PHONOLOGICAL REPRESENTATIONS OF CONSONANT SEQUENCES: THE CASE OF AFFRICATES VS. 'TRUE' CLUSTERS

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Abstract

In this paper we investigate the behavior of Greek affricates as opposed to all other Greek cluster types. The phonotactics of the language as well as the data of an off-line experimental task support a preference for the preservation of affricates over stop+/s/ over /s/+stop clusters and all other clusters. A strong tendency of the participants in the experiment was to break up clusters by inserting a vowel while they retained almost all affricates intact. This linguistic behavior is attributed, first, to the identity of place of articulation of the consonants being members of the clusters and, second, to the (degree of) satisfaction of the scale of consonantal strength. Affricates tend to exhibit a limited degree of decomposition; stop+/s/ clusters exhibit a relative degree of decomposition, /s/+stop clusters undergo and even higher degree of decomposition while other cluster types are decomposed massively. Our assumption is that different degrees of decomposition are the result of (a) different phonological representations, (b) the co-occurrence of clusters with other clusters in the word and (c) their position in the word.

1. Introduction

Affricates have been an interesting topic of discussion in linguistic circles due to their ambiguous phonological status. The various theoretical proposals are embedded in the more general discussion about the nature of the phonological representations of consonantal sequences and boil down to four main formal analyses resulting in four different types of underlying representations of affricates; according to the first proposal, affricates are thought of as bipositional consonant **clusters** consisting of the stop [t] and the fricative [s] (cf. Newton 1961; Setatos 1974; Joseph & Philippaki-Warburton 1987, for Greek). Second, affricates are considered to be monopositional **contour segments** with a representation in which the continuancy specifications [+stop] and [+cont] are subordinate to a single root node. Both specifications are ordered in the underlying representation; more specifically, the stop precedes the fricative (Sagey 1986). Third, affricates can be seen as **complex segments** in which the segmental features are unordered with respect to each other (Lombardi 1990, van

de Weijer 1994, Rubach 1994; see for Greek Householder 1964).[1] Finally, affricates are **simplex stops** and stridency is a mere phonetic implementation to make them perceptually more salient (Kehrein 2002). For Greek, Holton, Mackridge & Philippaki-Warburton (1997) make no decision regarding these hypotheses. These four formal analyses are schematized in the representations in (1a-d), respectively.

1.   a. **cluster**   b. **contour segment**

          X   X   X

        [+stop] [+cont]   [+stop]   [+cont]

          t   s   t͡ s

        c. **complex segment**   d. **simplex stop**
               X   X

          [+stop]   [+stop]
          [+cont.]

            t^s t^s

In previous work we explored the status of affricates compared to /s/ clusters[2] such as /sp/, /st/, /ks/, /ps/ (Tzakosta 2007, Tzakosta & Vis 2007). Both the phonotactic analysis as well as the results of the experimental task used in that study revealed that the members of affricates tend to not be broken up by vowels, while obstruent + /s/ sequences exhibit a higher degree of coherence compared to /s/ + obstruent ones. The latter displayed the highest degree of decomposition. The theoretical interpretation of these results was that Greek native speakers perceive affricates as complex segments, while they perceive /s/ as an extrametrical element in SC clusters. Finally, the status of CS sequences turned out to be ambiguous and its exact phonological representation has been left open to future research.

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[1] The crucial features that are proposed in the literature are [+cont] and [–cont] (Lombardi 1990), [+stop] and [+strident] (Rubach 1994) or [+stop] and [+cont] (van de Weijer 1994). The exact nature of these features remains open for future research. For convenience, we will use the features [+stop] and [+cont] throughout this article.
[2] Depending on the position of /s/ in the cluster, i.e. first or second, /s/ clusters are also referred to as CS or SC clusters in the paper. Moreover, stop + /s/ and /s/ + stop clusters are more specific aspects of obstruent + /s/ and /s/ + obstruent clusters, respectively. The former distinction is used in case we wish to make more refined claims.

