*The acoustics of high-vowel loss in a Northern Greek dialect and typological implications**

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1. Introduction

Northern Greek dialects (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 leading to the creation of various consonant clusters, as shown in (1).

(1)	Northern Greek	Standard Greek	
	plíθka	*plíθi̱ka*	'I washed'
	plí	*pu̱lí*	'bird'
	fsó	*fi̱só*	'blow'
	vnó	*vu̱nó*	'mountain'

The term VD (vowel deletion) here is not used in the narrow sense of vowel elision; rather, it refers to the phenomenon which phonetically gets to be realised along a continuum of processes (see below for details), chief among which are vowel devoicing and elision itself. Whenever a distinction needs to be made among the processes discussed, we will spell it out explicitly.

Moreover, Greek VD is unrelated to the process of metrically-driven vowel deletion occurring in other languages as a means to satisfy some metrical requirement (cf. Gouskova 2003)[1]. For instance, in odd-parity words of Yidiɲ, the final vowel is deleted so that all material is parsed in unmarked binary feet leaving no syllable unparsed, e.g. /gindanu/ → (gin.dán□) *(gin.dá□)nu 'moon-ABS' vs. /gindanu-ŋgu/ → (gínda)(núŋgu) 'moon-ERG'. In contrast, VD in Northern Greek may actually produce marked, metrically-speaking, structures as in e.g. /spiti/ → (spít) 'house' with a marked unary foot instead of the Standard Greek (spí.ti) which presents an unmarked binary one.

VD, despite being pervasive in Greek, is yet poorly understood. Our paper aspires to shed light on Greek VD from an acoustic point of view, examine its effects with respect to consonant cluster formation and compare its manifestation to other instances of the phenomenon typologically. The first goal is driven by the paucity of research on Northern Greek VD. While it is a phenomenon widely cited impressionistically within Greek linguistics, (Chatzidakis 1905, Papadopoulos 1927, Newton 1972, Browning 1991, Kondosopoulos 2000, Trudgill 2003), it has been barely investigated phonetically for this cluster of dialects. More recently there has been a number of experimental studies investigating VD in Cypriot Greek (Eftychiou 2008) and in Standard Modern Greek (Dauer 1980; Arvaniti 1994, 1999; Nicolaidis 2001, 2003; Baltazani 2007a, b; Loukina 2008), the majority of which suggest that it is common for high vowels. Our choice to study Kozani Greek (NW Greece) is justified by the fact that in this dialect VD habitually occurs, whereas in most of the other ones, it is less regular. We thus hope to offer a more comprehensive exploration of this phenomenon in Greek.

Our study leads to a number of findings. In particular, we show that VD correlates with increased aspiration and duration of the consonants adjacent to the deleted vowel to an extent, but not reliably for all segments. In addition, we confirm the gradience and variability of VD also reported in cross-linguistic research. Furthermore, we observe a rather dramatic asymmetry between high vowels in the application of VD, so that [i] appears more resistant to VD than [u].

A natural consequence of VD is of course consonant cluster formation, which brings us to the second aim of this paper. In particular, we examine the range of clusters created and see how they are differentiated from those of Standard Modern Greek (*SMG*). We conclude that several clusters emerge that are banned in SMG and that the dialect encompasses a much wider inventory of coda consonants. Furthermore, our results suggest that consonant clusters created as a result of VD are much less stable in duration than underlying clusters.

Finally, we examine how Kozani Greek (*KG*) fits within the VD typology. We show that it illustrates several findings, some of which are quite ordinary, while others are highly unusual cross-linguistically. In particular, it allows VD between voiced consonants, a pattern that is considered exceedingly rare (Dauer 1980).

It needs to be pointed out however that our data are based on one bidialectal speaker of KG and SMG, as explained in Section 2. Thus, the effects that stem from the acoustic analysis of these data, although robust for this speaker, should be checked for generalizability in future studies with additional KG speakers. On the other hand, our experience from listening to other KG speakers – but without having recordings to analyse – leads us to anticipate that VD-variability and increased coda inventory are uniformly found. Again, further research should be able to confirm this impression.

The paper is structured as follows. Section 2 discusses the data this research is based on. Section 3 reports the results of the study. After presenting general observations, the focus then shifts on the specifics of VD in KG. Section 4 deals with consonant clusters as a product of VD, while Section 5 places KG in a typological perspective. Finally, Section 6 offers a few concluding remarks.

2. Data collected

Our data come from recordings of a male speaker of KG in his 60's. The recording was conducted by the first author in December 2007 in Kozani. Kozani is a city of about 50,000 inhabitants in northern Greece, located in the western part of Macedonia, 120 Km south-west of Thessaloniki. The speaker, Lazaros Kouziakis, read aloud one of the stories he has collected in Kouziakis (2008), a volume with a collection of stories describing aspects of life in Kozani during the past decades. The piece we analysed relates to a story of a trumpeter. It contains 1264 words and 5555 segments and is approximately 18mins long.

Interestingly, KG texts attempt to represent the dialect's VD process, by deleting the vowel in question in the orthography and using an apostrophe in its place, e.g. "Κάθι βράδ**'** ύστ**'**ρα απ' τη δ**'**λειά, κατέβιναν οι Σκαρκιώτ**'** στα μπακάλ**'**κα" ("Every night, after work, the Skarkiotes would go to the grocery stores") (Kouziakis 2008: 193). In the Standard orthography, this would be: "Κάθι βράδ**ι** ύστ**ι**ρα απ' τη δ**ου**λειά, κατέβιναν οι Σκαρκιώτ**ες** στα μπακάλ**ι**κα" with the missing vowels (in boldface) in place.

Finally, note two facts here: (a) our data come from read, non-spontaneous speech, therefore the pronunciation is more deliberate and careful and (b) the speaker is bi-dialectal between KG and SMG, therefore there is a possibility that his dialectal 'accent' is not as strong as that of a mono-dialectal speaker. We expect to find more deletions and therefore more clusters in a speaker producing spontaneous speech and not influenced by the standard.

The speech was analysed acoustically using PRAAT (Boersma & Weenink 2009). Our analysis consisted of manually segmenting the speech into words and phones and, based on waveforms and spectrograms, annotating for vowel deletion in its various realisations, cluster creation and aspiration. We measured all non-deleted unstressed high vowels and the consonants flanking them, as well as the consonants forming clusters as a result of VD. For this paper we measured only segment durations systematically; formant measurements have not been completed yet, therefore we do not report on them at this stage.

3. Results

This section amasses the results of our study categorising them in three distinct subsections. §3.1 reports on general observations regarding VD that bring it on a par with other languages that exhibit VD. §3.2 presents the consonantal effects resulting from VD and §3.3 focuses on more specific aspects of Kozani VD itself.

3.1 General observations

Although VD is not a very common phenomenon, it nonetheless appears in a fair number of languages; however, devoiced vowels usually have an allophonic rather than contrastive relationship towards fully voiced vowels, as Gordon's survey shows (Gordon 1998). Typically, VD affects high vowels, found in unstressed positions with a preference for the final one. The VD-undergoing vowels are normally preceded and – in the case of a word-medial position – also followed by voiceless consonants.

Previous research on VD has concluded that it is a gradient rather than categorical phenomenon (e.g. Kondo 1994 for Japanese, Jannedy 1995 for Turkish, Jun and Beckman 1993, 1994 for Korean, Chitoran and Babaliyeva 2007 on Lezgian and Delforge 2008 on Cusco Spanish) with various phonetic realisations. KG too confirms this finding, displaying a range of VD outputs, including fully voiced vowels, completely or partly devoiced, as well as fully elided ones.

Variability is also found among tokens of the same word, which again is not unprecedented, c.f. Gordon (1998), Shiraishi (2003) for Ainu, Delforge (2008) for Cusco Spanish. For instance, in [tsitsóna] (‘female name’) – often mentioned in the story read by our speaker – the pretonic /i/ undergoes VD and surfaces with various manifestations ranging from full vowel to complete deletion as shown in Figure 1.

