FACHLITERATUR
EDITION ROMIOSINI
ΕΠΙΣΤΗΜΗ

ICGL12

12th INTERNATIONAL CONFERENC
ON GREEK LINGUISTICS
16 – 19 SEPTEMBER 2015
FREIE UNIVERSITÄT BERLIN, CEMOG

Proceedings of the ICGL12

vol. 1

The International Conference on Greek Linguistics is a biennial meeting on the study and analysis of Greek (Ancient, Medieval and Modern), placing particular emphasis on the later stages of the language.

PROCEEDINGS OF THE ICGL12
ΠΡΑΚΤΙΚΑ ΤΟΥ ICGL12

**Thanasis Georgakopoulos, Theodossia-Soula Pavlidou, Miltos Pechlivanos,
Artemis Alexiadou, Jannis Androutsopoulos, Alexis Kalokairinos,
Stavros Skopeteas, Katerina Stathi (Eds.)**

PROCEEDINGS OF THE 12TH INTERNATIONAL CONFERENCE ON GREEK LINGUISTICS

ΠΡΑΚΤΙΚΑ ΤΟΥ 12ΟΥ ΣΥΝΕΔΡΙΟΥ ΕΛΛΗΝΙΚΗΣ ΓΛΩΣΣΟΛΟΓΙΑΣ

VOL. 1

EDITION ROMIOSINI

Vertrieb und Gesamtherstellung: Epubli (www.epubli.de)
Satz und Layout: Rea Papamichail / Center für Digitale Systeme, Freie Universität Berlin
Gesetzt aus Minion Pro
Umschlaggestaltung: Thanasis Georgiou, Yorgos Konstantinou
Umschlagillustration: Yorgos Konstantinou

ISBN 978-3-946142-34-8
Printed in Germany

Online-Bibliothek der Edition Romiosini:
www.edition-romiosini.de

Στη μνήμη του Gaberell Drachman (†10.9.2014)
και της Αγγελικής Μαλικούτη-Drachman (†4.5.2015)
για την τεράστια προσφορά τους στην ελληνική γλωσσολογία
και την αγάπη τους για την ελληνική γλώσσα

ΣΗΜΕΙΩΜΑ ΕΚΔΟΤΩΝ

Το 12ο Διεθνές Συνέδριο Ελληνικής Γλωσσολογίας (International Conference on Greek Linguistics/ICGL12) πραγματοποιήθηκε στο Κέντρο Νέου Ελληνισμού του Ελεύθερου Πανεπιστημίου του Βερολίνου (Centrum Modernes Griechenland, Freie Universität Berlin) στις 16-19 Σεπτεμβρίου 2015 με τη συμμετοχή περίπου τετρακοσίων συνέδρων απ᾽ όλον τον κόσμο.

Την Επιστημονική Επιτροπή του ICGL12 στελέχωσαν οι Θανάσης Γεωργακόπουλος, Θεοδοσία-Σούλα Παυλίδου, Μίλτος Πεχλιβάνος, Άρτεμις Αλεξιάδου, Δώρα Αλεξοπούλου, Γιάννης Ανδρουτσόπουλος, Αμαλία Αρβανίτη, Σταύρος Ασημακόπουλος, Αλεξάνδρα Γεωργακοπούλου, Κλεάνθης Γκρώμαν, Σαβίνα Ιατρίδου, Mark Janse, Brian Joseph, Αλέξης Καλοκαιρινός, Ναπολέων Κάτσος, Ευαγγελία Κορδώνη, Αμαλία Μόζερ, Ελένη Μπουτουλούση, Κική Νικηφορίδου, Αγγελική Ράλλη, Άννα Ρούσσου, Αθηνά Σιούπη, Σταύρος Σκοπετέας, Κατερίνα Στάθη, Μελίτα Σταύρου, Αρχόντω Τερζή, Νίνα Τοπιντζή, Ιάνθη Τσιμπλή και Σταυρούλα Τσιπλάκου.

Την Οργανωτική Επιτροπή του ICGL12 στελέχωσαν οι Θανάσης Γεωργακόπουλος, Αλέξης Καλοκαιρινός, Κώστας Κοσμάς, Θεοδοσία-Σούλα Παυλίδου και Μίλτος Πεχλιβάνος.

Οι δύο τόμοι των πρακτικών του συνεδρίου είναι προϊόν της εργασίας της Εκδοτικής Επιτροπής στην οποία συμμετείχαν οι Θανάσης Γεωργακόπουλος, Θεοδοσία-Σούλα Παυλίδου, Μίλτος Πεχλιβάνος, Άρτεμις Αλεξιάδου, Γιάννης Ανδρουτσόπουλος, Αλέξης Καλοκαιρινός, Σταύρος Σκοπετέας και Κατερίνα Στάθη.

Παρότι στο συνέδριο οι ανακοινώσεις είχαν ταξινομηθεί σύμφωνα με θεματικούς άξονες, τα κείμενα των ανακοινώσεων παρατίθενται σε αλφαβητική σειρά, σύμφωνα με το λατινικό αλφάβητο· εξαίρεση αποτελούν οι εναρκτήριες ομιλίες, οι οποίες βρίσκονται στην αρχή του πρώτου τόμου.