An assumption related to the above was that cluster complexity is determined, first, by the degree of identity of the place of articulation of the cluster members and, second, by the satisfaction of the scale of consonantal strength. In other words, affricates are basically preserved because, on the one hand, their members are identical with respect to place of articulation and, on the other hand, they satisfy sonority given that /t/, the initial segment of the affricate, is less sonorous than /s/. Based on the above experimental results we suggested that perception and, consequently, production are circumscribed by the shape of the clusters' phonological representations.

In the present study we investigate the behavior of affricates as opposed to all other cluster types appearing in Greek, i.e. CL, CC[3], NN[4], SC, CS sequences. More specifically, the main goals of the present study are, first, to discuss the different analyses of affricates and /s/ clusters which are based on the phonotactics of the language, second, to investigate the behavior of the Greek affricates –/ts/, /dz/- as opposed to other clusters consisting of /s/ + stop, and stop + /s/, e.g. /sp/ vs. /ps/, as well as CL and CC sequences, third, to test whether the phonological environment of affricates such as their coexistence with other clusters, their emergence in stressed syllables or their position in the word (initial, medial or final) influences their preservation.

Our working hypotheses are summed up in the following; first, we consider 'true' clusters, i.e. CL sequences, to be easily perceived compared to other cluster types. Second, affricates tend to be more coherent compared to /s/ + obstruent and obstruent + /s/ clusters perception- and production-wise. Third, obstruent + /s/ are more coherent compared to /s/ + obstruent clusters perception- and production-wise. Fourth, /s/ clusters are less coherent compared to CL and CC clusters and, finally, cluster coherence is attributed to phonological representation (see also Tzakosta & Karra 2007, Tzakosta and Vis 2007, Tzakosta 2007, for comparable discussion). Finally, when affricates and /s/ clusters co-occur with other clusters in the target word or when /s/ clusters are part of syllables which follow the stressed one or occupy a second position among clusters they are more prone to decomposition.

One of the reasons that motivated this study is that we find the formal accounts proposed for Greek affricates to be insufficiently motivated given that they are based solely on sparse, abstract data and do not consider experimental data. In this study we attempt a thorough investigation of the nature of Greek affricates and other sequences made up of obstruent segments based, on the one hand, on the phonotactics of the language and, on the other hand, on experimental data drawn from adults native speakers of Greek.

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[3] By CC we refer to all possible combinations of fricatives (F) and stops (S), namely FS, FF, SS, SF are not acceptable consonant sequences in Greek. SF combinations are restricted to CS sequences or sequences emerging at word boundaries, for example [ek + θeto] 'expose-1PRES.SG.'.
[4] N stands for nasals.

The data strongly suggest that a three-way distinction should be made regarding the phonological representation of obstruent sequences in Greek. First, sequences [pt] and [kt] are bipositional consonantal clusters. Second, sequences [ps] and [ks] display extra phonological coherence, therefore, these sequences are thought of as contour segments (see also Simiris et al. in prep., for comparable discussion). Affricates are the most coherent consonantal sequences, though differing from simplex segments, and should therefore be analyzed as complex segments.

The structure of this study is the following: section 2 consists in a survey of the existing literature, which focuses on the phonotactics of Greek. For our discussion we will draw on data from i) phonetic duration, ii) co-occurrence constraints, iii) morphological boundaries and iv) the (non-)application of nasal + voiceless stop fusion. Section 3 provides some preliminary conclusions of the discussion in 2, while section 4 presents the methodology used for our research. Section 5 offers the findings of the experiment and section 6 promotes our formal analysis for the representation of different cluster types in Greek. Section 7 concludes the paper.

