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RESEARCH

Vocoid-driven processes: Palatalization and glide hardening in Greek and its dialects

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The point of departure of this article is the processes that front vocoids induce as triggers in language. We start with a description of *palatalization*, using Standard Modern Greek and other Greek dialects as an empirical basis. We then introduce a new, so far undescribed type of palatalization, dubbed *strengthened palatalization*. Despite its similarity to *secondary palatalization*, we argue that it is a different process because it is triggered by an unrealized high front /i/, unlike secondary palatalization, where the high vocoid is alongside the preceding consonant as a secondary gesture. Furthermore, the output of strengthened palatalization is different because it lacks the primary cue of secondary palatalization, that is, F2 raising in VC sequences. Next, we examine *glide hardening*, a process complementary to palatalization because it is also triggered by a high front vocoid. However, in glide hardening the glide is maintained as a separate segment and is strengthened into a palatal fricative (or even a stop). By focusing on the *triggers* – rather than the *outputs*, we attain a unified account of both palatalization and glide hardening as enhancement processes that aim at strengthening the phonetic cues of their targets for reasons of perceptual salience.

Keywords: glide hardening; Greek dialects; strengthened palatalization; palatalization

1 Introduction

The process of *palatalization* (henceforth PAL)[1] is a widely attested complex phenomenon with intriguing phonetic, phonological and typological properties. The term PAL is used in the literature for two different processes. One, termed *primary* or *full* PAL[2], involves a shift of the primary articulation of a consonant towards the palatal region, as in /t/ vs. /tʃ/, /s/ vs. /ʃ/. In English, for instance, PAL of this type occurs before /j/-initial suffixes, as revealed in alternations such as *habit/habitual, press/pressure*, (Holst & Nolan 1995; Nolan, Holst & Kühnert 1996; Zsiga 2000, a.o.). In a related but somewhat different process, called *secondary* PAL, the term describes complex consonants like [p^{j}], which involve "…a primary front or back closure or constriction location and a secondary tongue dorsum raising and fronting gesture…" (Recasens & Espinosa 2006: 296) like the gesture for the vowel [i]. The main phonetic correlate of this addition of a secondary palatal articulation has been reported to be a high F2, typically becoming

[1] A list of abbreviations used in the article is provided at the end of the main text.

[2] The two terms will be used interchangeably in the article.

evident as F2 lowering during CV transitions or raising during VC transitions (Halle & Jones 1971[/1959]; Purcell 1979; Gordon 1996; Zsiga 2000; Kochetov 2006; Bhat 2008; Bhaskararao et al. 2009).

Phonologically, PAL has been explained in different ways depending on the school of thought. Both in SPE and in Feature Geometry, the representation of PAL has taken the shape of spreading onto consonants different features, such as [−back], [Dorsal] or [Coronal], that triggering vowels are assumed to have (Chomsky & Halle 1968; Kenstowicz & Kisseberth 1979; Clements 1985; Sagey 1990, a.o.). Other accounts have adopted a more phonetic stance on the issue. Bateman (2007), for example, has explained PAL through gestural overlap, viewing full PAL as greater overlap of tongue gestures, and secondary PAL as minimal overlap of tongue/tongue or lips/tongue gestures. Still other approaches, e.g. Evolutionary Phonology (Blevins 2004), base their explanation of PAL on sound changes that involve coarticulation and reallocation of features due to reanalysis of the signal. Thus, fronting of /k/ to [tʃ] before an /i/ is primarily due to errors in the perception of velars (Guion 1996), rather than the phonology proper.

Several surveys of cross-linguistic PAL processes point to the fact that PAL varies in terms of targets, triggers and outputs (e.g., Bhat 1978; Bateman 2007; Kochetov 2011). Sibilants for example are a much more common output of primary or full PAL than non-sibilants, coronals are more prone to undergo PAL than dorsals, while labial sounds are less likely to be the targets of primary PAL. Finally, the most productive triggers are thought to be the high front vocoids /i/ and /j/ (Bateman 2007; Kochetov 2011). Furthermore, several typological surveys reveal cross-linguistic similarities of PAL processes and present evidence for the existence of variability and gradience in these processes. For instance, Bateman (2007) in a survey of 117 languages distinguishes between full and secondary PAL, with full PAL involving a complete shift in Place of Articulation (PoA) and secondary a concurrent articulatory movement coexisting with the primary one. She provides an articulatory account for the distinction, according to which differences in typology rely on articulatory overlap; full overlap of tongue gestures leads to full PAL and change of place (and often manner) of articulation, while lesser (or minimal) temporal overlap between the lip and/or tongue gestures results to secondary PAL. Bhat (1978) shows the variability in outputs in full PAL, whereby the target completely shifts PoA by either tongue fronting, tongue raising or else by spirantization. In some languages both full and secondary PAL are present (e.g., Jones & Ward 1969; Kochetov 2002; Ní Chiosáin & Padgett 2012 for Irish; Rubach 2000 for Russian), whereas in other languages secondary PAL is not attested (e.g., Standard Modern Greek (SMG), English).

The distinction between full/primary and secondary PAL has also been included in Kochetov's (2011) extensive survey and typology of PAL processes. Kochetov's typology divides PAL processes in three major categories. In addition to secondary PAL (Type I in Table 1 below), he identifies two categories of primary PAL (or full PAL, according to Bateman 2007) depending on the output: primary PAL resulting in a posterior coronal (Type III in Table 1) and primary PAL resulting in an anterior coronal (Type IV in Table 1). Of those, Type III can give rise to either sibilant or non-sibilant outputs, whereas Type IV only produces sibilant outputs (Kochetov 2011: 1671). Kotchetov's typology is often referred to in this article, since it is not only the most recent one, but also the most comprehensive to date and theory-neutral, which means that it is amenable to reductions and expansions regardless of theoretical claims.

Notice that despite their differences, the analyses of PAL presented above have one common element: they all concentrate on the *output* of PAL processes as the basis of description/categorization. In the present article instead we shift our focus to the triggers of PAL. A welcome result of this move is that it deftly enables us to generalize further and explore PAL not as an independent or isolated phenomenon within Greek but as an instantiation of one of the processes that front vocoids may induce in the language. Specifically, on the basis of extensive data from a northern dialectal variety of Modern Greek, we introduce a new type of PAL, dubbed here *strengthened PAL* (Type II in Table 1). The need for this addition is justified on both phonetic and phonological grounds; its acoustic output is dissimilar to both full and secondary PAL, while the triggering force is not the presence of a front vocoid but rather the loss of it in unstressed positions. The updated typology with the extra PAL pattern is presented in Table 1. The index [$^{+}$] is shorthand for various acoustic cues (e.g., frication and aspiration) typically associated with this type of PAL (see Section 3.2), and is not intended for an IPA representation.

Pattern	PAL		labial	coronal	dorsal
I	Secondary		p → p^{j}	t → t^{j}	k → k^{j}
II	***Strengthened***		*p* → *p*$^{+}$	*t* → *t*$^{+}$	*k* → *c*
III	Full/Primary to a posterior coronal	a. to a non-sibilant	p → c	t → c	k → c
		b. to a sibilant	p → ʧ	t → ʧ	k → ʧ
IV	Full/Primary to an anterior coronal	to a sibilant	p → ts	t → ts	k → ts

Table 1: Our proposed revision of Kochetov's (2011) typology of PAL.

Another process induced by front vocoids is *glide hardening* (GH). The process is also commonly referred to as *glide strengthening*. We use 'hardening' instead to avoid confusability with strengthened PAL. Here the trigger, that is, the glide, does not merge with the preceding C as is commonly the case for some types of PAL. On the contrary, it survives intact as a full separate segment and, furthermore, undergoes fortition, i.e. changes in manner of articulation from an approximant to a fricative or sometimes even a stop. Glide hardening is then treated as a process akin to PAL, an idea also independently proposed by Kochetov (2014, this issue), on the basis of data primarily from Kirundi (but also from Greek).

While PAL as a phenomenon in Greek has received attention in the literature, to date no cross-dialectal account has been available. Our comparison between SMG and Northern Greek dialects – with occasional reference to other dialects too – constitutes the first such account of Greek PAL processes, as well as GH. Through the discussion we aspire to offer insight into the dynamic processes that develop in V and C sequences and the micro-variation that is attested in the shaping of their outputs.

The article is structured as follows. Section 2 offers some basic facts about Greek and presents the data utilized for this study. Section 3 discusses the PAL processes in Greek and shows that only primary PAL is present (Section 3.1), next to the newly introduced strengthened PAL (Section 3.2). Secondary PAL is missing from the language. In Section 3.3 we consider some issues arising in the phonological analysis of PAL in Greek. In Section 4 we explore glide hardening, a process complementary to PAL, and suggest that an investigation of patterns from the perspective of triggers (here, the front vocoids) rather than the outputs, as is typically the case in PAL, renders the affinity of PAL to other processes such as GH more transparent.

2 Background on Greek and information on current data

Greek is spoken by approximately 11,000,000 speakers (2011 census). The exact number of speakers per dialectal group is impossible to determine due to lack of official data on the number of speakers for each dialect. As pointed out by Archakis, Lambropoulou & Papazachariou (2009), economic migration from rural to urban centres in Greece since the beginning of the 20th century has contributed to a rise in bi-dialectal speakers.

