# CLUSTER REPAIR STRATEGIES IN CHILD GREEK: AN OPTIMALITY THEORETIC ACCOUNT

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**Abstract:** This case study investigates the simplification strategies of reduction to the more sonorous cluster member and cluster deletion in [OBSTRUENT + LIQUID] clusters. These strategies are in complementary distribution: the former applies in [OBSTRUENT + LATERAL] clusters and the latter in [OBSTRUENT + RHOTIC] ones. There is a CONTIGUITY effect in the child's system, i.e. the grammar requires that the adjacent segments in the input be adjacent in the output. The pattern of reduction to the more sonorous member of the cluster in [OBSTRUENT + LATERAL] clusters is CONTIGUITY-driven and satisfies the adjacency requirement. The adjacency requirement is not met in [OBSTRUENT + RHOTIC] clusters. The complementary distribution of these strategies emerges from the permission of LATERAL-initial onsets and the prohibition of RHOTIC-initial ones in the output. We claim that cluster deletion is an epiphenomenon of the grammar's restrictions on onsets, i.e. the CONTIGUITY effect and the prohibition of RHOTIC-initial onsets results in cluster deletion.

**Keywords:** clusters, cluster reduction, cluster deletion, contiguity, laterals, rhotics

## 1. Introduction

This case study focuses on the acquisition of rising sonority [OBSTRUENT + LIQUID] clusters. Consonant clusters are considered marked structures. Such evidence comes from fully developed phonological systems, i.e. adult languages, and from non-fully developed systems, i.e. child languages. For example, there are several adult languages which do not tolerate consonant clusters, for instance Hua (Blevins 1995) and Senoufo (Zec 2007). Also, the literature on phonological acquisition shows that, initially, children's grammars do not tolerate the emergence of clusters (e.g. English: Gnanadesikan 2004; Gerlach 2010, Dutch: van der Pas 2004; Levelt et al. 1999, Jongstra 2003, German: Lleó & Prinz 1996; Rauch 2003, French: Rose 2000, Italian: Cucinelli 2020, Spanish: Lleó & Prinz 1996, European Portuguese: Freitas 2003; Ramalho & Freitas 2018, Romanian: Buja 2015, Greek: Kappa 2002; Ploumidi 2020). Early-state phonological systems show preference for the CV syllabic structure (Jakobson 1941/68; Moskowitz 1970; Branigan 1976; Ingram 1978; Fikkert 1994), which is considered (universally) unmarked with respect to syllable structures, e.g. CCV syllables (e.g. Clements & Keyser 1983; Clements 1990; Blevins 1995).

Marked syllable structures, e.g. CCV forms, start being realized later in the course of phonological acquisition, namely during the intermediate phase (e.g. Dutch: Levelt et al. 1999, European Portuguese: Freitas 2003, French: Rose 2000, German: Schaefer & Fox-Boyer 2017, Greek: Kappa 2009; Kappa and Papoutsi 2019; Ploumidi in press; Tzakosta & Kappa 2008, Chilean Spanish: Vivar & Lleó 2020). In this phase of

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acquisition, faithful and unfaithful cluster realizations may occur in parallel. Final-state grammars are adult-like and, therefore, adult-like cluster realizations occur, if consonant clusters are permitted forms in the target system, i.e. the ambient language (e.g. Levelt & van de Vijver 1998).

Crosslinguistic studies on child phonology show that the application of several cluster simplification strategies results in cluster avoidance. Reduction to the least sonorous member of the cluster is the prevalent simplification strategy in child phonology. This strategy results in the realization of the least sonorous cluster member and the deletion of the most sonorous one ((1), e.g. English: Ingram 1974; Gnanadesikan 2004; Parsons 2006; Gerlach 2010; Day 2014, German: Grijzenhout & Joppen 1998; Schaefer & Fox-Boyer 2017, Greek: Kappa 2002; Tzakosta, 2007, Dutch: Fikkert 1994; Kulig 2009, Italian: Cucinelli 2020, Polish: Łukaszewicz 2007, Brazilian Portuguese: Soares et al. 2019; European Portuguese: Freitas 2003, Hebrew: Bloch 2011, Romanian: Buja 2015, Croatian: Mildner & Tomić 2010, 2011, Chilean Spanish: Vivar and Lleó 2020)).

| (1) | | Target | Output | Gloss | Child | Age |
|---|---|---|---|---|---|---|
| | a. | prɛzɛnt | pɛzɛnt | 'gift' | Ola | 4 |
| | | | | | | (Polish: Łukaszewicz 2007: 58) |
| | b. | flor | fol | 'flower' | Fabiola | 3;04 |
| | c. | tren | tan | 'train' | Joaquin | 2 |
| | | | | | | (Spanish: Barlow 2006: 535-539) |

For example, in (1a) the target cluster /pr/ is reduced to [p], i.e. the least sonorous cluster member, the STOP, survives and the more sonorous one, the LIQUID, is deleted. The realized consonant is preserved according to a sonority scale, e.g. that in (2)[2]. The reason why the pattern of reduction to the least sonorous segment of the cluster prevails is that it results in the realization of an onset of low sonority. Low sonority onsets are mainly preferred in the course of acquisition.

