Asymmetries in /s/ cluster production and their implications for language learning and language teaching

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Abstract: In this paper we demonstrate that different two-member cluster types exhibit different simplification strategies in Greek child speech. We argue that such differences mirror variable degrees of cluster coherence and, therefore, presuppose distinct phonological representations. We suggest that cluster coherence is due to the combination and satisfaction of specific factors; first, the position of each cluster member, i.e. whether it is the initial or the second member, second, the featural synthesis of the obstruent member of the cluster and, third, the satisfaction of the Sonority Scale.

Keywords: cluster, coherence, phonological representation, sonority, affricate.

1. Introduction

The majority of research studies in L1 phonological development demonstrate that clusters undergo simplification by means of reduction, epenthesis and fusion during language development (cf. Barlow 1997; Pater & Barlow 2003, for child English, Fikkert 1994; Jongstra 2003, for child Dutch, Lukaszewicz 2000, for child Polish, Kappa 2001; Tzakosta 1999; 2001, for child Greek). Cluster simplification facilitates the production of unmarked CV syllables. More specifically, it takes the form of, first, cluster reduction. Reduction is driven by either markedness (Gnanadesikan 2004), which is, in turn, governed by the so-called ‘sonority pattern’ (Barlow 2001a; 2001b; Gnanadesikan 2004; Goad and Rose 2004; Jongstra 2003; Ohala 1996; Pater & Barlow 2003), or contiguity (van der Pas 2004). If sonority determines cluster reduction, segments which are unmarked at the level of either place/ manner of articulation or voicing surface. This is exemplified in the English data in (1). In (1) the least sonorous, or else strongest, segment is retained. If contiguity determines cluster reduction, segments which are unmarked at the level of either place/ manner of articulation or voicing surface. This is exemplified in the English data in (2).

Epenthesis is a second strategy of cluster simplification. It takes the shape of either anaptyxis of a vowel in between a cluster or prothesis of a vowel immediately before a cluster. According to Fleischhacker (2000), anaptyxis applies to CL\(^1\) while prothesis emerges in SC clusters. However, in the Greek data in (3), vowel anaptyxis is attested with CC clusters. In many cases in the Greek data, /æ/ is the inserted vowel placing

\(^1\)C stands for obstruents and L for liquids.
emphasis on its unmarked character. In fusion, on the other hand, a third mechanism of cluster simplification, the produced segment inherits place and manner features from both members of the cluster (cf. Barlow 1997), as shown in (4). In (4a), for example, output /c/ inherits the place specifications of /x/ and the manner specifications of /t/. Output /t/ of (4b) is the product of the place characteristics of /r/ and the manner features of /k/.

(3a) /xti.pá.i/ → [γæ.ti.bá.i] ‘hurt-3SG. PRES.’ (Mc: 2;00.26)
(3b) /pé.fti/ → [bé.fí], [pé.fæ.tí] ‘fall-3SG. PRES.’ (B.M.: 2;07.09)

(4a) /δá.xti.lo/ → [ká.ci.lo] ‘finger-SG. NEUT.’ (B.M.: 2;02.18)
(4b) /mi.kró/ → [mi.tó] ‘small-SG.NEUT.’ (F: 2;05.01)

Finally, cluster simplification may be governed by headedness (Goad & Rose 2004) or positional faithfulness considerations (Revithiadou & Tzakosta 2004) according to which clusters are reduced to their heads or to segments imposed by constraints demanding specific positions to be retained. In the Greek data in (5), the initial segments of the clusters are realized no matter what their featural composition is. In other words, initial segments are realized irrespective of whether they are even the most marked segments in the word.

(5a) /γlì.kó/ → [γò] ‘sweet-ADJ. SG. NEUT.’ (D: 2;01.09)
(5b) /frì.ya.nú.la/ → [fú.la] ‘cracker-DIM.’ (D: 2;03.07)

The problem with all the above analyses is that they are mostly descriptive with the attempt to be ‘translated’ into constraints (cf. Alves 2004). However, a question demanding theoretical explanation is whether all cluster types are realized the same way in child speech. In other words, are different cluster types simplified by means of equivalent repair mechanisms?