Η Οργανωτική Επιτροπή του ICGL12

ΠΕΡΙΕΧΟΜΕΝΑ

2ος Τόμος

A STUDY OF STANDARD MODERN GREEK AND CYPRIOT GREEK STOP CONSONANTS: PRELIMINARY FINDINGS

Eva Anastasi[1], Ageliki Logotheti[2], Stavri Panayiotou[1],
Marilena Serafim[1] & Charalambos Themistocleous[3]
[1]University of Cyprus, [2]National and Kapodistrian University of Athens, [3]University of Gothenburg
anastasi.eva@ucy.ac.cy, agellog@gmail.com, panayiotou.stavri@ucy.ac.cy, serafim.marilena@ucy.ac.cy, charalambos.themistocleous@gu.se

Περίληψη

Η παρούσα έρευνα εξετάζει την επίδραση του τόπου άρθρωσης και του δυναμικού τονισμού στα χαρακτηριστικά του ακουστικού φάσματος της έκρηξης των κλειστών άηχων συμφώνων της Κοινής Νέας Ελληνικής (ΚΝΕ) και της Κυπριακής Ελληνικής (ΚΕ). Στην έρευνα συμμετείχαν σαρανταπέντε ομιλήτριες (είκοσι ομιλήτριες της ΚΝΕ και εικοσιπέντε ομιλήτριες της ΚΕ). Μετρήθηκαν οι φασματικές ιδιότητες της έκρηξης των κλειστών συμφώνων και αναλύθηκαν με την μέθοδο των φασματικών στιγμών (spectral moments analysis). Τα αποτελέσματα έδειξαν ότι ο τόπος άρθρωσης και η γλωσσική ποικιλία επηρεάζουν σημαντικά τα φασματικά χαρακτηριστικά της έκρηξης ως προς το κέντρο βαρύτητας, την ασυμμετρία και την τυπική απόκλιση.

Keywords: stop consonants, spectral moments

1. Introduction

The acoustic signal conveys information that enables the listener to decode the encoded linguistic message. Also, the acoustic signal provides non-linguistic information, such as the gender, the age of the speaker, and other sociolinguistic information. In this study, we provide acoustic evidence from SMG and CG stop consonants and argue that dialectal differences are present in the fine acoustic representation of stop bursts. Specifically, we provide preliminary acoustic measurements of burst spectra using spectral moments analysis and show that SMG and CG stops differ in the spectral moments of the stops burst (Forrest, Weismer, Milenkovic, and Dougall 1988).

The spectral moments analysis is a statistical method that allows measurements of different parts of the sound spectrum. The *centre of gravity* describes the concentration of energy and constitutes the first spectral moment. The second moment measures the deviation from the mean; in this study we employ the standard deviation. The third spectral moment is *skewness,* which measures the asymmetry between the probability distribution of the variable and its mean. When skewness is negative, the tail is longer on the left side and the energy concentration is on the right side of the histogram of the distribution; the reverse takes place when it is positive. The fourth moment, kurtosis, describes the shape of the probability distribution of a variable as tall, when positive, or flat, when negative (see also Forrest, Weismer, Milenkovic, and Dougall 1988, Vicenik 2010, Tabain and Butcher 2015).

The analysis of SMG and CG stop consonants will indicate the differences of the varieties as manifested in the stops burst. SMG and CG differ in their phonemic structure (e.g., Themistocleous 2017, 2016, Themistocleous and Logotheti 2016). Most notably, SMG and CG differ greatly in their consonants. For example, SMG contains voiceless /p t k c/ and voiced /b d ɡ ɟ/ stops. In CG there are non-prenasalised voiced stops whereas in SMG, voiced stops are optionally pre-nasalised, especially in formal speech (Arvaniti and Joseph 2000). But it is in geminates where the two varieties differ phonemically the most: the CG phonemic inventory contains both singletons and geminates whereas the SMG phonemic inventory does not contain geminates. Even though geminates are represented in standard Greek orthography, this distinction has been lost in SMG. In the CG variety, the only singletons that exist (i.e., voiced stops and affricates), are allophones of their voiceless counterparts when they are preceded by a nasal (/ˈpanta/ → [ˈpanda]) or labiodental [ɱ] and the velar [ŋ] nasals (see Vayakakos 1973, Newton 1972). Overall, geminates exhibit greater length; also, plosive geminates exhibit longer aspiration and affricate geminates display longer frication (Arvaniti and Tserdanelis 2000, Arvaniti 2001, Botinis, Christofi, Themistocleous, and Kyprianou 2004, Payne and Eftychiou 2006, Armosti 2012). Additionally, when a final /s/ is followed by another /s/ or /ʃ/, then the geminates /sː/ and /ʃː/ occur respectively

(Armosti 2012). Besides geminate consonants, CG contains post-alveolar fricatives and affricates (Aristodemou, Savva, and Themistocleous 2015, Themistocleous, Savva, and Aristodemou 2016). As a result, the sheer number of consonants in CG is greater than in SMG.

Several studies investigated SMG stop consonants. For example, Botinis, Fourakis, and Prinou (1999) examined the voicing and duration of occlusion for both voiced and voiceless consonants, which provide evidence for place of articulation and voice oppositions. Arvaniti (2000) investigated the effects of stress on the duration of the syllable and found that stressed consonants are longer in duration. Also, Arvaniti and Joseph (2002) examined the pronunciation of voiced stop consonants /b d g/ in original recordings of early twentieth-century Greek rebetika and folk songs. Their results display variation and change in the production of stops. Other studies also examined several aspects of SMG stops (Antoniou, Best, Tyler, and Kroos 2013).