(2) Universal Sonority Scale (e.g. Selkirk 1984)

| S | F | N | L | G | V |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| least sonorous | | | | | most sonorous |

The less frequent cluster simplification strategies include reduction to the more sonorous member of the cluster ((3a), e.g. English: Smith 1973; Pater & Barlow 2002, Parsons 2006, Hebrew: Bloch 2011, European Portuguese: Freitas 2003, Dutch: van der Pas 2004, Greek: Ploumidi 2020), epenthesis ((3b), English: Gerlach 2010; Day 2014, Bulgarian: Ignatova et al. 2018, Brazilian Portuguese: Soares et al. 2019, European

[2] Malikouti-Drachman (1984) and Kappa (1995: 138) have proposed parametrized sonority scales for adult Greek.

Portuguese: Freitas 2003; Amorim 2014, Italian: Cucinelli 2020, Hebrew: Bloch 2011, Latvian: Rūķe-Draviņa 1990, Greek: Kappa 2002; Ploumidi 2020), coalescence ((3c), Dutch: Kulig 2009, European Portuguese: Ramalho & Freitas 2018, English: Gnanadesikan 2004, Greek: Kappa 2004; Coutsougera 2007; Tzakosta 2009; Ploumidi 2020, 2021; Latvian: Rūķe-Draviņa 1990, Polish: Łukaszewicz 2007) and deletion of the entire cluster ((1d), English: Ingram 1976; Chin & Dinnsen 1992; Smit 1993, European Portuguese: Freitas 2003, see also the crosslinguistic study of Greenlee 1974). All the other patterns are less frequent in the children's data. Representative examples are given in (3):

| (3) | | Target | Output | Gloss | Child | Age |
|---|---|---|---|---|---|---|
| | a. | trɛɪn | lɛɪn | 'train' | Saar | 1;11.08 |
| | | | | | | (Dutch: van der Pas 2004: 357) |
| | b. | kta'na | keta'na | 'small' | RM | 2;00.16 |
| | c. | $k_1l_2$ips | $t_{1,2}$its | 'clip' | RM | 2;05.15 |
| | d. | dʁaˈkon | a'kin | 'like' | SR | 2;02.06 |
| | | | | | | (Hebrew: Bloch 2011: 59-70) |

In this case study, we focus on the acquisition of rising sonority [OBSTRUENT + LIQUID] clusters, while investigating the application of cluster reduction to the more sonorous cluster member and cluster deletion, in child Greek. Cluster reduction to the more sonorous segment is documented in several child languages (e.g. Dutch: van der Pas 2004, European Portuguese: Freitas 2003, German: Schaefer & Fox-Boyer 2017, Hebrew: Bloch 2011). This pattern results in the realization of the LIQUID consonant, which is the rightmost member of the cluster and the one which is adjacent to the vowel of the syllable. The realized consonant is more sonorous compared to the deleted one, i.e. the OBSTRUENT. As a result, the onset of the produced CV syllable is of high sonority. Representative datasets are provided in (4):

| (4) | | Target | Output | Gloss | Child | Age |
|---|---|---|---|---|---|---|
| | a. | klɔk | lɔk | 'clock' | Len | |
| | b. | blɑt | lɑt | 'sheet' | Len | |
| | c. | trɛɪn | lɛɪn | 'train' | Saar | |
| | | | | | | (Dutch: van der Pas 2004: 357) |
| | d. | bisiˈklɛtʁ | bsiˈletʁ | 'bicycle' | Luis | |
| | e. | ˈfloriʃ | ˈloliʃ | 'flowers' | Marta | |
| | | | | | | (European Portuguese: Freitas 2003: 35) |
| | f. | kviʃ | viʃ | 'road' | RM | |
| | g. | kmo | mo | 'like' | RM | |
| | h. | tmuna | muna | 'picture' | RM | |
| | i. | dli | li | 'bucket' | RM | |
| | | | | | | (Hebrew: Bloch 2011: 33-53) |

In child Greek, it is reported that the pattern of reduction to the more sonorous cluster member is an infrequent emergent pattern. This realization pattern is attested in

Tzakosta (2003a, 2009) and Kappa (2002). Kappa (2002: 31-32), in her case study, presents a few instances of reduction to the more sonorous cluster member in [FRICATIVE + LIQUID] clusters (5d-f). In this study, Kappa argues that this simplification pattern is forced by the effects of the OBLIGATORY CONTOUR PRINCIPLE[3] (henceforth OCP, Goldsmith 1976; Itô & Mester 1986; McCarthy 1986; Yip 1988), i.e. this pattern occurs if the less sonorous member of the target cluster, i.e. the FRICATIVE, contains the same specified place feature with another onset consonant of the word. For example, in (5c) the deleted member of the complex onset, i.e. /ɣ/, and the simple onset /k/, are DORSALS. As a result, the input cluster /ɣl/ is reduced to the more sonorous cluster member and, therefore, the SONORANT /l/ is chosen rather than the FRICATIVE /ɣ/ to surface in the child's form. Also, in (5d) the deleted cluster member, i.e. /v/, and the simple onset of the initial syllable of the word, i.e. /v/, are LABIALS. Consequently, the input cluster /vl/ is reduced to the more sonorous cluster member and, therefore, the SONORANT /l/ surfaces rather than the FRICATIVE /v/ in the child's realization.

| (5) | | Target | Output | Gloss | Child | Age |
|---|---|---|---|---|---|---|
| | a. | ˈvle.pi | ˈle.pi | 'see' | Bebis | 1;11.29 |
| | | | | | | (Tzakosta 2003a: 2) |
| | b. | ˈvle.po | ˈle.po | 'see' | B.M. | 2;02.12 |
| | | | | | | (Tzakosta 2009: 368) |
| | c. | ɣli.ˈko | li.ˈko | 'sweet' | Sofia | 2;06.07 |
| | d. | vi.ˈvli.o | bi.ˈli.o | 'book' | Sofia | 2;09.13 |
| | | | | | | (Kappa 2002: 31) |