Taking a first glance at the data, we observe that different cluster types exhibit different output forms. Our fundamental assumption is that different output forms are due to different phonological representations. Regarding /s/ + obstruent clusters, two formal analyses have been proposed. Under the first analysis, /s/ is extrametrical, namely /s/ is not part of the syllabic onset but is directly associated with the syllabic node. Extrametrical /s/ is also reported as adjunct or appendix in the literature. This has been argued for adult languages (Drachman 1989; Giegerich 1992), as well as child development (cf. Fikkert 1994) and language disorders (Barlow 1997; 2001; Gierut 1999). Under the second analysis, /s/ + obstruent clusters are said to be complex segments equivalent to affricates (Fudge 1969; Selkirk 1982). The phonological representations reflecting each of the above analyses are given in figures 1 and 2, respectively.

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2 Syllabification is provided not only for the output but also for the input forms given that input forms are actual adult output forms.
3 According to Stemberger & Treiman (1986), variation is not phonological, rather it is intra-child.
4 A related discussion can be found in Barlow (2001) and Gierut (1999).
The above cluster representations have different implications for child speech. More specifically, if /s/ is extrametrical, it is expected to be deleted, as shown in (6a). On the other hand, if the /s/ + obstruent cluster is a complex segment, then the whole cluster is expected to either be deleted or be accurately produced from the beginning of the phonological development.

(6a) /sxo.lí.o/ → [xo.lí.o] ‘school-NEUT.NOM.SG.’
(6b) /sxo.lí.o/ → /sxo.lí.o/, [ø.o.lí.o] ‘school-NEUT.NOM.SG.’

Nonetheless, /s/ clusters exhibit various patterns in production cross-linguistically. /s/ is preserved due to either positional faithfulness, headedness (7a) or syllabification effects. When /s/ emerges in word-medial positions, it is uncertain whether it is perceived as part of the medial onset or the coda of the preceding syllable (7b). According to Barlow (2003), /s/ is deleted if it is more marked compared to the second member of the cluster or because it is syllabified as a coda word-medially. This is further supported by data where word-medial coda segments are deleted, as shown in (8a) and (8b). /s/ is never faithfully produced in two-member clusters in the examined data, although it is attempted when it is part of three-member clusters (8c).

(7a) /slip/ → [sip] ‘sleep’  (From Barlow 1997)
(7b) /é.sei.se/ → [é.ci.te] ‘tear-3SG.PAST’  (Me: 1;08.31)
(8a) /vá.to/ → [vá.to] ‘put it-2IMP.PERF.’  (B.T.: 1;11.09)
(8b) /kar.ðú.la/ → [kaɾ.ðú.la] ‘heart-FEM.NOM.SG.’ (Ma: 2;11.12)
(8c) /á.spro/ → [á.θpo] ‘white-ADJ.SG.NEUT.’  (D: 2;05.08)

2. Research issues
Our study is driven by three fundamental questions. First, how are different cluster types realized in child speech? Second, if different cluster types exhibit various production patterns in child speech, why does this happen? Third, what is the relation between /s/ clusters and CL clusters? And, in relation to the previous question, what is the subtle relation between /s/ clusters?

The major working hypothesis underlying our study is that different cluster types have different phonological representations and exhibit different degrees of coherence. Therefore, phonological representations determine the degree of coherence which, in turn, shapes perception and production. More specifically, the members of CL clusters significantly differ in sonority (Clements 1984, 1988). As a result, sonority distance leads to ‘clarity’ of perception which, in turn, facilitates production. In other words, CL
clusters, which we refer to as ‘true’ clusters, are accurately produced earlier compared to CC and /s/ clusters.

