [kaβəl], [mitru] or [mitər]) and such irregularities cannot be phonologically accounted for. Besides, such an alternation is not enforced by any conditions on the minimal word size as both strategies apply to French monosyllabic words and generate disyllabic loanwords. One additional remark is that whenever an inserted high vowel is preceded by an emphatic segment, it is realized as French [o], as in the word [jəʔro] (see Kenstowicz & Louriz, 2009, for more details on French vowel integration into MA).

Although schwa and a high vowel epenthesis are activated for the same goal (to satisfy SSP), they seem to act differently. While schwa epenthesis breaks a cluster of two segments to satisfy SSP, a high vowel does so without splitting the consonantal cluster; instead it requires the syllabication of the cluster as an onset rather than a coda. This satisfies SSP in the sense that the most sonorous sound is now adjacent to the nucleus.

Considering the interaction of the constraints in the data above, DEP (High-V) should be ranked low to allow outputs with an epenthetic high vowel to surface. As previously illustrated, this epenthesis is driven by sonority and as such DEP (High-V) must be dominated by SON. Consider their interaction in the following tableau:

(20)

/ kaβl/	SON	DEP (High-V)
a. kaβ.li		*
b. kaβl	*!	

Candidate (20a) is the harmonic candidate as it fails only the lower-ranked constraint, whereas candidate (20b) is excluded, for it incurs the violation of the higher-ranked SON constraint.

Also the fact that high vowel insertion is restricted to the word final position requires an alignment constraint demanding a coincidence between the epenthetic vowel to the right edge of the stem and the prosodic word (PWd). This constraint is stated below:

⁸ One might think such asymmetry results from assimilation; however, the data do not support the fact that the root vowel determines the features of the inserted vowel, since, for example, the vowel [i] is epenthesized regardless of the root vowel features.

ALIGN-R (High-V, PWd): This constraint asserts that the inserted high vowel to the right edge of the stem must match the right edge of the prosodic word (PWd).

Since the alignment of this high vowel takes priority over the avoidance of epenthesis, ALIGN-R (High-V, PWd) dominates DEP High-V. Consider the following tableau for illustration:

(21)

/kaβl/	Align-R (High-V, PWd)	DEP (High-V)
☞ a. kaβ.li		*
b. kaβ.il	*!	*

The difference between the two candidates lies in the alignment of the epenthetic high vowel. Unlike candidate (21b), candidate (21a) wins thanks to the right alignment of the epenthetic vowel.

What the tableau above does not include is the possible candidate [ka.βli]. Since MA does not allow candidates with complex margins to surface, *COMPLEX must be undominated. It should dominate Align-R (High-V, PWd) to rule out any output that satisfies alignment but involves a complex syllabic structure. Consider the following tableau:

(22)

/kaβl/	SON	*COMPLEX	Align-R (High-V, PWd)	DEP (High-V)
☞ a. kaβ.li				*
b. kaβ.il			*!	*
c. ka.βli		*!		*

Candidate (22a) represents the harmonic parse as it meets higher-ranked constraints. Candidate (22b) loses because the inserted high vowel is not right-aligned. Candidate (22c) incurs the violation of both higher and lower ranked constraints.

Note that a possible candidate like [kaβ.li] would be ruled out by *COMPLEX or by the adoption of undominated ONSET. However, the attentive reader may wonder how the possible candidates [kaβ.li] and [ka.β.li] can be excluded based on the proposed ranking above. Assessed against the generated set of constraints, these candidates would incur no violation and hence either of them would be selected the winner. To exclude them, we adopt PARSE-seg and *P/C, as shown in the following tableau:

(23)

/kaβl/	SON	*COMPLEX	PARSE-seg	*P/C	Align-R (High-V, PWd)	DEP (High-V)
☞ a. kaβ.li						*
b. kaβ.il					*!	*
c. ka.βli		*!				*
d. kaβ.l			*!			
e. ka.β.li				*!		*
f. kaβl	*!	*				

To this end, the following ranking of the proposed set of constraints predicts high vowel insertion in French nominal loans to MA:

- SON, *COMPLEX, PARSE-seg, *P/C >> Align-R (High-V, PWd) >> DEP (High-V)

In sum, it has been clearly shown that MA resorts to epenthesis to satisfy SSP in French loans with complex codas. However, an interesting question to ask here is as follows: does MA still prefer epenthesis in the case of morphological suffixation? The following section attempts to provide an answer to this question.