The pattern of cluster deletion results in the deletion of both cluster members. As a consequence, the realization of an onsetless syllable, which is considered marked in (non-)fully developed phonological systems, occurs (see Rice 2007). For example, this pattern is attested in child European Portuguese (6a-b) and Hebrew (6c-d). In child Greek, Ploumidi (2020) shows that the pattern of cluster deletion occurs sporadically (6e-g):

| (6) | | Target | Output | Gloss | Child | Age |
|---|---|---|---|---|---|---|
| | a. | ˈflor | ˈolɨ | 'flower' | Ines | 1;09.19 |
| | b. | ˈbɾuʃɐ | ˈûgɐ | 'witch' | JoãoII | 2;02.28 |
| | | | | | | (European Portuguese: Freitas 2003: 34) |
| | c. | ˈtʁaktoʁ | ˈato | 'tractor' | RM | 1;06.05 |
| | d. | dʁaˈkon | aˈkin | 'like' | SR | 2;02.06 |
| | | | | | | (Hebrew: Bloch 2011: 70) |
| | e. | kre.ˈva.ti | e.ˈja.ti | 'bed' | SPI | 2;02.13 |
| | f. | tra.ˈkter | a.ˈtet | 'tractor' | SPI | 2;06.15 |
| | g. | pli.ˈdi.ri.o | e.ˈdi.li.o | 'washer' | SPI | 2;08.23 |
| | | | | | | (Greek: Ploumidi 2020: 57) |

[3] Kappa & Papoutsi (2019) provide supporting evidence for effects of the OCP in the acquisition of branching onsets in child Greek. Specifically, in the intermediate phase of phonological acquisition, heterorganic clusters are realized whereas homorganic ones are prohibited due to OCP effects.

In this case study, we show that reduction to the more sonorous member of the cluster and cluster deletion occur in rising sonority [OBSTRUENT + LIQUID] consonant clusters. These cluster simplification strategies are in complementary distribution, namely they are attested in specific cluster types. The former strategy applies in clusters in which a LATERAL consonant is the rightmost cluster member (e.g. /ˈble/ → [ˈle] '*blue-* NEU. NOM. SG.', age: 2;05.01) whereas the latter applies in clusters in which a RHOTIC consonant is the rightmost member of the cluster (e.g. /ˈxro.ma/ → [ˈo.ma] '*color-* NEU. NOM. SG.', age: 2;04.18).

We provide evidence for a CONTIGUITY effect in the child's typically developing phonological system, namely the child's grammar requires that the segments which are adjacent in the input form, i.e. the target form, be adjacent in the output one, i.e. the realized form. As a result, the realization of the leftmost cluster member does not occur. We show that the pattern of cluster reduction to the more sonorous segment, i.e. the CONTIGUITY-driven[4] pattern, is attested in [OBSTRUENT + LATERAL] clusters since LATERAL-initial syllables are permitted in the child's developing system. In contrast, the CONTIGUITY-driven pattern does not occur in [OBSTRUENT + RHOTIC] clusters since RHOTIC-initial onsets are not permitted in the child's realizations. Hence, we claim that cluster deletion ends up being an epiphenomenon of the child's grammar restrictions on syllable-initial consonants.

This paper is organized as follows. Section 2 provides information for the participant of this case study and describes the methodology used to elicit the data. Section 3 describes the attested emergent patterns. In section 4, the theoretical analysis in light of the OPTIMALITY THEORY (Prince and Smolensky 1993/2004) is provided. Section 5 provides the concluding remarks.

## 2. Methodology

The data are drawn from a longitudinal study of a monolingual typically developing Greek-acquiring child, #65B, (age range: 1;10.29 – 2;05.15, boy). The child was recorded once a week by a trained linguist, the author of this study, who visited the child in 20–30-minute-long sessions. The experimental stimuli were designed to elicit all segments, possible prosodic structures and stress patterns in Greek. The data were collected from spontaneous speech, a picture/object-naming task *('What is this?')* and a picture-based sentence completion task (e.g. '*this chair is red*' and '*this chair is* ____*?*' [blue]). A professional recorder, Marantz PMD661MKII, was used for the recordings. The recorded speech samples were transcribed into International Phonetic Alphabet

[4] CONTIGUITY-driven reductions are reported in atypical child Greek (Ploumidi 2022). Ploumidi focused on cross-sectional data of three atypically developing Greek-acquiring children and investigated the unfaithful realizations of sonority plateau clusters (e.g. /pt/, /fθ/, /kt/, /vɣ/, /ɣð/). She found that the reductions are CONTIGUITY-driven, namely the rightmost member of the consonant cluster is realized (e.g. /a.ˈvɣo/ → [a.ˈɣo] 'egg- N. NOM. SG.'). Taking the findings of this study together, the sonority plateau clusters are reduced irrespective of (i) the sonority since both cluster members are of equal sonority, (ii) the degree of markedness of place of articulation of the cluster members, (iii) their position within the input form, i.e. positional faithfulness is irrelevant.

(IPA). The participation of the child in this study took place upon the explicit informed and signed parental consent, according to the regulations of the Ethics Committee of the University of Crete.