2. Phonotactics

In a previous account of Greek affricates we discussed the proposals cited in the existing literature regarding their phonological representation (Tzakosta & Vis 2007). We argued that some of those theoretical proposals are invalid whereas others do provide some indications on the nature of affricates and other consonantal sequences.[5] In this study we will elaborate on these valid indications, more specifically the phonetic duration of affricates (2.1.), the role of morphological boundaries on affricates' realization and representation (2.2.), the co-occurrence constraints with respect to affricates (2.3.). Moreover, the (non-)application of fusion of a nasal + voiceless stop within the domain of consonantal sequences is also discussed (2.4.). This phenomenon has not yet been discussed in the existing literature, though it provides strong arguments in favor of the tripartite distinction of consonantal sequences that we propose.

2.1. Phonetic duration

Phonetically, affricates are differentiated from the stop + /s/ sequences [ps] and [ks] when the latter occur in word-initial position. More specifically, when the strident [s] is member of the affricate it has a relatively shorter duration than when it occurs in the [ps] and [ks] sequences (Φουράκης και συνάδελφοι 2005). This could be an indication of the monopositionality of affricates, though the shorter tongue movement required for its articulation cannot be

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[5] See Tzakosta & Vis (2007) for an extended discussion of all cited potential arguments.

excluded as an alternative explanation of this short duration. In any case, the above argument points to a phonetic difference between affricates and other obstruent + /s/ sequences.[6]

2.2. Co-occurrence constraints

Affricates [ts] and [dz] impose additional restrictions on the formation of consonant clusters compared to simplex [t] and [s]. First, simplex [s] can be combined with all obstruents in tautosyllabic clusters, like [sp], [sk] and [st]. Clusters consisting of an affricate + obstruent like *[tsp], *[tsk], *[tst] are ill-formed. Note that neither simplex [t] can be combined with another obstruent; *[tp] and *[tk] are not allowed.

Secondly, simplex [t] can form tautosyllabic consonantal clusters with most sonorants, for example [tr], [tn] and [tm].[7] Affricates do not share these properties as can be concluded from the illicit non-existing clusters *[tsl], *[tsr], *[tsm] and *[tsn]. It should be noted that similar restrictions can be observed with respect to simplex [s]; *[sr], *[sl] and *[sn] are not allowed.[8]

Based on the above observations, it can be concluded that affricates combine the phonotactic restrictions of simplex [t] and [s]. With this respect, they differ from simplex segments and pattern phonotactically with other consonantal sequences like [ps], [ks], [pt] and [kt]. This conclusion, however, does not automatically lead to the assumption that affricates should be analyzed as two independent segments as was previously suggested in the literature (Joseph & Philippaki-Warburton 1987, Pagoni 1994). In addition, in the case of complex and contour segments the same features [+stop] and [+cont] are present and it is these features that impose phonotactic restrictions on cluster formation, not the number of segmental root nodes.

2.3. Phonological and morphological boundaries

The main difference of affricates in comparison with other obstruent sequences is that no morphological boundary is possible to intervene between affricate members [t] and [s] (Pagoni 1994). Affricates [ts] and [dz] are never the result of morphological processes like

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[6] The same phonetic properties have been observed in data where a word-final [t] is resyllabified with a following word initial [s] in sequences like [sut su] 'your shot' (Tserdanelis 2005). However, the latter observation does not provide any evidence with respect to the abstract phonological representation of affricates.

There are no phonetic data available for clusters [pt] and [kt] with respect to the relative duration of both members of the cluster. As a result, these clusters cannot be phonetically compared with the stop + strident sequences.

[7] *[tl] is considered to be ill-formed (Kappa 1995).

[8] Only when they are the result of compounding do /sr/, /sl/, and /sn/ occur across morpheme boundaries, e.g. [i**s** + **r**eo], [pro**s** + **l**amvano]. Note that also other morpheme-internal illicit clusters arise from compounding, e.g. [e**k** + **pt**osi], [e**k** + **f**ero], [i**s** + **p**noi]. This can be interpreted as the existence of weaker co-occurrence constraints in this specific context. The details remain open for future study.

inflection or compounding.[9] On the contrary, the sequences [ps] and [ks] are frequently the product of inflection or other word-formation processes. This is exhibited in the examples in (2).