Few studies, however, investigated CG consonants. Armostis (2012) showed that in prosodically dominant conditions in CG (i.e. in utterance initial position and when stressed), the oral articulation of singletons is almost identical to that of geminates. Botinis, Christofi, Themistocleous and Kyprianou (2004) pointed out the effects of stress and syllable position on the closure and burst duration of stop singletons and geminate consonants. Arvaniti and Tserdanelis (2000) examined the acoustic correlates of CG geminate consonants. They measured target segment duration, preceding vowel duration and quality, RMS and voice quality differences in the production of the geminates. The results confirmed the idea of duration being a very robust cue for gemination for all the types of consonants involved in the study. Arvaniti (2001) examined CG (singletons and geminates) and SMG stops and showed that faster speaking rate has a shortening effect on segments and that SMG data is not more variable than CG data.

Overall, most of the aforementioned studies are in line with the fact that certain factors, such as stress, affect the production of stop consonants, which by extension is also different in the two varieties examined in the present study. However, the limited amount of studies on voiceless Greek and CG stops highlights the importance of conducting more research to provide insights on the characteristics and classification of stop consonants. This study investigates the acoustic structure of the voiceless bursts [p t c k] using a spectral moments analysis to analyze the spectral characteristics of the stop bursts.

2. Methodology

2.1. Speakers

The participants of the study were 20 SMG and 25 CG female speakers between 19 and 29 years old. Participants were born and raised in Athens and Nicosia respectively, and had not lived abroad. Based on information from a demographic questionnaire that we had employed to avoid unwanted influences on the experimental material, the participants from each variety constituted a sociolinguistically homogeneous group: they originated from approximately the same socio-economic status and they were all university students at the University of Athens and the University of Cyprus. All participants were bilingual in Greek and English (as a second language). None reported a speech or hearing disorder.

2.2. Speech Material

The speech material consisted of a set of nonsense words, each containing one of the CG and SMG stop consonants ([p t c k]) in both stressed and unstressed word initial position before two vowel contexts /a/ and /i/. The nonsense words had the structure /CV̀ sa/—where the C stands for Consonant and V for vowel /i/ or /a/—(e.g., /ˈpasa, ˈkasa, ˈtasa, etc./) and CVsà/ (e.g., /paˈsa, kaˈsa, taˈsa, etc./). The experimental material is shown in Table 1. The keywords were uttered in a carrier phrase:

(1) the SMG phrase was: "/ ˈipes <keyword> ˈpali /" (You said <keyword>again).
(2) the CG phrase was: "/ ˈipes <keyword> ˈpale /" (You said <keyword> again).

Stops	stressed	unstressed	stressed	unstressed
/p/	ˈpisa	piˈsa	ˈsapi	saˈpi
/p/	ˈpasa	paˈsa	ˈsapa	saˈpa
/t/	ˈtisa	tiˈsa	ˈsati	saˈti
/t/	ˈtasa	taˈsa	ˈsata	saˈta

/c/	ˈcisa	ciˈsa	ˈsaci	saˈci
/k/	ˈkasa	kaˈsa	ˈsaka	saˈka

Table 1 | Speech material

2.3. Procedure

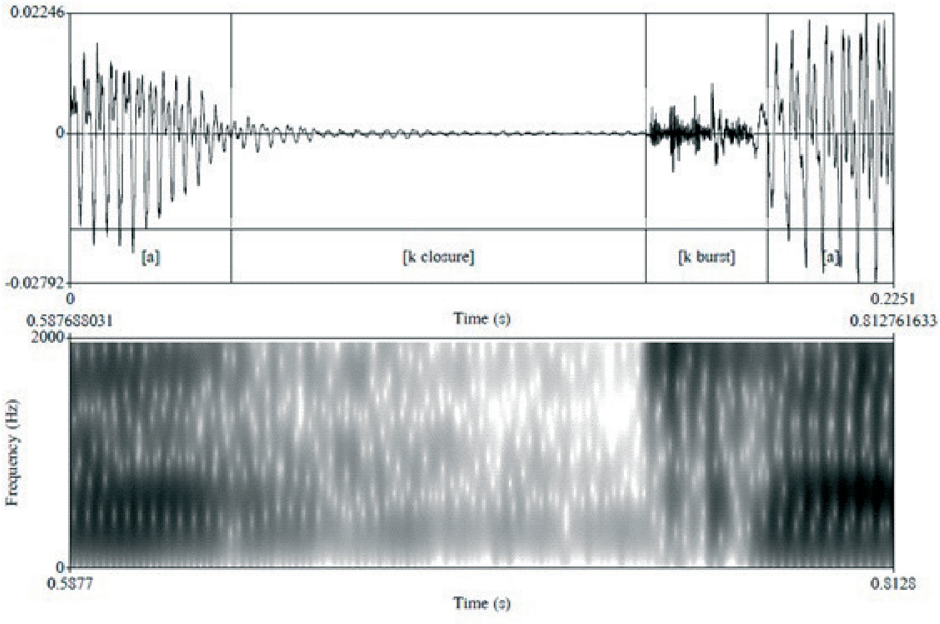

Figure 1 | The waveform and the spectrogram of the vowel /a/ in the keyword [ˈasa]

The SMG speech material was recorded in a recording studio in Athens and the CG speech material was recorded in a soundproof room at the University of Cyprus. Recordings were made on a Zoom H4n audio recorder where voice was sampled at 44.1 kHz. The keywords were located and segmented in Praat. Figure 1 shows the waveform and the spectrogram of the vowel /a/ as well as the corresponding segmental boundaries of the segments that constitute the keyword [ˈasa]. Each subject produced 64 utterances (i.e. 45 Speakers × 4 Segments × 2 Stress Positions × 2 Speech Varieties × 4 Repetitions) yielding a total of 2880 Productions.