Regarding the segmental aspect, SMG has a five-vowel system consisting of [i e ɐ o u], and so do all other dialects, albeit not in the same positions in the F1xF2 vowel space (for details on dialectal vowel spaces see Trudgill 2009; Baltazani et al. 2014; Kainada & Baltazani 2014). Note that for simplicity, the low vowel will be transcribed as [a] in what follows. The SMG consonantal inventory comprises voiceless and voiced obstruents [p b t d k g c ɟ f v θ ð s z x ɣ ç ʝ], nasals [n ɲ], liquids [l ʎ ɾ[3]] and a glide [j] (for a detailed description of and references on SMG see Arvaniti 1999; for the glide [j], see Soultatis 2013; Topintzi & Baltazani 2013; Revithiadou et al. 2014).[4] With respect to palatals in particular, their articulation has been examined by Nicolaidis (2003) using electropalatography. She reported variability in their articulation, and discussed articulatory differences across manners of articulation; lateral palatals are classified as post-alveolar, nasals as alveolo-palatals and fricatives and stops as post-palatals.

Our knowledge of the phonetic and phonological characteristics of Modern Greek dialects is still limited, with mostly impressionistic analyses (e.g., Hatzidakis 1905; Papadopoulos 1926; Triandaphyllidis 1938; Newton 1972; Kontossopoulos 2001[/1994]; Tzitzilis 2000, 2001, a.o.). To date no systematic, quantitative verification exists of the phonological landscape as it appears today. Studies such as Newton (1972), though quite detailed, give us a snapshot of dialects now more than 40 years old and bound to be obsolete. Newer articles, for example Trudgill (2003), offer valuable and systematic analyses, which are based on data from older studies. Lately some empirical studies have appeared (see below) but the field remains virtually unexplored.

Dialects spoken within Greece are classified in different groups on the basis of phonological characteristics; the main split is between Northern and Southern Greek dialects, as shown in Figure 1.

Northern Greek dialects,[5] roughly covering the areas of central Greece, Thessaly, Macedonia, Epirus, Thrace, Euboea, and some islands in the Ionian and NE Aegean, have a characteristic process of high vowel /i u/ deletion (VD) in unstressed syllables (Hatzidakis 1905; Papadopoulos 1926; Andriotis 1931, 1933a, b, 1940, 1943-44; Favis 1951; Newton 1972;

[3] Greek only has one /r/-phoneme that typically surfaces as an alveolar tap [ɾ] (Arvaniti 2007; Baltazani 2009; Baltazani & Nicolaidis 2013a, b). We will use /r/ for convenience in the underlying representations and when referring to the rhotic consonant.

[4] As discussed in detail later on, glides act as triggers of PAL and participate in glide hardening. It is still a matter of debate though whether [j] – most dialects have only a palatal glide (see Mirambel 1959; Householder 1964; Newton 1972; Joseph & Philippaki–Warburton 1987) – must be given phonemic status or is always derived, as a strategy of hiatus avoidance. The literature is considerable and arguments exist for both stances (see e.g., Rytting 2005; Baltazani & Topintzi 2012; Topintzi & Baltazani 2013 for overviews), but justifying any position is well outside the scope of the current article. What is undisputable though is that on the surface glides do exist and their significance is highlighted in much recent work (Baltazani & Topintzi 2010, 2012; Soultatis 2013; Topintzi & Baltazani 2013; Revithiadou et al. 2014). This is the view we also follow presently.

[5] The classification we give here is not uncontroversial. Different authors divide the dialectal areas differently (see Trudgill 2003 for a discussion), a state of affairs largely due to the lack of empirical studies. For more information on the classification of Greek dialects and their grammatical characteristics see also Hatzidakis (1905); Dawkins (1940); Newton (1972); Andriotis (1974); Malikouti & Drachman (1977, 1983); Charalambakis (1988–89); Christidis (1999; 2000; 2001); Delveroudi (1999); Malikouti–Drachman (2000); Tzitzilis (2000, 2001).

Figure 1: Map of Greek dialects. Northern dialects are those north of the red line and southern dialects are south of the line. The position of Athens and Kozani are also shown (red dot south and north of the line respectively), where recordings of SMG and Kozani Greek respectively were made for our corpus.

Margariti 1977; Panagopoulos 1977, 1983; Browning 1991[/1969]; Kontossopoulos 2001[/1994]; Trudgill 2003; Loukina 2008; Topintzi & Baltazani 2012; Kainada & Baltazani 2014) leading to the creation of various consonant clusters, as shown in (1), some of which are not attested in SMG or the Southern Greek dialects. They also have a process of mid vowel /e o/ raising in unstressed syllables, which shrinks the vowel space in comparison to the standard language and the other dialects (Loukina 2008; Christou & Baltazani 2010; Baltazani et al. 2014; Kainada & Baltazani 2014).

(1)		*Northern Greek*	*SMG*	
	a.	[ˈpʎiθka]	[ˈpliθi̲ka]	‘I washed myself’
	b.	[pʎi]	[pu̲ˈli]	‘bird’
	c.	[fso]	[fi̲ˈso]	‘blow’
	d.	[vno]	[vu̲ˈno]	‘mountain’

VD is attested in some southern dialects such as SMG and Peloponnesian Greek (Dauer 1980; Baltazani 2006, 2007, a.o.), but to a much lesser degree and typically in “quick casual speech” (Loukina 2008: 323). As a result, it is not considered a feature of the Southern Greek varieties.

In this article, we discuss a wealth of data coming from a number of different sources.

(i) Recordings from the project VOCALECT, a speech database of field recordings that contains both elicited and conversational data. The data presently explored come from Kozani (KozGr) and SMG, the latter as spoken in Athens. For more information on the collection and codification of recordings see Baltazani et al. (2013); Lengeris, Kainada & Topintzi (in press).

(ii) (On-line) ‘read aloud’ data (e.g., recording of KozGr online material: http://www.skrka.gr/kozanitiko_idioma.html).

(iii) Ad-hoc recordings from one speaker of Siatista Greek (SiatGr) producing words of interest for the present study.
(iv) Published data of these and other dialects (e.g., SiatGr, Margariti–Roga 1985; KozGr, Ntinas 2005; Christodoulou 2013, 2014; Cretan Greek, Lengeris & Kappa in press; Rhodian and Astypalean[6] Greek, Tsopanakis 1940; Peloponnese Greek, Pantelidis 2001, etc.). Wherever possible, our data were compared to recorded data collected by other researchers (e.g., Lengeris & Kappa in press).

Only a fragment of the database of the VOCALECT recordings has been employed for present purposes. In particular, 2 minutes of conversational speech was analyzed from 2 speakers of each dialect (SMG and KozGr). This amounts to roughly 1500 vowels and more than 2000 consonants. Within it, we found extensive variability in the rate of application of all phenomena, including PAL, suggesting that dialectal speech has been affected by SMG. Second, it should be pointed out that this paper is based on *qualitative*, not quantitative, analysis of the data, thus presentation of spectrograms merely serves illustration purposes.

3 Patterns of Greek PAL

On the basis of current research as well as previous typological descriptions of PAL, we demonstrate that all Modern Greek dialects have full/primary PAL to a posterior consonant (Section 3.1). Moreover, while PAL processes are common across Greek dialects, important differences arise with respect to the *targets*, *triggers* and its *outcomes*, indicating that PAL cannot receive a single uniform phonological and phonetic realization cross-dialectally. We also show that, on the basis of Greek dialectal data, and in particular data from the KozGr and SiatGr dialects (together referred to as Northern Greek), the PAL typology needs to be enriched by means of a new pattern which we term strengthened PAL (Section 3.2). We claim that this type does not fall under the rubric of any of the PAL patterns that have been described to date and, consequently, justifies the introduction of a new PAL type. In Section 3.3, we briefly consider the phonological analysis of these PAL patterns and discuss certain issues these raise.

3.1 Primary PAL

Ubiquitous across Greek dialects is primary PAL affecting velar obstruents /k g x ɣ/ and, on occasion, non-rhotic alveolar sonorants /n l/, which change their PoA to [c ɟ ç ʝ] and [ɲ ʎ] respectively. In SMG, primary PAL can have two kinds of trigger: either a front vowel /i e/, which remains *intact* through this process (aka simple PAL; examples in 2a) or a palatal glide which *coalesces* with the target consonant (aka extreme PAL; 2b; see Topintzi & Baltazani 2013 for a detailed analysis of the data for SMG). Only velars can become palatalized before /i e/, while both velars and /n l/ palatalize before /j/.

(2) *Two types or primary PAL in Greek, based on the nature and behavior of the trigger*
a. Trigger /i/ intact (simple PAL)
/ˈkima/ → [ˈcima] ‘wave’
/ˈxer-i/ → [ˈçeɾi] ‘hand’
b. Trigger /j/ coalescing with target C (extreme PAL)
/ˈkjal-i/ → [ˈcali] ‘binoculars’
/ˈxjon-i/ → [ˈçoni] ‘snow’

[6] Astypalean is spoken in the Dodecanese near Rhodes. It is, like Cretan and Rhodian, a southern dialect.

Inter-dialectal differences indicate that the phonology and phonetics of primary PAL is not constant throughout. For instance, in Peloponnesian Greek, Cretan Greek and Northern Greek the phonology of the phenomenon is somewhat different as compared to SMG, since besides velar obstruents, /l/ and /n/ also palatalize before /i/ (though not before /e/).