## 3. Data

The child was recorded between the ages of 1;10 and 2;05 and seems to be a representative of the intermediate phase of phonological acquisition. This phase of the acquisition lies between the initial phase, in which the children's realizations are mainly unmarked, and the final phase, in which adult-like realizations occur since the child's and the adult's system are (almost) identical (e.g. Levelt & van de Vijver 1998). During the intermediate phase, the child's system gradually starts permitting the realization of marked forms, e.g. FRICATIVES consonants, coda segments and clusters start being realized. The intermediate phase of phonological acquisition lasts long and is characterized by intra- and inter-child variation.

According to Ingram (1989) and Macken (1992) this phase starts at the age of 18 and 24 months, respectively. In this study, we do not set strict temporal boundaries of the intermediate phase of acquisition in child Greek since we rely on the data of a single child and no conclusive claims can be made; rather, by focusing on the child's longitudinal data, we argue that the child passes through the intermediate phase of acquisition since his typically developing system gradually suppresses the unmarked forms and starts permitting the production of (some) marked structures and segments. Specifically, STOPS, FRICATIVES and NASALS are realized faithfully in onsets (7a-g). Furthermore, AFFRICATES are not faithfully realized, as the data show (7f). Moreover, in the child's system the emergence of word-medial codas is prohibited (7c, f) whereas the realization of word-final coda consonants is permitted (7a, g).

(7)

| | Target | Output | Gloss | Age |
|---|---|---|---|---|
| a. | ba.ˈbas | ba.ˈbaç | 'dad-M.NOM.SG' | 1;10.29 |
| b. | ka.ˈfe | ka.ˈfe | 'coffee-M.ACC.SG' | 1;10.29 |
| c. | ˈçer.ja | ˈçe.ja | 'hands-N.NOM.PL' | 1;11.06 |
| d. | ˈpa.me | ˈpa.me | 'go-PRS.1PL' | 2;00.26 |
| e. | ˈka.ni | ˈka.ni | 'do-PRS.3SG' | 2;01.09 |
| f. | ˈkal.tsa | ˈka.ta | 'sock-F.NOM.SG' | 1;11.28 |
| g. | ˈpa.ɣos | ˈpa.ɣos | 'ice cube-M.NOM.SG' | 2;01.02 |

As far as LIQUIDS are concerned, the LATERAL /l/ is realized faithfully in simple onsets (8b, d-e) whereas the RHOTIC /r/ is not. Specifically, the deletion of the target RHOTIC onset consonant is a frequently attested emergent pattern, which results in an onsetless syllable (8a-c). Also, the avoidance of RHOTIC onsets is obtained by means of syllable deletion, namely the entire syllable in which the RHOTIC /r/ is in onset position, is deleted (8e). Later in the course of development, a pattern of neutralization emerges: Our data show that /r/ is neutralized and, thus, it is realized as [l] in simple onsets (8f). This realization pattern is theoretically explained as follows: according to Walsh (1997),

LIQUID constitutes a class, which is organized under the SV-node in which LIQUID dominates LATERAL (default) and VOCALIC sounds (r-sounds, the marked ones). In the child's grammar, it seems that the contrast between the LATERAL and the VOCALIC sounds has not been acquired and that is the reason why the LATERAL sound i.e. the default, surfaces in simple onsets. Overall, in our data three distinct patterns reflect means to prevent the realization of the RHOTIC consonant syllable-initially. We argue that these data provide evidence for a case of conspiracy (Kisseberth 1970) and of homogeneity of target and heterogeneity of process, since various means prevent the realization of a RHOTIC onset consonant. The emergence of the RHOTIC consonant happens relatively late, namely at the age of 2;05, and thereafter the frequency of its occurrence in the data is rather low. Representative examples are provided in (8):

(8)

| | Target | Output | Gloss | Age |
|---|---|---|---|---|
| a. | a.e.ro.ˈpla.no | e.ˈta.no | 'airplane-N.NOM.SG' | 1;11.28 |
| b. | ro.ˈlo.i | o.ˈlo.i | 'watch-N.NOM.SG' | 2;00.04 |
| c. | a.e.ro.ˈpla.no | o.ˈpa.no | 'airplane-N.NOM.SG' | 2;00.26 |
| d. | le.ˈfta | le.ˈta | 'money-N.NOM.PL' | 2;01.09 |
| e. | ro.ˈlo.i | ˈlo.i | 'watch-N.NOM.SG' | 2;02.06 |
| f. | ˈroz | ˈloj | 'pink-N' | 2;03.06 |
| g. | fo.ˈra.o | fo.ˈra.o | 'wear-PRS.1SG' | 2;04.10 |

In (9) we summarize the order of emergence of LATERALS and RHOTICS in the child's system. The emergence of the LATERAL consonant precedes the emergence of the RHOTIC one in simple onsets[5].

