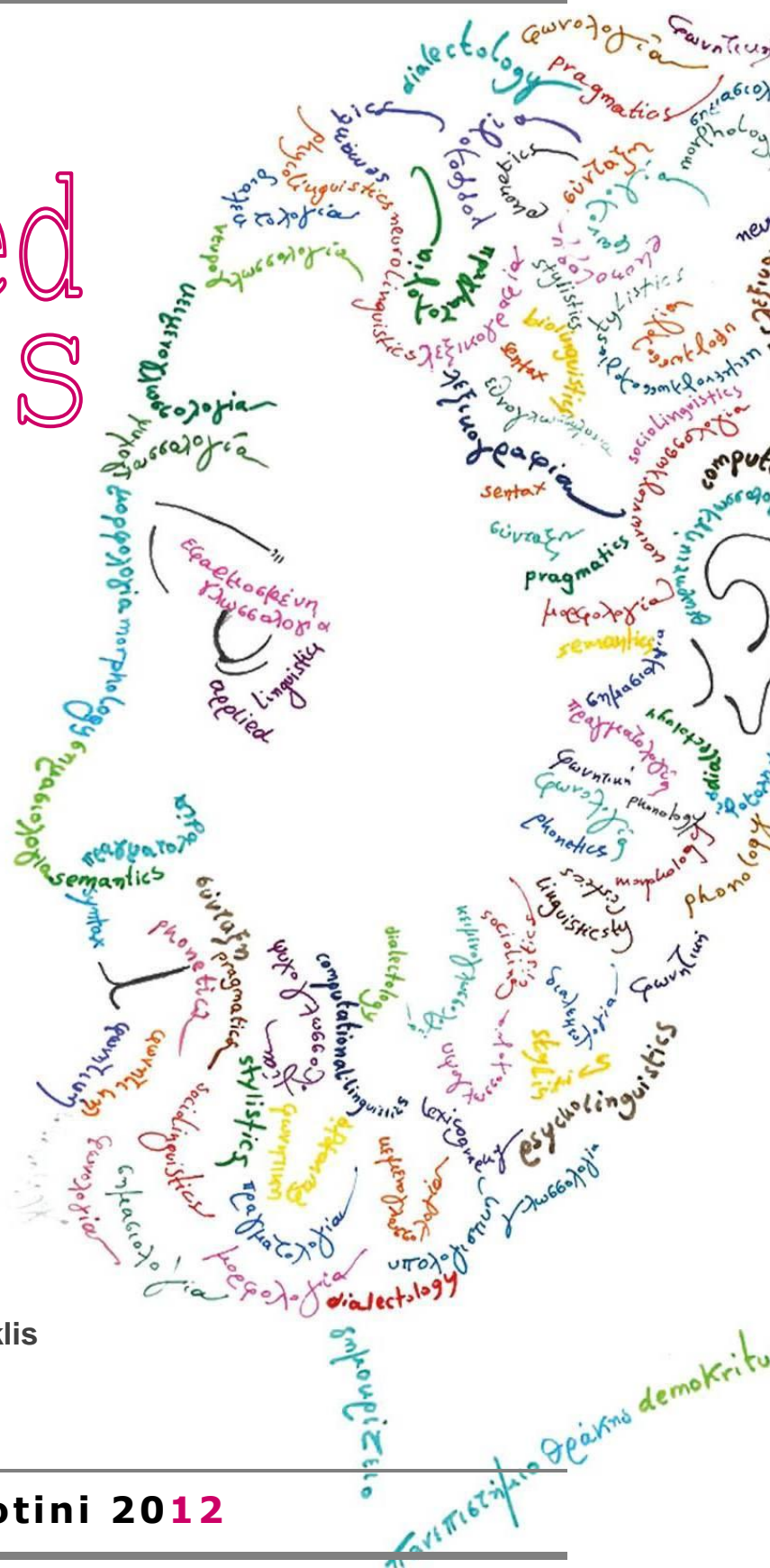


the **10th**
**International
Conference of
Greek
Linguistics**

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Komotini 2012



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■ **ISBN 978-960-99486-7-8**

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ON SOME PHONETIC AND PHONOLOGICAL PROPERTIES OF THE GREEK GLIDE

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ABSTRACT

This paper presents preliminary results of two experiments investigating acoustic characteristics of the glide in several environments in Greek. We show that the phonological claims of Topintzi&Baltazani (to appear) regarding the phonemic status of both /i/ and the glide /j/ as well as of the existence of two separate palatalization processes (simple vs. extreme) are phonetically supported. In the first experiment, different degrees of curvature in the F2 trajectory and different transition rates distinguish /Vi/ hiatuses from /Vj/ diphthongs. The second experiment supports the distinction between simple and extreme palatalization as signaled by durational and formant differences.

Keywords: Glide, diphthong, hiatus, palatalization, onglide transition, duration, formant trajectory, transition rates

1. Introduction and Aims

Considerable literature has been devoted to understanding the perplexing phonological distribution of the Greek glide because of its propensity to act both as an independent phoneme and as an allophone of /i/ (Mirambel 1959; Koutsoudas 1962; Householder 1964; Kazazis 1968; Setatos 1974; Warburton 1976; Nyman 1981; Malavakis 1984; Nikolopoulos 1985; Deligiorgis 1987; Malikouti-Drachman&Drachman 1990; Rytting 2005; Topintzi&Baltazani (to appear)). All previous analyses, however, have been relying on an impressionistic characterization of this segment, since an analysis of its phonetic nature is still lacking¹.

In this paper, we attempt to understand the nature of the glide by examining its acoustic properties in several environments, invoke new questions and provide insights to segments related to it, such as the palatals². Standard Modern Greek has a palatal glide³, whose phonetic realization depends on the phonetic environment, its position within the syllable, and, according to the acoustic results in this paper, on the morphophonological environment. Roughly speaking, postconsonantly it emerges as a fricative (voiced [j] or voiceless [ç]), but if there's a /l/ or /n/ directly preceding it, it surfaces as palatal lateral [ɭ] or nasal respectively [ɲ]. Postvocally however, it has been impressionistically claimed to surface as a true approximant [j] (references), a fact that we phonetically establish for the first time in the present work. Note that whenever our focus is on phonology and not phonetics, we will be using the shorthand GLIDE or /J/ to refer to all the possible realizations of this segment. The paper is structured as follows: Section 2 addresses phonological issues of the glide and poses questions that the phonetic investigation in §3 and §4 seeks to answer. In particular, §2.1 examines phonological diagnostics that differentiate the glide from the front high vowel. §2.2 summarizes a recent phonological analysis of the postconsonantal glide/onglide (Topintzi&Baltazani (to appear)), also presently adopted. Section 3 presents the first experiment –dealing with the phonetics of postvocalic glides and section 4 presents the second experiment

¹There is only a brief mention in Arvaniti (1999, 2007), where the glide is described as a palatal fricative.