2.4. Statistics

A linear mixed effects analysis of the relationship between normalised intensity, center of gravity, standard deviation, skewness, and kurtosis as response variables and stress, variety and, place of articulation as predictors was performed. Intercepts for subjects and items were taken as random effects.

(1) DV ~Segment * Variety * Stress + (1|Speaker) + (1|Keyword)

The linear predictors are related to the conditional mean of the response through a logit link function for binomial distributions (McCullagh and Nelder 1989, Dobson 1990). Statistical tests were conducted by using R (R Team 2016) and statistical packages lme4 (Bates, Mächler, Bolker, and Walker 2015).

3. Results

In this section, the spectral properties of each stop consonant are presented. The spectral moments analysis described in the methodology section aims at providing measurements of those spectral characteristics. The following discussion provides a description of the stop burst spectra.

3.1. Normalized Intensity

Figure 2 shows the mean results for the normalized intensity. Intensity is highly influenced by the segment. The burst of stop consonants articulated at the lips has lower intensity than that of stop consonants articulated in the palatal and velar place of articulation. Table 2 presents the findings for the normalized intensity. The results point out a significant effect for the place of articulation and for the variety. Specifically, there are significantly different slopes from the intercept for all stops. Despite the fact that there are no significant interactions between variety and segment, overall, the

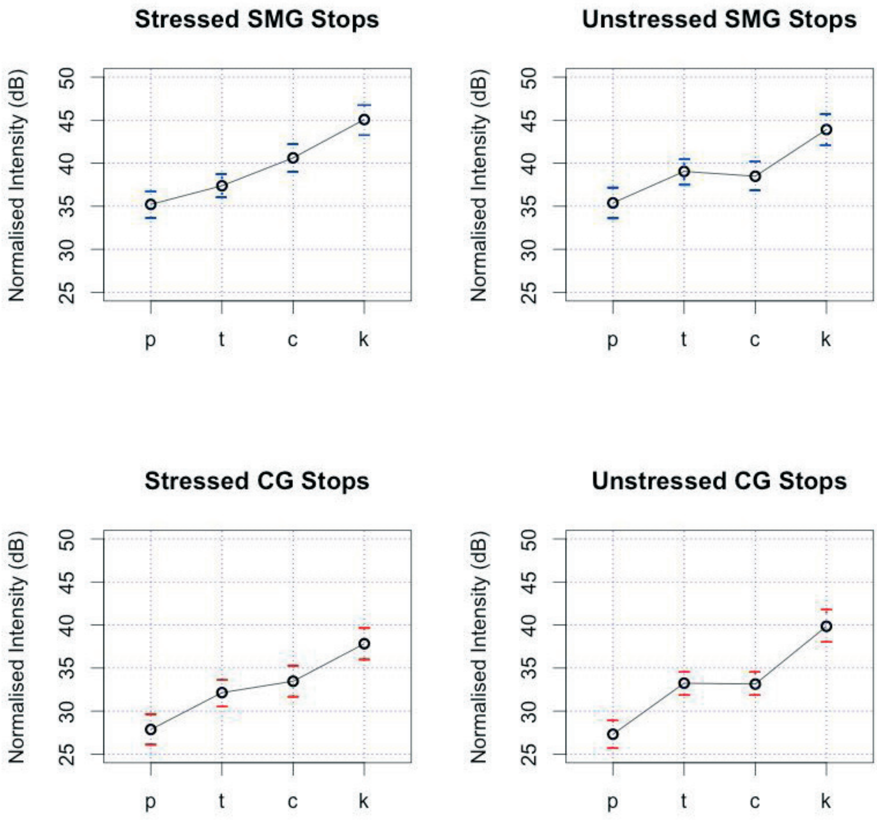

Figure 2 | Normalized Intensity for stressed and unstressed SMG and CG stop consonants

	Estimate	**SE**	**df**	**t value**	**Pr(> |*t*|)**
(Intercept)	34.7278	1.1589	42.2700	29.967	.001
Segment [t]	3.9533	0.8997	11.0200	4.394	.001
Segment [c]	4.8092	1.0927	10.6500	4.401	.01
Segment [k]	10.0033	1.0937	10.6900	9.146	.001
Variety CG	-6.3072	1.4436	32.8800	-4.369	.001

Table 2 | Normalized Intensity

intensity is lower in CG than in SMG speakers, which results in a significant effect of the variety over the intercept (see Table 2 on the previous page).