3. The study
Our study draws on longitudinal production data from seven children who acquire Greek as their mother language and range in age between 1;07.05 – 3;05 years. Their names are abbreviated in the parenthesis (B.M., B.T., D., F., I., Kon., Ma.). The data are representative of the intermediate developmental phase during which variation is extensive. The present study is mostly qualitative rather than a study supported by statistical frequencies. We aim at illustrating the general linguistic tendencies appearing in Greek child speech regarding different cluster types. Data are presented in broad phonetic transcriptions.

4. Data and findings
As already mentioned, we investigate the repair strategies activated per cluster type. We remind the reader of our initial assumption that different cluster types exhibit different production patterns in child speech due to differences in the phonological representations of the former. A related assumption is that the higher degree of coherence clusters exhibit the fewer repair strategies are activated during the process of their being repaired.

More specifically, regarding ‘true’ CL clusters, we observe that all children simplify them through markedness and contiguity (7/7 of the children). In other words, it is the least sonorous segment or the segment most adjacent to the syllabic nucleus that is preserved. This supports the fact that markedness and contiguity are the most ‘popular’ repair strategies adopted by children. Representative examples are given in (9). (9b), (9d) and (9e) constitute cases of markedness, while (9a) and (9c) are cases of contiguity.

(9a) /vlé.po/ → [lé.po] ‘see-1SG.PRES.’ (B.M.: 2;02.12)
(9b) / prá.si.no/ → [pá.to] ‘green-ADJ. NEUT.’ (B.T.: 1;10)
(9c) /pá.vlos/ → [pá.los] ‘Paul-PR.NM.’ (F: 2;02.03)
(9d) /o.bré.la/ → [o.bé.la] ‘umbrella-SG. FEM.’ (I: 2;04.03)
(9e) /cí.trí.no/ → [tí.ti.no] ‘yellow-ADJ. SG. NEUT.’ (Kon: 1;11)

On the other hand, positional faithfulness is recruited by all but one child (6/7). This is shown in (10a-c). In addition, five out of seven children employ epenthesis (10d-g) and only three out of seven children make use of fusion (10h-i).

(10a) /xró.ma/ → [xó.ma] ‘color-SG. NEUT.’ (B.M.: 2;03.04)
(10b) /γló.sa/ → [γó.θa] ‘tongue-SG. FEM.’ (D: 2;02.17)
(10c) /á.vlí/ → [á.ví] ‘garden-SG. MASC.’ (I: 2;09.07)

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5 We follow the terminology used in the Multiple Parallel Grammars Model (Revithiadou & Tzakosta 2004; Tzakosta 2004).
6 Tzakosta (2004) assumes that the initial and final phases of language development are characterized by specific production patterns. For example, children produce only fully unmarked structures during the initial developmental phase. In the intermediate phase, on the other hand, children produce unmarked, relative unmarked, relative marked as well as forms fully faithful to the input.
7 For the time-being we refer to affricates as clusters.
8 Due to space limitations we only present representative data.
9 Moreover, children tend to employ markedness more frequently than contiguity, although we do not provide any statistical evidence for such a claim.
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(10d) /kri.o/ → [kæ.rι.o] ‘cold-SG. NEUT.’ (B.M.: 2;02.12)
(10e) /ble/ → [bæ.λε] ‘blue-ADJ. SG. NEUT.’ (I: 2;08.11)
(10f) /tsi. xls/ → [ti..INSTANCE] ‘gum-PL. FEM.’ (I: 3;03.08)
(10g) /klé.i/ → [kæ.lé.i] ‘cry-3SG.PRES.’ (Kon: 1;11.11)
(10h) /klé.i/ → [tæ.i] ‘cry-3SG.PRES.’ (B.M.: 1;10.26, I: 2;08.28)
(10i) /klι.δι/ → [ti.δι] ‘key-SG. NEUT.’ (I: 2;05.19)

With respect to SC clusters, all children simplify them through markedness (11a-d), two out of seven children simplify them through fusion (11e-f) and epenthesis (11h-i). Interestingly, there are no instances of simplification due to positional faithfulness.