²Note that in the articulatory analysis of Nicolaidis (2003) these segments are described as palatalized velars.

³ This is not true for other dialects. For example, Baltazani&Topintzi (2010) show that Northwestern Greek dialects also exhibit the glide [w].

examining postconsonantal glides. Finally, in section 5 we offer a discussion on the implications for the analysis and understanding of the glide.

2. (Morpho)phonology of the glide

2.1 Glide vs. /i/ diagnostics

Identification of a /V+highvocoid/ sequence as involving an autosegmental [Vj] or a heterosyllabic [V.i] string is not straightforward for native Greek speakers. We offer several diagnostics, however, which facilitate the task. Notably, the fact that [i] and [j] are distinct from one another in the same environment corroborates the idea that both these sounds are phonemic in the language. Diagnostics A-C are useful for the detection of postvocalic glides, while Diagnostic D for the detection of postconsonantal ones. To begin with, consider how the trisyllabic window constraint of Greek stress (restricting the appearance of stress on the final three syllables of a word) enlightens us on glide identification. Forms in (1a) must contain a glide, since otherwise stress would be on the pre-antepenult, which is illicit. For the examples in (1b) though this issue is irrelevant, given that either syllabification respects the trisyllabic window.

(1)	Diagnostic A: Trisyllabic stress window		
	<i>Antepenult</i>	<i>Pre-antepenult</i>	<i>Gloss</i>
(a)	ɣáj.ða.ros ⁴	*ɣá.i.ða.ros	“donkey”
	xáj.ðe.ma	*xá.i.ðe.ma	“caressing”
(b)	ne.ráj.ða	ne.rá.i.ða	“fairy”
	psa.ro.káj.ko	psa.ro.ká.i.ko	“fishing boat”

Tokens of the (1b) type thus warrant a different diagnostic. This comes from the so-called enclitic stress (ES) that appears on words normally stressed on the antepenult when followed by a possessive clitic, *mu* “my”, *su* “your”, etc. In such instances, a second, enclitic, stress emerges as illustrated below. We abstract away from the issue of which stress is considered primary and which secondary.

(2)	Diagnostic B: Enclitic stress		
	<i>Enclitic stress</i>	<i>No enclitic stress</i>	<i>Gloss</i>
(a)	án.θro.póz mu	*án.θro.poz mu	“my person”
(b)	psa.ro.ká.i.kó mu	*psa.ro.káj.ko mu	“my fishing boat”
(c)	*ne.rá.i.ða mu	ne.ráj.ða mu	“my fairy”

(2a) exemplifies normal application of ES without the presence of any vocoid. The antepenultimately-stressed [án.θro.pos] receives an additional stress on the ultima once the clitic attaches to it. (2b) shows application of ES which is only possible if we assume that the /V+highvocoid/ sequence is heterosyllabic. (2c) on the other hand demonstrates that an offglide has to be assumed since no-ES appears.

The third diagnostic also employs stress. Under certain types of prefixation, e.g. with [paʎo-] ‘old-’, [θeo-] ‘god-’ or [pan-] ‘all’, among others, stress shifts from its original position and retracts to the antepenult. Once more, if these prefixes attach to words containing vocalic sequences in the right position, we can spot the difference between /i/ and /j/.

(3) Diagnostic C: prefixation		
(a)	[kaíci] “small boat”	pa.ʎo.ká.i.ko *pa.ʎó.kaj.ko “old small boat”
(b)	[xaváni] ⁵ “jackass”	pa.ʎo.xáj.va.no *pa.ʎo.xa.í.va.no “rotten jackass”

⁴Throughout the paper the /r/ symbol is used for the Greek rhotic instead of the tap for practical reasons. Similarly, the vowels are transcribed as /i, e, a, o, u/. For a description of the quality of the Greek vowels, see Arvaniti (1999, 2007).

⁵ We use the Greek grapheme *iota* *i* here to indicate that either [i] or [j] would be compatible with this example. Of course, once we apply our diagnostics, its true nature becomes clear.

The final diagnostic to consider here applies to postconsonantal positions, thus it differentiates between /i/ and the onglide. As becomes evident through the near-minimal pairs of (4), /i/ and /J/ are contrastive.

- (4) **Diagnostic D:** minimal pairs
- | | | | |
|----------|-----------------|---------|--------------------|
| á.ði.a | “permission” | á.ðja | “empty-FEM-NOM-SG” |
| sci.á.zo | “shade” | scá.zo | “scare” |
| pi.é.ste | “press-2PL-IMP” | pç'este | “drink-2PL-IMP” |
| ó.pi.o | “opium” | ó.pço | “whichever” |

The picture though is not as yet complete. While /i/ and /J/ indeed contrast, there are also cases where they alternate with one another, indicating an allophonic relationship too. A well-known and highly productive alternation of this type arises in the paradigm of neuter nouns ending in *-i*.

- (5) [i]~[j] alternations
- | | | | |
|----------|----------|-----------|-----------|
| pó.ði | “foot” | pó.ðja | “feet” |
| ðo.ká.ri | “girder” | ðo.kár.ja | “girders” |
| má.ti | “eye” | má.tça | “eyes” |

2.2 Summary of Topintzi&Baltazani (to appear)

To account for the observation that /i/-/J/ can both contrast as well as alternate, we adopt a recent analysis in Topintzi&Baltazani(to appear), whereby we suggest that both /i/ and /J/ are phonemes that can neutralize in specific contexts due to morphophonological pressure. In particular, it is claimed that word-internal hiatus is generally admitted in the language (IDENT-IO[±voc] >> *VV⁶). This means that an underlying glide and an underlying high front vowel normally surface intact, as for instance, in [xaj.vá.ni] “jackass” vs. [la.i.kós] “public”. The contrast however is neutralized under the influence of the paradigmatic constraint requiring an identical number of syllables throughout a paradigm (OP-Faith-σ#) and the ranking in (7).