(3) */l/ and /n/ palatalize before /i/ in non-SMG dialects*

	SMG	*non-SMG*	
a.	[liˈmani]	[ʎiˈmaɲi]	‘harbor’
b.	[leˈɾono]	[leˈɾono]/ *[ʎeˈɾono]	‘stain-1SG’

In KozGr and SiatGr the sibilants /s z/ are also targeted by the PAL rule rendering outputs with [ʃ ʒ] in the context of /i/, e.g. [ʃiˈɲi] /sini/ ‘large pan for pies’, /ziˈta/ → [ʒiˈta] ‘ask-3SG’ as well as in the context of /j/, e.g. [xapˈʃa] /xaps-ja/ ‘bite’, [ˈbadʒus] /batzj-os/ ‘kind of cheese’. Finally, it is worth mentioning that the phonetics of PAL processes is different in several insular southern dialectal varieties. For instance, simple PAL yields affricated outputs in Cretan, e.g., [aˈdʑizi] ‘touch-3SG’ (cf. SMG [aˈʝizi] /agiz-i/) (Lengeris & Kappa in press; see also Kalymnos Greek [tseˈfali] ‘head’ (cf. SMG [ceˈfali] /kefal-i/), Pantelidis 1929: 48).

3.2 A new pattern: Strengthened PAL

While secondary PAL is not attested in Modern Greek dialects,[7] the acoustic output of some words in Northern Greek dialects resembles in some ways secondary PAL (e.g., Ní Chiosáin & Padgett 2012 for aspiration as an acoustic cue of secondary PAL), and it has been described as such in past literature for word final /Ci(C)#/ → [C(C)#] sequences (for impressionistic, phonological reports on KozGr, SiatGr, Velvendos and other Northern Greek dialects, see Andriotis 1933a, b; Newton 1972, a.o.). Specifically, Northern Greek dialects exhibit a process which arises in connection to *unstressed high vowel deletion* (cf. (1)), as shown in (4) below (Topintzi & Baltazani 2012 for KozGr). Note that the final underlying /-i/ is either a class marker indicating declension class for neuter nouns or an inflectional suffix for other nouns and verbs. The superscript ‘+’ is discussed momentarily.

(4) *Strengthened PAL in KozGr*

a.	/ðjavas-i/	[ðjaˈvaʃ]	‘read-3SG’	(Vocalect corpus)
b.	/luz-i/	[luʒ]	‘wash-3SG’	(Vocalect corpus)
c.	/elen-i/	[eˈleɲ]	‘Helen’	(Vocalect corpus)
d.	/pol-i/	[poʎ]	‘city’	(Vocalect corpus)
e.	/skin-ak-i/	[ʃciˈnac]	‘rope-DIMINUTIVE’	(Vocalect corpus)
f.	/anem-i/	[aˈnem^{+}]	‘spinning wheel’	(Ntinas 2005: 60)
g.	/ðond-i/	[ðond^{+}]	‘tooth’	(Ntinas 2005: 62)
h.	/vɾað-i/	[vɾað$^{+}$]	‘night’	(Vocalect corpus)
i.	/spit-i/	[ʃpit^{+}]	‘house, home’	(Vocalect corpus)
j.	/kunav-i/	[knav^{+}]	‘ferret’	(Ntinas 2005: 60)
k.	/xasap-i-s/	[xaˈsap^{+}s]	‘butcher’	(Vocalect corpus)
l.	/zaxar-i/	[ˈzaxaɾ$^{+}$]	‘sugar’	(Vocalect corpus)

That the vowel /i/ is present in the underlying representation is justified by the existence of morphophonological alternations, where the vowel re-appears as soon as it is

[7] For argumentation in favor of this position see the text later in the section, and for a more detailed discussion see Section 3.3.

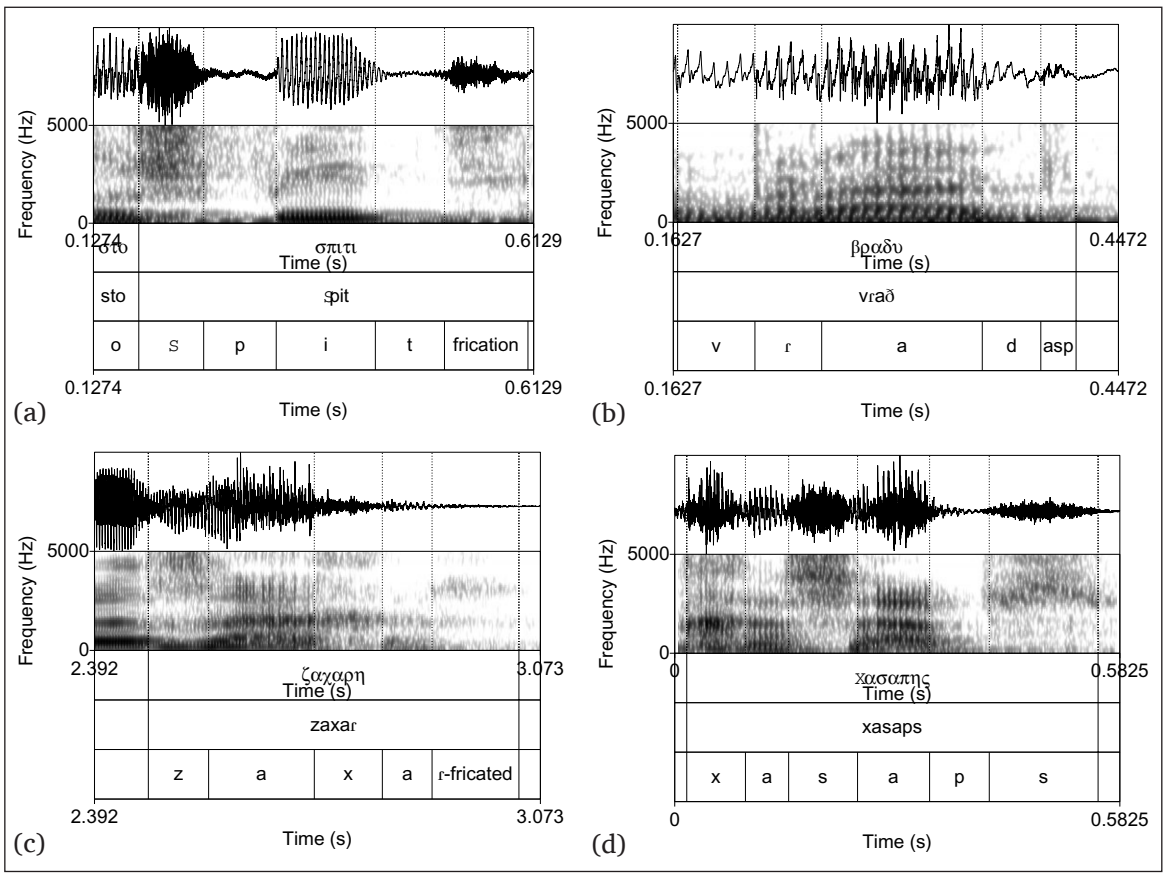


Figure 2: Examples of strengthened PAL. (a) frication, (b) aspiration,[8] (c) frication and lengthening of the target consonant. Also note the lack of F2 raising in the vowel preceding the target consonant in (b), (c) and (d) (see text for details).

found in stressed positions. Thus, [ʃpit^{+}] for example alternates with [ʃpi$^{\text{l}}$tisçus] 'home-made, domestic'. Also contrast [ʃpit^{+}]/[vɾað$^{+}$] with [pi$^{\text{l}}$ði] /peð-i/ 'child', a noun of the same declensional class but with a different stress pattern. In KozGr, targets of such PAL are dorsal consonants, coronals, labials, sibilants, liquids and nasals. In the neighboring SiatGr dialect, the same consonantal set gets to be affected with the exception of labials.

Traditionally, this pattern has been called PAL and has been transcribed as [C$^{\text{j}}$] in the literature on Greek dialects (e.g., Papadopoulos 1926; Newton 1972; Margariti–Roga 1985; Kontossopoulos 2001[/1994], a.o.), most likely meant to correspond to secondary PAL. We argue that this classification is inaccurate. To begin with, consonants that in general do not undergo a shift in PoA in Greek, e.g. the labials and the coronal stops (like 4f–4l), go through a change which is different from secondary PAL. As described in the literature, the main phonetic cue of secondary PAL in VC sequences is the raised F2 which is evident, especially for stops, during the final part of the vowel in the VC transition (Halle & Jones 1971 [/1959]; Purcell 1979; Gordon 1996; Zsiga 2000; Kochetov 2006; Bhat 2008; Bhaskararao et al. 2009). In contrast, the labial and coronal stop C^{+} consonants in our corpus lack the anticipated F2 raising (see Figure 2 for representative examples) and cannot be therefore thought to have undergone secondary PAL. The constellation of phonetic cues that these consonants surface with instead, includes frication, aspiration and lengthening and we represent them with the superscript '+' next to the target consonants.

[8] As an anonymous reviewer notes, aspiration is a term for glottal frication. Here we use the term frication to mean *s*-like frication and aspiration to mean *h*-like frication in Figure 2(a) and (b).