2.   a. e-kla**p-s**-a   'cry-1SG.PERF' (cf. kle-o)

      b. ala**k-s**-a   'change-1SG.PERF.' (cf. alaz-o)

      c. ko**p-s**i   'blade-FEM.NOM.SG..' (cf. kov-o)

      d. le**k-s**i   'word-FEM.NOM.SG.' (cf. leγ-o)

      e. γra**p-s**imo   'writing-NEUT.NOM.SG.' (cf. γraf-o)

In the data in (2a) and (2b), the formation of the perfective stem with the morpheme -s- creates the clusters [ps] and [ks]. In the data in (2c - e), nouns are formed by the addition of the suffix -si or -simo to a verbal stem. The result is the realization of clusters [p#s] and/or [k#s] both members of which are split up by a morphological boundary.[10]

2.4. (Non) application of fusion of nasal + voiceless stop

In Greek, the sequence of any nasal + voiceless stop is realized as a prenasalised voiced stop. This process of segmental (or featural) fusion occurs both in word-internal contexts (see examples at 3a-c) as well as across word boundaries, i.e. in the case of an N-final clitic + host, as illustrated in (4a-c) (see Arvaniti 1999, for an optimality theoretic account of this process).

3.   a. /n+t/ → [d]   /pente/ → [pe^{n}de]   'five'

      b. /m+p/ → [b]   /θampos/ → [θa^{m}bos]   'dim-MASC.NOM.SG.'

      c. /n+k/ → [g]   /ankaθi/ → [a^{N}gaθi]   'thorn-NEUT. NOM.SG.'

4.   a. /n+t/ → [d]   /δen teriazo/ → [δe ^{n}deriazo]   'match-1PRES.SG.NEG.'

      b. /n+p/ → [b]   /δen prospaθo → [δe ^{m}brospaθo]   'try-1PRES.SG.NEG.'

      c. /n+k/ → [g]   /δen kano/ → [δe ^{N}gano]   'do-1PRES.SG.NEG.'

However, in the case of obstruent sequences the process is not straightforward. Especially [pt] and [kt] clusters as well as [ps] and [ks] ones display aberrant phonotactics as the data in (5) and (6) regarding their emergence word-internally and across word boundaries, respectively, show:

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[9] If the same morphemes adhere to a /t/-final stem, this /t/ usually deletes, e.g. /θet-s-o/ → [θeso] 'put-1.SG.SUBJ.'

[10] A similar account for clusters [pt] and [kt] cannot be given due to the fact that no morpheme begins with the obstruent [t].

5. a. /n+ts/ → [dz]   /rantso/ → [ra^{n}dzo]   'camp bed-N.NOM.SG.'

    b. /n+ps/ → [mps]   /elampse/ → [elampse] **elabze** 'shine-PERF.3.SG.'

    c. /n+ks/ → [Nks]   /elenksa/ → [eleNksa] **elegza** 'check-PERF.1.SG.

    d. /n+pt/ → [mpt]   /sinptosi/ → [simptosi] **sibdosi** 'coincidence-F.NOM.SG.

    e. /n+kt/ → N/A   **non existent**

6. a. /n+ts/ → [dz]   /δen tsapizo/ → [δe ^{n}dzapizo]   'hoe-1PRES.SG.NEG'

    b. /n+ps/ → [bz]   /δen psino/ → [δe ^{m}bzino]   'fry-1PRES.SG.NEG.'

    c. /n+ks/ → [gz]   /δen ksero/ → [δe ^{N}gzero]   'know-1PRES.SG.NEG'

    d. /n+kt/ → [Nkt]   /δen ktizo/ → [δeN ktizo] **gdizo** 'build-1PRES.SG.NEG.'

    e. /n+pt/ → [mpt]   /δen ptoo/ → [δem ptoo] **bdoo** 'daunt-1PRES.SG.EG.'