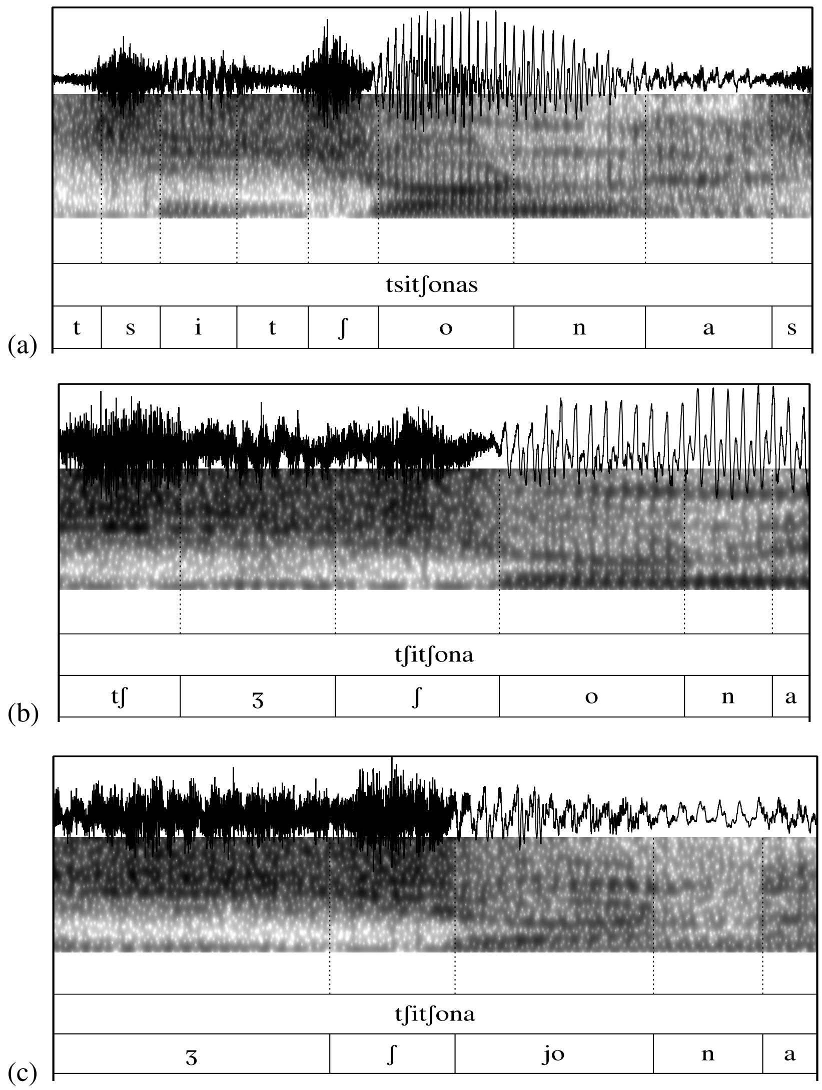

Figure 1. *Token variability of pretonic [i] in [tsitsóna] (female name). Panel (a) shows a full vowel; panel (b) has a voiced fricative instead of [i] & panel (c) shows total deletion of the segment.*

Panel (a) shows the realisation of [i] as a full vowel with regular voicing and formant structure. In panel (b) there is still a separate segment between the two [ts] affricates but it is mostly a voiced fricative, thus marked as [ʒ]. In panel (c) there is no transition evident from the first affricate into a different segment. Instead, the affricate itself lasts longer, almost twice as much as in the previous two tokens. Lengthening is only one of the effects of VD on its adjacent consonants. The relevant effects are thoroughly examined in the next section.

3.2 Consonantal effects associated with VD

A number of effects accompany KG VD to a certain degree. However, as it will be shown, none is systematic and consistent enough to be regarded as the principal effect of VD for all segments. As already mentioned (Section 2), among our measurements was the duration of consonants flanking the unstressed high vowels [i] and [u] whether they underwent VD or not. In the discussion below regarding duration of consonants we do not distinguish between C_1 and C_2, i.e. the consonant before and after the VD undergoing vowel (for additional discussion on the distribution of the flanking consonants, see section 4).

With regard to stops, the first noticeable effect is aspiration (see also Mo 2007 and Jun & Beckman 1993 on Korean [2]). In Kozani Greek, voiceless stops in general have a small amount of aspiration (up to 30ms), just as has been reported for Standard Modern Greek (e.g. Dauer 1980, Fourakis 1986, Arvaniti 2001). However, in KG [t] and [c] show increased aspiration duration after VD compared to their counterparts in environments where no VD has occurred, (Fig. 2, left panel) a finding which is particularly interesting, since Greek is claimed to lack aspirated Cs (Dauer 1980, Fourakis 1986, Arvaniti 2001, among many others). On the other hand, the aspiration of [p] and [k] shows no difference in the two conditions[3].

A similar result appears in relation to the stop closure duration. This time, it is [t] and [k] which show slightly increased closure duration after deletion but the closure of [p] and [c] shows the opposite trend (Fig. 2, right panel). Here and henceforth, ND indicates absence of deletion, whereas D marks its presence.

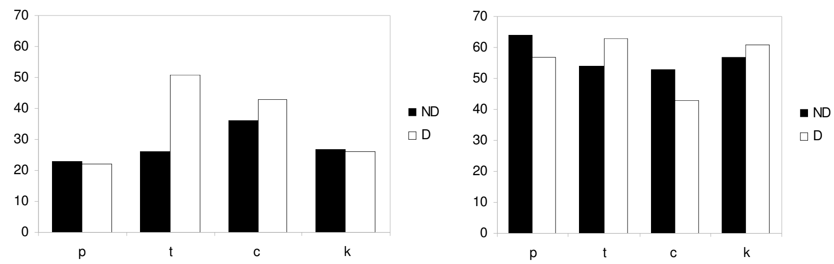

Fig. 2.
Aspiration in stops is not consistently longer after VD (left panel)
Stop closure duration is not consistently longer after VD (right panel)

We also examined the sum of duration + aspiration changes in the two conditions to determine whether there was an additive effect of VD, but as is shown in Figure 3, vowel deletion only seems to have an effect on the duration of [t] and no effect on the duration of [p, c, k].

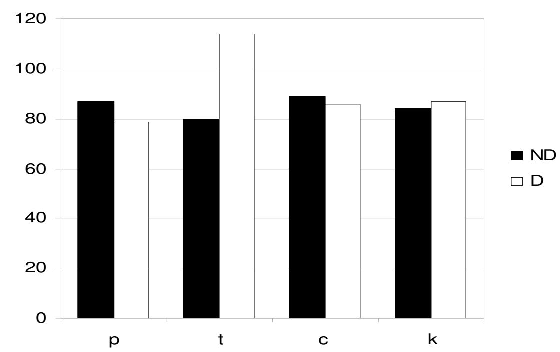

Fig. 3. *Only [t] is consistently longer after VD*

Figure 4 gives a representative example of increased aspiration after VD for [t]. The token shown in this figure is the word [spiti] (*'home'),* pronounced [spit], that is, with the final vowel deleted. As we will see (section 3.3) vowel deletion most frequently occurs in word-final position and it is in that position that its effects on adjacent consonants are most robust. In the example shown here, the aspiration period is dramatically longer (91ms) than the average value not only because of the word final position, but also, we hypothesise, because of the segmental environment:

the word is part of the phrase [sto spiti tis tsitsonas] ('at tsitsona's home') which surfaces as [sto spit ts tsitsonas], with two adjacent instances of VD and the creation of the long consonantal sequence [t ts ts].

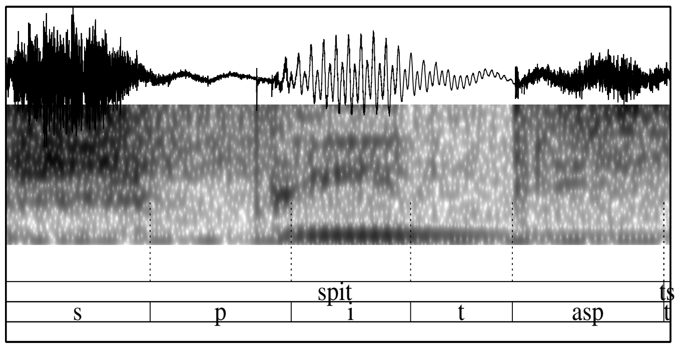

Fig. 4. *Spectrogram of* [sto spit ts] *'at her house'*

Duration increase as a result of VD is also observed for fricatives and sonorants as well. Figure 5 presents the results in the environment of VD and lack thereof both for fricatives (left panel) and for sonorants (right panel). For the majority of the segments examined, the effect of VD was duration lengthening of the consonants adjacent to the deleted vowel[4].