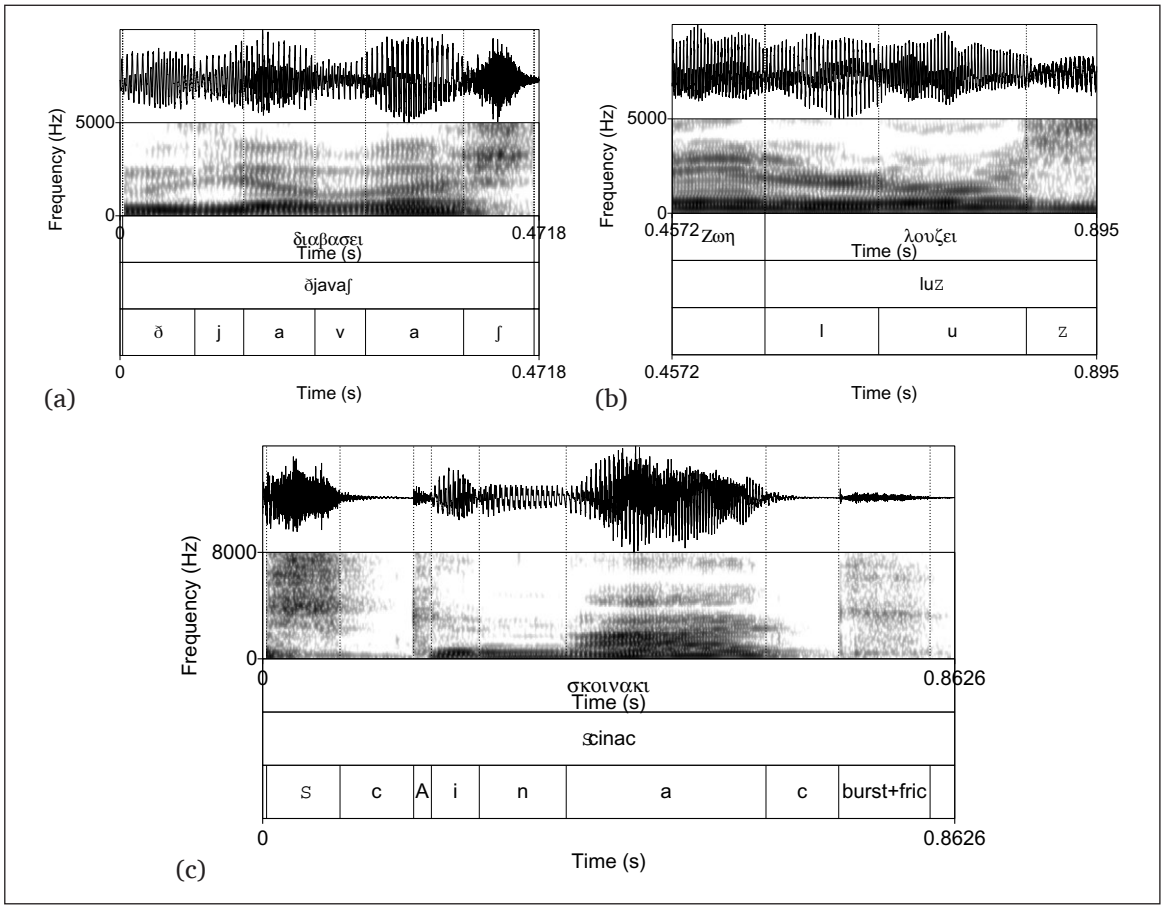


Figure 3: Examples of strengthened PAL with /s z l n/ and velars. In the words /ðjavas-i/ → [ðjaˈvaʃ] 'read-3SG', /luz-i/ → [luʒ] 'wash-3SG' and /skin-ak-i/ → [ʃciˈnac] 'rope-DIM', the spectral information of PAL is evident in the vowel preceding the palatalized consonants /s/, /z/ and /k/ during the last third of which F2 is rising. Notice also the extensive frication noise following the bust of [c] in (c) (see text for details).

On the other hand, as shown in (4a–e), the output can be a shift in PoA, for sibilants, laterals, nasals and velars (see Figure 3 for examples). Notwithstanding the similarity in output between full PAL and examples like (4a–e), we take the latter to be instances of the new PAL pattern presented here because in full simple PAL the trigger always remains intact, while here the trigger is invisible (in contrast to the examples in (3) and the ones discussed at the end of Section 3.1; for more details see also discussion in Section 3.3). Given that full PAL already yields a string of palatal correspondents to the group of velars and /s z l r/ consonants, it does not come as a surprise that the outputs of strengthened PAL converge to the same set of palatals.

More importantly, as mentioned in Section 1, we name this pattern strengthened PAL and claim that it offers an extension to the current PAL typology. In this pattern, the trigger, i.e. a high front vowel, is segmentally invisible, but its cues (phonological or articulatory) are preserved by means of either a full change in PoA (4a–e), or in terms of frication (Ní Chiosáin & Padgett 2012 for Irish), aspiration (Jun & Beckman 1993; Mo 2007 on Korean; Chitoran & Babaliyeva 2007 for Lezgian; Ní Chiosáin & Padgett 2012 for Irish) and often lengthening (Ní Chiosáin & Padgett 2012 for Irish) of the preceding consonant in VC sequences.

Figures 2 and 3 demonstrate examples of the variable acoustic outputs available in this type. Importantly, all types exemplified in (4) i.e., consonants that change PoA, like /s/→

[ʃ] and those that don't, like /ð/→ [ð⁺] are viewed as part of the same process because they are both triggered by high front vowel loss and, more importantly, they are understood here as outputs of one and the same strategy, that is, one which aims at preserving the information of the unpronounced /i/ either through noise which carries the coarticulatory influence of /i/ on the preceding consonant (i.e., frication or aspiration) or by prolonging its articulatory gesture. The relevant phonetic cues are employed to support a contrast between consonants with and without loss of their vocalic nucleus.

In Figure 2(a), the word-final /t/ in [ʃpit⁺] is realized with a substantial period of frication noise (approx. 90 ms), whereas in SMG stops are unaspirated, with a range of aspiration duration reported between 9 and 24 ms across various instrumental studies (Fourakis 1986; Arvaniti 1987; 2007; Botinis et al. 2000; Nicolaidis 2001; 2002); in Figure 2(b) the final /ð/ is realized as a stop [d] with aspiration/frication; in Figure 2(c) the final [ɾ] lasts for 132 ms, in stark contrast to the average duration of 20 ms for intervocalic tap reported in Baltazani & Nicolaidis (2013a; b); in Figure 2(d) the word-final labial is followed by frication noise, which merges with the /s/ that follows but is qualitatively different from /s/: notice that the formant pattern during the beginning 1/3 of the /s/ interval (the frication noise that follows /p/) is different from the final 2/3 of the interval (the /s/ proper). Figure 3 illustrates consonants that shift their PoA towards the palate due to the loss of final /i/. The /s/ is realized as [ʃ] in Figure 3(a), the /z/ is realized as [ʒ] in Figure 3(b) and the /k/ as [c] in Figure 3(c). Note also that in Figure 3(c) there is a prolonged period of frication noise after the word-final [c], approximately 113 ms, five times longer than the frication after the first [c] in the word, marked as A in the figure, which is 22 ms long.

An interesting subcase of strengthened PAL regards spreading of palatality through word final consonant clusters. Such a process is at work affecting the sibilants /s z/ and the sonorants /l n/ (see 5). When the final consonant palatalizes, the palatality spreads to a preceding consonant, so a /sk/ cluster, for instance, surfaces as [ʃc] with both consonants palatalized (Figure 4). Note the long duration of frication noise after [c]. Importantly, if the final consonant is not palatalized, as in the case of the labials in the SiatGr example /laspi/ [lasp], the process is blocked and hence the neighboring sibilant is not affected either.

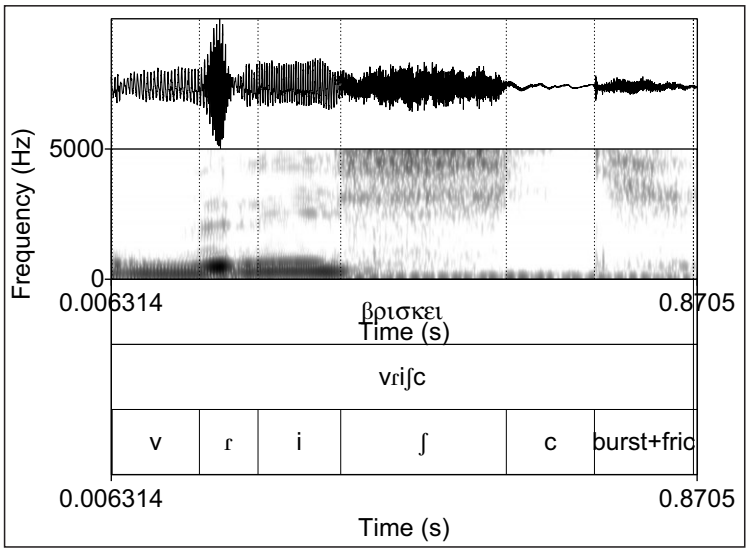


Figure 4: Leftward spreading of strengthened PAL. The final consonant in the word /vrisk-i/ is produced as [vriʃc], with both final consonants palatalized and final /i/ deletion in KozGr and SiatGr.

(5) *PAL spreading*

			KozGr	*SiatGr*
a.	/vrisk-i/	'find-3SG'	[vɾiʃc]	[vɾiʃc]
	/lasp-i/	'mud'	[laʃp^{+}]	[lasp]
b.	/mulk-i/	'estate'	[muʌc]	
	/vints-i/	'winch'	[viɲtʃ]	

According to Bateman (2007), PAL spreading is not uncommon cross-linguistically. For instance, it is attested in Yimas, Basque, Romanian (Bateman 2007: 77–82), and in Polish (Rubach 1984: 72–73), whereas instances of long-distance PAL spreading have also been reported, for example, in Harari (Rose 2004). Especially in Romanian, the process looks a lot like the one described here, e.g. [prost] 'stupid-MASC.SG' vs. [proʃtʲ] 'stupid-MASC.PL' (Bateman 2007: 80). In addition, the ungrammaticality of *[laʃp] in SiatGr (as opposed to KozGr) suggests that labials can also act as blockers of the process, a fact in line with Kochetov's (2011) generalization that labial consonants avoid PAL.

