

**Langues naturelles et Théorie de la Complexité**  
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**Structural and algorithmic geolinguistic complexity. The case of Berber**

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**1. Topic and approach**

How certain phonological and morphological innovation processes triggered by the vocalisation of the liquids /r/, /r̄/, /rr/ and /r̄r̄/ in Tarifit (North Berber/Afro-asiatic, North Morocco) create language variation and change and how these innovations are geolinguistically patterned.

- Qualitative (structural) perspective: synchrony & diachrony  
+ quantitative (algorithmic) perspective: computing geolinguistic distance by means of the Levenshtein distance calculating method (pondered)
- Valuable insights into the geolinguistic patterns and their variability; “holistic” point of view in addressing complexity (Léonard et al. 2016, O’Sullivan 2004)
- Functional and social factors interact in the diffusion of language forms
- Language change is gradual and non-linear on an extra-linguistic level (geographical and social variation) as well as on a linguistic one (Tarifit geolinguistic continuum, Lafkioui 2008)
- Data mainly from the *Atlas Linguistique des variétés berbères du Rif* (Lafkioui 2007) and linguistic/sociolinguistic/ethnographic fieldwork (summer 1992-autumn 2015)

**PART I. STRUCTURAL GEOLINGUISTIC COMPLEXITY**

**2. Vocalisation of the liquids /r/ and /r̄/ and the vowel system of Tarifit**

Pan-Berber comparative perspective, VOC is an idiosyncrasy (Central Rif area)

- VOC of /r/ also in Timimoun (Gourara region, Algerian Sahara)
  - end of a lexeme, /r/ disappears without leaving any trace
  - preconsonantal position, /r/ transforms into /h/ ([h]), /h̄/ ([h̄]) and /ε/ ([ʔ]) (Boudot-Lamotte 1964)
  - less systematic and productive as in Tarifit
- Large geographical distance; contact did not instigate this innovation

2 types of vowel systems in Berber:

a) Basic type with mainly 3 vowels (majority):

- Closed front vowel /i/ often pronounced as [ɪ]; ex. (1) [ɪzɪ] ‘fly’.
- Closed back vowel /u/ often pronounced as [ʊ]; ex. (2) [ʊɪ] ‘heart’.
- Open central vowel /a/ often pronounced as [æ] or [ɛ]; ex. (3) [æmæ’n] or [ɛmɛ’n] ‘water’.

b) Extended type (minority); e.g. Tuareg and Tarifit (object of the study)

+ Central vowel [ə], an epenthetic realisation feature (except in e.g. Berber of Jerba in Tunisia)

## 2.1. Vocalisation of the tap /r/ and the trill /r̄/ (VOC)

Diachronic vocalisation process in Tarifit varieties of the Central Rif area (cf. Fig. 1: grey zones) has caused an extension of the vowel system through the creation of units that are distinct from the basic vowels by:

- a changed quality – an apparent compensatory lowering for [ɪ] and [ʊ]
- a considerable quantitative value due to compensatory lengthening

Table 1: Long vowels resulting from the vocalisation of /r/ and /r̄/

Diachronic Form	Synchronic Form	Phonetic Form
ir	ī	diphthong [ɛæː] monophthong [ɪː]
ur	ū	diphthong [ɔɑː] monophthong [ʊː]
ar/ər	ā	monophthong [ɛː], [æː] or [aː]
ir̄	ī̄	monophthong [eːː]
ur̄	ū̄	monophthong [oːː]
ar̄	ā̄	monophthong [ʌːː]

Examples from Ayt Temsaman (Central Rif):

- (4) *atbir* [ɛθβɪr̄] or [æθβɪr̄] + vocalisation ⇒ *atbī* [ɛθβɛæː] or [æθβɛæː] ‘pigeon’  
 (5) *urtu* [ʊrθʊ] + vocalisation ⇒ *ūtū* [ɔɑːθʊ] ‘fig tree’  
 (6) *aryaz* [ɛryɛːz] or [æryæːz] + vocalisation ⇒ *āyaz* [ɛːyɛːz] or [æːyæːz] ‘man’  
 (7) *tarwa* [θʌr̄ːwɛ] + vocalisation ⇒ *tāwa* [θʌːːwɛ] ‘children’