3.2. Center of Gravity

Figure 3 shows the mean values for the center of gravity in Hz for the burst of stressed and unstressed SMG and CG stops. There is an overall higher center of gravity for the palatal stops whereas the bilabial and velar stops associate with the lowest center of gravity. This results in significant effects of segment over the intercept; only [k] does not present a significant effect. The speech variety does not result in significant differences, yet the interactions of speech variety with the segment for [t] and [k] are highly significant (see Table 3).

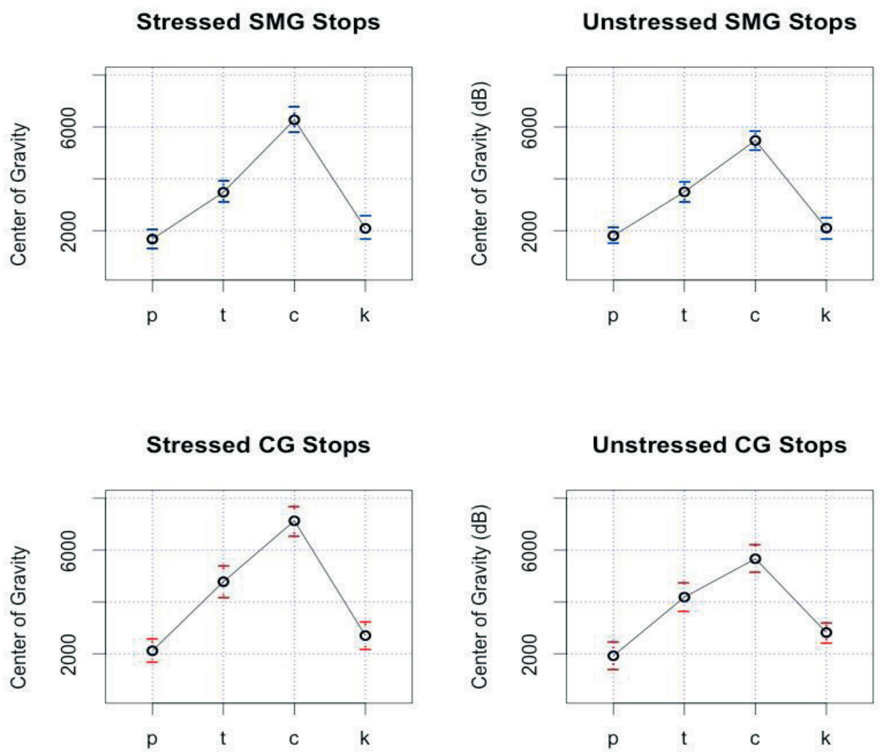

Figure 3 | Center of Gravity for stressed and unstressed SMG and CG stop consonants

	Estimate	SE	df	t value	Pr(> |*t*|)
(Intercept)	1621.3	421.7	16.2	3.845	.001
Segment [t]	1739.7	484.6	12.7	3.590	.01
Segment [c]	4129.0	593.5	12.7	6.957	.001
Segment [k]	348.2	593.5	12.7	0.587	n.s.
Variety CG	246.1	258.2	47.3	0.953	n.s.
Stressed	247.9	389.6	11.9	0.636	.53
Segment [t] : Variety CG	729.6	184.9	1546.3	3.945	.001
Segment [c] : Variety CG	273.3	225.3	1546.2	1.213	n.s.
Segment [k] : Variety CG	462.3	226.8	1546.7	2.039	.05

Table 3 | Center of Gravity

3.3. Standard Deviation

Figure 4 on the next page shows the mean values for the standard deviation. The patterns are similar to those reported for the center of gravity, namely there are low values for standard deviation for [p] and [k] and higher values for [t] and [c]. In fact, [k] has no significantly different slopes whereas the other stops differ significantly (see Table 4).

	Estimate	SE	df	t value	Pr(> |*t*|)
(Intercept)	2082.42	160.36	23.58	12.986	.001
Segment [t]	883.74	185.97	11.82	4.752	.001
Segment [c]	762.83	227.64	11.79	3.351	.001
Segment [k]	-170.32	227.79	11.83	-0.748	n.s.
Variety CG	848.39	141.80	32.73	5.983	.001

Table 4 | Standard Deviation

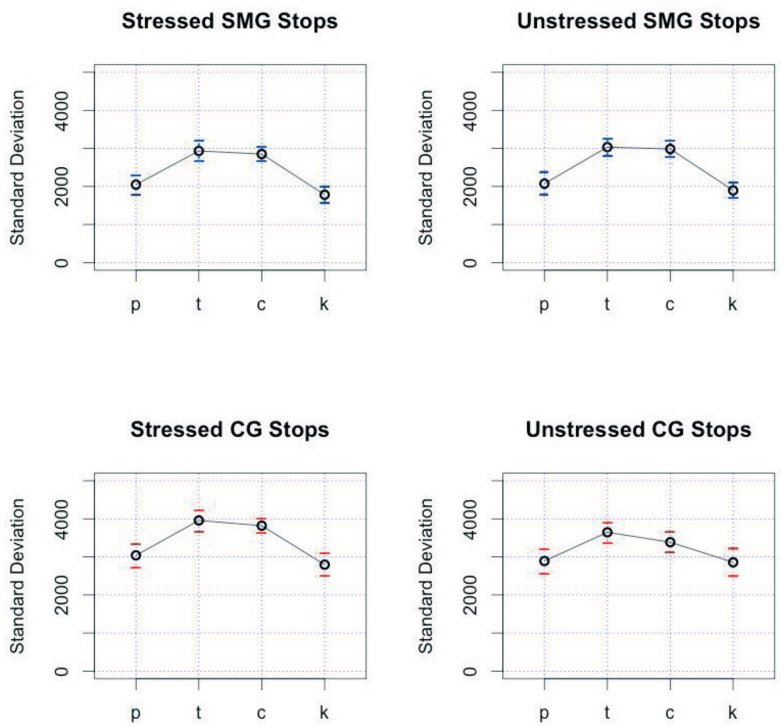

Figure 4 | Standard Deviation for stressed and unstressed SMG and CG stop consonants