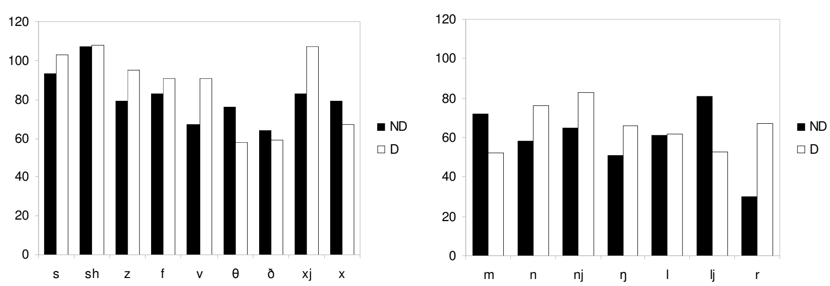

Fig. 5. *Most fricatives (left panel) & sonorants (right panel) are longer after VD*

Eleven out of the sixteen consonant categories displayed increased duration after vowel deletion: 6 out of 9 fricatives and 5 out of 7 sonorants. On the other hand, [θ, ð, x] and [m, ʎ] in fact appear shorter after VD. At this point, we can only speculate about this discrepancy. Anticipating next section's discussion, we find that half the time, VD occurs word-finally, thus creating a host of singleton codas (or consonantal clusters). With the exception of the three fricatives just mentioned, all other fricatives emerge as word-*final* codas and commonly appear much longer than in other positions, including word-medial codas. Thus, there is perhaps a final lengthening effect – or as Dauer (1980: 25) calls it: "a stretching-out of final syllables" – that raises the average duration of a specific set of fricatives. It is of course an open question whether [θ, ð, x] are illegitimate final codas in KG. Although they have not appeared in the string of speech we analysed, we cannot rule out the possibility that they will appear in a longer stretch of speech.

As for the sonorants, all of them appear as word-final codas. However, [m] only shows up idiosyncratically in the place of the definite article [tin] when followed by a labial-initial word, e.g. /tin porta/ → [m borta] 'the door', but without any lengthening effect. Presumably, this is because it belongs to a larger prosodic word, and in that position it is not final. As for [ʎ], the transition between this palatal segment and a following vowel is characterised by a [j]-like onglide which makes the CV boundary very elusive and therefore we suspect that our measurements in the 'No deletion' condition overestimated the duration of the consonant, something that did not happen in the 'Deletion' condition since in that case the neighbouring sound was a consonant making segmentation much easier.

Duration increase thus superficially seems a relatively good indicator of VD for fricatives and sonorants, but it is not infallible. To decide how reliable the above results were, we also calculated the standard deviation (stdev) for the duration measurements of all the sounds above. It turns out that this number is larger in deletion cases than non deletion ones, which suggests that there is greater variability to the duration of consonants after VD than when no deletion takes place.

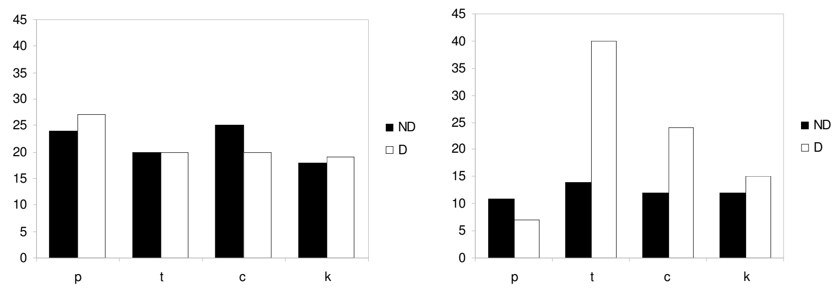

Fig. 6. *Standard deviation from the average value of duration for stop aspiration (right panel) is greater than for stop closure (left panel). Higher values of this number show greater variability in duration*

The least variability after VD appears in the stop closure duration, whereas it is greater for stop aspiration, especially for [t], which recall, was most affected by VD (Fig.6). Variability proves even greater for fricatives and sonorants (Fig.7).

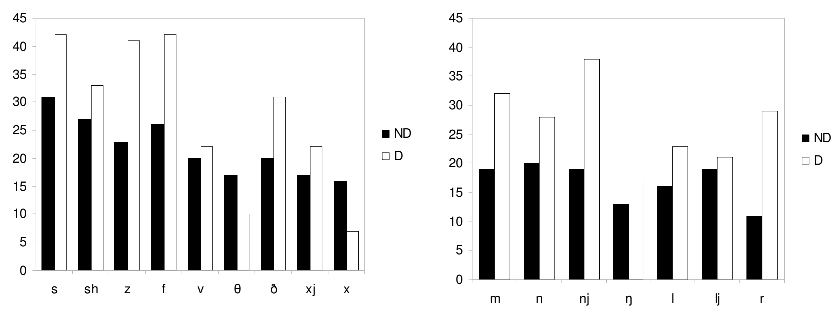

Fig. 7. *Standard deviation from the average value of duration for fricatives (left panel) and sonorants (right panel). There are higher values of stdev for the VD condition suggesting greater duration variability after VD*

There are various ways we can interpret these results. The most extreme one is to suggest that none of the properties shown above is systematically an effect of VD, since too much variability appears. Another, more conservative, and perhaps more insightful explanation is that the duration of the underlying consonants is more stable than that of derived ones, as mirrored by the reduced variability of consonantal duration without

VD. Speakers may thus be attuned to associate VD with greater duration fluctuation.

3.3 Vowel deletion in KG

One of the prominent factors that regulate VD distribution relates to the voicing of the flanking consonants. Given that in the environment of …C_1VC_2…, either C_1 or C_2 can be [+/- voice], four logical voicing combinations are available, all of which emerge in KG. These are outlined below with representative examples.

(2) VD and voicing of surrounding consonants
a. Voiceless – voiceless: **si**kóθ**i**ke > skóθke 's/he stood up'
b. Voiceless – voiced: p**u**lúse > plúʃe 's/he was selling'
c. Voiced – voiceless: cín**i**se > cínse 's/he moved'
d. Voiced – voiced: traɣ**u**ðún > traɣðún 'they sing'

Of course, not all patterns appear with equal frequency (Table 1).

Table 1. *VD frequency in different voicing environments. The last three columns show, from left to right, frequency in word medial positions (% medial), in word final position (% final), and in all positions considered together (Total %).*

Pattern	i	u	Total #	% of medial	% of final	Total %
a. -voi VD -voi	31	8	39	40.21		20.31
b. -voi VD +voi	10	2	12	12.38		6.25
c. +voi VD –voi	34	1	35	36.08		18.23
d. +voi VD +voi	6	5	11	11.34		5.73
e. -voi VD#	44	11	55		57.9	28.65
f. +voi VD#	35	5	40		42.1	20.83
TOTAL	160	32	192			100

Rows a-d correspond to the four voicing combinations when they occur in word medial positions. The first two columns show the number of [i] and [u] VD-undergoing tokens in each voicing environment. The next two columns give totals in raw numbers and percentages in word medial positions respectively. Word-medial VD most often occurs when C_2 = -voi (rows a+c = 76%), and much less frequently when C_2 = +voi (rows b+d =

24%). C_1's voicing quality, on the other hand, practically seems irrelevant. The asymmetry in the distribution between patterns b and c will be further explored in section 5, as will case d, the most interesting one due to its typological rarity. Pattern d comes up to 12% of the word-medial data, that is, as frequently as deletion between a voiceless and a voiced C (row b).

The penultimate column presents the frequency of VD word-finally, considered separately from other environments. In this position VD is highly common and seemingly fairly independent from the voicing of the preceding consonants, as the comparison between rows e and f highlights.

In the last column, putting these results together, we gain further insights into the phenomenon. In particular, word-final VD regardless of voicing (e+f) accounts for the 50% of total VD[5]. Moreover, if we group the environments according to voicing (a+f), then 49% of deleted high vowels occur in the environment [-voi -voi & -voi #].