3.4 Resolving SSP by the addition of a feminine suffix {-a}

In addition to the phonological repair strategy, schwa and high vowel epenthesis, the morphological behavior of certain French noun loans to MA reveal that there is some phonological and morphological conspiracy to satisfy SSP. Consider the following data:

(d)

French	MA	Gloss
tabl	ɬabl-a	'table'
fɛʁm	firm-a	'farm'
puɖɛ	budr-a	'powder'
sitɛʁn	sitirn-a	'tank'

The data above exhibit the suffixation of the morpheme {-a} to the base to generate feminine nouns in MA. Such suffixation is different from the epenthesis of a high vowel and a schwa in that this addition is morphologically triggered. That is, the suffix {-a} does not arise for phonological targets, namely to satisfy SSP in this case. However, what is it that forces the absence of some phonological process such as epenthesis in the coda clusters where SSP is violated? Indeed, the absence of epenthesis or any other phonological process in the contexts where SSP is violated is justified by the presence of the morphological suffix, which happens to resolve sonority violation. The fact that there is no word, in the data above, that contains both a morphological suffix and a phonological repair strategy (e.g. *budɛr-a) suffices to claim that the morphological suffixation and phonological repair strategy conspire to ensure the non-violation of SSP. Therefore, since the morphological feminine suffix {-a} contributes to satisfying SSP, a constraint militating against this suffix and another to enforce its alignment should be generated. For this purpose, the constraints DEP-Affix and Align-Affix-R are postulated⁹.

To generate outputs with the suffix {-a} right-aligned, the constraint Align –Affix–R must be ranked above DEP–Affix, as shown in the following tableau:

(24)

/puɖɛ,{-a}/	Align –Affix–R	DEP –Affix
a. bud.ar	*!	*
☞ b. bud.ra		*

Candidate (24b) wins because it meets the highly ranked Align-Affix-R constraint, whereas the other candidate fails to do so. Note that an output without the feminine suffix {-a} (e.g. [budr]) would trivially satisfy the two constraints in (24) and surface as the optimal one, as shown in tableau (25) (where the symbol ☞ indicates the wrong optimal candidate):

(25)

/puɖɛ,{-a}/	Align –Affix–R	DEP –Affix
a. bud.ar	*!	*
b. bud.ra		*
☞ c. budr		

To derive the correct output, the constraint *COMPLEX, militating against consonantal clusters, is adopted and should be undominated to eliminate any parses with complex syllabic structures. The following tableau reflects this interaction:

(26)

/puɖɛ,{-a}/	*COMPLEX	Align –Affix–R	DEP –Affix
a. bud.ar		*!	*
☞ b. bud.ra			*

⁹ Since our concern is sonority violation, we will ignore faithfulness constraint, IDENT-voice.

c. budr	*!		
d. bu.dra	*!		*

The stipulated ranking in the tableau above derives the correct harmonic candidate, (26b), which fares better than the candidates (26c) and (26d) in as far as *COMPLEX is concerned, and better than candidate (26a) as regards Align–Affix–R. The inclusion of the previously generated undominated SON constraint would also eliminate candidates with complex syllabic structures that violate SSP. However, with the addition of possible outputs like [bud.r] and [bud.r.], the ranking provided above would fail to generate the desired optimal candidate as these parses satisfy all constraints. Therefore, to yield the correct parse, the constraints, PARSE-seg and *P/C must come into play. In (27), we show how the output [bud.ra] is obtained:

(27)

/pudɤ,{-a}/	SON	*COMPLEX	PARSE-seg	*P/C	Align–Affix–R	DEP –Affix
a. bud.ar					*!	*
ب. bud.ra						*
c. budr	*!	*				
d. bu.dra		*!				*
e. bud.r			*!			
f. bud.r.				*!		