3.3 Issues in the phonological analysis of Greek PAL

The main features of the PAL processes described so far can be summarized as follows:

(6) *Greek PAL overview*

	Trigger	*Target*	*Outcome*	*Dialect*	*Example*
Simple PAL	/i/ or /e/	DOR	Shift in PoA; trigger intact	SMG	/**ki**ma/ → [ˈ**ci**ma]
Extreme PAL	glide /j/	DOR, /l n/	Shift in PoA; trigger invisible	All	/**kj**al-i/ → [ˈ**c**ali]
Strengthened PAL	deleted-/i/	LAB, COR non-sibilant obstruent	No shift in PoA, extra aspiration/noise; trigger invisible	Northern	/spi**t-i**/ → [ʃpit^{+}]
		DOR, /s z l n/	Shift in PoA; trigger invisible		/ð**isi**/ → [ði**ʃ**]

In this section, a phonological account of PAL in Greek is examined. Our aim is not to offer a fully-fledged analysis, which is beyond the scope of this article. Rather, we aim to identify some key components any analysis would require and address some difficulties the Greek data raise. One important difference between our account of PAL and previous ones is that we view the triggers – instead of the outcomes – as the basis of our understanding of PAL processes. This change in perspective allows for broader generalizations: strengthened PAL can be conceived as another instantiation of PAL (see below) and glide hardening as a process similar to PAL (see Section 4).

Neither outcomes nor targets are homogenous in the PAL processes discussed so far. Considering the outcomes first, a consonant that was not palatal either shifts in PoA, as in simple and extreme PAL, or exhibits secondary features associated to PAL, as in strengthened PAL. Naturally, the targets of PAL are not uniform either, depending on the dialect and processes, but we could for current purposes, assume that PAL is driven by some kind of *licensing* constraint that prefers sequences of palatal consonants and front vocoids, e.g., C_{PAL}/front (see, for instance, Crosswhite 2001). In order to have a visible effect, this constraint (or possibly set of constraints, applicable to different instances of PAL) must dominate faithfulness constraints against featural change and of course be dominated by other faithfulness constraints which protect those consonants that resist PAL. For example, in

simple PAL in SMG, FAITH-LAB and FAITH-COR will need to dominate C_{PAL}/front which in turns dominates FAITH-DOR, so as to express that labials and coronals do not palatalize before front vowels unlike the velars.

As mentioned above, front vocoids as triggers are considered to be a unifying factor behind these processes. However this view is not entirely unproblematic either: a very important parameter is the fortune of the PAL trigger in the outcome, since in some cases the trigger survives and in others it does not. Compare what happens in SMG vs. the Northern dialects. SMG presents the two sub-types of full PAL (i.e., simple and extreme), whereas Northern dialects additionally display a third type, that of strengthened PAL. The situation is such that in simple PAL the triggers /i/ or /e/ are preserved in the output, unlike the triggers in extreme and strengthened PAL.

Inspired by Bhat (1978) and Bateman (2007), Topintzi & Baltazani (2013) – who importantly only examine SMG – have treated extreme PAL as an instance of coalescence, whereby the glide trigger of PAL gets to be absorbed by its target, thus a sequence such as /$k_1j_2a_3$/ maps to [$c_{1,2}a_3$] (cf. 2b). This possibility of fusion rests on the idea that "the information contained in the trigger can be recovered from the PAL on the consonant target" (Bateman 2007: 82–83), but also on the fact that glides, more than vowels, are more prone to such an absorption. This is attributed to the different positions vocoids hold within the syllable; loss of vowels entails loss of nuclear information, while for glides this is no issue. Simple PAL, triggered by vowels only, is also compatible with this observation, since the triggers are preserved.

Beyond descriptive commentaries, strengthened PAL per se has not been dealt with in past literature, however the context in which it appears, i.e. that where the unstressed trigger ends up invisible in the output, has. Traditionally this has been treated as vowel deletion of high vowels in unstressed positions (cf. Section 3.2). Extending this descriptive generalization to an actual phonological analysis where the triggering vowel indeed genuinely deletes, we are faced with an instance of non-surface apparent opacity, since PAL occurs although its source is not visible on the surface.[9] More concretely, as shown in (7), for an example such as [ʃpit$^+$], we would need to assume that the UR /spit-i/ first undergoes PAL [ˈʃpit$^+$i] and then the final /i/ deletes as it is found in unstressed position producing the output [ʃpit$^+$]. While this superficially works, it is problematic. In particular, if PAL happens early in the derivation, why is it the case that there are no instances where the trigger /i/ is stressed and therefore not deleted, as in [spiˈtisços] instead of the anticipated *[ʃpiˈt$^+$isços]? One possibility would be to somehow tie this (specific) rule of PAL to the absence of stress, but this is unlikely, given that cross-linguistically the two processes seem unrelated.

(7) *Strengthened PAL as a product of deletion through opaque interaction, and problems*

	/spit-i/	/spiˈtisços/[10]
PAL	ˈʃpit$^+$i	ʃpiˈt$^+$isços
unstressed-/i/ deletion	ʃpit$^+$	N/A
	[ʃpit$^+$]	*[ʃpiˈt$^+$isços] instead [spiˈtisços]

[9] In Amharic the trigger of PAL may optionally delete yielding both an opaque and a transparent pattern. For example, outputs such as *märrəž* and *märrəži* 'poison-IMP' (< *märräzä*, where *ä* is a mid-low central vowel, halfway between [ə] and [a]) show that the trigger /i/, which codifies the imperative, may delete/be absorbed by the preceding consonant or it may be salvaged (Leslau 1995: 14; see also Bateman 2007: 311).

[10] This input is simplified; [spiˈti**sç**os] in fact presents PAL itself (shown bold), presumably of the extreme kind. Also, the final /o/ would probably be expected to raise to [u], due to a vowel-raising process affecting unstressed mid-vowels in Northern Greek. As both processes are tangential to the issue at hand, we omit reference to them and focus only on the first two syllables of the word.

An alternative is to view strengthened PAL as an instance of coalescence, although different from the type of coalescence arising in extreme PAL (see above). In particular, strengthened PAL is not seen as a process generally applying, but instead as a specific process that acts as a response to compromise general needs of the language found in conflict.[11] On the one hand, there is the need to get rid of unstressed vowels; on the other, there is the need to preserve lexical contrast between forms that contain the vowels in the UR and forms that do not. When the vowel fails to surface, lexical contrast is maintained through the vowel's traces on the preceding consonant. These may concern a change in PoA or addition of features such as frication and the like, i.e. strengthened PAL. A theory suitable to model this trade-off is Contrast Preservation (Łuwobicz 2007; 2012, this issue).

Notably, the coalescence approach correctly predicts the forms and avoids the problem generated in (7). This is simply because in the case of [spiˈtisços], due to the retention of the stressed /i/, lexical contrast is preserved, and consequently application of strengthened PAL, as in *[ʃpiˈtˠisços], is unwarranted, only leading to unnecessary faithfulness violations.

This approach raises at least two issues that stem from the descriptive generalization that 'unstressed high-vowels delete' in Northern Greek. First, given that unstressed /i/ may delete not only in final positions, as has largely been our focus, but also medially, e.g. /fis-o/ → [fso] 'blow-1SG', we might wonder whether strengthened PAL is applicable there. Second, given that unstressed /u/'s also fail to emerge e.g. /vun-o/ → [vno] 'mountain', we may ask how this process is best described. We deal with these in turn.

If a coalescence approach is applicable word-finally to /spit-i/ → [ʃpitˠ], then a natural extension would be its application to /fis-o/ → [fso] medially too. At present, we do not have enough data to determine whether the process is applicable there too, and if so, whether it is phonetically identical in the two contexts. However, even if fusion actually underapplies in examples such as [fso], this is not necessarily problematic. As a reviewer correctly points out, there exist palatalization processes that only apply in morphologically derived environments, as in Polish (Rubach 1984). Greek may also exemplify such a case. While /spiti/ is arguably morphologically complex, i.e. /spit-i/ (a position in line with Revithiadou & Spyropoulos 2015, but see Ralli 2005 for a different view), the locus of potential PAL in /fis-o/ → [fs-o] is undoubtedly morphologically underived and, consequently, eligible to escape PAL application.

The second issue relates to the proper characterization of /u/ as coalescence or as true deletion. The former approach predicts that just like as with /i/, the invisibility of /u/ should trigger some process in order to maintain contrast. How exactly this process is realized though, is not specified. If, on the other hand, there are no traces of the omitted vowel, then indeed we may have to do with an instance of genuine deletion, in which case, we would be forced to view the loss of the unstressed high vowels as two different phenomena; as coalescence for unstressed /i/s, but as real deletion for unstressed /u/s. Again, as before, not enough research is available on this point to reach a safe conclusion. A better understanding of the phonetics of the various processes might help us resolve the conundrum in future research.

4 Other vocoid-induced processes: Glide hardening

In this section, we examine glide hardening (GH), a process widely attested in Greek. GH resembles PAL as it involves the high front glide /j/ as a trigger. As discussed in Section 3.1, front vowels in SMG induce simple primary PAL in velars, while /j/ induces extreme primary PAL in both velars and /l n/. Interestingly, when /j/ occurs after target consonants

[11] This idea lurked in earlier versions of our article. We thank an anonymous reviewer for helping us bring it forward and to refine it in the context of theories such as *Contrast Preservation* (Łuwobicz 2007; 2012; this issue).

resistant to a change in PoA such as labials, coronal obstruents and /r/, the result is GH instead, as shown in (8b). Words that lack such a glide are included (8a) to illustrate the effect even more clearly. Moreover, the examples in (9) illustrate a tripartite distinction according to which the same C precedes a V other than /i/ (9a), a high front vowel (9b) and a hardened glide (9c).