Up to this point, i-deletion and u-deletion have been considered together. However, their behaviour is not identical when it comes to their susceptibility to undergo VD in the first place. Recall that VD occurs inconsistently. This means that we often find instances where segments could theoretically delete, but fail to do so.

More specifically, out of the 320 unstressed [i] segments which could possibly undergo deletion, more than half (169) do not delete and the remaining 151 delete. Respectively, the numbers for [u] are 40 (10+30) indicating a substantially different picture for it, since only 25% of the possible [u] VD-undergoers fail to delete[6]. Baltazani (2006) in a study of cross-word hiatus resolution in SMG, also reports that [i] deletion is rare, while [u] deletes 75% of the time.

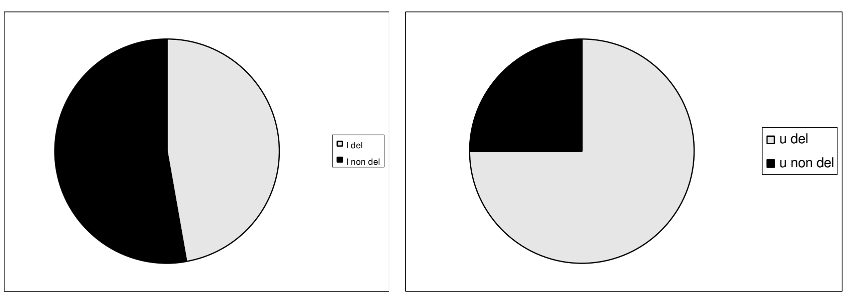

Fig. 8

53% of unstressed [i] do not delete (left pie chart)
25% of unstressed [u] do not delete (right pie chart)

A second asymmetry between the high vowels comes forth in terms of the environment VD applies in (compare Tables 2 and 3). While the overwhelming majority of *i-VD occurs post-tonically* (almost 91%) with a mere 9% applying pre-tonically, [u]-VD shows a strong tendency to be pre-tonic.

Table 2 gives more information on [i] VD (Column B). First, no [i] can delete, unless it is immediately adjacent to the stressed syllable (cf. rows 1, 4&5 vs. rows 2&3). For [i]'s that fail to delete even though they could (Column A), it doesn't really matter whether the segment is before or after stress: 49% of the [i]-tokens are post-tonic (rows 4&5) and 51% are pre-tonic (rows 1, 2&3). Of the latter, most occur exactly one syllable before the stressed one, whereas 9% appears 2, 3 or 4 syllables away from it. This can be seen as a strengthening phenomenon of the pre-tonic position, something that has been observed in other languages such as English (Turk & White 1999) and Spanish, Romanian and Portuguese (Chitoran & Hualde, 2007)[7].

Table 2. *The majority of [i] VD occurs post-tonically*

A. no deletion	ND #	ND %	**B. deletion**	D #	D %
Pre-tonic by 1σ	36	41.86	Pre-tonic by 1σ	12	9.16
Pre-tonic by 2σ	6	6.98	Pre-tonic by 2σ	0	0
Pre-tonic by 3-4σ	2	2.33	Pre-tonic by 3-4σ	0	0
Post-tonic medially	26	30.23	Post-tonic medially	50	38.17
Post-tonic finally	16	18.6	Post-tonic finally	69	52.67
Sum	**86**		**Sum**	**131**	

As for [u] (Table 3), roughly equal proportions fail to delete (although they could potentially) in either pre- or post-tonic position (2nd column). This is on a par with the [i]-ND results.

Table 3. *Tendency for [u] VD to occur pre-tonically*

	ND #	ND %	D #	D %
Pre-tonic	6	60%	7	87.5%
Post-tonic	4	40%	1	12.5%

A third asymmetry concerns where in the word VD occurs more often for each of the vowels [i] and [u]. Setting aside the voicing specifications of the surrounding consonants (that will be discussed in Section 5), a comparison between the two panels in Figure 9 reveals that overall i-deletion (left panel) occurs in all positions within the word (initial, medial, final), whereas u-deletion (right) appears almost exclusively word-initially.

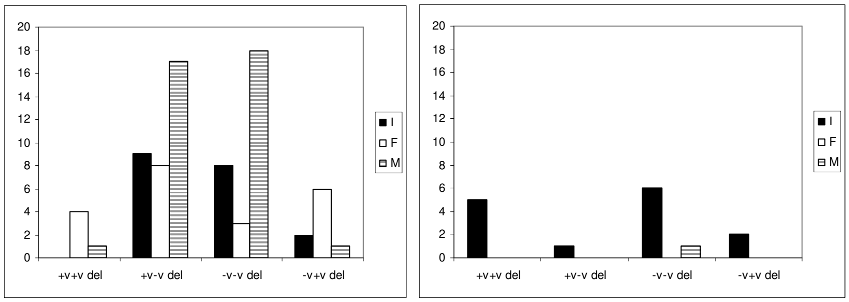

Fig 9. *Position within the word where i-deletion (left panel) and u-deletion (right) occur. i-deletion occurs in all positions within the word (initial, medial, final), u-deletion (right) is largely confined to the word-initial one.*

One final asymmetry between [i] and [u] crops up. Before we present it though, we need to describe another characteristic process of Northern Greek dialects, unstressed mid vowel-raising, whereby we get /peði/ → [piðí] 'child', /liɣo/ → [líɣu] 'a little'. In some dialects, raising and VD interact so that raising feeds VD, e.g. /peði/ → [piðí] → [pðí] in Mesolongi (Chatzidakis 1905: 261), but in most – including KG for the most part[8] – such chain shift is inapplicable. Consequently, surface high vowels may either originate from underlying high vowels or from underlying mid vowels /e/ and /o/ that raise to [i] and [u] respectively, when unstressed, due to vowel raising[9].

The fourth asymmetry then, relates to the source of surface high vowels: while only 30% of unstressed surface [i]'s hails from underlying /e/, the number for unstressed surface [u]'s differs significantly. Here, only 8% stems from underlying /u/ and the source of the remaining 92% is from input /o/. We also anticipate that KG underlying high vowels should delete when unstressed, but derived ones, should not. However, our prediction is not entirely borne out: 70% of unstressed surface [i]'s started high in the input too and should have deleted but did not, compared to only 8% of unstressed surface [u]'s failing to delete although they stemmed from underlying /u/.

To recap, we have identified four main asymmetries between [i] and [u] VD, summarised below:

- [u] deletes more than [i] (75% vs. 47%)
- [u]-deletion tends to be pretonic; [i]-deletion is overwhelmingly post-tonic
- [u]-deletion systematically occurs word-initially; [i]-deletion occurs in all positions in the word
- most remaining unstressed surface [u]'s are derived; most remaining unstressed surface [i]'s are underlying

All in all, our data thus reveal that [i] is more resistant to VD, whereas [u] tends to delete more. Similar results, albeit debatable (see Tsuchida 2001: 227), have been reported for Japanese (Han 1962, Maekawa 1983). The exact opposite situation emerges in Turkish (Jannedy 1995: 80), where [u] is slightly more resistant to VD than the other high vowels of Turkish [i y ɨ]. Differences in the application of high vowel deletion based on the vowel's quality thus seem to arise on a language specific basis (see also Gordon 1998: 103, fn. 15).

But, what is the cause for this asymmetry[10]? An obvious answer could be vowel duration. Recall that high Vs are usually subject to VD due to their short duration. It is thus conceivable that [u] is more prone to VD than [i], because it is shorter. SMG vowel measurements are not clear on this point; Nicolaidis (2003) finds that unstressed [u] is shorter than unstressed [i], whereas Fourakis et al. (1999) finds the reverse. In both cases the length difference is only about 7-9 ms, which is presumably hardly noticeable. Our own measurement for KG vowels shows that, on average, [u] is longer by 10ms than [i], contra our expectations. Again, the difference is not only small, but also more importantly, the standard deviation value is very large and if it is taken into account, then we cannot truly find a difference in duration between the two vowels.