(9) The order of emergence of LIQUIDS in the child's system

LATERAL >> RHOTIC

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earlier emergence later emergence

Rising sonority clusters, namely clusters with a rising sonority slope from the leftmost member of the cluster, i.e. the OBSTRUENT, to the rightmost one, i.e. the SONORANT, do not emerge in initial and non-initial onsets of stressed and unstressed syllables. Specifically, the child's intermediate-state grammar does not tolerate faithful realizations of [STOP + LIQUID] and [FRICATIVE + LIQUID] consonant clusters. The dominant simplification pattern is cluster reduction to the leftmost member of the cluster, namely the less sonorous cluster member is realized and the more sonorous one is deleted (see also the crosslinguistic studies presented in section 1 and the relevant data in (1)). For example, in (10a) the input form /ˈble/ is realized as [ˈbe]. The rising sonority cluster /bl/ is reduced to the less sonorous and, consequently, the leftmost member of the cluster is preserved whereas the rightmost one is deleted. The realized consonant preserves the LABIAL place of articulation, [−continuant] manner of articulation and the [+voiced] feature of the input leftmost cluster member. In other words, the realized consonant

[5] The same order of emergence of LIQUIDS is reported in Kappa's (2009) study on child Greek.

faithfully preserves the featural content of the input leftmost cluster member. Additional examples are given in (10):

| (10) | | Target | Output | Gloss | Age |
|---|---|---|---|---|---|
| | a. | ˈble | ˈbe | ‘blue-N.NOM.SG’ | 1;11.06 |
| | b. | ˈðe.dro | ˈðe.do | ‘tree-N.NOM.SG’ | 1;11.28 |
| | c. | ˈkle.i | ˈce | ‘cry-PRS.3SG’ | 2;02.06 |

The patterns of cluster reduction to the more sonorous member of the cluster and cluster deletion constitute non-dominant patterns in the child’s longitudinal data. Both patterns are attested in rising sonority [OBSTRUENT + LIQUID] clusters, namely in [STOP + LIQUID] and [FRICATIVE + LIQUID] clusters, which occur in initial- and non-initial onsets of stressed and unstressed syllables. The former cluster simplification strategy results in the deletion of the leftmost cluster member, i.e. the less sonorous consonant, and the realization of the rightmost one, which is the most sonorous member of the target cluster and the adjacent to the nucleus of the syllable ($C_1C_2V \rightarrow [C_2V]$). Also, this strategy results in the realization of a CV syllable in which the onset consonant is of high sonority. The latter cluster repair strategy results in the deletion of the entire cluster, namely both cluster members are deleted ($C_1C_2V \rightarrow [V]$). Consequently, a syllable which consists only of a vowel is realized.

In our data, the patterns of cluster reduction to the more sonorous cluster member and cluster deletion exhibit striking differences in their application. We claim that these strategies of cluster avoidance are in complementary distribution since they are attested in specific cluster types. Specifically, cluster reduction to the more sonorous member of the cluster occurs in clusters in which the leftmost consonant is OBSTRUENT and the rightmost one is the LATERAL /l/. For example, in (11d) the target form /ˈble/ is realized as [ˈle]. The reduction of the target cluster results in a single consonant, i.e. the LATERAL [l], which is more sonorous compared to the voiced STOP /b/. Also, the LATERAL is adjacent to the vowel of the syllable. A CV syllable surfaces in the output. We argue that this cluster simplification strategy is CONTIGUITY-driven, namely it occurs since the grammar requires the adjacent segments in the target form be adjacent in the child’s form, too.

| (11) | | Target | Output | Gloss | Age |
|---|---|---|---|---|---|
| | a. | a.e.ro.ˈpla.no | to.ˈla.no | ‘airplane-N.NOM.SG’ | 1;11.06 |
| | b. | vi.ˈvli.o | le.ˈli.o | ‘book-N.NOM.SG’ | 1;11.06 |
| | c. | ˈblu.za | ˈlu.sa | ‘blouse-F.NOM.SG’ | 2;03.19 |
| | d. | ˈble | ˈle | ‘blue-N.NOM.SG’ | 2;05.01 |

Cluster deletion occurs in clusters in which the leftmost cluster member is OBSTRUENT and the rightmost one is the RHOTIC /r/. For instance, in (12d) the target form /ˈxro.ma/ is realized as [ˈo.ma]. As can be seen, both cluster members are deleted and an onsetless syllable, which is considered to be more marked compared to a CV syllable (see e.g. Rice 2007), is realized. Interestingly, the rightmost member of the complex onset is never realized as [l], i.e. as a result of neutralization (e.g. /ˈxro.ma/ → *[ˈlo.ma], see also

the relevant discussion and the data of RHOTIC-neutralization in simple onsets in (8)). Rather, it seems that the child's grammar favors the pattern of RHOTIC onset deletion, which is also well-attested in target simple RHOTIC-initial onsets (see 8a-c). In other words, reduction to the more sonorous member of the cluster is never observed in clusters in which the rightmost member is a RHOTIC since RHOTIC onsets are not allowed to emerge in the child's forms. More data are given in (12):

| (12) | | Target | Output | Gloss | Age |
|---|---|---|---|---|---|
| | a. | tra.ˈpe.zi | a.ˈpe.zi | 'table-N.NOM.SG' | 2;01.02 |
| | b. | tra.ˈpe.zja | a.ˈpe.ca | 'tables-N.NOM.SG.' | 2;02.06 |
| | c. | zo.ɣra.ˈfi.zi | zo.a.ˈfi.zi | 'paint-PRS.3SG' | 2;03.13 |
| | d. | ˈxro.ma | ˈo.ma | 'color-N.NOM.SG' | 2;04.18 |

In (13) and (14) we summarize the application of the patterns of faithful and unfaithful realization of LIQUIDS in simple onsets and the patterns of reduction to the more sonorous member of the cluster and cluster deletion. All these emergent patterns constitute clear cases of intra-child variation in the child's intermediate-state grammar. We argue that these realization patterns comprise a possible acquisition path in the process of acquisition of simple and complex onsets in child Greek and we show that a LATERAL consonant can be attested syllable-initially, i.e. in onsets, whereas a RHOTIC one cannot be realized at the left syllable margin.