- (6) OP-Faith-σ#: Words in a paradigm have an identical number of syllables (cf. Bat-El 2008)
- (7) *i-J alternation vs. lack thereof*
OP-Faith-σ# >> IDENT-IO[±voc] >> *VV

This explains why hiatus is tolerated throughout the paradigm of nouns ending in <-io>, e.g. ðomátio - ðomatíu “room-NOM.SG.” vs. “room-GEN.SG”, but is resolved in the nouns in <-i>, e.g. ðemáti - ðematçú “sheaf-NOM.SG.” vs. “sheaf-GEN.SG”. While in the former case the number of syllables across the paradigm remains constant and thus hiatus is permitted⁷, the only way to keep the number of syllables identical in the latter example (and simultaneously conform to the language’s phonotactics) is through i-J alternation. For details and the technical aspects of the analysis, see Topintzi&Baltazani (to appear).

The analysis of the glide has welcome extensions for the understanding of Greek palatals in general. For starters, consider the fact that the examples [pó.ði - pó.ðja] “foot - feet” and [ní.çi - ní.ça] “nail - nails” are morphophonologically comparable and thus ought to receive the same account. In addition, notice that the palatal in the NOM.SG. [ní.çi] corresponds to palatalization as velar fronting before a front vowel, whereas the palatal in the NOM.PL. [ní.ça] is more complex, since it should also involve gliding, in analogy to [pó.ðja].

We thus propose that there are two types of phonological palatalization in Greek. The former is termed *simple palatalization* and occurs in underived environments, as in [cípos] “garden”. It can be schematized

⁶ We adopt Nevins’ and Chitoran’s (2008) view that the feature that distinguishes vowels from glides is [+/- vocalic]. Vowels are [+voc], glides are [-voc]. Glides thus can pattern with vowels because they share [-cons] and can pattern with consonants because they share [-voc].

⁷ OP-Faith-σ# would also be satisfied if the paradigm wholly contained a glide, e.g. [ðomátço - ðomatçú], but this would cause unnecessary IDENT-IO [±voc] violations. Of course, one also predicts such paradigms stemming from words with input glides. This prediction is borne out, e.g. [psóño - psóñu] “shopping”.

as *Velar+i,e* → *Palatal+i,e*. The second type comes under the name of *extreme palatalization* (cf. Bateman 2007 and references therein) and involves the palatalization of a consonant (either a velar obstruent or n, l) before a glide, which subsequently gets to be absorbed by the newly created palatal. Thus, schematically: *Velar/Alveolar+J+V* → *Palatal+V*. We additionally claim that extreme palatalization not only occurs in derived environments, cf. [ní.ça], but also in underived ones, e.g. [çóni] “snow”. Consequently, palatals in Greek – apart from /j/, that is – are always derived and originate from either plain velars (simple palatalization) or from velars + J (extreme palatalization). Notably this analysis accounts for the seemingly phonemic nature of palatals in minimal pairs like [xóni] “sticks in” vs. [çóni] “snow”, [náta] “there they are” vs. [náta] “youth”, among others.

2.3 Experimental questions

The preceding phonological discussion generates a number of interesting questions about the phonetic character of the glide, which, to our knowledge, have not been investigated in Greek. This paper forms part of a bigger project which addresses these issues testing the /i/ vs. /j/ phonemic hypothesis and the distinction among the three palatalization processes outlined above. Here we present results from a subset of the speakers that were recorded and of the measurements that have been planned (see below for details). In §3 we present findings regarding /V+high front vocoid/ sequences (henceforth postvocalic environments) and in §4 /palatal C+V/ sequences (postconsonantal environments).

3. Experiment 1 – postvocalic environment

In postvocalic environments, it is not always clear whether /V+high front vocoid/ sequences are hiatuses (vowel-vowel) or diphthongs (vowel-glide). The diagnostic tests (section 2.1) are moot in words with final or penultimate stress after the /V+high front vocoid/ sequence. As a result of this limitation, we decided to inspect sequences where our diagnostic tests do distinguish between /V+i/ and /V+j/ for acoustic differences between them.

3.1 Methodology

We report preliminary results from four female speakers, AM, SL, VM and PM, who were recorded in a quiet room with a head-mounted microphone directly into the computer, reading the material presented to them in random order on slides on the computer screen, at a comfortable speed. After manual segmentation of the target segments (see below for criteria), durations of palatal segments and their surrounding vocoids (/i/ and /j/), as well as formants of vocoids were automatically obtained using Praat scripts (Boersma & Weenink 2007).

20 words were used (Table 1) in two vocoid (/j/ or /i/), two stress (stressed/unstressed preceding V) and two focus (focussed/unfocussed word) conditions. Table 1 presents the materials: the first two columns show the 10 words that contained a [V+i] sequence and the last two columns the 10 words with a [V+j]⁸ sequence (5 with a stressed and 5 with an unstressed V). The target words were embedded in a sentence (a) without focus [leo ___ ksana] “I say ___ again” and (b) with focus [ipa ___, oxi ___] “I said x, not y”, where y is a word contrasting with x. The resulting corpus contained 160 tokens (4 speakers X 20 words X 2 focus conditions).

⁸No consistent terms are used in the literature for these sequences. From here on, we call tautosyllabic sequences ‘diphthongs’ and heterosyllabic ones ‘hiatuses’.

Stressed [i]	Unstressed [i]	Stressed [j]	Unstressed [j]
táizma “feeding”	aθinaikós “athenian”	xájdēma “caressing”	majmú “monkey”
psarokáiko “fishing boat”	mosaikó “mosaic”	nerájða “fairy”	kajmáci “cream”
áipnos “sleepless”	laikós “folksy”	májna “mynah”	majdanós “parsley”
máios “May”	aploikós “simplistic”	korójðo “sucker”	xajváni “jackass”
vúizma “buzzing”	plainí “side”	yájðaros “donkey”	xajmalí “amulet”

Table 1 Material for Experiment 1

According to the cross-linguistic literature the most consistent index for the glide/i distinction is the F2 transition trajectory (Gay 1968; Ren 1986; Aguilar 1999). Fast transitions are interpreted as a diphthong whereas slow ones are interpreted as a hiatus (cf. Chitoran 2002). F2 values for [i] and [j] were automatically measured through a Praat script at 0%, 25%, 50%, 75%, 100% points and the range of the F2 curvature was determined by the difference between the maximum frequency value and the values at the beginning and end points. The rate of F2 change was calculated by dividing the start-max distance in frequency by the corresponding distance in time, and the durations of [i] were compared to those of [j] across stress and focus conditions. Examples illustrating the criteria for segmenting the vowel from the following [j/i] are provided in 3.2.