The long vowels /ī/, /ū/, /ā/ and /ā̄/ are integrated into the phonological system of Tarifit (Lafkioui 2000, 2002, 2006a, 2007: 29–37, 2011):

Table 2: Vowel System of Tarifit (Central Rif)

Basic Vowels	Long Vowels
i	ī
u	ū
a	ā
	ā̄

VOC, as part of *weakening of consonants* = essential feature of Tarifit phonetics and phonology (Biarnay 1917; Renisio 1932); e.g.:

- spirantisation of plosives • fricatives • approximants • zero (Lafkioui 2006b, 2007:38-58)
- vocalisation of semi-consonants (Lafkioui 2007: 27-28)

➤ Phonetic economy is probably the functional triggering factor

Formal restrictive rule = vocalisation in the syllable coda only:

- (8) *īdn* ← *irdn* (= ir + dn) ‘grain’  
 (9) *tammūt* ← *tammurt* (= ta + mmurt) ‘land’  
 (10) *aḍrā* ← *aḍrar* (= aḍ + rar) ‘mountain’  
 (11) *asādun* ← *asrdun* (= a + sr + dn) ‘mule’

VOC of /r/ and /r̥/ shows a homologous course of transformation:

- functional factor of “economy” has triggered both processes
- /r̥/-VOC is a formal development created by analogy with /r/-VOC

### 3. Extended vocalisation (EXTVOC)

Two “extended” vocalisations (EXTVOC) in Berber of the Central Rif area:

- 1) VOC of the liquids /r/ and /r̥/ in onset position, i.e. EXTVOC1
- 2) VOC of the transformed liquid /l/ (/r ⇔ l/ or /r̥/), i.e. EXTVOC2

#### 3.1. Vocalisation in onset position - EXTVOC1

EXTVOC1 has a serious impact on the phonetic, phonological and morphological structure of the lexemes in question (Lafkioui 2006a; 2007: 37, 2011).

- Ayt Weryaḡel varieties (mainly), in prevocalic and intervocalic positions

- Prevocalic position:

- (12) *ab̥īd* [æβi:ð] ⇐ *abrid* [æβrið] ‘way’  
 (13) *ag̥ūm* [aɣu:m] ⇐ *aḡrum* [aɣruːm] ‘bread’  
 (14) *amqqḁn* [æmqqa:n] ⇐ *amqqr̥an* [æmqqraːn] ‘big’

- Intervocalic position:

- (15) *īy* [i:j], [εæ:j] or *yīy* [ji:j] or [jεæ:j] ⇐ *iri* [iri] ‘neck’  
 (16) *āy* [æ:j], [ε:j] or *yāy* [jæ:j] or [jε:j] ⇐ *ari* [ari] ‘write’  
 (17) *diḡūy* [ðiɣu:j] ⇐ *diḡuri* [ðiɣuri] ‘study’  
 (18) *imzḡā(w)* [imzjæ:w] or [imzjε:w] ⇐ *imzḡura* [imzjuːræ] ‘first ones’

/r̥/-VOC in intervocalic/onset position:

- (19) *dū(w)* [doː(w)] ⇐ *duru* [doru] ‘duro’, ‘coin’

/r/-VOC in onset and coda position (double vocalisation: EXTVOC1 + VOC):

- (20) *aeū* [æfu:] or [æfuː] ⇐ *aerur* [æruːr] ‘back’

Formal restrictive sub-rule = no EXTVOC1 in an absolute Anlaut position before a vowel:

- (21) \**āža* ⇐ *raža* [raʒa] ‘wait’ (AOR-IMP-SG)

- Recent data indicate a shift to ignoring this rule in certain varieties (Imzuren)

- EXTVOC1a [\*absolute Anlaut] ⇒ EXTVOC1b [absolute Anlaut]

- (22) *āža* [a:ʒa] ⇐ *raža* [raʒa] ‘wait’ (AOR-IMP-SG)