| (13) | Target simple onset | | Pattern |
|---|---|---|---|
| | a. | RHOTIC | RHOTIC-onset deletion<br>Syllable deletion<br>RHOTIC neutralization |
| | b. | LATERAL: | Faithful realization |
| (14) | Target cluster | | Pattern |
| | a. | [OBSTRUENT + LATERAL] | Reduction to the more sonorous cluster member |
| | b. | [OBSTRUENT + RHOTIC] | Cluster deletion |

All in all, in the child's system LATERAL-initial onsets are permitted whereas RHOTIC-initial ones are forbidden. Taking the findings together, variable patterns of avoidance of RHOTIC-onsets (see 8) and of cluster simplification (see 10-12) are attested in our data. We argue that the patterns of RHOTIC-onset avoidance which are attested in simple onsets, the pattern of faithful realization of LATERAL-initial onsets (see 8), the CONTIGUITY-driven reductions in [OBSTRUENT + LATERAL] clusters and the divergence from the CONTIGUITY-based simplification pattern in [OBSTRUENT + RHOTIC] clusters are interrelated in the child's grammar, namely they constitute an acquisition path of simple and complex onsets in child Greek.

We claim that, in this acquisition path, clusters are not reduced to the less sonorous; rather, divergence from the sonority pattern is attested. We argue that the divergence from the sonority-based reduction pattern is conditioned by a CONTIGUITY effect, namely it seems that the child's grammar demands that the segments which are

adjacent in the input form be adjacent in the output one, as well. We show that the pattern of cluster reduction to the more sonorous element in the cluster, i.e. the CONTIGUITY-driven simplification pattern, occurs in [OBSTRUENT + LATERAL] clusters since LATERAL-initial syllables are permitted in the child's realizations. Nevertheless, this pattern does not occur in [OBSTRUENT + RHOTIC] clusters due to the child's grammar tendency to prohibit RHOTIC-initial onsets. Hence, we claim that cluster deletion ends up being an epiphenomenon of the child's developing system restrictions on syllable-initial consonants. Put differently, the CONTIGUITY effect and the prohibition of RHOTIC-initial onsets results in a pattern which resembles cluster deletion.

In the next section, we propose a theoretical analysis, while focusing on the application of the CONTIGUITY-driven reduction pattern in [OBSTRUENT + LATERAL] clusters and the divergence from this simplification strategy in [OBSTRUENT + RHOTIC] clusters. It will be argued that the divergence from this pattern implies the emergence of the pattern of cluster deletion.

## 4. Theoretical framework and analysis

The analysis is couched in the non-linear theoretical framework of OPTIMALITY THEORY (henceforth OT, Prince & Smolensky 1993/2004). In OT, a universal constraint set is used to theoretically analyze child and adult languages. There are two basic groups of constraints: MARKEDNESS constraints, which require the production of unmarked forms, and FAITHFULNESS constraints which require identity between the input, namely the target form, and the output, namely the produced form. The grammar is a system of constraints which are universal, (partially) ranked on a language-specific basis, violable and according to which the (possible) output forms for a given input form are evaluated. The candidate that best satisfies the hierarchy of constraints is selected as the optimal or harmonic output.

The phonological acquisition is theoretically expressed as follows: In the initial phase of phonological acquisition, there is a bias for the MARKEDNESS constraints to be ranked higher than the FAITHFULNESS constraints (Demuth 1995, Gnanadesikan 2004; Pater 1997, Levelt & Vijver 1998). Therefore, during this phase of acquisition, unmarked structures and segments are systematically produced, for instance universally unmarked CV syllables, STOPS and voiceless consonants are selected as the optimal outputs.

Gradually, in the course of the acquisition, marked structures/forms start being produced, for example CVC syllables, coda consonants, onset and coda clusters and FRICATIVES surface. Therefore, the gradual convergence to the target language is theoretically explained in terms of constraint reranking. In other words, the phonological acquisition consists of continuous constraint rerankings. In the intermediate phase of phonological acquisition some FAITHFULNESS constraints dominate some MARKEDNESS constraints. In the literature on phonological acquisition, it is reported that the reranking takes the shape of constraint demotion, i.e. the MARKEDNESS constraints are demoted (Tesar & Smolensky 2000, Adam 2002), constraint promotion, i.e. the FAITHFULNESS constraints are promoted (Gnanadesikan 2004, Levelt & Vijver 1998, Ben-David 2001), or both constraint demotion and promotion (e.g. Boersma 1997, Tzakosta 2003b, 2004).

In the final phase of phonological acquisition, the child's and the adult's phonological system are identical and, thus, the FAITHFULNESS constraints are ranked higher than the MARKEDNESS ones. As a result, the child's realizations are adult-like.

In this case study, we show that the child's data reflect an intermediate-state grammar in which some MARKEDNESS constraints have been demoted below some FAITHFULNESS constraints. Put differently, the constraint reranking has taken place since marked forms are attested in the child's longitudinal production data. We argue that constraint reranking(s) creates intermediate-state grammars in which variation is well-attested. In other words, the application of various emergent patterns within the intermediate phase of phonological acquisition is a consequence of constraint reranking.