The shorter-u duration hypothesis however cannot yet be eliminated. This is because the unstressed u-tokens in our data have been very few; hence, our duration measurement may not be entirely reliable. This apparent weakness is by no means intrinsic to our study. Instead, it relates to general vowel frequency effects. In a study of the occurrence frequency of all segments of Standard Greek undertaken by the Institute for Language and Speech Processing (ILSP), based on a corpus containing 148,333,836 SMG phone tokens (Protopapas et al, in prep.), unstressed [i] is the vowel occurring most frequently in SMG (22% among vowels), while unstressed [u] is the least frequent (4% among vowels), giving a 5:1 [i]:[u] ratio. Although no similar study has been conducted on the frequency count of dialectal vowels, our hypothesis is that there will not be great differences in the [i] – [u] ratios in KG either.

4. Discussion: Consonant Clusters

As mentioned previously, VD takes various manifestations ranging from full vowel maintenance to complete deletion, also allowing for intermediate stages of devoicing along the way. While it is at present unclear how to phonologically represent VD (see also Gordon 1998 for discussion) in KG, it seems reasonable to assume that at least in the instances of total vowel loss, various consonant clusters are created (henceforth: derived clusters)[11].

Regardless of their position in the word, many of these derived clusters are licit in SMG, but others appear as an innovation of this dialect.

(3) Derived clusters in KG & their correspondents – if extant – in SMG[12]

	Legal in both KG&SMG			Legal in KG only		
	2C	3C	4C	2C	3C	4C
Word-initially	pl,ft,sk, ts,sx,pt			dv,bs,ðʎ,θk, gnj,zn,mk		
Word-medially	lk,rz,ns,rɣ, rs,sk,fc,fk, xt,ɣð	str,rst, rks		θk,ʃk,zt,nʃ,tk, θc,ʃm,ss	mpʃ,ʃtc, lts	
Word-finally				çn,ʃn,sn,nɟ,ts, st,nt,ls,ks,ʎn, ps,ɟn,tr,rs	rsn,lts, tʃn,spr,skn, vsn,ksn,θkn	ndsn

Before attempting to analyse (3), a word of caution is in order. This is a by no means exclusive list of the clusters arising in SMG and KG. It just represents *derived* clusters that arose in our corpus of KG data. There are additional underlying clusters in both KG, as well as SMG. With this in mind, numerous observations can be made. First, the inventory of KG clusters is much richer than that of SMG. This is extraordinarily so in the case of word-final clusters that SMG totally lacks. Second, word-initial clusters present all possible sonority patterns that emerge according to the sonority hierarchy in (4).

(4) Sonority scale (> : more sonorous than…) [Gouskova 2004, Zec 2007]

Low Vs > Mid Vs > High Vs & Glides > Rhotics > Laterals > Nasals > Voiced Fricatives > Voiced Stops > Voiceless Fricatives > Voiceless Stops

In particular, we get sonority rises (pl, dv, zn, ðʎ), plateaus (pt, sx) and even reversals (θk, mk). Existence of plateaus and reversals is generally deemed not ideal for onset clusters, but proves unproblematic if one endorses Berent et al. (2007: 594) who state that: "In any given language: (a) The presence of a small sonority rise in the onset implies that of a large one. (b) The presence of a sonority plateau in the onset implies that of some sonority rise. (c) The presence of a sonority fall in the onset implies that of a plateau." (Berent et al. 2007: 594).

Word-medial biconsonantal clusters on the other hand, form for the most part fine coda-onset sequences, in line with the Syllable Contact Law (Hooper 1976, Vennemann 1988, Baertsch 2002, Gouskova 2001, 2004), which asks that sonority falls across syllable boundaries. Exceptions are: *tk*, *ss* (sonority plateaus), as well as *ɣð* and *ʃm*. The latter comprise a sonority rise, indicating that they are instead complex onsets. This idea is corroborated by the fact that *ɣð* and *zm* – akin to *ʃm* - are also found word-initially as underlying clusters, e.g. *ɣðérno* 'flay', *zmínos* 'flock'. Longer clusters, e.g. *str* may also constitute coda-onset sequences, containing either a complex onset (s.tr) or a complex coda (st.r)[13].

The majority of word-final clusters ends in /n/, followed by /s/ and then /r/ or /t/. Matters seem much more complicated here; assuming a syllabification that only involves complex codas, then we should only anticipate falling or, at worse, level-sonority codas. Instead, we also find rises, e.g. *tr*, *skn*. However, it is well-known that sequences of word-final consonants may commonly appear as extraprosodic or extrasyllabic (Vaux & Wolfe 2009, Goad to appear), thus escaping sonority considerations. Alternatively, and given that most of the clusters end in *n*, it is also possible to pursue an account that views such consonantal sonority-peaks as syllabic consonants.

The matter of fact is that we cannot at present offer a clearer picture of KG syllabification, since this requires a number of resources we currently lack; these include among others: syllable-counting perception experiments and, of course, additional data. We believe this matter partly accounts for an issue raised by a reviewer, namely the distribution of the consonants surrounding the VD-undergoing vowel. Differences in that respect may relate to syllabification issues as well as token frequency which may skew the distribution, for example the word [spit] from /spiti/ ('house') occurs several times in our data, therefore increasing the number of [t] tokens in C_1 word final position.

One thing is nonetheless certain; KG not only admits a richer inventory of clusters in all positions (cf. (3)), but it also concedes a wider range of final singleton codas than SMG. (5) lists those found word-finally in both dialects. It is evident that KG includes a much larger coda inventory. Besides [n, s, r] which occur as underived codas in both dialects, they also appear as derived ones after vowel deletion in KG, along with the remaining consonants below.

(5) Singleton codas in KG and SMG and representative examples

KG	n, s, r, m, ʎ, t, c, ts, ʃ, z, f, ð, v e.g. beθamén 'dead-FEM', ðjavás 'read-3SG', záxar 'sugar', m 'mine', óʎ 'all', spít 'house', sukác 'alley', ts 'of-FEM-SG-GEN', ʒíʃ 'live-3SG', ríz 'rice', céf 'exuberance', láð 'oil', nív ''bride'
SMG	n, s, r (very rarely)

5. Typological observations

Gordon's (1998) typological survey of VD compiles numerous properties of devoiced/voiceless vowels, many of which are also attested in KG VD (e.g. the gradience and usually allophonic nature of the phenomenon, token-by-token variation, the strong preference to devoice high vowels, etc.). Gordon additionally points out that voiceless vowels are usually favoured in particular positions within the word, primarily word-finally and then adjacent to voiceless consonants. To account for the attested patterns, he is inspired by work by Dauer (1980) and Jun and Beckman (1993, 1994) and offers two rather distinct explanations of vowel devoicing depending on the position within the word.

Word-finally, where devoicing is most predominant, the low subglottal pressure characteristic of that position is held responsible. Word-medially however, a gestural overlap account is promoted instead, whereby unstressed high Vs, intrinsically quite short in duration, are more susceptible to having their glottal adduction gesture overlapped by the glottal abduction gestures of neighbouring voiceless consonants. The gradience observed in this phenomenon is captured by the extent of this overlap—the more extensive the overlap, the more complete the devoicing.

This split in accounts has a welcome result. The word-final explanation works regardless of voicing considerations and is independent of the word-medial voicing explanation. Indeed, as the empirical facts reveal (both our own and cross-linguistically), final vowel devoicing disregards the voicing of neighbouring consonants (see Table 1, rows `e+f`). On the other hand, the overlap account word-medially specifically predicts that devoicing will more likely occur when a vowel is flanked by voiceless consonants both ways. It is also corroborated cross-linguistically since VD is indeed more frequent if both Cs are voiceless, followed by cases where C_2 is voiceless and finally where C_1 is voiceless (Gordon 1998: 98).

One final possibility has not yet been discussed, namely the case where VD takes place between *voiced* consonants. In Gordon's (1998) typological study of VD this pattern is omitted altogether, presumably because it never arises in any of the 55 languages in his survey[14]. Furthermore, to our knowledge, none of the VD accounts that employ gestural overlap has addressed this possibility.

We propose however that VD of this type occurs and that gestural overlap can extend to it too. In fact, 12% of KG VD occurs between voiced consonants, e.g. /ðuʎa/ → [**ðʎ**á] 'work, job', /duvarja/ → [**dv**árja] 'walls', /mariɣula/ → [ma**ɾɣ**úla] 'a female name' (cf. Fig. 10).