3.2 Segmentation

The onset and offset of the vocalic sequence were marked at the onset/offset of periodicity next to a stop closure, burst, or noise, or next to a frication period, and as the beginning/end of a larger period or greater amplitude next to nasals or liquids.

The [V+i] sequences (Figure 1) were the most straightforward to segment, as they typically had two steady states, one for each vowel. In the sequence /ai/ from the word /plainí/ “side” produced by speaker AM, the boundary between the vowel and the following /i/ is marked at the end of the steady state for /a/. The entire transition from the steady state of /a/ to the steady state of /i/ has been included in /i/ so that the curvature in the F2 trajectory could be compared across experimental conditions. Notice also that there is a change in amplitude at the F2 transition onset, a common occurrence in our data. We followed this method for all hiatus tokens.

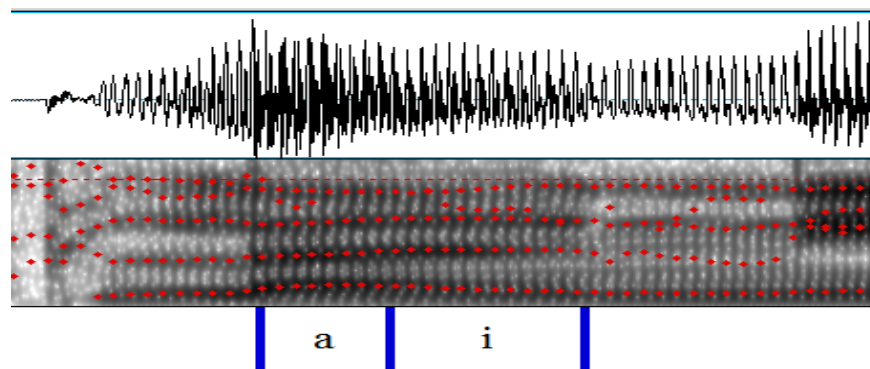


Figure 1 Speaker AM, /plainí/ “side”. There is a clear steady state in both V1 and /i/ in this example and the F2 transition onset from /a/ to /i/ is clear. There is also a change in amplitude at the F2 transition onset

The [V+j] sequences were frequently much more difficult to segment, as the typical structure for diphthongs showed a continuous transition from V to [j] and no steady state was easily discernible, as Figure 2 illustrates. The sequence shown is [aj] from the word [majdanós] “parsley”. We followed criteria used for Chinese diphthongs in Ren (1986) and Romanian in Chitoran (2002), to define the transition onset from V to the [j] as the lowest F2 value at the end of V, before a rise of at least 20 Hz. The change in amplitude in the waveform at the F2 transition onset is visible in this example, as well.

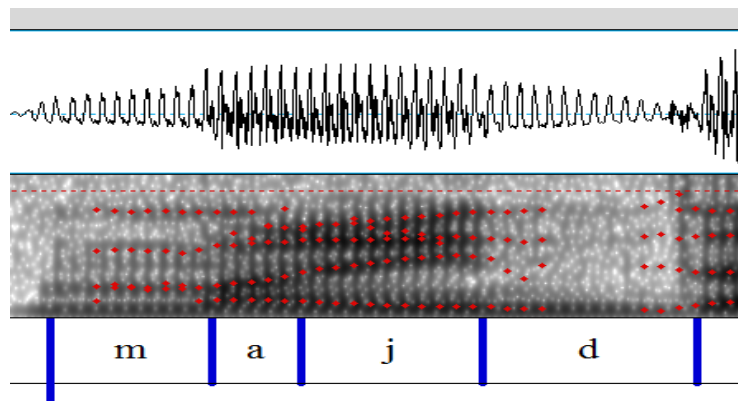


Figure 2 Speaker AM, [majdanós] “parsley”. This example illustrates tokens that were difficult to segment since no clear steady state is discernible

3.3 Results

The results did not show duration differences between hiatuses and diphthongs; they did, however, show differences in F2 transition values. Duration results are presented first.

The duration of [i] and [j] showed variability across speakers, segments and focus conditions. Figure 3 shows representative results of the average durations across tokens for two out of the four speakers analysed, AM (top) and PM (bottom). Stressed [i] and [j] were longer than their unstressed counterpart. Apart from that, no other general trend can be observed to differentiate hiatuses from diphthongs. Notice for example that while focussed and stressed [i] and [j] are longer than unfocussed ones for speaker AM, the same does not hold for speaker PM. Moreover, focussed unstressed [j] is longer than [i] for AM, but the opposite holds for PM. These results, although tentative since they are based on a small number of speakers, suggest that duration cannot safely differentiate between hiatuses and diphthongs.

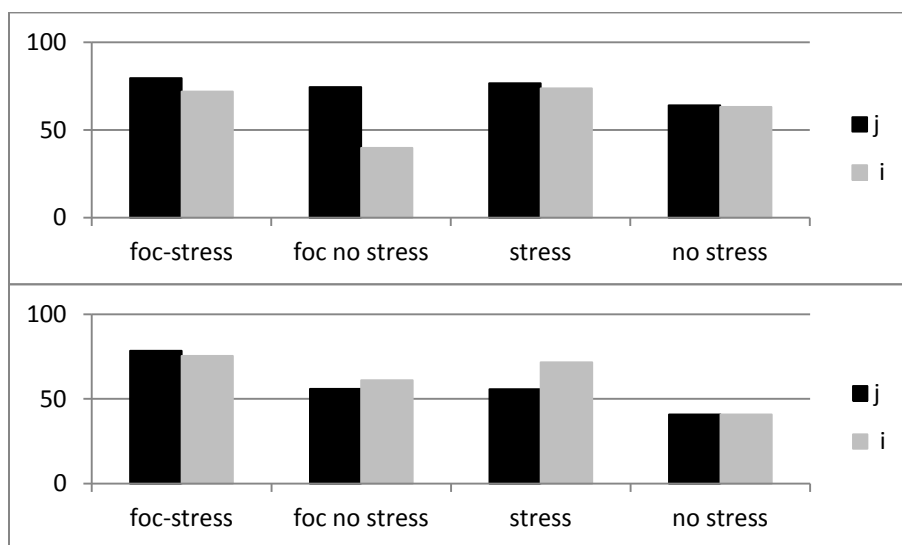


Figure 3 Duration of [i] and [j] in vocalic sequences across stress and focus conditions shown for two of the four speakers, namely AM (top), PM (bottom)

Evidence of a difference between a [Vi] hiatus and a [Vj] diphthong was evident, however, in the F2 comparisons, where, a greater F2 curvature was observed for [j], resulting from a greater difference between the maximum F2 value and the start and end values, as shown in Figure 4. Comparable results were found for the other two speakers. In addition to the greater F2 curvature, much less variability is exhibited in the beginning, max and end point values for [j] than for [i], suggesting less articulatory freedom for the former. Stress and focus did not show a consistent effect on F2.