As the data in (5) and (6) show, clusters [pt] and [kt] are never the target of fusion. The nasal + affricate sequences, on the other hand, always undergo fusion resulting in the voiced affricate [dz]. The sequences [ps] and [ks] exhibit ambiguous phonotactics. In word-internal position, they are realized faithfully with respect to their input but when a clitic precedes it, fusion with the preceding nasal applies. A detailed analysis of this process remains open for future research, but the examples in (3) – (6) clearly demonstrate the tripartite phonotactics of consonantal sequences in Greek.

3. Preliminary conclusions

Considering the phonotactic constraints of Greek discussed in the previous section, Greek affricates sometimes pattern with simplex segments given the evidence provided from phonetic duration and fusion; sometimes they pattern with consonantal sequences, as co-occurrence constraints display. Sequences [ps] and [ks] demonstrate ambiguous linguistic behaviour as well. With respect to phonetic duration, co-occurrence constraints and word-internal fusion they pattern with true clusters. However, fusion across word boundaries affects these sequences with the result that the latter appear to be simplex segments. This is summarized in table 1 below. Cells of the same greyscale signal similar phonotactics.

Table 1: Overview of the phonotactic constraints of obstruent sequences in Greek.

target → process ↓	simplex segments	Affricates [ts], [dz]	[ps], [ks]	clusters [pt], [kt]
phonetic duration	Short	Short	long	N/A
Co-occurrence	Simple	Double	double	double

constraints				
Morphological boundary	Unseparated	unseparated	separated	N/A
word-internal fusion	Yes	Yes	no	no
fusion across word boundaries	Yes	Yes	yes	no

Consequently, given that obstruent sequences in Greek exhibit three types of linguistic behavior, we argue that this is the surface mirror of three different underlying phonological representations; first, affricates [ts] and [dz] are complex segments, second, the sequences [ps] and [ks] are contour segments and, finally, the third category consists of true clusters like [pt] and [kt]. In the remainder of this article we demonstrate that the tripartite phonological behavior of consonantal sequences discussed above is supported by experimental data in which the native speaker's perception has been elicited.

4. Research methodology

In order to test our working hypotheses we designed and conducted an off-line experimental task which took the form of a questionnaire. 21 adults, native speakers of Greek (age range: 20-29 years) participated in the experiment. The subjects were asked to break up consonantal strings which reflected all Greek cluster types in 150 existing Greek words by means of inserting a vowel wherever they considered it convenient. A representative example is given in (7) below.

7.   a. /**pr**oí/ → [**p**o.**r**o.í]

Words were ordered randomly. Put differently, the tokens were not ordered based on any of the variables of stress, word position or co-occurrence with other clusters. The aim of the experiment was to evaluate the linguistic mechanisms activated in the perception and the production of different types of consonant clusters.

5. Preliminary results

Regarding /s/ sequences, the data demonstrated a preference for the preservation of affricates and obstruent +[s] clusters over [s] + obstruent combinations.[11] The participants in the experiment showed a strong tendency to break up 'true' consonant clusters by inserting a

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[11] When we refer to the actual data the discussed clusters are included in brackets, reflecting surface realization, and not side lines, which refer to the underlying representations.

vowel while they retained affricates intact. In what follows we present the reader with some representative graphs reflecting the above claim. Graphs 1-2, 3-4 and 5-6 provide us with the results of three participants who gave us interesting data regarding the realization of all clusters. Figures 7-10, on the other hand, present the tendencies of all participants regarding the realization of all cluster types.

Mes 1 is the participant who exhibits the lowest rates of /s/ clusters decomposition (20%) compared to all other participants. This is shown in figure 1. Mes 1 exhibits an extremely high rate of CL and CC decomposition (92%) (figure 2). This is an indication that CL and CC clusters are clearly recognized as clusters to a much higher extend compared to /s/ sequences. This means that CL and CC combinations are broken up. The data showed that this happens irrespective of the position of clusters in the word or whether they belong to a stressed syllable or not.