As explained beforehand, when a morphological suffix is added, MA does not make recourse to the phonological strategy: epenthesis. Therefore, to rule out any possible output that involves either a high vowel or a schwa, the constraints DEP (High-V) and DEP-ə should dominate DEP-Affix and be dominated by SON, *COMPLEX, PARSE-seg, and *P/C, as the following tableau explains:

(28)

/pudɤ,{-a}/	SON	*COMPLEX	PARSE-seg	*P/C	Align – Affix–R	DEP-ə	DEP (High-V)	DEP–Affix
a. bud.ar					*!			*
ب. bud.ra								*
c. budr	*!	*						
d. bud.r.				*!				
e. bud.r			*!					
f. bu.də.ra						*!		*
g. bu.di.ra							*!	*

As shown in the tableau, all competing constraints incur at least the violation of one higher-ranked constraint except the winner which involves a minimal violation of the lower-ranked constraint, DEP-Affix. The elimination of the last two candidates indicates that MA never has recourse to both morphological suffixation and phonological epenthesis to satisfy SSP. To this end, we assume that the following ranking is capable of generating the correct optimal output in the case of morphological suffixation of the feminine morpheme {-a} to the base:

SON, *COMPLEX, PARSE-seg, *P/C >> Align–Affix–R, DEP-ə, DEP (High-V) >> DEP–Affix

4. Loanword adaptation: phonetic or phonological?

Now we examine whether the adaptation of French nominal loans into MA is phonetically or phonologically driven. Proponents of the phonetic approach argue that acoustic as well as perceptual features condition loanword adaptation; speakers of the native language heavily depend on how foreign sounds are phonetically closer or similar to the native language (Peperkamp & Dupoux, 2003). On the other hand, advocates of the phonological approach (e.g. Paradis & LaCharité, 1997) contend that the phonological constraints of the adopting language are highly preserved. In this respect, speakers of the borrowing language employ many adaptation processes that reflect their phonological competence of their native language and possibly knowledge of the donor language.

As far as the adaptation of French nominal loans is concerned, the phonetic approach predicts that MA speakers should pronounce words with coda clusters as in *film* [film] without any epenthesis since MA has these sounds in its phonemic inventory, and the investigated clusters are permissible in MA phonology at least in the onset position [lma] 'water'. However, the collected corpus contradicts this and instead provides further support to the phonological stance. Reflecting on their L1 phonological competence, the informants, whether monolingual or bilingual, do apply epenthesis to adapt French nominal loans to the phonological system of MA. Recourse to this phonological strategy is enforced by the phonotactic constraints of MA. Thus MA speakers, as regards their adaptation of French complex codas, do not rely on any phonetic features or perceptual similarity between French and MA sound inventory but on their phonological competence in L1.

5. Conclusion

This paper has examined the violation of SSP in French nominal loans to MA. Adopting the theoretical framework of OT, this article has analyzed the resolution of SSP in the phonological context of complex codas. The highlighted phonological strategy is epenthesis. Recourse is made to schwa epenthesis as a repair strategy to break biconsonantal coda clusters that violate SSP. When three coda consonantal clusters are involved, schwa epenthesis is conditioned by the sonority value of the consonants; it is consistently epenthesized before the most sonorous segment. A high vowel is epenthesized in the final position without splitting the consonantal cluster; however, when this cluster remains intact, it must be syllabified as an onset instead of a coda, and as such SSP is satisfied. It has also been shown that the addition of a morphological feminine suffix, which is primarily morphologically driven, does indeed contribute to the resolution of SSP. It blocks the application of epenthesis and similar to high vowel epenthesis strategy it also requires the syllabification of the consonantal cluster as an onset. This behavior of the morphological marker points out to the fact that phonological and morphological strategies conspire to satisfy SSP. In all these strategies, the elided vowel creates a new syllable in which it occupies the nucleus position. We concluded with the claim that the adaptation in question is driven phonologically. Finally, future research may provide further evidence for the resolution of SSP in French loanwords to MA by highlighting other phonological or morphological aspects in loan phonology.

About the Author

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