Derived environment effects and logarithmic perception - Benjamin Storme (Paris 8/CNRS)

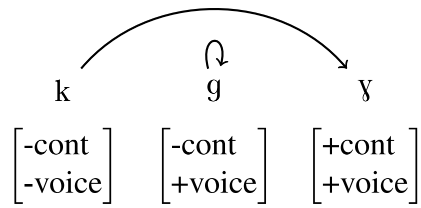
1. Background. Phonologically-derived environment effects (PDEEs) describe patterns where a phonological process applies only if fed by another phonological process. For example, in Campidanian Sardinian, lenition applies to voiced stops derived from underlyingly voiceless stops via intervocalic voicing (1-a), but not to underlyingly voiced stops (1-b) (Bolognesi 1998). PDEEs give rise to 'saltations' (Hayes & White 2015), i.e. alternations where an underlying string 'leaps' over an intermediary form (2).

(1) Campidanian Sardinian lenition

a. /k/→[ɣ]/V_V
  /**k**uatːru/ [**k**uatːru] 'four'
  [dɛ **ɣ**uatːru] 'of four'

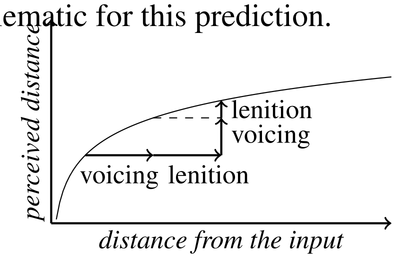
b. /g/→[g]/V_V
  /**g**ɔma/ [**g**ɔma] 'rubber'
  [dɛ **g**ɔma] 'of rubber'

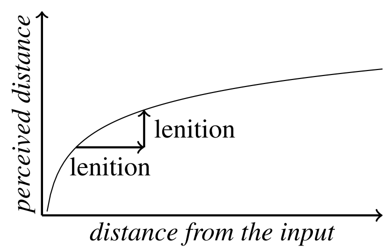
(2) Saltation in Campidanian Sardinian



Modeling PDEEs in a faithfulness-based approach requires assuming that *a smaller input-output change may be worse than a strictly larger change*, in violation of a basic principle of faithfulness: the minimal modification bias (H&W2015). This bias is at the center of the P-map (Steriade 2009), a theory predicting that if two dissimilar sounds alternate then two sounds that are less dissimilar should also alternate. Sardinian lenition, where [k] alternates with [ɣ] but [g] does not, is problematic for this prediction.

2. Proposal. This paper proposes a theory that reconciles the analysis of PDEEs and the P-map, based on the idea that a feature change might be less noticeable in the context of another feature change. If the perception of the input-output distance is logarithmic (cf Weber-Fechner law), it is expected that a change in an input-output pair will be perceived as less noticeable if accompanied by another change. The same lenition is perceived as smaller in case it is preceded by voicing (upper figure) than in case it is not preceded by voicing (lower figure).





On the grammatical side, the proposal is implemented using context-sensitive faithfulness constraints that penalize a feature change differently depending on whether or not it is accompanied by another feature change. For Campidanian Sardinian, Ident(cont) is split into Ident(cont)/nochange(voice) and Ident(cont)/change(voice).

(3) Splitting Ident(cont) into two context-sensitive variants:

a. Ident(cont)/nochange(voice) = Ident(cont)&¬Ident(voice)
  Assign a violation to an input-output segment pair violating Ident(cont) if it does not also violate Ident(voice).

b. Ident(cont)/change(voice) = Ident(cont)&Ident(voice)
  Assign a violation to an input-output segment pair violating Ident(cont) if it also violates Ident(voice).

By the P-map, the fact that changing continuancy has a smaller perceptual impact if accompanied by a change in voicing than if not accompanied by a change in voicing translates into the following ranking: Ident(cont)/nochange(voice)≫Ident(cont)/change(voice). The interaction of these faithfulness constraints with Ident(voice) and markedness constraints that motivate intervocalic voicing and lenition derives the Campidanian Sardinian pattern (4).

(4) a.

/dɛ kuatːro/	$*VC_{[\text{-voice}]}V$	Ident(voice)	Ident(cont)/no change(voi)	$*VC_{[\text{-cont}]}V$	Ident(cont)/ change(voi)
dɛkuatːro	*!			*	
dɛxuatːro	*!			*	
dɛguatːro		*		*!	
☞ dɛɣuatːro		*			*

b.