As it was shown in section 3, the child's typically developing intermediate-state grammar does not tolerate the realization of rising sonority [OBSTRUENT + LIQUID] clusters. The [OBSTRUENT + LATERAL] clusters undergo CONTIGUITY-driven reduction whereas the [OBSTRUENT + RHOTIC] clusters seem to undergo cluster deletion. For the purposes of the theoretical analysis of our longitudinal data, we adopt syllable structure constraints in order to account for the (non-)realization of onsets. Also, in order to theoretically account for the fact that some segments are permitted or prohibited at the left syllable margin, we resort to the MARGIN HIERARCHY (Prince & Smolensky 1993/2004). This hierarchy consists of constraints which are strictly ranked and reflects the preference for low sonority consonants at the left edge of the syllable (15).

(15) The Margin Hierarchy
$*M_1/a$ >> $*M_1/i$ >> $*M_1/r$ >> $*M_1/l$ >> $*M_1/n$ >> $*M_1/t$

In this hierarchy, the high ranking of $*M_1/a$ and $*M_1/i$ show that vowel-initial syllables are the least preferred. $*M_1/r$ prohibits RHOTIC-initial syllables and $*M_1/l$ bans LATERAL-initial ones. The relative ranking of $*M_1/r$ and $*M_1/l$ show that RHOTIC-initial syllables are worse-formed compared to LATERAL-initial ones. NASAL-initial syllables are better-formed compared to RHOTIC- and LATERAL-initial ones, since $*M_1/n$ is dominated by $*M_1/r$ and $*M_1/l$. The fact that $*M_1/t$ is the lowest ranked constraint in the hierarchy implies that OBSTRUENT consonants, which are of low sonority, constitute the most preferred left-syllable margin.

The constraints in (16)-(17) are adopted to theoretically analyze the emergent patterns:

(16) Markedness constraints

| | |
|---|---|
| *COMPLEX: | No consonant clusters |
| *M1/t: | OBSTRUENTS should not be parsed as a syllable margin |
| *M1/l: | LATERALS should not be parsed as a syllable margin |
| *M1/r: | RHOTICS should not be parsed as a syllable margin |
| ONSET: | Every syllable has an onset |

(17) Faithfulness constraints

| | |
|---|---|
| MAX: | Every segment in the input must have a correspondent in the output. |
| CONTIGUITY: | Segment adjacent in the input should be adjacent in the output. |

Our theoretical analysis sheds light on an acquisition path in which LATERAL-initial onsets are allowed whereas RHOTIC-initial ones are prohibited. In (18) we demonstrate the constraint hierarchy.

(18) Constraint ranking

*COMPLEX >> CONTIGUITY >> *$M_1$/r >> ONSET >> *$M_1$/l, *$M_1$/t, MAX

We propose that cluster reduction to the more sonorous cluster member and cluster deletion are in complementary distribution and we show that a single constraint ranking regulates the attested patterns. We argue that *COMPLEX is the highest ranked constraint in order to ensure that tautosyllabic consonantal sequences do not occur in the output. Also, we show that the high ranked CONTIGUITY represents a key-constraint in the child's system, since it prohibits the emergence of the leftmost member of the cluster, i.e. the OBSTRUENT. It is as if the ranking of *COMPLEX and CONTIGUITY "conspires" in favor of the realization of the rightmost member of the cluster, i.e. the LIQUID consonant. Nevertheless, recall that LATERAL-initial onsets are permitted whereas RHOTIC-initial ones are prohibited. It seems that there is a constraint paradox in the child's system but it is not the case.

The crucial aspect of our analysis is the fact that the effects of CONTIGUITY and *$M_1$/r are combined and give rise to the compliance with the CONTIGUITY-driven pattern in [OBSTRUENT + LATERAL] clusters and the divergence from this pattern in [OBSTRUENT + RHOTIC] clusters. We claim that CONTIGUITY, which forces the adjacency of input segments in the output form, and *$M_1$/r, which prohibits the realization of RHOTIC-initial onsets, are both highly ranked in the hierarchy. Hence, the divergence of the sonority pattern is ensured and the prohibition of RHOTIC-initial onsets is observed.

The MARKEDNESS constraint ONSET, which requires that syllables have an onset, dominates the MARKEDNESS constraints *$M_1$/l and *$M_1$/t which prohibit the emergence of a LATERAL and an OBSTRUENT consonant, respectively, at the left syllable margin. *$M_1$/l, *$M_1$/t and MAX are lowly ranked and unranked with respect to each other since no evidence permits us to determine their relative ranking based on the available data.

In (19-20) we present the OT tableaux. In these tableaux, the pointing finger (☞) indicates the optimal output/candidate, an asterisk (*) marks an incurred violation and the exclamation mark (!) denotes a fatal violation which results in the elimination of a non-optimal output candidate. Also, solid lines divide crucially ranked constraints whereas vertical dotted lines will be used to indicate cases in which two or more constraints are unranked with respect to each other. Constraints remain unranked if no evidence permits us to determine their relative ranking based on the available data. Grayed-out cells represent areas of the tableau that are not relevant to the optimal output.