EXTVOC1 provides for syllabic restructuring of the lexeme, with a reduction of the number of syllables (mainly in intervocalic position)

➤ Formal adaptation strategy of two possible innovation types:

- Functional triggered innovation in which the economy principle is driven to extremes
- A formal triggered innovation in which analogy is made between EXTVOC1 and VOC

#### 3.2. Vocalisation of the mutated liquid /l/ - EXTVOC2

EXTVOC1 is in co-variation with another diachronic phenomenon of the Central Rif area, i.e. the phonetic mutation of the lateral approximant /l/ (Lafkioui 2007: 69-71):

a) /r ⇐ l/ = 1) voiced tap [r] with an ultra light friction or 2) a voiced trill [r]

b) /r̥/ = fricative [ɹ]

The difference between the two taps becomes more apparent when vowels precede them: /v/ + /r ⇐ l/ ≠ /v/ + /r/; only the original tap /r/ has a lowering effect on the vowels that it follows:

(23) *ari* ⇐ *ali* ‘climb’: [æɹɪ] of [ɛɹɪ] ≠

(24) *ari* ⇐ *ari* ‘write’: [aɹɪ]

These consonant mutations are in direct correlation with the *phonetic restriction* that excludes the vocalisation of /r/ obtained from /l/ = formal restrictive rule

➤ Ayt Weryaǧel is an exception to this rule; /r ⇐ l/ can indeed be vocalised, following a course of evolution analogous to the original tap /r/, with long diphthongs as maximum transformations = EXTVOCC2

Examples of EXTVOCC2; Ayt Weryaǧel (Central Rif):

(25a) /irs ([ɪrs], [ɪrs]) ⇐ ils/ + vocalisation /r/ ⇒ [ɛæ:s], [jɛæ:s] and [ɪjɛæ:s] ‘tongue’

(25b) /irs ([ɪrs], [ɪrs]) ⇐ ils/ + maintain /r/ ⇒ [ɪrs], [ɪrs] ‘tongue’

Examples of blocking rule of EXTVOCC2; Ayt Wlišek and Iqelɛiyen (Central Rif):

(25c) /irs ⇐ ils/ + maintain /r/ ⇒ irs ([ɪrs], [ɪrs] ‘tongue’)

(25d) /iřs ⇐ ils/ + maintain /r̥/ ⇒ iřs ([ɪ.ɫs] ‘tongue’)

#### 4. Vocalisation of the geminate trill /rr/ (Lafkioui 2006a, 2007: 34)

(26) *ərr* ‘give back’:

- No VOC + qualitative timbre change *arr* ([ɛrr], [ærr])

- No VOC + qualitative and quantitative timbre change, *ārr* ([ɛ:rr], [æ:rr])

- VOC + compensatory lengthening + simplification of articulatory tension, *ār* ([ɛ:r], [æ:r])

➤ Tap /r/ + intensification ⇒ trill /rr/

➤ Typologically uncommon phenomenon because Tarifit allows for applying a phonetic rule (i.e. vocalisation) to a part of the geminate (first part), which invalidates Kenstowicz & Pyle (1973) and Guerssel (1977)

➤ Development of /rr/-VOC does not necessarily go in parallel with /r/-VOC

➤ Opposition [simple or vocalised /r/] vs [long or reduced /rr/] is used for morphological marking (e.g. TAM, derivation)

#### 5. Vocalisation is a gradual linguistic process

Different transformation stages exist depending on the structure of the variety and the lexeme under consideration.

➤ A case of phonetic driven gradualism is the complementary link between /r/ and its vocalised variants: /r/ can serve as a continuous glide sound when a long vowel precedes another vowel in a quickly articulated utterance, the former being reduced in quantity.

(27) *awssā i d-y-usin* + high cadence ⇒ *awssar i d-y-usin* ‘the old man who has come’

(28) *awssā i d-y-usin* + high cadence ⇒ *awssā y i d-y-usin* ‘the old man who has come’

(29) *uma i d-y-usin* + high cadence ⇒ *uma y d-y-usin* ‘my brother who has come’

➤ Semi-vowel /y/ has taken over the glide function of the etymological /r/; confirms the phonological status of the long vowels in Tarifit.