Mel 8, on the other hand, demonstrates a different statistical tendency compared to Mes 1. To be more specific, Mel 8 decomposes all cluster types almost to the same extent. Figure 3 shows that [s] clusters have a rate of 72% of decomposition, while CL and CC clusters have a rate of 74% of decomposition. These results let us assume that Mel 8 perceives all kinds of consonant sequences as clusters.

Figure 1: Mes 1 - /s/ cluster realization

Figure 2: Mes 1 – CL & CC realization

Figure 3: Mel 8 - /s/ cluster realization

Figure 4: Mel 8 – CL & CC cluster realization

Finally, Pir 3 is the participant who exhibits a less extreme linguistic behaviour. More specifically, Pir 3 demonstrates a 45% rate of [s] clusters reduction and a 62% rate of CL and CC reduction. Therefore, Pir 3 seems to recognize CL and CC sequences as clusters to a greater extent compared to [s] sequences. However, it is obvious that the participant is hesitant to display a stable behaviour towards either CL/ CC or [s] sequences. This seems to be evident for all types of syllables irrespective of their position or their being stressed or not.

Figure 5: Pir 3 - /s/ cluster realization

Figure 6: Pir 3 – CL & CC realization

Figures 7-10 demonstrate the totals of all subjects regarding the rates of preservation and reduction of all cluster types. More specifically, figure 7 illustrates the total results of all [s] sequences. Note that affricate [dz] displays the lowest rate of decomposition (~12%) followed by [ks] (~15%). Interestingly, [dz] is not followed by its voiceless counterpart affricate [ts], though the latter also exhibits a very low degree of decomposition (~16%). This evidence adds to the assumption that CS clusters, especially their stop + /s/ version, are dealt with like affricates by native speakers of Greek (cf. Simiris et al. in prep.). This is further supported by the fact that [ps] also has a low rate of decomposition (~17%). Other [s] clusters have higher rates of decomposition ranging between 20% (for [st]) and ~72% (for [sp]). Apparently, [sp] is the 'clearest' /s/ cluster as shown in figure (7). Figure 8 illustrates the degree of coherence of CC and NN clusters. It is obvious that compared to [s] clusters, CC and NN sequences are much more frequently decomposed with rates ranging between ~40% exhibited by [kt] and <80% exhibited by [mn].

Figure 7: coherence of /s/ clusters

Figure 8: coherence of CC and NN clusters

Figures 9 and 10 show the rates of decomposition/ correct realization of CL sequences when the initial obstruent member is voiceless and voiced, respectively. It is interesting that, in general, CL clusters with voiceless initial obstruent display higher rates of decomposition compared to the voiced counterparts. The exception to this is [tr] which is less prone to decomposition (>20%).[12] [kl] and [kr] display the highest rate among all CL sequences, voiceless and voiced.

Figure 9: coherence of CL clusters (voiceless)

Figure 10: coherence of CL clusters (voiced)

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[12] For additional reasons driving these differences between clusters, see Tzakosta (in prep).

6. Cluster coherence and phonological representations

Based on the discussion of the phonotactic restrictions of Greek, affricates seem to be more coherent compared to all cluster types. [ps] and [ks] sometimes pattern with affricates and sometimes with true clusters like [pt] and [kt]. For this reason, they can be interpreted as having a moderate degree of coherency. This is shown in the hierarchy in (8) below. The experimental data provided us with a slightly different version of the scale in (8), as shown in the hierarchy in (9) where CS sequences are promoted to the same highest level with affricates. A combined scale stemming from the fusion of both scales in (8) and (9) is the one given in (10), where affricates are clearly place in the highest level of the hierarchy, stop + /s/ clusters are placed in the following level, whereas all other cluster types are placed in the lowest level of the hierarchy.