(11a) /ðó.to/ → [ðó.to] ‘give it-2IMP.’ (B.T.: 1;11.07)
(11b) /sci.los/ → [ci.lo] ‘dog-SG. MASC.’ (F: 2;00.27)
(11c) /spí.tá.ci/ → [te.fá.ci] ‘hat-DIM.’ (B.M.: 2;07)
(11d) /sku.ťá.ci/ → [te.ťá.ti] ‘dog-DIM.’ (I: 2;04.03)
(11e) /sté.la/ → [te.θé.la] ‘Stela-PR.NM.’ (B.M.: 2;05.21)
(11f) /bro.stå/ → [bo.θæ.tå] ‘front-ADV.’ (Kon: 2;00.01)

Data from CS clusters, on the other hand, exhibit even more limited repair strategies. More specifically, all children reduce them due to markedness/contiguity (12a-c) and fusion (12d-f). Only one child, D, exhibits extremely rare cases of epenthesis (12e).

(12a) /pşé.ma/ → [pɛ.ma] ‘lie-SG. NEUT.’ (B.M.: 1;11.01)
(12b) /ksi.lo/ → [ci.lo] ‘stick-SG. NEUT.’ (F: 2;05.24)
(12c) /fjá.kso/ → [fá.ko] ‘repair-1SG.FUT.’ (Ma: 2;07.06)
(12d) /pɛ.kso/ → [pi.θo] ‘play-1SUBJ.’ (B.M.: 1;11.18), [pɛ.to] (I: 2;04.03)
(12e) /spi.lá/ → [fi.lá] ‘high-ADV.’ (D: 2;02)
(12f) /pe.tá.kso/ → [pe.tá.to] ‘throw-1SG.SUBJ.’ (F: 2;01.18)
(12g) /ksé.ro/ → [kæ.δɛ.ro] ‘know-1SG.PRES.’ (D: 2;04.17)

Finally, affricates primarily undergo reduction to their unmarked, i.e. stop, member. This is displayed in the examples in (13a-e). Except for reduction, there are sporadic cases of fusion in the data of two out of the seven children, as exemplified in (13f-g).

(13a) /e.le.ni.tsa/ → [ni.ta] ‘eleni-DIM.’ (B.M.: 1;09.22, 1;10.18)
(13b) /ku.kú.tsi/ → [kú.ti] ‘core-SG. NEUT.’ (B.T.: 1;10)
(13c) /ka.ró.tsi/ → [te.tu.ro.ti] ‘pushchair-SG. NEUT.’ (D: 2;01)
(13d) /mu.dzú.ra/ → [mu.dú.ra] ‘stain-SG. FEM.’ (I: 3;01.03)
(13e) /ko.pe lié.tsa/ → [ko.pe lié.tå] ‘lady-DIM.’ (Ma: 2;07.06)
(13f) /tsi.bá.i/ → [θe.θa.i] ‘bake-SG. PRES.’ (B.M.: 2;02.05)
(13g) /pe.tsé.ta/ → [pe.θɛ.ta] ‘towel-SG. FEM.’ (F: 2;09.05)

The repair strategies employed by the tested children are summed up in tables 1 through 4. Table 1 represents the repair mechanisms activated in the simplification of CL clusters. It is evident that all repair strategies are activated, if not by all, by at least most

10 The available data are very limited.
children. Markedness/ contiguity and positional faithfulness are more prevalent compared to epenthesis and fusion. Markedness prevails in the simplification of SC clusters, followed by fusion and epenthesis, which are each activated by two children, as illustrated in table 2. Positional faithfulness is never activated in SC simplification. This also holds for CS clusters and affricates, as shown in tables 3 and 4, respectively. Markedness and contiguity are still more prevalent in the simplification of CS clusters and affricates. It is obvious that affricates are the most conservative ‘clusters’ regarding the activated simplification mechanisms.