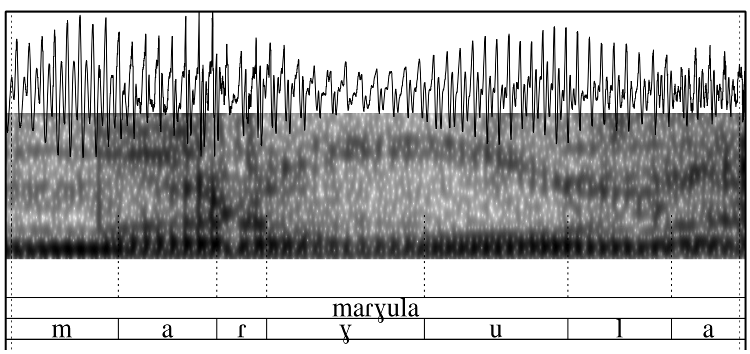

Fig. 10. *Complete i-deletion between voiced Cs in the word [maɾ̥iɣula] 'a female name'*

Recall that in this paper VD has been used as a cover term and does not specifically refer to vowel devoicing or vowel deletion. The latter two are just a couple of the stages encompassed by the phenomenon in question. What we predict then is that between voiced consonants all stages of VD should be able to emerge, save one, vowel devoicing itself[15]. This is because voiced consonants have a similar type of glottal gesture as vowels. Thus, none of the consonants can be associated with a devoicing gesture that could overlap into the vowel. Consequently, VD, with the exception of the devoicing stage, may occur.

Given the above, we hypothesise that word-medial VD as a phenomenon may appear between all types of consonants in terms of voicing. However, its possible realisations between voiced consonants form a subset of those emerging between other combinations of consonants. The hypothesised situation is schematised in (6). At present, we lack a sufficient number of data that can be adequately tested against such prediction; nonetheless, initial examination of the data at hand, seem to support our proposal. We anticipate that future work shall be able to offer a more conclusive answer.

(6) Stages of VD in the environment $C_1V_{[\text{high unstr.}]}C_2$

If C_1,C_2 = -voi	All stages are possible, but devoicing should be found here with the highest frequency
If C_1= -voi, C_2= +voi or C_1= +voi, C_2= -voi	All stages are possible, but devoicing should appear less frequently
If C_1,C_2 = +voi	All VD stages are possible with the exception of devoicing

Moreover, we contend that the gestural overlap account (GOA) alone is not sufficient to explain the full range of attested facts cross-linguistically. There are numerous other traits that it leaves unaccounted for, which should be further investigated. For example, GOA cannot explain why in Kozani Greek VD is much more frequent when C_2 is voiceless (row c) than when C_1 is (row b) (see Table 1 repeated here as Table 4), although the two patterns are identical in the sense that both share the presence of a –voi and a +voi consonant (but in different linear order).

Table 4. *VD frequency in different voicing environments. The last three columns show, from left to right, frequency in word medial positions (% medial), in word final position (% final), and in all positions considered together (Total %).*

Pattern	i	u	Total #	% of medial	% of final	Total %
a. -voi VD -voi	31	8	39	40.21		20.31

b. -voi VD +voi	10	2	12	12.38		6.25
c. +voi VD –voi	34	1	35	36.08		18.23
d. +voi VD +voi	6	5	11	11.34		5.73
e. -voi VD#	44	11	55		57.9	28.65
f. +voi VD#	35	5	40		42.1	20.83
TOTAL	160	32	192			100

A possible explanation for this asymmetry is already hinted at in Figure 9. Pattern c, i.e. +voi VD –voi, most frequently arises word-medially, contrary to pattern b, i.e. –voi VD +voi, which is only marginally manifested in that position. Results are more comparable for the word-final position, whereas word-initially c is found more often than b, but their difference is by no means as dramatic as it was word-medially[16].

The word-medial results can be understood if sonority is taken into consideration[17]. Recall from (4) that sonorants are more sonorous than voiced obstruents which in turn are more sonorous than voiceless obstruents. As shown before, VD – at least when interpreted as full elision – creates a consonant cluster. We propose that the reason VD occurs more often when it is to create $C_{[+voi]}C_{[-voi]}$ rather than $C_{[-voi]}C_{[+voi]}$ sequences is because such strings are analysed heterosyllabically and only the former offer good Syllable Contact (see Gouskova 2004)[18], that is, the transition from coda to onset is one of falling sonority, rather than rising.

Besides arguing that sonority is also at play in VD, we further speculate that its role is subordinate to that of GOA. Such an idea stems from the fact that in the current data pattern d is slightly less common than b. Based on the speculation outlined next, we believe that this difference will be bigger in a larger set of data. Evaluating the patterns of VD in Table 4 in terms of declining well-formedness, we get the order a > b, c > d for GOA and c > a, d > b for Syllable Contact preferences. Matching these to our frequency results, it must be that GOA is more important than Syllable Contact so that a is more widespread than c. Pattern c then follows, since it is next to best in GOA terms, but perfect in terms of sonority. This leaves us with b and d. Pressures here are conflicting; b > d for GOA, but d > b for Syllable Contact. If our reasoning is correct, then pattern b should be more frequent than d. The present results are compatible with this prediction, but are by no means conclusive. Perhaps, examination of additional data will shed light on this issue.

All in all, the *frequency* of VD as regulated by the flanking consonants largely seems to be a matter of GOA and sonority considerations.

By the same token, GOA alone is incapable of accounting for differences in the *nature* of VD. In prototypical VD, only voiceless consonants drive VD (Gordon 1998), whereas in KG their voicing value seems to be irrelevant. We can thus perhaps make recourse to the spreading of [-voi] (cf. McCawley 1968 and Teshigawara 2002 for Japanese) vs. the spreading of [αvoi], respectively. Alternatively, we can say that traditional VD is more phonological in that it involves [-voi] spreading, whereas KG VD is more phonetic, in that it reflects a more general reflex of gestural overlap regardless of the phonological specification of voicing.

Whatever the answer to this issue, it is clear that GOA is quite successful in capturing the gradience of VD (unlike any purely phonological account of [voi] spreading), but it too fails to be entirely accurate. If GOA is right for KG, then why doesn't VD between voiced consonants appear more frequently than it does? While we wouldn't expect devoicing to occur - for reasons explained above - other realisations of VD, especially elision itself, should be able to emerge, and yet they only do limitedly. Even more puzzlingly, Shiraishi (2003) finds that VD in Ainu applies to high vowels between voiceless consonants. However, the vowels in the syllables *pi*, *pu*, and *tu* never appeared devoiced or deleted in any of the 120 instances found in his recordings, even though they occur in the right devoicing environment. Consequently, GOA needs to be complemented by additional considerations, both phonological as well as language-specific.

6. Conclusion

In this paper, we have offered an acoustic analysis of Vowel Deletion /Devoicing in a dialect of Greek. We have principally investigated the environment, the acoustic correlates, the various realisation stages and the vowel quality differences in the application of VD. In doing so, we have examined the nature of the consonantal clusters in Kozani Greek and have found that a wider inventory than that of Standard Greek emerges. The range of codas is likewise much richer.

Beyond the descriptive goals of the paper, we have also seen that the Kozani Greek data are of much empirical value and have theoretical implications for the typology of VD. The presence of VD between voiced consonants is extremely rare and so far had been left unaccounted for by gestural overlap theories of VD. However, we have tentatively argued that gestural overlap can extend to this case too and have hypothesised its specific effects awaiting empirical confirmation.