- Reinterpretation of /y/ as a glide in the phonetic context [ $\bar{v} + v$ ] by analogy with the glide function of /y/ in the context [ $v + v$ ] (formally triggered innovation).

## 6. Morphological implications of vocalisation

VOC and EXTVOIC have caused a number of significant morphological transformations; e.g. restructuring of morphological patterns of its verbal and nominal system.

### 6.1. The Berber verbal system

Root-Pattern type, structured around a complex aspectual hierarchical configuration with three levels:

1. Verb = stem + person or participle marker (highest level)
2. Stem = root + vowel pattern (middle level)
3. Root = consonantal radicals (basic level)

(30) *y-udf* [juðəf] ‘he has entered’ (3MSG-PFV) = PM *y-* (3MSG) + stem *-udf* [uðəf] (root *df* action ‘to enter’ + pattern /u--/)

Predominance of tri-radical roots; use of both consonant length and intraradical vowel alternation (apophony) to indicate aspectual categories; fundamental morphological opposition of Perfective (PFV) versus Imperfective (IPFV) for the positive aspects and Perfective (PFV) versus Negative Perfective (NEGPFV) for the negative aspects (Basset 1952; Galand 1977; Cadi 1987: 59–65; Chaker 1989; Lafkioui 2007: 174–191).

### 6.2. Morphological innovations of the verb system

1) Extension of verbal paradigms of the type /ccv/, /vcc/ and /cvc/ at the expense of /ccc/

(31) *ccc* + vocalisation  $\Rightarrow$  *ccv*; *mžr* [mʒər]  $\Rightarrow$  *mžā* [mʒæ:] ‘plough’

(32) *ccc* + vocalisation  $\Rightarrow$  *vcc*; *rwl* [rʷəl]  $\Rightarrow$  *āwl* [a:wəl] ‘run away’

(33) *ccc* + vocalisation  $\Rightarrow$  *cvc*; *frn* [frən]  $\Rightarrow$  *fān* [fæ:n] ‘sort’

In (32) [ə] is inserted before /r/:

– [rʷəl]  $\Rightarrow$  [ərʷəl]  $\Rightarrow$  [arʷəl]  $\Rightarrow$  ...  $\Rightarrow$  [a:wəl] (*āwl*)

In (33) the sequence [rə] undergoes a permutation under the influence of the sonority rule before vocalisation may occur:

– *cre*  $\Rightarrow$  *cer*  $\Rightarrow$   $\bar{v}$   
 [frən]  $\Rightarrow$  [fərɲ]  $\Rightarrow$  [fɛ:n] or [fæ:n] (*fān*)

2) Reorganisation of the paradigmatic structure of the verb

a) *Perfective (PFV) ~ Negative Perfective (NEGPFV)*

Verbs with a vocalised /r/ as second or third consonant display for the NEGPFV the base /c $\bar{v}$ c/ or /cc $\bar{v}$ / with  $\bar{v}$  as the same long vowel as in the PFV.

➤ *fān* ‘sort’ (33) and *mžā* ‘plough’ (31) are forms of both PFV and NEGPFV ( $\neq$  expected respective forms \**fīn* ‘sort’ and \**mžī* ‘plough’, NEGPFV of /ccc/-verbs have /ccic/ as their base, e.g. *frin* ‘sort’, *mžir* ‘plough’)

➤ Formal re-analysis of the bases c $\bar{v}$ c and cc $\bar{v}$  of the PFV as bases of the NEGPFV, with  $\bar{v}$  as a long invariable vowel.