Table 1: CL clusters

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Table 2: SC clusters

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Table 3: CS clusters

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Table 4: Affricates

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5. Discussion

The goal of this section is to discuss whether the preference for certain mechanisms over others in the process of cluster simplification is attributed to specific reasons. A relevant question is why fusion and epenthesis are the simplification strategies less frequently attested compared to markedness, contiguity and positional faithfulness. Both epenthesis and fusion demand accurate perception of both cluster members. Moreover, epenthesis involves lengthening of the ambient form in terms of the number of syllables that need to be produced. Epenthesis is more common in CL and SC clusters. Fusion, on the other hand, presupposes accurate perception not only at the segmental but also at the featural level for the produced segment to inherit features from both cluster members. Reduction is the most common repair because it involves cluster simplification as well as preservation of the prosodic shape of the ambient form.

Another issue related to our study is why CL clusters undergo all types of cluster simplification while SC/CS clusters and affricates are mainly prone to deletion and fusion. Would that differentiation imply that affricates are recognized as clusters and, consequently, they are reduced to their least marked segment? Regarding this question, our claim is that differences in the production patterns are attributed to differences in perception, which, in turn, is influenced by differences in the phonological representations of different cluster types. This claim is supported by arguments stemming from pure theory as well as perception and production data.
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In theory, CL clusters satisfy the Sonority Scale (SS) (cf. Steriade 1982, Selkirk 1984) and are perfect clusters. Nonetheless, they are less coherent because the sonority distance between the cluster members is relatively big. Such sequences -if not simplified- are realized by being broken up or by leaving featural traces of their members through fusion. SC clusters, especially /s/ + [fricative] clusters violate the SS. Therefore, they are ‘problematic’ clusters which are simplified through deletion of their more marked segment (cf. Goad and Rose 2002, 2004, for a different account). CS clusters, on the other hand, satisfy the SS; in addition, they are highly adjacent on the SS which underlines their coherent status. Finally, affricates satisfy the SS and are the most coherent clusters not only due to their adjacency on the SS but also due to the homorganicity of their members, i.e. the identity in place of articulation.

To sum up, different degrees of variation in cluster production are attributed to different degrees of cluster coherence with respect to the SS and the clusters’ internal structure. If structure determines output variation, word position and stress do not influence cluster preservation/ simplification (cf. also Tzakosta 2004; 2007). This is supported by data from developmental stages during which CL clusters emerge systematically, while /s/ clusters keep on being simplified. The proposed representations for each one of the examined cluster types are provided in figures 3-6. Note that the representation for CL clusters given in fig. 3 mirrors mostly a psycholinguistic/ phonetic rather than a purely phonological effect. This is why the lines of the terminal segmental level do not coincide at the upper level of syllabic constituency, namely that of the onset. SC clusters cannot have the same representation as CS clusters or affricates (contra Barlow 1997, 1998, Lléo and Prinz 1997, Barton et al. 1980) provided that different /s/ combinations undergo different sets of repairs (cf. Tzakosta & Vis, this volume).

The phonological representations in figures 3-6 demonstrate that SC sequences consist in clusters whose first member is extrametrical, CS are clusters characterized by high coherence, whereas affricates are complex segments. With respect to perception, the more clusters satisfy the SS and the more coherent, i.e. the more adjacent they are, the more chances they have to be perceived as complex segments. Therefore, under this assumption, affricates are more probable to be perceived as complex segments followed by CS clusters and these followed by SC clusters (cf. Tzakosta & Vis this volume).