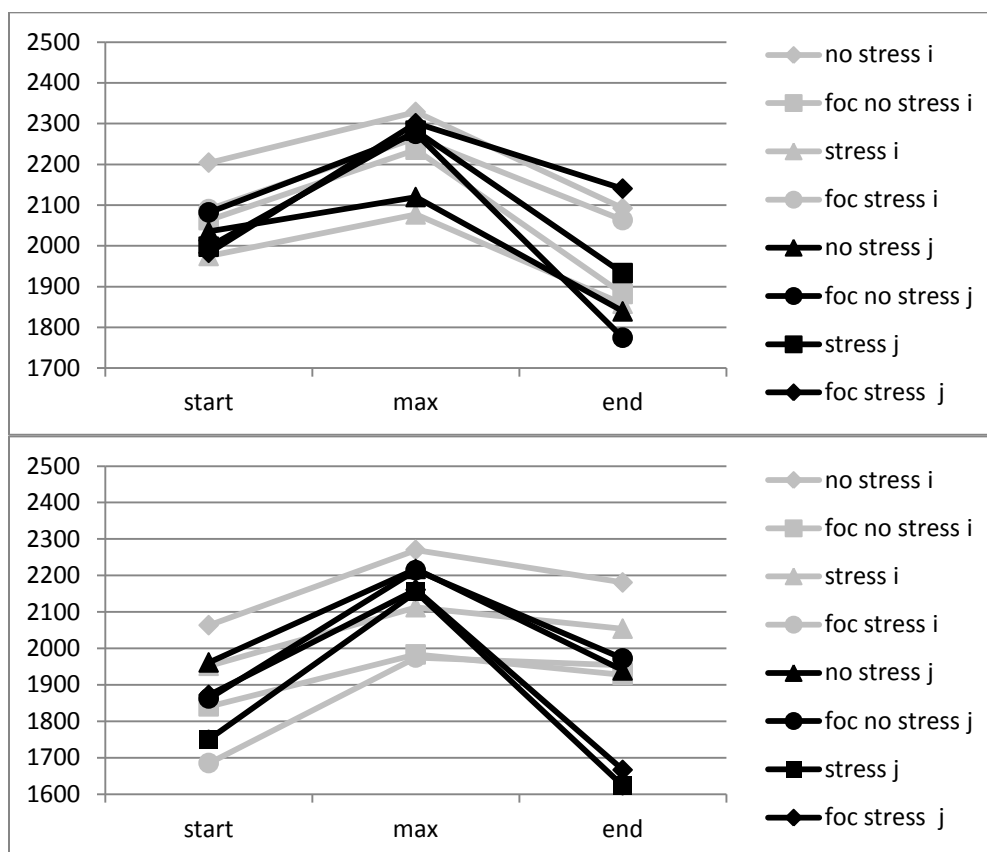


Figure 4 F2 trajectories for hiatus and diphthong for VM (top) AM (bottom)

The rate of F2 change results (Figure 5) revealed that on average, across experimental conditions, transitions from V1 into [j] were faster than those from V1 to [i]. Similar results have been reported in Chitoran (2002). Figure 5 shows representative results for two out of the four speakers analysed, namely, AM (left) and VM (right). Although the general trend for all four speakers analyzed was faster transitions for diphthongs, it was not consistent across all experimental conditions, as can be observed in focus-stressed condition for AM and unstressed condition for VM, and therefore our conclusions are tentative, awaiting confirmation from the analysis of the four additional speakers recorded.

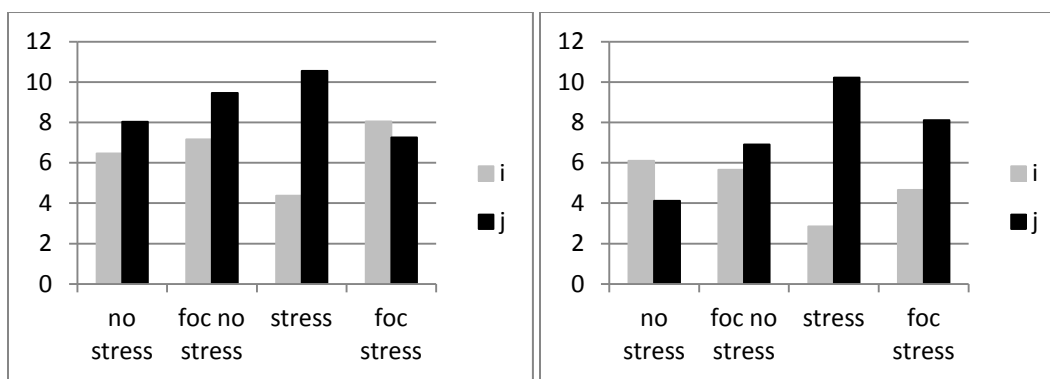


Figure 5 F2 transition rates for hiatuses and diphthongs for AM (left) and VM (right)

4. Experiment 2 – postconsonantal environment

Postconsonantal sequences were investigated for phonetic differences among segments participating in different palatalization processes:

- Simple palatalization: Velar⁹ + /i, e/ → Palatal + /i, e/, that is, a process where the palatalization target does not absorb the palatalization trigger, i.e. *afront*, non-low V, cf. /kípos/ → [cípos] “garden”, /kerós/ → [cerós]
- Extreme palatalization whereby the triggering high glide is absorbed by the resulting palatal consonant:
 - Velar/Alveolar + J+V → Palatal+V in morphologically underived environments, e.g. [çóni] “snow”
 - Velar/Alveolar + J+V → Palatal+V in morphologically derived environments, e.g. [níç+a] “nails”, with a morphological boundary between the palatal and the following vowel, in this case the neuter plural marker

4.1 Methodology

The materials were recorded together with those for postvocalic sequences (section 3). Six categories of target words, one per segment [ç, j, c, ʝ, ɲ, ʎ] were tested across three conditions: Simple pal. (SP), extreme derived (EDP) and extreme underived (EUP).