	Estimate	SE	df	t value	Pr(>|*t*|)
(Intercept)	4.52892	0.42861	20.30	10.567	.001
Segment [t]	-2.19155	0.47398	14.00	-4.624	.001
Segment [c]	-3.66034	0.58037	14.00	-6.307	.001
Segment [k]	0.36317	0.58037	14.00	0.626	n.s.
Variety CG	0.96448	0.35430	55.50	2.722	.001
Stressed	-0.03605	0.37099	11.90	-0.097	n.s.
Segment [t] : Variety CG	-0.89637	0.29602	1546.40	-3.028	.01
Segment [c] : Variety CG	-0.61724	0.36058	1546.30	-1.712	n.s.
Segment [k] : Variety CG	-1.82927	0.36293	1546.90	-5.040	.001

Table 5 | Skewness

3.4. Skewness

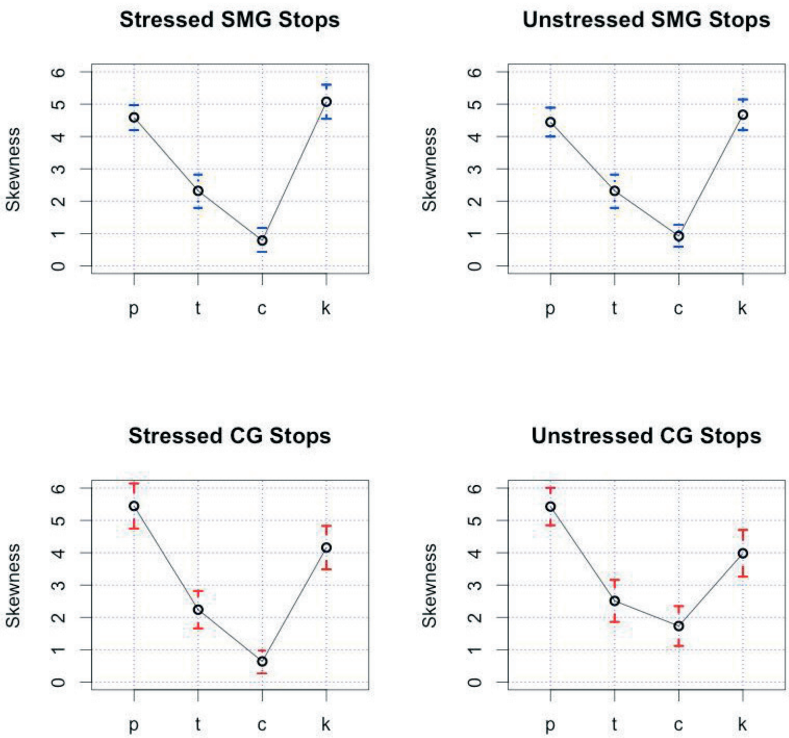

Figure 5 | Skewness for stressed and unstressed SMG and CG stop consonants

Figure 5 shows the means for the measurements of skewness on the burst of stressed and unstressed SMG and CG stop consonants. The findings indicate that overall skewness is high for [p] and [k] and low for [t] and [c]. The results show again significant effects of [t] and [k] over the intercept. By contrast, [k] does not differ significantly from the intercept (see Table 5).

3.5. Kurtosis

Figure 6 on the next page shows the means of kurtosis for stressed and unstressed SMG and CG stop consonants. The findings indicate high values of kurtosis for [p] and [k] and low values of kurtosis for [t] and [c]. This results in statistically significant effects for [t] and [c] (see Table 6).