(8) *SMG: /j/ emerges as [ç] or [ʝ] post-consonantally*

a. Plain consonant		b. CjV string[12]		GH: Glide hardens, preceding C is not PAL	
[ˈ**pa**no]	‘up’	ˈpjano	[ˈ**pça**no]	‘catch-1SG’
[ˈ**so**ni]	‘enough’	iˈsjoni	[iˈ**sço**ni]	‘straighten-3SG’
[ˈ**ða**kos]	‘dacus’	ˈðjakos	[ˈ**ðʝa**kos]	‘deacon’
[**ma**ˈʎa]	‘hair-PL’	mjaˈla	[**mɲa**ˈla]	‘brain-PL’
[xoˈ**ɾo**]	‘fit in-1SG’	xoˈrjo	[xoˈ**ɾʝo**]	‘village’

(9) *A tripartite distinction: ∅, i and hardened-j*

a. [ˈ**va**.zo.] ‘place, put-1SG’
b. [**vi**.ˈa.zo.] ‘rape-1SG’
c. [ˈv**ʝa.**zo.me.] ‘be in a hurry-1SG’

The process targets glides in onset positions in CjV sequences, turning them into consonants. More specifically, the glide strengthens into a palatal fricative, whose distribution is entirely predictable; [ç] appears after voiceless consonants, as in [‘pçano] in (8) and its voiced counterpart [ʝ] after voiced ones, as in [ˈðʝakos] (8). Note that this process targets only glides and therefore GH does not apply in CiV sequences (compare (9b) and (9c)). Figure 5 illustrates the differences among the triplet presented in (9). The differences among Figures 5(a), (b) and (c) are clear: in 5(c) the presence of the fricative [ʝ] is quite clear between the initial consonant and [a], while in 5(b) there is a distinct vowel [i] between them. 5(a) is provided for comparison.

GH is panhellenic and, just like primary PAL, it exhibits variation depending on the dialect. While the outcomes of GH in the dialects focused on in this article are comparable to the SMG case (8), in some other dialects, especially the south-eastern varieties (e.g., Dodecanese, Cyprus), strengthening is more dramatic, since the glide displays further fortition. Revithiadou et al. (2014) examine cases in which the glide strengthens to either a non-sibilant (Rhodian varieties, (10)) or to a sibilant PAL (Vati Rhodian, Astypalaea, (11)). What is intriguing in this data is that the dialectal distribution of the phenomenon presents a continuum, according to which in some varieties GH is inert (South Rhodes), whereas in others GH applies yielding PAL consonants that even spread by totally assimilating neighboring obstruents giving rise to surface geminates (Archangelos).

(10) *GH in Rhodian varieties* (after Tsopanakis 1940: 41, 70–72)

a.	kariðj-a →	(i)	kaˈɾiðja	(South Rhodes)
	‘walnut-PL’	(ii)	kaˈɾiðɟa	(Trianta, Salakos)
		(iii)	kaˈɾiɟɟa	(Archangelos)
b.	aliθj-a →	(i)	aˈliθja	(South Rhodes)
	‘truth’	(ii)	aˈliθca	(Trianta, Salakos)
		(iii)	aˈlicca	(Archangelos)

[12] Footnote 5 presents the debate as to whether the Greek glide is underlying or derived. We deliberately place the words in the first column of (b) in no brackets at all to remain neutral with respect to this issue. All that matters for us here is that at some level of representation prior to GH, a glide exists. That the underlying forms do not contain a palatal fricative is evidenced by variants such as [ˈmi.a.] ~ [mɲa.] ‘one-FEM’ and pairs such as [pa.ɾu.ˈsça.zo.] ‘present-1SG’ but [pa.ɾu.ˈsi.a.sa.] ‘present-PAST.1SG’. In these examples the surface palatal fricative alternates with a high front vowel under stress, suggesting that the fricative cannot be underlying.

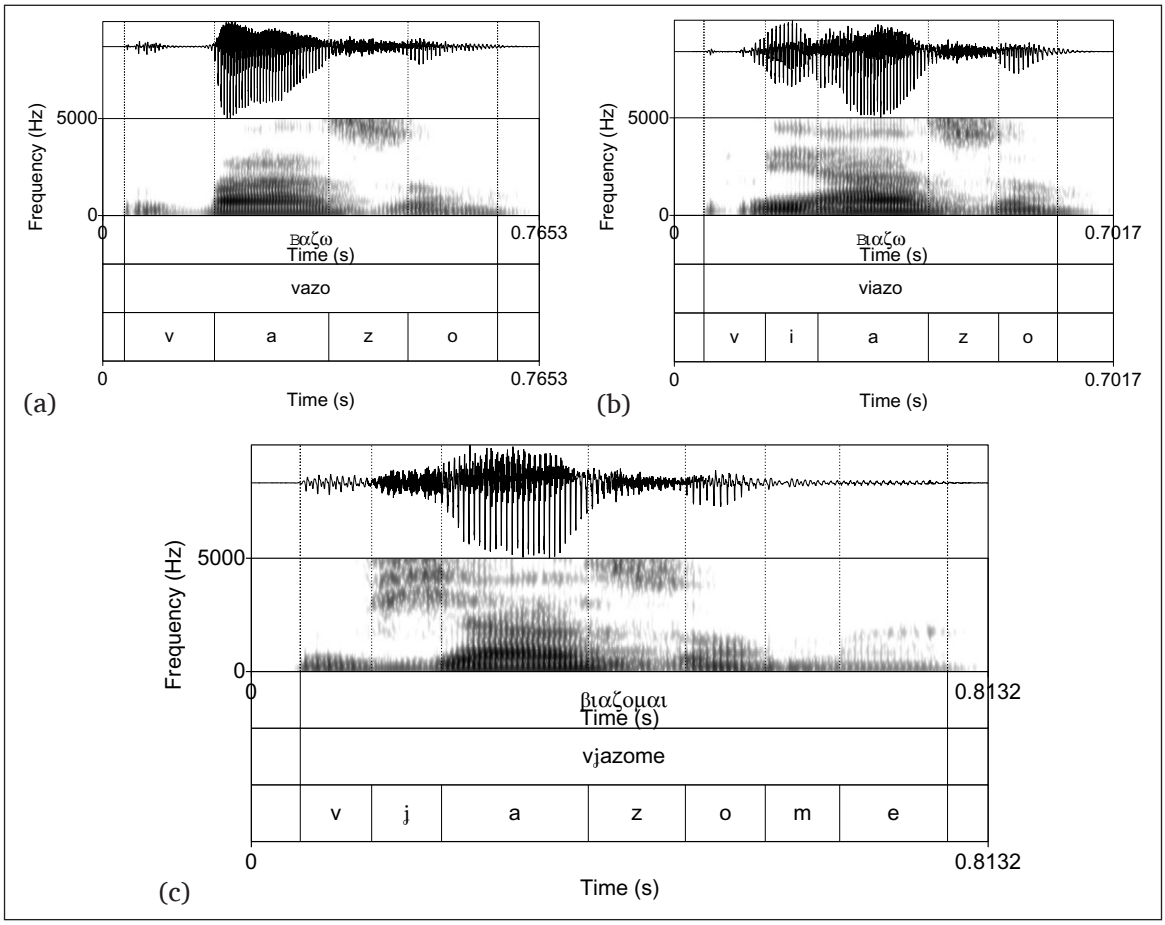


Figure 5: Example of glide hardening. Illustration of a tripartite distinction according to which the same C precedes: (a) any V other than /i/, (b) a high front vowel, and (c) a hardened glide (see text for details).

(11) *GH in Vati (Rhodes island), Astypalaea* (after Tsopanakis 1940: 69–71)

a.	karavj-a	kaˈɾavʒa	‘ship-PL’
b.	peðj-a	peˈðʒa	‘kid-PL’
c.	ðoⁿdj-a	ˈðoⁿdʒa	‘tooth-PL’
d.	xorafj-a	xoˈɾafʃa	‘field-PL’
e.	vjaz-ome	ˈvʒazome	‘be in a hurry-1SG’
f.	pjann-o	ˈpʃanno	‘touch-1SG’

Glide hardening is attested in a number of languages. In Bolognese (Hajek 1991), for instance, diphthongal offglides /ʷ/ and /ʲ/ turn into [ŋ] or its palatal variants, [jᵑ] and [ŋʲ]. Furthermore, in Cypriot Greek and Bergüner Romansch (Kamprath 1987; Kaisse 1992; 2011; Montreuil 1999) glides become stops ([c] in Cypriot, [g] in Romansch) after or before a consonant, that is, in an onset (Cypriot) or a coda (Romansch) position, e.g. [aˈðerfi] ‘brother’ but [aˈðeɾf**c**a] (< /aˈðerfj-a/) ‘brother-PL’ (Cypriot); *kreja* ‘believe-3SG’ but *krek̟r* ‘to believe’ (Romansch). Romansch – which lacks a general process of consonantilization in coda position, e.g. *laj* ‘lake’ – shows that occupying the onset position is not a necessary condition for strengthening, while Cypriot examples such as [ˈjerakos] ‘falcon’ demonstrate that it is not sufficient either (Kaisse 1992; 2011). Even a cursory review of the literature makes clear that there is hardly any consensus on the phonetic forces that trigger GH or on its phonological representation. According to Kaisse (1992; 2011) the

process involves spreading of the [consonantal] feature of the neighboring consonant to the glide. Hume & Odden (1996) treat the same data as cases of fortition that involve the feature [continuancy]. On the other hand, the hardened glides of Bergüner Romansch arise due to a specific licensing choice they make in syllable structure. Montreuil (1999) analyses them as stray elements trapped between a nucleus and a final consonant which end up being associated with the mora of the consonant at their right under certain conditions not relevant to the discussion here. The phonetic consequence of this licensing choice is their consonantization.