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Finally, production-wise, the examined data demonstrate that if clusters are not phonologically coherent, they are perceived as ‘true’ clusters and they are prone to being repaired frequently. On the other hand, if clusters are phonologically coherent, they are perceived as complex segments and they are prone to limited repair strategies. As already mentioned, the degree of coherence determines the number of activated strategies. A question related to the discussion about how the tested consonantal sequences are perceived is whether SC and CS clusters exhibit equivalent production patterns. SC sequences appear to be less coherent in production compared to CS ones; the position of /s/ is significant for its preservation; /s/ is frequently deleted in SC clusters, especially when C is a stop, while in CS clusters /s/ is accurately produced, irrespective of the featural composition of C (cf. also Kirk and Demuth, for child English, Φουράκης & συν 2005, for a relevant discussion). The explanation for the former case is twofold: /s/ serves as an appendix word-initially, and as such it is prone to reduction. On the other hand, /s/ may be heterosyllabic word-medially, in which case it is correctly realized (cf. Chambliss 2004, for child English). When simplified, CS clusters undergo reduction both word-initially and word-medially. Because of the fact that affricates demonstrate a low rate of simplification, we assume that, due to the homorganicity of their members, affricates tend to be acquired before /s/ clusters, but after CL clusters, as exemplified in (14j-14l). Due to their high degree of coherence affricates occasionally substitute other cluster types as shown in (14a-15e). The fact that affricates may be perceived as complex segments is shown by the data in (14f-14i), where affricates also substitute simple segments.

(14a) /má.ze.psè.ta/ → [má.ze.tsè.ta] ‘pick them up’ 2IMP. PERF. (D: 2;04.17)
(14b) /ta.ksi.òi/ → [a.tsì.òi] ‘trip-SG. NEUT.’ (I: 2;07.01)
(14c) /ksè.ro/ → [tsè.ro] ‘know-1SG.PR.’ (I: 3;03.15)
(14d) /fù.sta/ → [fú.tsì] ‘skirt-SG. FEM.’ (F: 2;00.27)
(14e) /γrá.ma.ta/ → [tsá.ma.ta] ‘letter-PL. NEUT.’ (I: 3;01.24)
(14f) /mo.rá.ci/ → [mo.rá.tsì] ‘baby-DIM.’ (I: 3;00.24)
(14g) /é.pe.sa/ → [é.pe.tsì] ‘fall-1SG.PAST’ (F: 2;02.24)
(14h) /mü.òo.se/ → [mü.òo.tsì] ‘give me-3SG.PAST’ (I: 3;03.28)
(14i) /bu.zú.ci/ → [bu.dzú.ci] ‘bouzouci-SG. NEUT.’ (Kon: 2;00.30)
(14j) /tsí.xí.òra/ → [tsú.li.òa] ‘slide’ (D: 2;08.09, F: 2;11.01)
(14k) /tsí.xl.a/ → [ti.kla] ‘gum-SG. FEM.’ (F: 2;01.14)
(14l) /tsí.xl.es/ → [Øí.xìes] ‘gum-PL. FEM.’ (Ma: 2;08.29)

6. Conclusions
In this study, we investigated the factors driving the production patterns of different cluster types. Different production patterns are attributed to the activation of distinct repair simplification mechanisms. Cluster simplification primarily takes the shape of reduction, epenthesis, fusion and positional faithfulness. The degree of activation of these strategies is governed by the degree of satisfaction of the SS and the degree of coherence is mirrored by the phonological representations of various cluster types.

An issue related to the above theoretical claims is what the implications of the acquisition of /s/ clusters are for language teaching. More specifically, if affricates are perceived as single segments and CS sequences as clusters, preschool and primary school children need to realize the inconsistency holding between the phonology of Greek and its orthographic representation. In other words, children need to distinguish the fact that affricates are represented by two segments, i.e. /ts/ → [τσ] /dz/ → [τζ] and CS clusters by one segment, namely /ps/ → [ψ], ks/ → [ξ], something that contradicts
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perception. Through language games kindergarten and primary school teachers should emphasize the fact that the orthography preserves relics from the phonology of older periods of the acquired language.

References


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