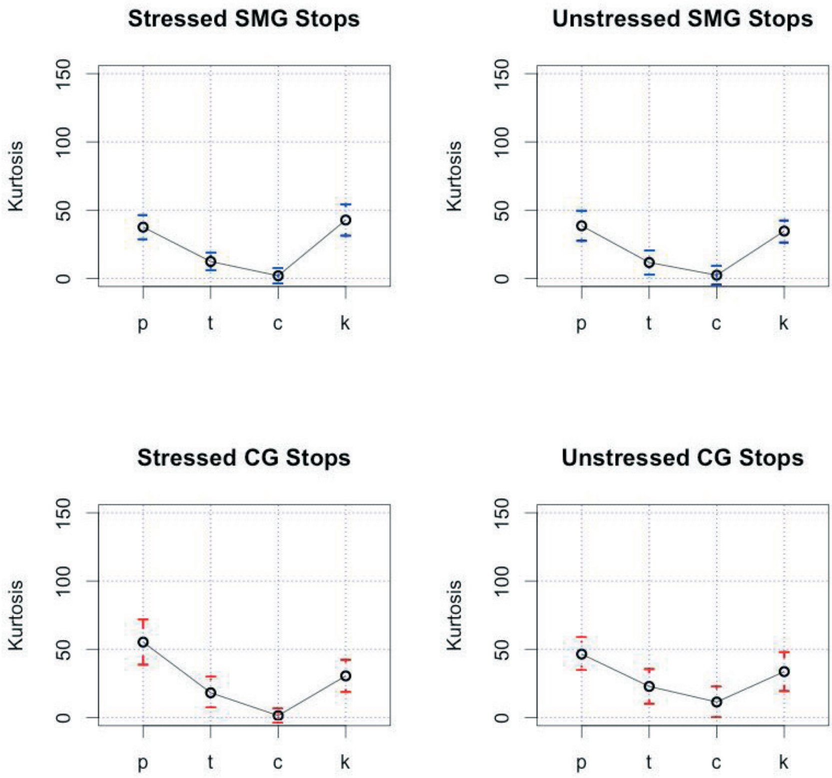

Figure 6 | Kurtosis for stressed and unstressed SMG and CG stop consonants

	Estimate	**SE**	**df**	**t value**	**Pr(> |*t*|)**
(Intercept)	43.992	4.434	19.472	9.921	.001
Segment [t]	-28.179	5.423	11.718	-5.196	.001
Segment [c]	-39.864	6.632	11.648	-6.011	.001
Segment [k]	-8.755	6.643	11.727	-1.318	0.2

Table 6 | Kurtosis

4. Discussion

This study investigated the shape of the burst noise by using a spectral moments analysis and showed that there are significant differences in the spectral properties of the burst noise of SMG and CG stop consonants /p t c k/. The effects are most evident on the center of gravity, standard deviation, and skewness. Specifically, the center of gravity of /p t k/ is significantly higher in CG than in SMG, which suggests that the overall energy concentration for these sounds is higher in CG (see also the estimate of the model in Table 3). The standard deviation of stop bursts is significantly greater in CG. So, the values of the CG stops deviate more from the center of gravity than the SMG values, which seem to be closer to the center of gravity. SMG and CG differ in the skewness of [t] and [k], with greater effects on the latter. Overall, higher values of positive skewness suggest that the tail of the spectral distribution is longer on the right side, indicating that the concentration of energy is distributed on the left side in the histogram of the probability distribution. High positive kurtosis indicates tall peaks whereas a negative kurtosis is more flat; in the findings kurtosis is higher for [p] and [k] and low for [t] and [c]. Notably, the language variety does not affect the kurtosis. In another study (see Themistocleous 2016), velar consonants were found to have significantly different kurtosis in the two varieties. Themistocleous (2016), using a classification model, showed that skewness and standard deviation have a major contribution for the classification of SMG and CG bursts. The consequences of these findings are discussed in the following paragraphs.

First, the spectral differences imply that the cognitive representation in the speakers of the two varieties differs, which affects the articulation of these sounds and, as a consequence, the spectral properties of bursts. These distinct cognitive, articulatory and acoustic representations of stops may be interpreted by the phonemic differences of these two varieties, as CG and SMG phonemic inventories differ in the quantity and also in the place of articulation of their consonants. Most notably, CG contains both long and short stop consonants. Also in CG, there are consonants articulated at the postalveolar place of articulation. So, the overall phonemic inventory of CG is significantly greater than the SMG one. Therefore, the use of the oral cavity for the articulation of sounds that the two varieties make, differs, which may suggest different effects in the exact places of articulation.

Second, the results suggest that the acoustic differences of stops within the Greek speaking speech communities can manifest dialectal differences. Conspicuously, even extremely small portions of sound, such as the stop bursts can carry both linguistic and sociolinguistic information. In other words, they can be employed by the speakers to identify the speaker of one variety from the speaker of another. But what is the role of the stops bursts in Cyprus and Greece? To describe the functions of acoustic variables in speech communities, Labov (1971) suggested the term 'indicators' which are dialectal variables that can distinguish social or geographic properties but remain subtle, do not change across different styles and registers, lie under the level of consciousness of speakers, and do not convey negative or positive evaluations. The acoustic properties of stops seem to play a similar role. They are not associated with a specific evaluation, yet they constitute a characteristic of SMG and CG speech. In addition to dialectal information, a number of other studies suggest that the bursts of stops can carry sociolinguistic information (see Eckert 2008).

To conclude, this study proposes a method for studying sociophonetic variation in stops, by employing spectral moments, (see also, Themistocleous 2016, Aristodemou, Savva, Themistocleous 2015, and Themistocleous, Savva, and Aristodemou 2016), contributes to research on language variation and change, and can have potential applications in forensic linguistics and speech pathology.

References

Antoniou, Mark, Catherine T. Best, and Michael D. Tyler. 2013. "Focusing the Lens of Language Experience: Perception of Madi Stops by Greek and English Bilinguals and Monolinguals." *Journal of the Acoustical Society of America* 133(4):2397–2411. Accessed June 15, 2015. doi:10.1121/1.4792358.

Aristodemou, Andria, Angelandria Savva, and Charalambos Themistocleous. 2015. "The Acoustics of Cypriot Greek Fricatives." Paper presented at the 6th International Conference of Experimental Linguistics, Exling 2015, Athens, Greece, June 26–27.