A synchronic path of segmental changes similar to the one attested in the Southern Greek of Rhodes and other islands, is attested in certain Polish dialects illustrated in (12). Here the GH process affects labial consonants which exhibit palatalized outputs at one end of the line and outputs with glide hardening at the other (see Kochetov 1998; also discussed in Bateman 2007). A similar path of diachronic change is also found in PAL processes that affected labial consonants in Moldavian (Bateman 2007: 112–113) and in Romanian (Operstein 2010: 110).

(12) *Palatalized labials in Polish dialects* (Bateman 2007: 112; Kochetov 1998: 2)

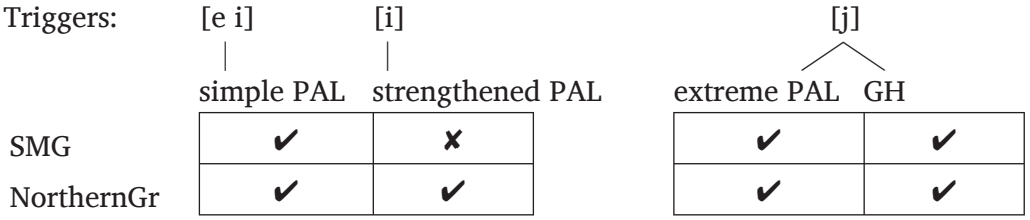
I	II	III	IV	
[pʲ]ivo	[pj]ivo	[pç]ivo	[pɕ]ivo	‘beer’
[bʲ]ały	[bj]ały	[bʝ]ały	[bʑ]ały	‘white’

As is evident from (12), the labial consonant is palatalized only in dialect I; all other dialects display a sequence of a labial with a glide (II) or a palatalized fricative (III and IV). The Polish dialectal data suggest that the two processes are two different sides of the same coin. According to Kochetov (1998: 7–8), the different phonetic realizations of palatalized labials must be attributed to the different timing relations between the articulatory gestures of the labial and those associated with PAL. The larger the delay the less synchronized/overlapped the gestures will be, resulting in the patterns II, III and IV, which present a longer and more salient off-glide. Kochetov treats the strengthened patterns III and IV as the outcome of enhancement processes that aspire at maximizing a contrast that is hard to perceive (see Flemming 1995; 2006; Ní Chiosáin & Padgett 1997; Steriade 2008[/2001], a.o.). The gain is maximization of the auditory distinctiveness of the surface contrast. On the other hand, Kochetov (2014, this issue) proposes that the strong functional and formal resemblance between PAL and palatal glide hardening derives from a deeper need to avoid marked C + j sequences. This is due to a contextual markedness constraint *C + pal which is argued to be articulatory and perceptually grounded. However, this functional explanation cannot easily hold for Greek – despite the fact that it is proposed by Kochetov on the basis of Greek dialectal data as well – for the simple reason that Greek presents other PAL-inducing contexts, namely /i/ and /e/. It would be somewhat odd to argue that such vowels widely generate marked structures once combined with a consonant at their left. Even in the strengthened PAL type, which involves the obliteration of the triggering segment, the driving force of final vowel loss is not a markedness co-occurrence restriction but rather the weakening effect that the absence of stress inflicts on the unstressed high vowels /i u/.

Although the role of functional constraints in the shaping of PAL and GH is acknowledged, especially in relation to maximizing perceptual salience, we would like to slightly shift the attention from the targets of these processes to their triggers, namely front vocoids. Recall that in Greek GH is activated by a palatal glide, whereas PAL is triggered either by front vowels (simple) or by a palatal glide (extreme). Similarly, strengthened PAL is initiated by the loss of a front high vowel (to our knowledge, back high vowels

have not been reported to leave a trace on the preceding consonant). The advantage of this move is that it allows us to unite all three processes examined in this article under the rubric of segmental changes initiated by front vocoids, as depicted by the diagram in (13).

(13) *Processes triggered by front vocoids in Greek*



Viewed from this perspective, the common denominator in all processes is the front vocoid which affects a class of consonantal neighbors either by changing the PoA of the preceding consonant (simple PAL), or by enhancing its perceptual salience by adding extra cues (e.g., aspiration, frication) as a means of signaling the omitted vowel (strengthened PAL), or by fusing with the preceding consonant (extreme PAL), or, finally, by preserving its segmental status and maximizing the C+j contrast compared to other clusters via enhancement of its own cues (e.g., frication, stridency, etc.) (GH).

An interesting outcome from this classification is that, at some abstract level, strengthened PAL and GH can both be treated as processes that enhance the perceptual prominence of the contexts in which their trigger occurs. In strengthened PAL, the trigger, which is silenced when unstressed and in word-final position, spares some of its cues by transferring them to the preceding consonant, which, as a result, gets enhanced (if not a velar or /s z l n/). In GH, on the other hand, the trigger itself is transformed by enhancing its own cues, so that the input C+j cluster maximizes its auditory distinctiveness while at the same time preserving its palatality. Sometimes both strengthened PAL and GH may give rise to phonologically or phonetically augmented/lengthened outputs (see, for instance, the surface geminates in the Rhodian variety of Archangelos (10a-b.iii) and the lengthening of /r/ in outputs such as (4l) in KozGr). That being said, we need to keep in mind that there are some important differences between the two processes: GH applies obligatorily and categorically in all varieties of Greek, whereas strengthened PAL is a phonetic rule that applies mainly in Northern varieties yielding variable outputs.

5 Discussion and conclusions

In this section, we explore in more detail a few issues raised earlier and offer some concluding remarks. In Section 3.3 we explored the position that extreme PAL and strengthened PAL are both treated as instances of coalescence. Here we wish to draw attention to the way these differ from one another, but also focus on specific traits that the strengthened-PAL-as-coalescence analysis bears.

For starters, the two processes differ with respect to their PAL triggers. While they share the invisibility of the trigger on the surface, in extreme PAL, the glide /j/ serves as a trigger, as opposed to strengthened PAL, where the trigger is the vowel /i/ (like in simple PAL) and not the glide. Coalescence with a vocalic trigger is, as explained in Section 3.3, not preferred, but this does not mean that it is wholly unattested. Bateman (2007: 311) lists a few languages, among which Amharic (see footnote 8), Moldavian and Romanian, where in certain contexts deletion (as she calls it) of the trigger is allowed (see also Polish where in the 3rd person plural present tense forms the trigger /j/ surfaces after labials, e.g. [ʃum^{j}**j**-ɔ̃] (*szumi-ą*) 'hum-PRES.3PL' but deletes elsewhere, [zap^{j}jʃ-ɔ̃] (*zapisz-ą*) 'inscribe-PRES.3PL', Rubach 2011). We argue then that fusibility of triggers in Greek is a

dialect-specific feature. In SMG, only glide triggers may fuse, whereas in Northern dialects both the palatal glide and the high front vowel do.

Moreover, in the case of extreme PAL, coalescence is maximally general, since it fuses a triggering glide with a preceding (appropriate) consonant to produce a single palatal output no matter its position in a stressed or unstressed syllable, in a morphologically derived or underived environment. Strengthened PAL is much less consistent. Of paramount importance for its application is the lack of stress on the trigger, and, as the data so far suggest, morphological boundaries seemingly play a role.

In particular, recall from Section 3.2 the presence of morphophonological alternations in nouns or verbs ending in *-i*. When this vowel is stressed, it emerges as in [piˈði] 'child', but when unstressed it gets eliminated, causing nonetheless strengthened PAL to the preceding consonant, as in [vɾaðʲ] 'evening'. Effectively, we suggest, this allows us to witness how phonetic cues may interfere with morphophonology. In KozGr, this deleted high vowel is usually a theme vowel (e.g., *-i-* as a marker of classhood in neuter nouns in *-i* and in masculine nouns in *-is*) or an inflection (e.g., *-i* as an exponent of NOM/ACC singular in feminine nouns and 3rd singular non-past tense in verbs) and thus a carrier of morphosyntactic information. When silenced, this morphosyntactic load is not totally lost but is transferred to the preceding consonant by means of the remnant vocalic cues that are imprinted on it in the form of acoustic effects such as aspiration, frication, etc. As a result of this development, minimal contrasts of the type /aku-s/ [aˈkus] 'hear-INDIC.2SG' vs. /akus-i/ [aˈkuʃ] 'hear-SUBJ.3SG' reflect much more than a mere contrast between a plain and a strengthened PAL consonant.

A comparable synchronic pattern arises in Romanian, where the root-final consonant undergoes PAL in front of suffixes such as the plural *-i* and the second person singular verbal suffix *-i*. Depending on the nature of the target consonant, full or secondary PAL occurs, as in /fak-i/ [fatʃ] 'make/do-2SG' or /brad-i/ [brazʲ] 'fir tree', respectively, accompanied by deletion of the triggering vowel (Bateman 2007: 12, 91). Evidence for the existence of the underlying /-i/ appears in different forms where the plural suffix actually emerges (Bateman 2007: 96). Compare for example /papuk-i/ [paputʃʲ] for 'shoe-NOM/ACC.PL' vs. /papuk-i-lor/ [paputʃʲilor] 'shoe-GEN/DAT.PL'. Unlike Greek, in Romanian, this type of PAL has acquired categorical status.