Tableau (19) demonstrates the pattern of cluster reduction to the more sonorous segment:

(19) Input form: [ˈble] - Output form: [ˈle] 'blue- N. NOM. SG.', age: 2;05.01

| Input: ˈble | *COMPLEX | CONTIGUITY | *$M_1$/r | ONSET | *$M_1$/l | *$M_1$/t | MAX |
|---|---|---|---|---|---|---|---|
| a. ˈble | *! | | | | | * | |
| b. ˈbe | | *! | | | | * | * |
| c. ☞ ˈle | | | | | * | | * |
| d. ˈe | | | | *! | | | ** |

The tableau shows that in the child's intermediate-state grammar the constraint *COMPLEX, which prohibits the realization of clusters, is undominated, namely it is the highest ranked constraint in the hierarchy. The output candidate (19a) violates fatally *COMPLEX constraint since it contains a cluster. CONTIGUITY forces the adjacency of the input segments in the output. The high ranking of CONTIGUITY results in the preservation of the consonant which is adjacent to the vowel nucleus. Consequently, the output candidate (19b), which consists of the leftmost cluster member and the vowel, fatally violates CONTIGUITY. The output candidates (19c-d) satisfy CONTIGUITY. The MARKEDNESS constraint ONSET is fatally violated by (19d) and satisfied by (19c). As a result, the output candidate (19c) is selected as the harmonic output.

In OT, constraints are ranked in a hierarchy of (strict) domination. Consequently, once an output candidate does worse than another candidate on the highest-ranking constraint distinguishing them, it incurs a fatal violation. Once an output candidate fatally violates a constraint, it cannot be selected as the harmonic output form, even if it outperforms the other candidates on the rest of the hierarchy. Thus, despite the fact that the output candidate (19c) violates the constraints *$M_1$/l and MAX, these violations are not fatal and this candidate is still selected as the harmonic one. All in all, we claim that the ranking of *COMPLEX and CONTIGUITY 'conspires' resulting in cluster reduction and the preservation of the rightmost cluster member. Thus, divergence from the sonority pattern occurs and the CONTIGUITY-driven reduction is obtained in clusters in which the rightmost cluster member is a LATERAL segment.

Tableau (20) demonstrates the pattern of cluster deletion:

(20) Input form: [ˈxro.ma] - Output form: [ˈo.ma] 'color-N.NOM.SG', age: 2;04.18

| Input: xro.ma | *COMPLEX | CONTIGUITY | *$M_1$/r | ONSET | *$M_1$/l | *$M_1$/t | MAX |
|---|---|---|---|---|---|---|---|
| a. ˈxro.ma | *! | | | | | * | |
| b. ˈxo.ma | | *! | | | | * | * |
| c. ˈro.ma | | | *! | | | | * |
| d. ☞ ˈo.ma | | | | * | | | ** |

The undominated *COMPLEX excludes (20a) and the highly ranked CONTIGUITY excludes (20b). The relative ranking of *$M_1$/r and ONSET determines the harmonic output. The

crucial constraint in the hierarchy is *$M_1$/r. This constraint is fatally violated by the output candidate (20c) which has a RHOTIC consonant at the left syllable margin and is satisfied by (20d) which does not have a RHOTIC as initial segment. The violation of *$M_1$/r by (20c) is fatal. As a result, (20d) is selected as the optimal output. Thus, cluster deletion occurs since the child's grammar does not permit a RHOTIC consonant in onsets. The violation of ONSET by (20d) does not count as a fatal violation since this candidate satisfies all the higher ranked constraints in the hierarchy.

In the next section, we turn to the final remarks of this case study.

## 5. Conclusions

This case study focused on the unfaithful realizations of rising sonority [OBSTRUENT + LIQUID] clusters in the speech of a monolingual typically developing Greek acquiring child. The focus was on the strategies of reduction to the more sonorous member of the cluster and cluster deletion in [OBSTRUENT + LIQUID] clusters. These strategies are in complementary distribution, i.e. they occur in specific cluster types. The former strategy applies in clusters in which the LATERAL /l/ is the rightmost cluster member whereas the latter strategy occurs in clusters in which the RHOTIC /r/ is the rightmost member of the cluster.

We documented multiple emergent patterns which simultaneously operate in the child's developing system during the intermediate phase of phonological development. We argue that the patterns of RHOTIC-onset avoidance which are attested in simple onsets, the pattern of faithful realization of LATERAL-initial onsets, the CONTIGUITY-driven reductions in [OBSTRUENT + LATERAL] clusters and the divergence from the CONTIGUITY-driven reduction pattern in [OBSTRUENT + RHOTIC] clusters are interrelated in the child's grammar, namely they constitute an acquisition path of simple and complex onsets during the intermediate phase of phonological acquisition in child Greek. All in all, in the child's system LATERAL-initial onsets are permitted whereas RHOTIC-initial ones are forbidden.

We provided evidence for a contiguity effect in the child's typically developing system, namely the child's intermediate-state grammar requires that the segments which are adjacent in the input form be adjacent in the realized one. As a result, in this acquisition path, the pattern of cluster reduction does not result in the realization of the leftmost cluster member. We show that the pattern of cluster reduction to the more sonorous member of the cluster, i.e. the CONTIGUITY-driven pattern, is attested in [OBSTRUENT + LATERAL] clusters since LATERAL-initial syllables are permitted by the child's system. In contrast, the CONTIGUITY-driven pattern is not obtained in [OBSTRUENT + RHOTIC] clusters due to the child's developing system tendency to avoid RHOTIC-initial onsets. In other words, it seems that the acquisition path that the child follows in the process of acquisition of simple and complex onsets is the same, namely the child's grammar tolerates LATERAL simple onsets but it does not tolerate RHOTIC ones. As a result, the emergence of LATERAL-initial syllables as a consequence of the CONTIGUITY-driven cluster reduction pattern is tolerated whereas a RHOTIC-initial one as a consequence of the same pattern is prohibited. Hence, we claim that cluster deletion ends up being an epiphenomenon of the child's grammar restrictions on syllable-initial consonants.

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