- Systematisation of the new variants with a morphologically unmarked base for the NEGPFV is related to their widespread diffusion.
- But this diffusion is not wholesale; gradual pattern related to combinatorial opposition: conditions:

(34)

- *mžā* (PFV) ~ *ur* (NEG) + *mžā* (NEGPFV, -mark); optional frequent opposition in varieties with complete vocalisation (core area)
- *mžā* (PFV) ~ *ur* (NEG) + *mžir* (NEGPFV, +mark); optional frequent opposition in all vocalisation areas
- *mžr* (PFV) ~ *ur* (NEG) + *mžā* (NEGPFV, -mark); optional frequent opposition in vocalisation areas
- *mžr* (PFV) ~ *ur* (NEG) + *mžir* (NEGPFV, +mark); obligatory opposition in areas without vocalisation

b) *Perfective (PFV) ~ Imperfective (IPFV)*

Marking diversification for /crc/-verbs; solutions counterbalance the eroded aspect markers:

- New morphemes are created from vocalisation (/ø/ for PFV; /ā̄r/ and /ā̄rr/ for IPFV);
- The existing IPFV marker /t/ is prefixed to the base of the PFV without any changes;
- A combination of both developments (/t-/ + /ā̄r/ or /t-/ + /ā̄rr/ for IPFV).

Table 3: Perfective ~ Imperfective Markers

PFV	IPFV
/r/ - <i>frn</i>	/r̄r/ - <i>frrn</i>
ø - <i>fān</i>	/ā̄r/ - <i>fārn</i>
	/ā̄rr/ - <i>fārrn</i>
	/t-/ - <i>tfān</i>
	/t-/ + /ā̄r/ - <i>tfārn</i>
	/t-/ + /ā̄rr/ - <i>tfārrn</i>

- New variants are compensatory adjustments for eroded morphological configurations of the PFV and the IPFV (Lafkioui 2011).
- The structural adequacy of these specific and central morphophonemic oppositions has been a significant factor in their general diffusion in the vocalising Rif areas.

## PART 2. ALGORITHMIC GEOLINGUISTIC COMPLEXITY

See PPT

### 7. Complex geolinguistic aggregates

#### 7.1. VOC-diffusion

- Varieties with the highest phonetic diversity for /r/ and /r̄/ are mostly located in contact areas: border zones, transit areas and socio-economic centres.
- The innovated vowels are most likely engendered in a particular location from which several variants are distributed (diffusion model, Chambers & Trudgill 1998: Chapter 11).
- The great size of the diffusion area points to social acceptance.
- The functional factors of *economy* and *code conformity* also contribute to the transmission of the vocalised variants; they may explain the absolute preference in the core area for

complete vocalised variants, which cannot be directly associated with specific social functions

## 7.2. EXTVOC-diffusion

- Functional trigger of “economy” exerts such a strong pressure that the functional properties of “transparency” and “intelligibility” – of crucial importance for the form-function balance of language structure – are in jeopardy.
- From a formal perspective, these innovations have a great impact and are sometimes even pernicious because of their significant eroding effect on the basic syllable and lexeme structure of Tarifit. Nevertheless, they are adopted by the Ayt Weryaǧel.
- Onset-vocalisation in particular has had a remarkable success in this region.
  - Functional factor of code conformity is a probable functional explanation
  - Formal factors also play an important role in their development and diffusion. Ex. of the recent innovation *aǧūm* (← *aǧrum* ‘bread’; ex. 13) which is an extension by analogy with older innovations like *abīd* (← *abrid* ‘way’; ex. 12) and *amqqān* (← *amqqran* ‘big’; ex. 14 ); Lafkioui (2011).

## 8. Conclusion

- Language is constantly modulated in the form of innovations that may emerge in structurally layered and causal formations mainly dictated by system-based properties.
- Functional and social factors interact in the selection and hence diffusion of language forms and in some cases (e.g. restructuring of the verbal paradigm) system-internal properties may dominate.
  - = evidence against the language evolutionary claim that only social factors are responsible for variant selection (Milroy 1992: 201–202; Croft 2000: 38, 39, 54)
- Language change is gradual (and non-linear) not only on an extra-linguistic level (geographical and social variation) but also on a linguistic one. Therefore, it is important to consider the continuous selection process of variants not solely from a social perspective (“propagation” as in Croft 2000: 38, 178) but also in terms of how the variants are formally and functionally integrated into ever-changing linguistic structures (Lafkioui 2011).

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