What sets the Greek case apart is that it offers a snapshot of a potential morphophonological change *currently in progress*. Although still phonetic and hence non-categorical in nature, strengthened PAL has the proper functional load to be transmuted into a dynamic morphophonological rule of the KozGr grammar. Whether this process will be completed or will be constrained – perhaps under the normalizing pressure of the dominant Standard language – remains to be seen.

A different set of findings concerns asymmetry generalizations regarding PAL triggers and targets. In line with Kochetov (2011), we too have found support for the statement that crosslinguistically [Labial] consonants are more reluctant palatalizers.[13] In SiatGr, for instance, they are unaffected by strengthening. We have also shown that front vocoids are PAL triggers in Greek, with /i/ being somewhat special in triggering simple and strengthened PAL in KozGr and SiatGr (cf. Section 3.1) that affects a rather motley group of coronal consonants, namely /s z l n/ to the exclusion of the other coronals of Greek, that is, /t d r/ (Arvaniti 2007). While different sets of coronals across languages may undergo

[13] Battisti & Hermans' (2015) analysis of PAL in Brazilian Portuguese offers interesting insights on what constitutes an ideal trigger and target of PAL as a function of how similar at the featural level these entities are. We thank an anonymous reviewer for bringing this work to our attention.

PAL (see detailed information in the Appendix of Bateman 2007), a common thread is that among the coronals the stops /t d/ are typical targets. In fact, in some languages, e.g. Hausa (Bateman 2007: 369), only the coronal obstruents /t d s z/ undergo PAL, whereas the sonorants /l n r/ do not.

How can the failure of /t d r/ to be explained? The situation for /r/ is quite clear. Hall (2000) shows that rhotics are generally incompatible with PAL. While rhotics may exhibit secondary PAL as in [rʲ], they are much more marked than non-rhotic [tʲ nʲ lʲ], a finding supported by synchronic and diachronic evidence. This is because secondary PAL by definition requires laminal articulation with the tongue blade/front, while rhotics – as well as non-rhotic apicals, such as the retroflexes – are apical.[14] With regard to full PAL now, Hall (2000: 15) proposes that rhotics are universally immune to such a process, since this would imply shift of their primary PoA from the alveolar-dental region to the postalveolar region. In turn this would entail a postalveolar laminal rhotic, an inexistent sound.[15]

This leaves us to explain the unwillingness of /t d/ to palatalize. Given that these segments are generally good palatalizers, we suspect that the type of PAL that targets /s z l n/ is sensitive to the features that these segments share and which differentiate them from /t d/. It is however not obvious what natural class /l n s z/ form. One way to go about this issue is to focus on the PoA of the coronals in question. Most studies, e.g. Arvaniti (2007: 102), characterize SMG phonemic stop coronals as alveolars, but a lot of variation is evident, as several EPG studies have revealed, depending on context and type of speech (laboratory vs. conversational). Thus, /t/ has been alternately described as dental (Nicolaidis 1991), dentoalveolar (Nicolaidis 1994) and alveolar (Nicolaidis 2001). On the other hand, the general consensus is that /s z/ are retracted alveolars and /l n/ are alveolars (Arvaniti 2007 and references therein). This constellation of facts allows us then the interpretation that, phonologically speaking, /t d/ are dentals,[16] thus [+ant, +distr], whereas /s z n l/ are alveolar, thus [+ant, −distr]. Perhaps, PAL then turns [+ant, −distr] alveolars to the corresponding [−ant, +distr] laminals, a fact also in line with Hall (2000: 5).

A different way of thinking rests on the observation (Mielke 2008, esp. Section 4.1.3 and references therein) that nasals are not universally [−cont]. In fact, in Mielke's survey (2008: 66) nasals patterned as [+cont] 73.5% of the time. Given that laterals are commonly [+cont] and fricatives are typically [+cont], we may argue that in Greek, nasals too are [+cont], thus /s z l n/ form the group of [+cont] alveolars.

Whatever the answer to that is, there is further evidence besides PAL that these consonants cluster together phonologically. /n/-deletion at morphophonological boundaries targets *all* the alveolars, including /r/. More specifically, when the final-*n* in morphemes like /sin-/ combines with bases starting with /s z n l r/, it deletes. Forms such as /sin/ + /zo/, /reo/, /lamvano/, /sorevo/, /nomos/ result in [**si**ˈzo] 'co-habit-1SG', [**si**ˈreo] 'flock together-1SG', [**si**laŋˈvano] 'arrest-1SG', [**si**soˈrevo] 'accumulate-1SG' and [ˈ**si**nomos] 'lawful'. The /n/ however is not deleted in [**sim**baˈθo] 'I like-1SG (someone)', [**siŋ**foˈnia] 'symphony', [ˈ**siɲ**θesi] 'synthesis'. As predicted, /r/ – an alveolar sound – now freely

[14] This also means that non-rhotic anterior coronals such as /t d s z/ are pronounced as laminal when palatalized. Actually, Russian displays this contrast in its phonemic system. Non-palatalized anterior coronals /t d s z/ are apical and contrast with the palatalized anterior laminals /tʲ dʲ sʲ zʲ/ (Hall 2000: 21).

[15] In the discussion that follows, since rhotics are alveolars they may too belong to the natural classes formed, but at least for the purposes of PAL, a universally(?) high-ranking constraint blocks them from palatalizing. For convenience, we omit further reference to /r/, as far as natural classes go.

[16] In fact, Arvaniti (1999) considers /t/ a dental sound in another dialect of Greek, namely Cypriot.

teams up with the other alveolar partners, since its incompatibility with PAL is irrelevant to the process at hand.

More generally, our study has revealed a range of PAL processes across Greek dialects. In some cases, the PAL processes are shared among dialects but may differ in terms of triggers, targets or outputs of PAL according to the dialect in question (cf. e.g. Section 3.1), while in other cases, a more fundamental difference arises. In particular, some dialects present PAL processes that other dialects completely lack, i.e. strengthened PAL emerges in Northern Greek, but not in SMG.

As a whole however, the language displays full PAL with two variants, i.e. simple and extreme (Section 3.1) and strengthened PAL (Section 3.2). Of paramount importance in each case is the nature and fate of the PAL trigger. In simple PAL the trigger (vowels /i/ and /e/) survives intact, whereas in extreme PAL, the trigger (the glide /j/) is unpronounced, and seemingly gets to be absorbed by the target. In strengthened PAL the trigger combines features of both. Like simple PAL, the trigger is a high front vowel; like extreme PAL, the trigger is systematically invisible. Crucially though, strengthened PAL involves an assortment of acoustic effects (e.g., aspiration, frication, lengthening) that are associated with secondary PAL, without however the predominant feature of the latter, namely F2 raising. In fact, none of the examined dialects of Greek demonstrates secondary PAL.

Furthermore, our attention to *triggers* – rather than *outputs*, which is typical in PAL studies – has allowed us to go beyond PAL and gain a more complete picture of the patterns in the language. In particular, by focusing on examining processes triggered by front vocoids, we observe that GH emerges as a process complementary to PAL, since it consistently occurs with target consonants resistant to PAL. Glides, following, for instance, labials are in this case maintained in the structure as separate segments, but turn to palatal fricatives (or even stops), without any further change to the PoA of the target consonant, i.e. here the labial, thus /pjan-o/ [ˈpçano] 'I catch/touch'. Seen in this light, typologically different processes, such as GH and PAL are united under the rubric of enhancement processes that aim at strengthening/intensifying the phonetic cues of their targets for reasons of perceptual salience.

Independent work reaching the same conclusion, cf. Kochetov (this issue, supports the line of thought followed here.). However, Kochetov's attempt to explain the relationship between GH and PAL, basing himself on Kirundi data, cannot be easily transferred to the Greek facts for reasons explained in Section 4. While his functional explanation with the addition of some of our own preliminary thoughts has been acknowledged, we believe a full story is not yet available. Further research should reveal more cases of this kind and help us pinpoint the specific mechanisms establishing this close connection.

Abbreviations Terminology

PAL: palatalization

PoA: place of articulation

VD = **vowel deletion** (Section 2): The deletion of unstressed high vowels in Greek dialects, esp. of the Northern variety.

Primary/full PAL (Section 3.1): Type of PAL where the PoA of the target shifts to the palatal region. Triggers are front vocoids /i e j/. Targets in all dialects are velars, but in Northern dialects some coronals are affected too.

- **Simple PAL** (Section 3.1): Subtype of primary/full PAL, triggered by the front vowels /i e/. The trigger remains intact in the structure after PAL has applied.
- **Extreme PAL** (Section 3.1): Subtype of primary/full PAL, where the trigger /j/ coalesces with the target consonant of PAL.

Secondary PAL (Section 3.2): Type of PAL that *does not* exist in Greek; its typical trait is F2 raising and may be accompanied by other acoustic cues, such as frication, aspiration or lengthening.

Strengthened PAL (Section 3.2): Type of PAL specific to Northern Greek dialects. Similar to secondary PAL in the acoustic cues it presents, but crucially lacks F2 raising. The trigger (unstressed vowel /i/) is unpronounced and there is change in PoA of target consonant for velars and /s z n l/, while there is no PoA change of target consonant after PAL has applied for labials and the remaining coronal consonants.

GH = Glide hardening (Section 4): A process complementary to PAL, occurring next to target consonants resistant to PAL. It turns glides to palatal fricatives (or stops), without changing the PoA of the target.

Glosses

ACC = accusative; DAT = dative; FEM = feminine; GEN = genitive; INDIC = indicative; MASC = masculine; NOM = nominative; PAST = past; PL = plural; PRES = present; SG = singular; SUBJ = subjunctive

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Competing Interests

The authors declare that they have no competing interests.

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