	SP	EDP	EUP
ç	níç <i>i</i> “nail”	níç <i>a</i> “nails”	çonás “wintry weather”
j	zíj <i>i</i> “weight”	zíj <i>a</i> “weights”	jojó “yo-yo”
c	lúc <i>i</i> “gully”	lúc <i>a</i> “gullies”	cotís “coward”
ʝ	cúj <i>i</i> “jar”	cúj <i>a</i> “jars”	ʝulékas “(name)”
n/ɲ	pçón <i>i</i> “pawn”	pçón <i>a</i> “pawns”	ɲonó “brain”
ʎ	vól <i>i</i> “bullet”	vól <i>a</i> “bullets”	ʎodári “lion”

Table 2 Materials for postconsonantal sequences

⁹ Palatalization does not directly affect labials or coronal obstruents, e.g. [pçáto] “plate”, [ðódja], where both the obstruent and the following glide surface, although it should be pointed out that the glide is strengthened to a fricative. This is unsurprising, since palatalization typically applies to a subset of consonants (cf. Bateman 2007).

Several measurements have been planned (F2 of C, V and C-to-V transitions, duration of C, V and C-to-V transitions, intensity, and center of gravity of consonantal release); in this paper we are reporting on duration of the palatal segments and on F2 of the transitions from the palatal into the following vowel: NíChiosáin & Padgett (2012) report higher F2 for vowels next to palatalized consonants, which predicts differences in F2 for the C-to-V transitions among SP, EDP and EUP, if these three processes involve different degrees of trigger absorption.

4.2 Segmentation

Similar segmentation criteria to those in Experiment 1 were used (see 3.2). Figure 6 shows a representative example, the sequence [ja] contained in the word [cúja] “jars”, produced by speaker PM (N.B: to aid relevant measurements, [j] in the annotation marks transition from the palatal to the beginning of the steady state of the following V). The left boundaries of palatal segments were marked at the end of formant structure of the vowel preceding them and their right boundaries either at the onset of noise or the onset of formant structure of the following vowel. For a full description of this example, see section 4.3.

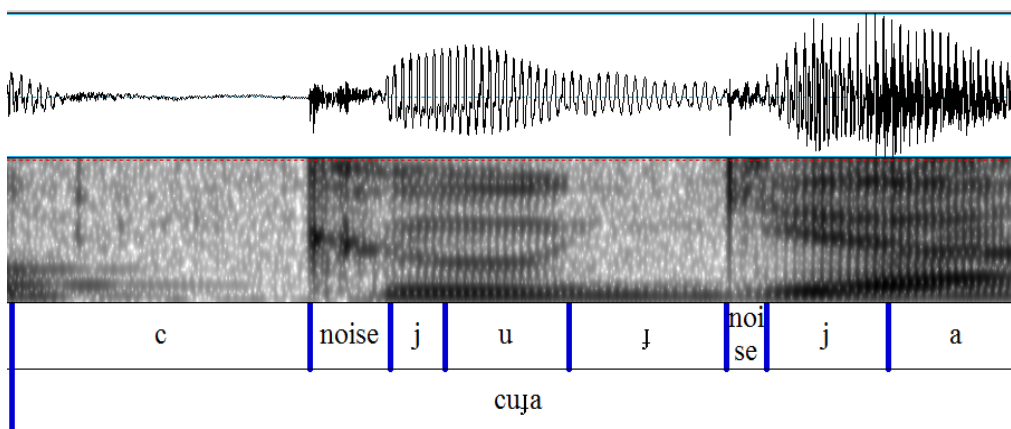


Figure 6 Two instances of extreme palatalization in the word *cúja*, “jars” (underived in [cú]; derived in [ja])

4.3 Results

Our results showed that the three palatalization processes (SP, EDP, EUP) differ in the acoustic parameters of their phonetic realization examined in this paper. Before proceeding with the duration and formant results we first discuss three representative examples.

Figure 6 nicely illustrates many characteristic events in extreme palatalization both at morpheme boundaries, i.e. the sequence [ja], as well as in underived environments, i.e. in [cú]. The effect of the palatal consonants is visible on the vowels on either side of each consonant, showing a high F2 on glide/offglide (whose movement is also visible during the noise of the palatal /c/). Notice however that the downward F2 movement after the /j/ starts from a much higher point, (2345 Hz), compared to that after /c/, (1751 Hz), and similar to the point (2387 Hz) where the downward F2 movement starts during the noise of /c/. Moreover, the rate of F2 change from /c/ to /u/ is much faster than from /j/ to /a/, 8.19 and 14.65 Hz/msHz/ms respectively. The transition in /u/ is steeper and much shorter in duration: 26ms in /u/, 57ms in /a/. These phonetic differences were consistently found in our data and suggest that in EDP there is a smaller degree of absorption of the triggering [j] than in EUP. For some of the speakers there were no transitions at all in EUP environments like in Figure 7, which shows the sequence [çɔ] in the word [çonás], something that was never observed in EDP environments (see 4.3.1).

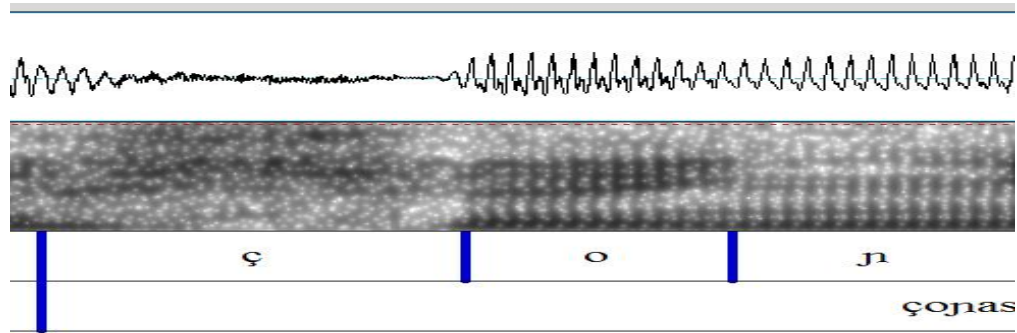


Figure 7 Extreme palatalization in underived environments in the sequence [ço] in the word [çoπάς] “wintry weather”, speaker AM. There are no transitions from the palatal consonant into [o]

Finally, Figure 8 presents an example of simple palatalization. The figure shows the word [cúji], “jar” (cf. Fig 6). The [i] in the sequence [ji] is, as expected, much longer than the [j] transition in the previous examples.