References

Arvaniti, Amalia (1994) Acoustic features of Greek rhythmic structure. *Journal of Phonetics* 22: 239-268

Arvaniti, Amalia (1999) Illustrations of the IPA: Standard Greek. *Journal of the International Phonetic Association* 29: 167-172

Arvaniti, Amalia (2001) Comparing the Phonetics of Single and Geminate Consonants in Cypriot and Standard Greek. *Proceedings of the Fourth International Conference on Greek Linguistics*, pp. 37-44, Thessaloniki: University Studio Press

Baertsch, Karen (2002) *An Optimality-Theoretic Approach to Syllable Structure: The Split Margin Hierarchy*. Doctoral Dissertation, University of Indiana

Baltazani, Mary (2006) Focusing, prosodic phrasing, and Hiatus resolution in Greek. In *Laboratory Phonology 8*, Luis Goldstein, Douglas Whalen, Catherine Best (eds.), pp. 473-494, Berlin: Mouton de Gruyter

Baltazani Mary (2007a) Prosodic rhythm and the status of vowel reduction in Greek. In *Selected Papers on Theoretical and Applied Linguistics from 17th International Symposium on Theoretical and Applied Linguistics*, pp. 31-43, Thessaloniki

Baltazani, Mary (2007b) The effect of prosodic boundaries on syllable duration in Greek. Paper presented in *Old World Conference in Phonology 4,* Rhodes, 18-21 January 2007

Berent, Iris, Donca Steriade, Tracy Lennertz and Vered Vaknin (2007) What we know about what we have never heard: Evidence from perceptual illusions. *Cognition* 104: 591-630

Boersma, Paul and David Weenink (2009) Praat: doing phonetics by computer. Computer program; available at: http://www.praat.org/

Browning, Robert (1991) *Medieval and Modern Greek* [*Η ελληνική γλώσσα μεσαιωνική και νέα*]. 1st edition 1962, 2nd edition 1983; Greek edition 1991 Athens: Papadima Publications

Chatzidakis, Georgios (1905) *Medieval and Modern Greek* [*Μεσαιωνικά και Νέα Ελληνικά Α΄*]. Athens: P.D. Sakellarios

Chitoran, Ioana and Ayten Babaliyeva (2007) An Acoustic Description of High Vowel Syncope in Lezgian. *Proceedings of the 16th International Congress of Phonetic Sciences*, Saarbruecken, Germany, August 2007, pp. 2153-2156

Chitoran, Ioana and José I. Hualde (2007) From hiatus to diphthong: The evolution of vowel sequences in Romance. *Phonology* 24(1): 37-75

Dauer, Rebecca (1980) The reduction of unstressed high vowels in Modern Greek. *Journal of the International Phonetics Association* 10: 17-27

Delforge, Ann Marie (2008) Unstressed Vowel Reduction in Andean Spanish. In *Selected Proceedings of the 3rd Conference on Laboratory Approaches to Spanish Phonology*, Laura Colantoni and Jeffrey Steele (eds.), 107-124, Somerville, MA: Cascadilla Proceedings Project

Dinas, Kostas (2005) *The dialect of Kozani* [*Το γλωσσικό ιδίωμα της Κοζάνης*]. Kozani: Institute of Book and Reading

Eftychiou, Eftychia (2008) *Lenition processes in Cypriot Greek*. Doctoral Dissertation, University of Cambridge

Fourakis, Marios (1986) An Acoustic Study of the Effects of Tempo and Stress on Segmental Intervals in Modern Greek. *Phonetica* 43:172-188

Fourakis, Marios, Antonis Botinis and Maria Katsaiti (1999) Acoustic characteristics of Greek vowels. *Phonetica* 56: 28-43

Gafos, Adamantios and Angela Ralli. 2001. Morphosyntactic features and paradigmatic uniformity in two dialects of Lesvos. *Journal of Greek Linguistics* 2: 41-73

Goad, Heather (to appear) sC. In *Companion to Phonology*, Marc van Oostendorp, Colin Ewen, Beth Hume and Keren Rice (eds.), Oxford: Wiley-Blackwell

Gordon, Matthew (1998) The phonetics and phonology of non-modal vowels: a cross-linguistic perspective. *Berkeley Linguistics Society* 24: 93-105 [Available online at: http://www.linguistics.ucsb.edu/faculty/gordon/Nonmodal.pdf]

Gouskova, Maria (2001) Falling sonority onsets, loanwords, and Syllable Contact. In *CLS 37: The Main Session. Papers from the 37th Meeting of the Chicago Linguistic Society. Vol. 1* , Mary Andronis, Christopher Ball, Heidi Elston and Sylvain Neuvel (eds), Chicago: CLS

Gouskova, Maria (2003) *Deriving Economy: Syncope in Optimality Theory*. Doctoral Dissertation. University of Massachusetts, Amherst

Gouskova, Maria (2004) Relational hierarchies in OT: the case of Syllable Contact. *Phonology* 21(2): 201-250

Han, Mieko Shimizu (1962) Unvoicing of Vowels in Japanese. *Onsei no Kenkyuu* 10: 81-100

Hooper [Bybee], Joan (1976) *An Introduction to Natural Generative Phonology*. New York: Academic Press

Jannedy, Stefanie (1995) Gestural phasing as an explanation for vowel devoicing in Turkish. *OSU Working Papers in Linguistics* 45: 56-84

Jun, Sun-Ah and Mary Beckman (1993) A gestural-overlap analysis of vowel devoicing in Japanese and Korean. Paper presented at the 67th Annual Meeting of the Linguistic Society of America. Los Angeles, CA

Jun, Sun-Ah and Beckman, Mary (1994) Distribution of devoiced high vowels in Korean. Proceedings of the 1994 International Conference on Spoken Language Processing, vol. 1, pp. 479-482

Kondo, Mariko (1994) Is vowel devoicing part of the vowel weakening process? In *Proceedings of the Edinburgh Linguistics Department Conference 1994*, pp. 55-62

Kondosopoulos, Nikolaos (2000) *Dialects and Idioms of Modern Greek* [*Διάλεκτοι και Ιδιώματα της Νέας Ελληνικής*.] 3η έκδοση, Αθήνα: Εκδόσεις Γρηγόρη

Kouziakis, Lazaros (2008) *I've heard, I've been told and I've written* [*Άκ'σα, μ'είπαν κι έγραψα*]. Kozani

Loukina, Anastassia (2008) Regional phonetic variation in Modern Greek. Doctoral Dissertation, University of Oxford

Maekawa, Kikuo (1983) Kyootsuugo-ni Okeru Boin-no Museika-ni Tsuite [On Vowel Devoicing in Standard Japanese]. *Gengo-no Sekai* 1: 69-81

McCawley, John D. (1968) *The Phonological Component of a Grammar of Japanese*. The Hague: Mouton

Mo, Yoonsook (2007) Temporal, spectral evidence of devoiced vowels in Korean. In the *Proceedings of the 16th International Congress of Phonetic Sciences*, Saarbrücken 2007

Newton, Brian (1972) *The Generative Interpretation of Dialect: A Study of Modern Greek Phonology*. Cambridge: Cambridge University Press

Nicolaidis, Katerina (2001) An electropalatographic study of Greek spontaneous speech. *Journal of the International Phonetic Association* 31: 67-85

Nicolaidis, Katerina (2003) Acoustic variability of vowels in Greek spontaneous speech. *Proceedings of the 15th International Congress of Phonetic Sciences*, pp. 3221-3224, Barcelona

Papadopoulos, Anthimos (1927) *Grammar of Modern Greek Northern Idioms* [*Γραμματική των Βορείων Ιδιωμάτων της Νέας Ελληνικής*]. Athens: P.D. Sakellarios

Protopapas, Athanassios, Marina Tzakosta, A. Chalamandaris, & P. Tsiakoulis (in preparation). IPLR: An online resource for Greek word-level and sublexical information. Athens: Institute for Language and Speech Processing

Shiraishi, Hidetoshi (2003) Vowel devoicing of Ainu: How it differs and not differs from vowel devoicing of Japanese. In *A New Century of Phonology and Phonological Theory, A Festschrift for Professor Shosuke Haraguchi on the Occasion of His Sixtieth Birthday*, T.Honma, M. Okazaki, T. Tabata and S. Tanaka (eds.), pp. 237-249, Tokyo: Kaitakusha

Teshigawara, Mihoko (2002) Vowel Devoicing in Tokyo Japanese. In *Proceedings of the North West Linguistics Conference* 2002, G.S. Morrison & L. Zsoldos (eds.), pp. 49-65, Burnaby, BC, Canada: Simon Fraser University Linguistics Graduate Student Association

Trudgill, Peter (2003) Modern Greek dialects: a preliminary classification. *Journal of Greek Linguistics* 4: 45-64

Tsuchida, Ayako (2001) Japanese Vowel Devoicing: Cases of Consecutive Devoicing Environments. *Journal of East Asian Linguistics* 10: 225–245

Turk, Alice and White, Lawrence (1999) Structural effects on accentual lengthening in English. *Journal of Phonetics* 27: 171-206.