/dɛ gɔma/	*VC$_{[\text{-voice}]}$V	Ident(voice)	Ident(cont)/no change(voi)	*VC$_{[\text{-cont}]}$V	Ident(cont)/ change(voi)
☞ dɛgɔma				*	
dɛɣɔma			*!		

3. Constraining the typology of PDEEs. One advantage of this account is that it provides a principled way to constrain the features that interact in PDEEs and the domain of this interaction. In particular, if PDEEs are grounded in logarithmic perception of changes along a physical dimension, this predicts the following properties for PDEEs: (i) the two feature changes happen along the same physical/perceptual dimension (*one-dimension condition*), (ii) the two feature changes happen on the same segment (*locality condition*), (iii) the second change is a continuation of the first change along the relevant dimension (*monotonicity condition*). At least two cases of PDEEs attested in several languages have these properties: *voicing feeds lenition* (Sardinian, Manga Kanuri: H&W 2015) and *destressing feeds raising/deletion* (Romanian, Armenian, Paluai: Khanjian 2009). *Voicing feeds lenition* patterns satisfy these conditions: (i) voicing and lenition both affect closure duration, (ii) the two changes affect the same consonant, and (iii) lenition involves a further step of shortening after voicing (d(k) $>$ d(g) $>$ d(ɣ)). *Destressing feeds raising/deletion* patterns also satisfy these conditions: (i) destressing and raising/deletion both involve vowel duration, (ii) the two changes happen to the same segment, (iii) raising (or deletion) involves a further step of shortening after destressing. The fact that these particular types of feature interactions are attested in several languages is mysterious under accounts that impose no substantive restriction on PDEEs (e.g. H&W2015). Also, nonrestrictive accounts predict that all kinds of PDEEs should potentially be attested, e.g. patterns where voicing feeds labialization. Under the current analysis, voicing is unlikely to feed labialization because the two features changes (voicing vs. place) involve different perceptual cues.

4. Extensions. This analysis can extend to (i) PDEEs where the licensing change happens on a different segment as the licensed change (in apparent violation of the locality condition) and (ii) morphologically-derived environment effects (MDEEs) under certain conditions. The two cases can be illustrated with Sanskrit ruki, where [s]-retroflexion (/s̪/→[ʂ]) applies after back segments like [r] or [u] if the back segment and the sibilant became adjacent through vowel deletion (5-a) or morphological concatenation (5-b) but not otherwise (5-c).

(5) a. uṣtá /ua**s̪**-tá/ [u**ʂ**ʈá] ‘shone, dwelt’ c. pustaka [pu**s̪**taka] ‘book’
b. bib^{h}arṣi /bi-b^{ɦ}ar-**s̪**i/ [bib^{ɦ}ar**ʂ**i] ‘you carry’

The present analysis can extend to theses cases provided that (a) phonological representations are phonetically detailed (Flemming 2008) and (b) different perceptual dimensions may integrate to form a single perceptual dimension (Kingston et al. 2008). Via (a), vowel deletion and morphological concatenation have phonological consequences on the choice of the sibilant allophone: through the deletion of [a] in /uas̪-tá/ in (5-a) and the concatenation of /bi-b^{ɦ}ar/ with /s̪i/ in (5-b), dental [s̪] becomes adjacent to a back segment on the surface and F3 closure transitions that were rising into /s̪/ underlyingly are now falling on the surface because of coarticulation with the preceding low-F3 segment (=‘half-retroflexion’). This subtle phonological process then feeds a full assimilation of the place of the sibilant to the preceding back segment (‘full-retroflexion’). Via (a) and (b), the two changes (half and full retroflexion) satisfy the three conditions on PDEEs: (i) they happen along the same perceptual dimension (the sibilant’s closure transitions and the sibilant’s center of gravity integrate to form a single perceptual ‘frequency’ dimension à la Kingston), (ii) they happen to the same segment (closure transitions and center of gravity are both cues signaling the sibilant’s place), and (iii) lowering of the sibilant’s F3 closure transitions and lowering of its center of gravity both involve lowering along the integrated frequency dimension.

5. Conclusion. To summarize, this paper makes three contributions: (i) it reconciles the analysis of PDEEs and the theory of faithfulness via the Weber-Fechner law, (ii) by doing so, it allows for a more restrictive theory than alternative accounts, and (iii) it accounts for both PDEEs and MDEEs.