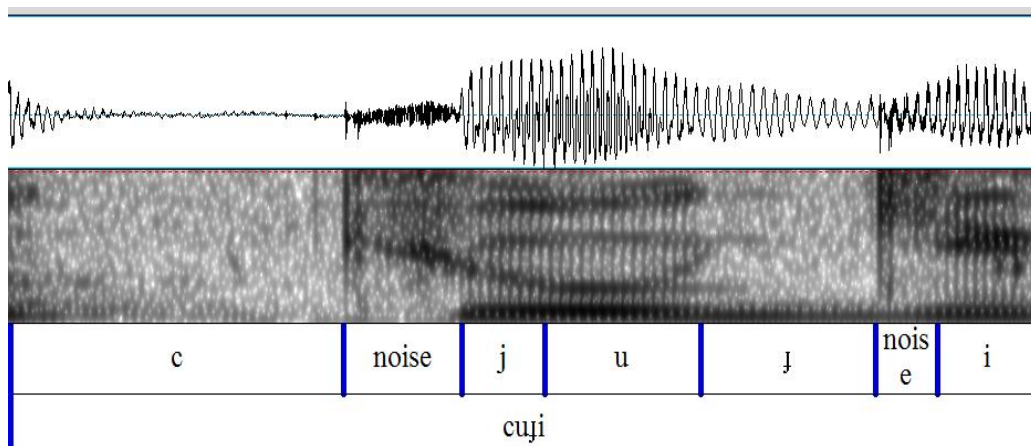


Figure 8 Simple palatalization in the sequence [ji] in the word [cúji], “jar”

In the following two sections, we present duration and formant results.

4.3.1 Duration

Variation in the duration for consonants, vowels and speakers was evident across conditions in our data. Starting with consonant duration, the analysis showed no consistent trend other than variability for the palatal consonants and the low/back vowels following them. In addition to these segments, we also compared the duration of the glide-like transition from the palatal consonant to the following low or back vowel (Figure 9). The six panels in Figure 9 show durations of the glide transition in EDP environments (black) and EUP environments (striped), for [ç, j, c, ʝ, ɲ/n, ʎ/l] in order from top left to bottom right. In order to appreciate the transition length, these durations are also compared with the duration of the full vowel [i] which follows the palatal consonants in SP environments. On average the transition duration in EDP environments (33.25 ms) is almost 50% that of a full vowel [i] in SP (56.75ms) and almost double that of the transition in EUP environments (18.25 ms). Moreover the maximum transition duration in EDP environments is on average 75% the duration of the vowel [i] in SP, in other words, this transition is quite substantial in duration.

The difference in duration between the transitions in EDP and EUP environments is evident in Figure 9. More concretely, the transition in EDP environments was longer than that in EUP ones in all but one environment (for speaker PM after the consonant [j]). . For some speakers and palatal segments (e.g. the top

left panel) there was no [j] transition at all evident in extreme palatalization in underived environments. Moreover, the transition in EDP is longer than the full segment [i] in simple palatalization, as can be seen for speaker AM in the panels for j, n/n, ʌ/l and speaker PM in the panel for n/n. These results offer evidence in support of our phonological analysis of the different palatalization processes.

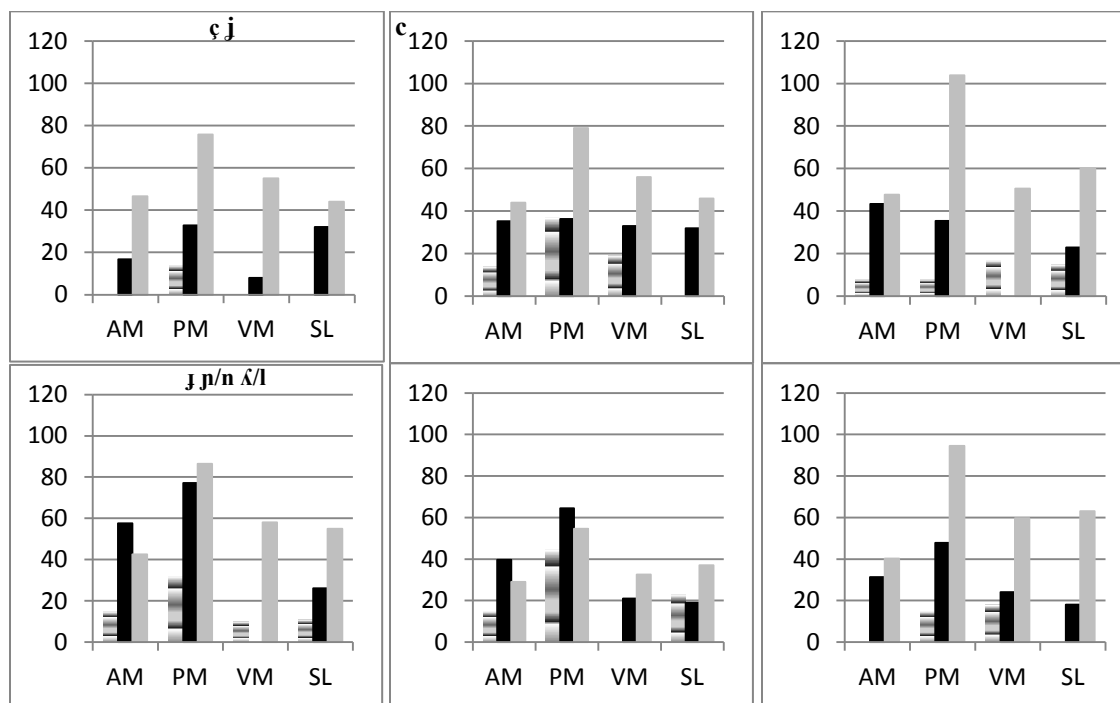


Figure 9 Transition durations across palatalization conditions. SP (grey), EDP (black) and EUP (striped), are shown for [ç, j, c, j, n/n, ʌ/l] in order from top left to bottom right

4.3.2 Formants

More evidence for the differences among palatalization conditions is provided by the formant analysis. In order to make comparisons among the three palatalization processes, we obtained the F1 and F2 values at a point 5ms into the vowel after the palatal consonant (henceforth *transition point*) in all three palatalization conditions, so that the transition from the consonant into the vowel can be captured; any consistent differences in the quality of this transition point, combined with the duration differences reported above, could arguably be ascribed to different degrees of absorption of the palatalizing trigger by the preceding consonant. Figure 10 shows the position of the transition point in the F1XF2 space for each of the three conditions across the different consonantal environments. EDP (black) and EUP (grey) values are compared to each other and also to the corresponding values for [i] in SP¹⁰ (white) so that the position of this transition point can be appreciated in relation to the position of the vowel [i]. To begin with, the space covered by the points in each condition is clearly separated and also the position of the transition points for both EDP and EUP are further back and lower in the F1XF2 space than that for SP, which is expected since the quality of these points is also influenced by the upcoming back and low vowels.