Vaux, Bert and Andrew Wolfe (2009) The appendix. In *Contemporary Views on Architecture and Representations in Phonology*, Eric Raimy and Charles Cairns (eds.), pp. 101-143. Cambridge, MA: MIT Press

Vennemann, Theo (1988) *Preference laws for syllable structure and the exploration of sound change*. Berlin: Mouton

Zec, Draga (2007) The Syllable. In *The Cambridge Handbook of Phonology*, Paul de Lacy (ed.), pp. 161-194, Cambridge: Cambridge University Press

Appendix

The following table gives examples of words illustrating clusters occurring in KG which are illicit in SMG. The columns show the cluster (column a), the word as it is pronounced in KG (b), as it is pronounced in SMG (c) and its gloss (d).

a. Cluster	b. Word in KG	c. Word in SMG	d. Gloss
	WORD INITIAL		
dv	[dvarja]	[duvárja]	‘walls’
bs	[bso]	[misó]	‘half’
ðʎ	[ðʎa]	[ðuʎá]	‘work’
θk	[θkos]	[ðikós]	‘my own’
zn	[zn]	[stin]	‘at the’
mk	[mkros]	[mikrós]	‘small’
ʃk	[ʃkóθkan]	[sikóθikan]	‘rose 3-PL’
	WORD MEDIAL		
zt	[terjázti]	[terʝázete]	‘fit 2-PL’
nʃ	[ʝitónʃes]	[ʝitónises]	‘neighbours’
ʃm	[meʃmér]	[mesiméri]	‘noon’
θk	[ðéθkami]	[ðeθíkame]	‘tied ourselves’
θc	[apulíθcin]	[apolíθice]	‘was released 3-SING’
mpʃ	[ampʃós]	[anipsjós]	‘nephew’
	WORD FINAL		
çn	[içn]	[íçe]	‘had 3-SING’
ʃn	[plúʃn]	[pulúse]	‘sold 3-SING’
ls	[bakáls]	[bakális]	‘grocer’
ts	[pulíts]	[polítis]	‘civilian’
rs	[tésers]	[téseris]	‘four’
rsn	[çírsn]	[ʝírise]	‘came back 3-SING’
lts	[vanɟélts]	[vanɟélis]	‘Vangelis (male name)’
tʃn	[krátʃn]	[krátise]	‘kept 3-SING’
skn	[tirjáskn]	[terjástike]	‘fit 3-PL’

* We gratefully acknowledge Lasse Bombien and two anonymous reviewers for instructive comments and suggestions. The usual disclaimers apply.

[1] We thank an anonymous reviewer for asking this question.

[2] In Jun & Beckman (1993, 1994) the causation chain is the reverse: aspirated consonants cause devoicing and not the other way round.

[3] An anonymous reviewer correctly points out that what we have called aspiration may be frication at the release of a coronal stop into the narrow constriction of a high vowel, explaining the difference between [t] and [c] on one hand and [p] and [k] on the other. This distinction merits further exploration, however, the fact remains that regardless of the exact phonetic nature of this interval, in VD environments the period between the burst of a stop and the onset of the next segment is longer than in non-VD environments.

[4] In the graphs below, the following symbols have been used for convenience: sh = ʃ, xj = ç, nj = ɲ, lj = ʎ.

[5] Prosodic position has also been argued to affect VD. For example, positions where prosodic lengthening occurs are less likely to induce devoicing or deletion (Jun & Beckman 1994 and references therein). Table 1 reveals that almost half the VD tokens occur word-finally, something that could be difficult to explain if Greek exhibits word-final prosodic lengthening. However, as shown in Baltazani (2007b), SMG exhibits phrase-final but no word-final lengthening. Furthermore, among the tokens in our corpus with word final VD, only 18 out of the total 95 occur phrase finally—the remaining 77 occur in a phrase medial position. Even in those 18 phrase final VD tokens, we observed considerable lengthening of the final consonant and, in many occasions, of the vowel in the preceding syllable.

[6] More specifically, 29 tokens delete and 10 do not. Of the deleted ones, 21 are in monosyllables, mostly articles (tu, tus) or pronouns (mu). The remaining 8 occur in larger words and are the ones considered in Table 4 below.

[7] Thanks to a reviewer for pointing this connection out.

[8] We say 'for the most part', because on occasion we have also seen VD of /e/ or /o/ in our data, e.g. /istera/ → [ístra]. It is possible to argue that such forms are under the influence of neighbouring dialects, e.g. the Velvendos dialect (Velvendos is a town 33km NE of Kozani), where raising feeds VD. In that view, we must assume an intermediate stage of vowel raising, i.e. [ístira], that subsequently underwent VD.

[9] An anonymous reviewer raised the subject of whether there are contexts in which this stem and others like it surface with a mid vowel. Although this stem does not surface with a mid vowel and therefore its derivation from [e] is opaque in the dialect, there are other stems where [é] and [i] alternate in a paradigm making the reason for non-deletion of the unstressed [i] transparent, e.g., [cifáʎ] 'head' ~ [punucéfalus] 'headache', [kasirác] 'cheese-diminutive' [kasér] 'cheese', etc.

[10] A reviewer makes a very interesting suggestion regarding potential differences in the morphosyntactic load of /i/ and /u/ (cf. Gafos and Ralli 2001). Greek is highly inflectional and /i/ seems to be carrying more morphosyntactic features than /u/. If that is the case, then its deletion would endanger its recoverability more than the deletion of /u/. This hypothesis definitely merits exploration to be carried out in future work.

[11] No consonant clusters are created, of course, in cases of non complete deletion. Even in tokens without any spectral evidence of vowel presence, however, we cannot safely assume that speakers perceive acoustically adjacent consonants as consonant clusters. There is a possibility that speakers still have a vowel in their phonological representation and what we

treat in the following discussion as consonant clusters are not really such in the speakers' mind.

[12] See the Appendix for words containing these clusters.

[13] On the special status of /s/ in clusters and various other possibilities of syllabification, see Goad (to appear).

[14] Dauer's (1980) study on Standard Greek reports the same results regarding the distribution of VD, although she claims that instances where VD occurs after voiceless C_1 are somewhat more frequent than those where C_2 is voiced. She also states that reduction between voiced Cs happens but is highly rare, which is why she totally disregards it in the ensuing discussion.

[15] Such devoicing does arise in KG as shown in Figure 11.

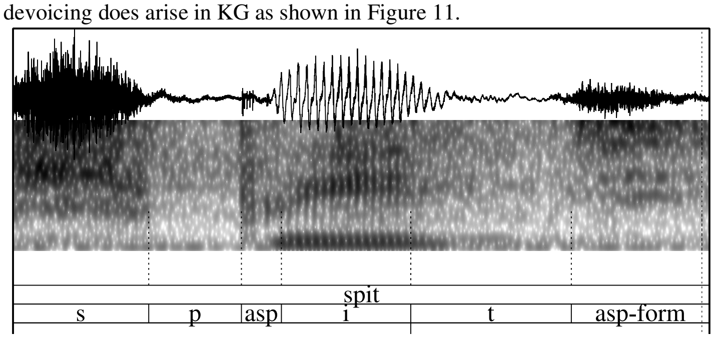

Fig. 11. *Final i-deletion in the word [spit], accompanied by aspiration and formant structure, but no voice bar*

[16] Only the left panel of Fig. 9 is used here, since the right panel contains too few data to allow us any claim. Also, reference is solely made to the word-medial position, since it is the one that shows the most systematic effects.

[17] Thanks to Lasse Bombien for suggesting this line of thought to us.

[18] The $C_{[-voi]}$ $C_{[+voi]}$ string implies either the sequence T-S or T-D where S=sonorant, T=voiceless obstruent, D=voiced obstruent. In a heterosyllabic analysis, both are ill-formed in terms of Syllable Contact, however, we cannot rule out the possibility of a tautosyllabic analysis in tems of complex onsets, e.g. TS. Such cluster would be well-formed, but TD would not (for reasons having to do with consonant phonotactics in Greek). At present, we assume that heterosyllabic syllabification is preferred over tautosyllabic one for derived consonant clusters, a matter that requires further investigation though.