Armostis, Spyros. 2012. "The Acoustics of Cypriot Greek Post-lexical Gemination: The Case of Plosives and Affricates." In *Current Trends in Greek Linguistics,* edited by Georgia Fragaki, Athanasios Georgakopoulos, and Charalambos Themistocleous, 220–241. Cambridge: Cambridge Scholars Publishing.

Arvaniti, Amalia. 2000. "The Phonetics of Stress in Greek." *Journal of Greek Linguistics* 1:9–39. Accessed July 10, 2015. doi: 10.1075/jgl.1.03arv.

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,* 37–44, Thessaloniki: University Studio Press.

Arvaniti, Amalia, and Georgios Tserdanelis. 2000. "On the Phonetics of Geminates: Evidence from Cypriot Greek." *Proceedings of International Conference on Spoken Language Processing*, Beijing, China, October 23–27.

Arvaniti, Amalia, and Joseph D. Brian. 2002. "Modern Greek [b d g] in the Early 20c.: Evidence from Folk and Rebetika Songs." In *Recherches en Linguistique Grecque I: Actes du 5e Colloque International de Linguistique Grecque,* edited by Christos Clairis, 67–70. Paris: L'Harmattan.

Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software* 67(1):1–48. Accessed June 20, 2015. doi:10.18637/jss.v067.i01.

Botinis, Antonis, Marios Fourakis, and Irini Prinou. 1999. "Prosodic Effects on Segmental Durations in Greek." *Proceedings of the 6th ECSCT Eurospeech 99* 6:2475–2478, Budapest.

Botinis, Antonis, Marios Christofi, Charalambos Themistocleous, and Aggeliki Kyprianou. 2004. "Duration Correlates of Stop Consonants in Cypriot Greek." In *Proceedings FONETIK* 2004, the XVIIth Swedish Phonetics Conference, edited by Peter Branderud and Hartmut Traunmüller, 144–147. Sweden: Stockholm University.

Dobson, Annette J. 1990. *An Introduction to Generalized Linear Models*. London: Chapman and Hall.

Eckert, Penelope. 2008. "Variation and the Indexical Field." *Journal of Sociolinguistics* 12(4):453–476. Accessed July 8, 2015. doi: 10.1111/j.1467-9841.2008.00374.x.

Forrest, Karen, Gary Weismer, Paul Milenkovic, and Ronald N. Dougall. 1988. "Statistical Analysis of Word-initial Voiceless Obstruents: Preliminary Data." *Journal of the Acoustical Society of America* 84(1):115–123. Accessed May 12, 2015. doi: http://dx.doi.org/10.1121/1.396977.

McCullagh, Peter, and John A. Nelder. 1989. *Generalized Linear Models*. 2nd edition. London: Chapman and Hall.

Labov, William. 1971. "The Study of Language in its Social Context". In *Advances in the Sociology of Language*, edited by Joshua A. Fishman, Vol.

1, 152–216. The Hague, The Netherlands: Mouton.
Newton, Esther B. 1972. *Cypriot Greek: Its Phonology and Inflections*. Paris: Mouton, The Hague.
Payne, Elinor, and Eftychia Eftychiou. 2006. "Prosodic Shaping of Consonant Gemination in Cypriot Greek." *Phonetica: International Journal of Speech Science* 63(2–3):175–198. Accessed June 25, 2015. doi: 10.1159/000095307.
R Core Team. 2016. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.
Tabain, Marija, and Andrew Butcher. 2015. "Stop Bursts in Pitjantjatjara." *Journal of the International Phonetic Association* 45(2):149–176. Accessed May 6, 2015. doi: http://dx.doi.org/10.1017/S0025100315000110.
Themistocleous, Charalambos. 2016. "The Bursts of Stops Can Convey Dialectal Information". *Journal of the Acoustical Society of America* 140(4), EL334-EL340. doi: http://dx.doi.org/10.1121/1.4964818.
Themistocleous, Charalambos. 2017. "Modern Greek Vowels and the Nature of Acoustic Gradience." *Phonetica* 74(2):1–16. doi: 10.1159/000450554.
Themistocleous Charalambos, and Logotheti Ageliki. 2016. "Standard Modern Greek and Cypriot Greek Vowels: A Sociophonetic Study." In *6th International Conference on Modern Greek Dialects and Linguistic Theory* (MGDLT6), edited by Angela Ralli, Nikos Koutsoukos and Stavros Bompolas, 177–183. University of Patras.
Themistocleous, Charalambos, Angelandria Savva, and Andria Aristodemou. 2016. "Effects of Stress on Fricatives: Evidence from Standard Modern Greek." Paper presented at Interspeech 2016, San Fransisco, USA, September 8–12.
Vayakakos, Dikaios. 1973. "I Kypriaki Dialektos kai to Istorikon Lexikon tis Akadimias Athinon (Cypriot Dialect and the Historical Dictionary of the Academy of Athens)." In *1o Diethnes Kyprologiko Synedrio Lefkosia Vol. C: Neoteron Tmima, Meros V': Filologia Laografia,* edited by Theodoros Papadopoullos, Menelaos N. Christodoulou and Athanasios Papageorgiou, 23–102, Nicosia, Cyprus.
Vicenik, Chad. 2010. "An Acoustic Study of Georgian Stop Consonants." *Journal of the International Phonetic Association* 40(1):59–62. Accessed June 27, 2015. doi: https://doi.org/10.1017/S0025100309990302.