Phonetics in Phonology: evidence from Scottish Gaelic preaspiration

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NELS 39, November 7-9 2008, Cornell University

Abstract

OT factorial typology predicts a range of theoretically possible grammars. **Typological gaps** can result: systematic mismatches between predicted and attested constraint rankings. There is thus a conundrum.
There are two opposing theoretical solutions:

Analytic bias: Theory should be constrained so as to allow a tighter fit with ttypology, e.g. via the ***P-map*** (Steriade 2002). Assumes typology product of UG.

Channel bias: Some constraint rankings are unattested because the relevant ***phonetic precursors*** do not occur. If good diachronic explanation available, to constrain theory is redundant and undesireable (Myers 2002).

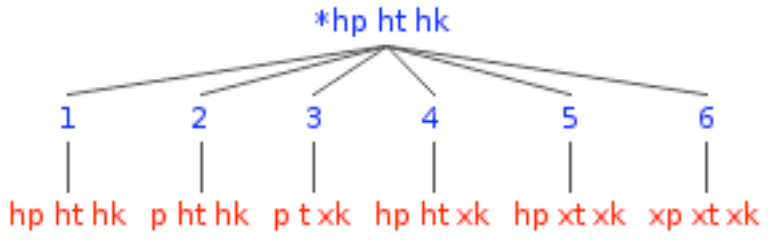
➢ **This study supports the *Channel Bias hypothesis*,** drawing evidence from two previously unremarked asymmetries in the typology of Scottish Gaelic (SG) preaspirated voiceless stops.

- Standard OT account of the two asymmetries massively overgenerates. A **P-map analysis** resolves overgeneration, but so far lacks experimental confirmation.
- *But*, robust **phonetic precursors** to both asymmetries are experimentally identified, supporting the precursor hypothesis.
- The P-map hypothesis predicts ***perceptual biases*** consistent with the two asymmetries. If biases are found, then P-map mimics diachrony. If such biases not found, P-map fails in practice. Experiment in progress.

Scottish Gaelic Preaspiration

The historically preaspirated stops of early SG have undergone processes of *deaspiration* and *fortition* in the modern dialects, and now show at least six configurations:

Preaspiration variants in six Gaelic dialects:



***Key points*:**

- Variation is not random.
- Instead, both deaspiration and fortition follow strict but opposing place hierarchies.

Deaspiration:

Labial >> Coronal >> Dorsal

Loss of preaspiration. Targets bilabial stops, then extends to dentals.

Fortition:

Dorsal >> Coronal >> Labial

[h] strengthens to [x]; targets velars, then extends to dentals and bilabials.

<u>OT analysis overgenerates</u>

Freely rankable anti-PA constraints ***hp, *ht, *hk** interact with **MAX** (contra deaspiration) and **IDENT[place]** (contra fortition).

High-ranked MAX & ID[place] ⇒ 1 [hp ht hk]:

/hT/	MAX	ID[place]	*hp	*ht	*hk
☞hp ht hk			*	*	*
xp xt xk		*!			
p t k	*!				

Low-ranked ID[place] ⇒ 6 [xp xt xk]:

/hT/	MAX	*hp	*ht	*hk	ID[place]
hp ht hk		*!	*!	*!	
☞xp xt xk					*
p t k	*!				

High-ranked ID[place] and *[hp] ⇒ 2 [p ht hk]:

/hp/	ID[place]	*hp	MAX	*hk	*ht
☞ p			*		
xp	*!				
hp		*!			
/ht hk/					
t k			*!		
xt xk	*!				
☞ ht hk				*	*

But if *[hk] is ranked above MAX instead of *[hp], unattested [hp ht k] results:

/hk/	ID[place]	*hk	MAX	*hp	*ht
xk	*!				
hk		*!			
☞ k			*		
/hp ht/					
p t			*!		
xp xp	*!				
☞ hp ht				*	*

Similarly, if *[hp] and MAX outrank ID[place], the result is unattested [xp ht hk]:

/hp/	MAX	*hp	ID[place]	*hk	*ht
p	*!				
☞ xp			*		
hp		*!			
/ht hk/					
t k	*!				
xt xk			*!		
☞ ht hk				*	*

<u>P-map resolves overgeneration</u>
Via the P-map, projection and ranking of faith constraints are based on scales of perceptual similarity. The winning candidate incurs the smallest perceptual cost.