8.   Affricates > stop+/s/ > /s/+stop, CC, NN, CL

9.   Affricates and stop+/s/ > /s/+stop, CC, NN, CL

10.   Affricates > stop+/s/ > /s/+stop, CC, NN, CL

The main question resulting from the discussion in the previous chapters is why affricates are more coherent compared to other cluster types. Our argument is that this is attributed to two factors; first, to the identity of place of articulation (PoA) of the members of the examined consonant sequences and, second, to the satisfaction of the scale of consonantal strength (Lass 1984). More specifically, affricate members share the same place of articulation but also satisfy the scale of consonantal strength, i.e. the consonantal strength of its members is rightwards. As a result, affricates exhibit the highest phonological coherence. Obstruent + /s/ clusters, on the other hand, display a relative degree of decomposition due to the fact that they violate the first factor, namely their members do not share the same place of articulation; however, they satisfy the scale of consonantal strength. Therefore, obstruent + /s/ sequences are phonologically less coherent compared to affricates. Finally, /s/ + obstruent clusters undergo the highest degree of decomposition because they violate both criteria; consequently, /s/ + obstruent clusters are phonologically the least coherent clusters compared to all sequences containing a /s/ in either first or second position.

Moreover, CC and CL sequences exhibit comparable behavior with SC sequences, even though CLs may satisfy the scale of consonantal strength as well as the PoA hierarchy. They are more prone to decomposition because of the distance existing between cluster members on the scale of consonantal strength. Word position and stress did not provide us with clear tendencies regarding cluster decomposition. In general, we claim that different degrees of

decomposition are attributed to different phonological representations. These are depicted in (11). The representations (a), (b) and (c) are rather straightforward; (a) represents affricates as complex segments whose members fuse into one single node. Members of CS clusters start off sharing the same node, which ends in two distinct branches, i.e. contour segments. According to (b), CS sequences have the representation previously proposed for affricates (cf. Sagey 1986). (c) is the representation proposed for SC clusters in which /s/ functions as an appendix. The problem appears with the representations proposed for CC, NN and CL clusters in the sense that the same representation reflects different cluster types, as shown in (11d-f). This constitutes a discrepancy between actual data and a formal analysis because CC, NN, CL are characterized by different degrees of decomposition (cf. Tzakosta & Vis 2007, for comparable discussion).[13]

11. Phonological representations

a. Affricates **b. CS clusters** **c. SC clusters**

σ σ σ

O R O R O R

ts x p s x s p x

d. CC clusters **e. NN clusters** **f. CL clusters**

σ σ σ

O R O R O R

p t x m n x p l x

7. Conclusions

In this paper we explored the nature of the phonological structure of affricates as opposed to all types of Greek clusters. The phonotactic analysis combined with our experiment testing the perception of native speakers revealed that affricates are complex segments, while CS sequences seem to be contour segments. CL sequences are perfect clusters because of the

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[13] The discrepancy is subject to further research (cf. Tzakosta and Vis in prep.).

biggest possible distance existing between their members on the sonority scale. CC and SC clusters occur somewhere in between affricates, CS clusters and CL ones, with the former behaving like true clusters and the latter like heterosyllabic sequences.

In general, cluster complexity seems to be determined by the degree of identity of place of articulation and the satisfaction of the scale of consonantal strength. However, word position and stress do not seem to influence cluster preservation. Rather, these factors affect preservation or reduction of all clusters on an intra-subject basis. The data further revealed that perception and, consequently, production are circumscribed by phonological representations.

There are several issues that have not been explored here; first, the exact difference in the representations of affricates and CS clusters, second, the subtle differences in the representations of CC, NN and CL clusters, third, whether sonority distance is a phonetic or phonological epiphenomenon, fourth, the statistical evidence favoring cluster coherence and, finally, the behavior of heterosyllabic (LC) sequences as opposed to tautosyllabic clusters. These issues are amenable to future research.

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