Moreover, the position of the transition point in simple palatalization is much less variable than those in EDP and EUP. Finally, the position of the transition point for EDP is more variable across segments than that for EUP. This last result in combination with the duration results can be tentatively taken as evidence

¹⁰ Values for this point after alveolar segments [l, n] are not shown because they do not participate in simple palatalization.

of the different absorption degree of the palatalization trigger in these processes: the longer duration of the transition in EDP combined with the greater stability of the position of the transition point in the F1XF2 space could be understood as less absorption of the palatalizing trigger, compared to the shorter transition duration and more variable position of the transition point for EUP.

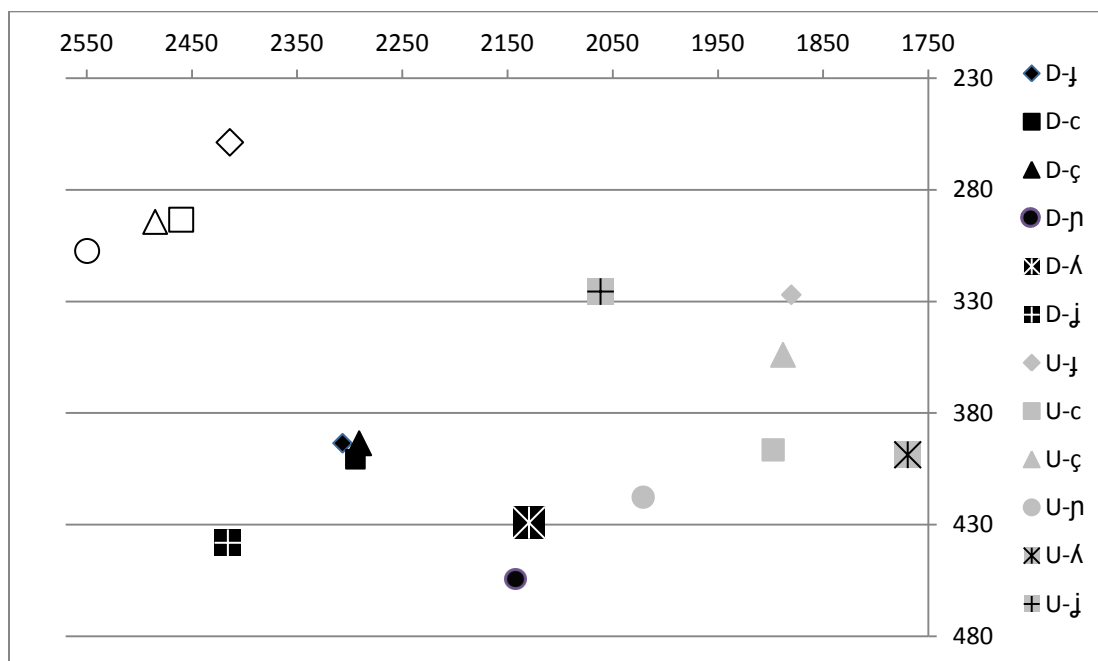


Figure 10 The position of the transition point in the F1XF2 space for each of the three conditions (EDP in black, EUP in grey and SP in white) across the different consonantal environments (see text for details)

5. Discussion

The analysis exposed some phonetic differences between /i/ and /j/ both in post vocalic and in post consonantal environments, giving preliminary support to our claim that these are two separate phonemes in the Greek system. Highlighting the results, the first experiment revealed that the distinction between [V.i] hiatuses and [Vj] sequences is conveyed through a greater curvature in the F2 trajectory for postvocalic [j] than for [i], realized through a longer F2 range for [j] with faster transition rates, a result which has also been reported in Chitoran (2002) for Romanian. No duration differences were detected between hiatuses and diphthongs. More speakers need to be analysed before a safe conclusion can be reached, however such a result should not be surprising, given the difficulty of native speakers to consistently distinguish hiatuses from diphthongs. Another question which needs to be explored, not addressed in this paper, is the position occupied by [j] in [Vj] sequences. We have been calling these sequences ‘diphthongs’ throughout but it is not clear whether they share the nucleus of the syllable with the vowel preceding them or whether their position is more peripheral, in the coda.

Turning to postconsonantal environments, our investigation provided preliminary evidence for a phonetic distinction predicted by our phonological analysis, according to which, simple palatalization, extreme derived palatalization and extreme underived palatalization have different triggers, different targets and different acoustic outcomes. Simple palatalization is triggered by (non-low) vowels, while extreme by the (high) glide; simple palatalization targets only velar consonants, while both

velars (/k, g, x, ɣ/) and alveolars¹¹ (/n, l/) can be extreme palatalization targets; the triggers are left intact after simple palatalization, while they are absorbed after extreme palatalization. The distinction among these processes was signalled both by duration and by formant differences, which we tentatively interpret to suggest that the realization of the glide depends on the phonetic environment, its position within the syllable, and on the morphophonological environment.

Specifically, the transition from the palatal consonant to the following vowel in EDP environments was typically shorter in duration than its counterpart in EUP and also the position of the transition point for EDP was more variable across segments than that for EUP. This last result in combination with the duration results can be tentatively taken as evidence of the different absorption degree of the palatalization trigger in these processes: the longer duration of the transition in EDP combined with the greater stability of the position of the transition point in the F1XF2 space could be understood as less absorption of the palatalizing trigger, compared to the shorter transition duration and more variable position of the transition point for EUP. This conclusion is further supported by the fact that for some of the speakers and tokens there was no transition at all observed in EUP environments (see Figure 7), while a transition was always present in EDP environments. The phonetic differences described above suggest a possible divergence in the articulation among types of palatals which should be further investigated. Since our results here are based on a limited amount of data and a small subset of the acoustic analyses that we have planned, they need to be viewed with caution, and the trends they are revealing must await confirmation from our fuller analysis.

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¹¹Our phonological analysis also covers environments involving all the remaining Greek consonants for which neither simple nor extreme palatalization applies, where the post-consonantal glide turns to a palatal fricative ([ç, j]). Phonetic examination of these environments is planned in future work.

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