If P-map responsible for SG asymmetries, then these constraint rankings are implied:

Deaspiration:
MAX[h-Ø]/V_k » MAX[h-Ø]/V_t » MAX[h-Ø]/V_p
Perceptual difference between [h] and nil greatest before [k], least before [p].
(*Ensures that deaspiration targets labial stops first.*)

Fortition:
ID[h-x]/V_p » ID[h-x]/V_t » ID[h-x]/V_k
Perceptual difference between [h] and [x] greatest before [p], least before [k].
(*Ensures that fortition targets dorsal stops first.*)

If individual place-specific F constraints rank below *hT, either process can apply partially. Low-ranked ID[h-x]/V_k ⇒ dialect 4 [hp ht xk]:

/hk/	ID[h-x]/V_p	ID[h-x]/V_t	MAX[h-Ø]/V_k	MAX[h-Ø]/V_t	MAX[h-Ø]/V_p	*hT	ID[h-x]/V_k
k			*!				
☞ xk							*
hk						*!	
/ht/							
t				*!			
xt		*!					
☞ ht						*	
/hp/							
p					*!		
xp	*!						
☞ hp						*	

But low-ranked MAX[h-Ø]/V_p ⇒ 2 [p ht hk]:

/hk/	ID[h-x]/V_p	ID[h-x]/V_t	ID[h-x]/V_k	MAX[h-Ø]/V_k	MAX[h-Ø]/V_t	*hT	MAX[h-Ø]/V_p
k				*!			
xk		*!					
☞ hk						*	
/ht/							
t					*!		
xt		*!					
☞ ht						*	
/hp/							
☞ p							*
xp	*!						
hp						*!	

➢ **Problem:** Analysis is provisional; still no experimental evidence for the perceptual scales entailed by a P-map account.

➢ **Alternative:** Channel Bias hypothesis—are there phonetic precursors to asymmetries?

Experiment finds precursors
Phonetic precursors to both SG asymmetries exist; supports Channel Bias hypothesis.

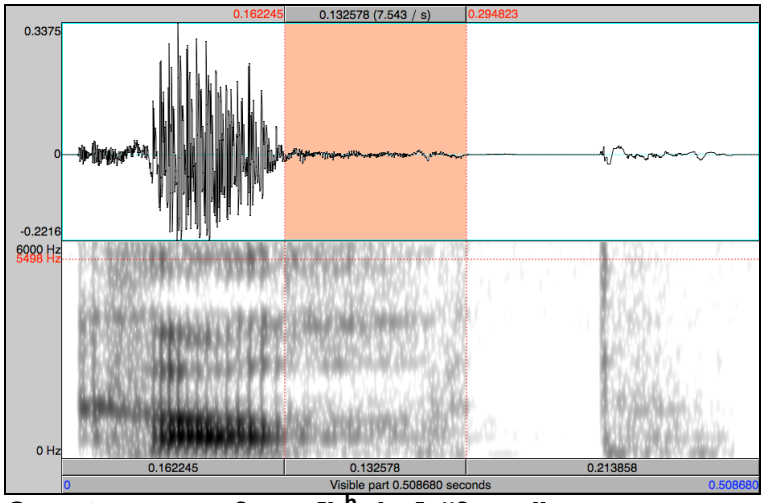
Hypotheses:
1. **Deaspiration**: Phonemically preaspirated stops will frequently appear without PA, especially labial stops.

2. **Duration:** PA will be longest in velar stops, shortest in bilabial stops: [hk] >> [ht] >> [hp].

Method:
Consultants:
- 8 native speakers of dialects 1 & 3
- Age range: mid-20's to mid-60's
- balanced male/female

Stimuli:
- 36 SG words x 2 presentations = 76 tokens
- [hp ht hk~xk] in medial & final position
- follow vowels /i e a o u/, ±long

Analysis:
Duration, frequency of PA measured using Praat software (Boersma and Weenink 2006).



Spectrogram of* cop [k^{h}ohp] *"foam"

Results:
Both hypotheses were confirmed. Robust precursors for the two asymmetries were found:
- PA is shortest, most frequently omitted before bilabial stops.
- PA is longest and most reliably produced before velar stops.

Average duration by context:

	Bilabial	Dental	Velar	
Avg (ms)	89	110	138	
	VC	V:C	VCV	V:CV
Avg (ms)	160	100	112	70

Deaspiration frequency (% of total):

	Bilabial	Dental	Velar
V:CV	72.2	33.3	6.7
VCV	6.3	21.4	6.3
V:C	20.0	0.0	0.0
VC	8.8	0.0	3.6

Conclusions and next steps

- P-map account provisionally successful; but experimental confirmation of perceptual biases required. (Experiment currently underway.)
- Channel Bias Hypothesis clearly supported: phonetic precursors identified.
- If perceptual biases found consistent with asymmetries, then P-map mimics Channel bias. This supports the view of Myers (2002): accounting for typology synchronically recapitulates diachronic factors.
- If no such biases found, P-map refuted. Other analytic bias/UG possibilities remain, e.g. learning bias? Cf. Moreton (2008) and Wilson (2006).

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