

THE ACQUISITION OF THE FINAL CODA POSITION IN THE SPEECH OF A GREEK-ACQUIRING CHILD

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Abstract: This case study investigates the acquisition of the word-final coda in child Greek. The data show that the child has acquired the CVC syllabic form word-finally and that the acquisition process of the final coda consonant involves intra-child variation. Initially, the child realizes a STOP word-finally, instead of the target sibilant /s/, which is a morphological marker in Greek. We claim that the realization of [t] word-finally is morphologically driven and is not attributed to input frequency effects since STOPS are prohibited as codas in Greek. We argue that the child's grammar prohibits a marked segment for continuancy in the prosodically weak coda position. Therefore, POSITIONAL NEUTRALIZATION occurs resulting in the realization of the unmarked [-continuant] [t]. Later, [t^{*}] and [t⁰] occur word-finally, before the child's realizations become adult-like. We argue that as long as a final coda consonant occurs, the morphological information is evident in the child's realizations.

Keywords: final coda position, fricatives, positional neutralization, child Greek, phonological acquisition.

1. Introduction

In this case study¹, we investigate the acquisition of the word-final coda position in child Greek based on longitudinal data from a typically developing Greek-acquiring child (age: 3;04.06-3;07.07, intermediate phase of the phonological acquisition). In the literature, it is reported that codas are marked vis-à-vis onsets. For example, such evidence is provided by end-state phonological systems which do not tolerate codas at all, for example Cayuvava (Key 1961), Hua (Blevins 1995) and Senufo (Clements & Keyser 1983), as well as from developing phonological systems in which codas are not permitted during the initial phase of the acquisition (e.g. Jakobson 1941/68).

Cross-linguistic studies on the acquisition of phonology show that codas are marked constituents (e.g. Roark & Demuth 2000; Bat-El 2013, Ben-David & Bat-El 2016, de Almeida et al. 2019) and as such it is expected to be avoided during the initial phase of the phonological acquisition². Initial-state (developing) grammars allow unmarked syllabic structures and segments to be realized, for example, the earlier productions consist of the universally unmarked CV syllabic shape, voiceless and STOP consonants (e.g. Jakobson 1941/68, Stampe 1969, Demuth 1995, Demuth & Fee 1995). This tendency can be seen as an innate bias, which within the framework of OPTIMALITY THEORY (Prince & Smolensky 1993/2004) is theoretically expressed as a bias for the

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² The marked status of codas led some researchers to analyze coda consonants as onsets of empty-headed syllables (for child languages see e.g. Goad 1998, Goad & Brannen 2003, Rose 2000, for child Greek see Kula & Tzakosta 2006 and for fully developed languages see e.g. Kaye 1990, Charette 1991, Piggott 1991).

MARKEDNESS constraints, namely the ones which favor the realization of unmarked structures, to be ranked higher than the FAITHFULNESS constraints, the ones which require identity between the input and the output form, i.e. between the adult/target form and the child's realization (Demuth 1995, Gnanadesikan 2004, Pater 1997, Levelt & Vijver 1998). Consequence of this bias is the systematic realization of unmarked forms early in the acquisition³.

Given the preference for unmarked structures in the initial phase of the phonological acquisition, the early children's realizations are codaless. The emergence of codas is expected to occur later in the acquisition, namely during the intermediate phase⁴ (e.g. Fikkert 1994, 1998, Levelt & Vijver 1998 for Dutch; Ingram 1976; Branigan 1976; Salidis & Johnson 1997, Goad & Brannen 2003 for English, Rose 2000 for French, Shaked 1990, Ben-David 2001 for Hebrew, Fikkert & Freitas 1997, Freitas 1999 for Portuguese, Macken 1978, Goldstein & Cintron 2001 for dialects of Spanish)⁵. Nevertheless, the emergence of codas in the child's realizations does not entail their emergence in every word position, namely cross-linguistic studies show that there is a tendency for the final codas to emerge before the medial ones in child speech⁶ (e.g. Fikkert 1994 for Dutch, Kirk & Demuth 2006 for English, Rose 2000, Kehoe 2020 for French, Prieto 2006, Borrás-Comes & Prieto 2013 for Catalan, Ben-David 2012, Ben-David & Bat-El 2016 for Hebrew). Representative examples are given in (1):

(1)	Target	Output	Gloss	
a.	<i>da:r</i>	<i>da</i>	'there'	
b.	<i>pu:s</i>	<i>pu:s</i>	'cat'	
				(Dutch, Fikkert 1998: 194-195)
c.	<i>bakbúk</i>	<i>babú</i>	'bottle'	
d.	<i>bakbúk</i>	<i>babúk</i>	'bottle'	
e.	<i>bakbúk</i>	<i>bakbúk</i>	'bottle'	
f.	<i>agvanyót</i>	<i>avayó</i>	'tomatoes'	
g.	<i>agvanyót</i>	<i>avayót</i>	'tomatoes'	
h.	<i>agvanyót</i>	<i>agvanyót</i>	'tomatoes'	
				(Hebrew, Ben-David & Bat-El 2016: 17)

Previous studies on child Greek phonology have shown that during the earliest stages of the phonological acquisition unmarked structures/forms occur systematically (e.g. Kappa 2002a, b). Consequently, in the initial phase, codas are not realized whereas they start being produced during the intermediate phase (Kappa 2002a, b, Tzakosta & Kappa 2008). In child Greek, the emergence of final codas precedes the emergence of

³ Buja (2015, 2020) reports that final coda deletion is not a frequent strategy even in the early phase of the phonological acquisition of Romanian.

⁴ Ingram (1989) and Macken (1992) argues that the intermediate phase of the phonological acquisition starts at the ages of 18 and 24 months, respectively.

⁵ Grijzenhout & Joppen (1998) report that in the absent of a consonant from that word-initial onset, a coda consonant occurs word-finally during the initial phase of the acquisition in child German.

⁶ The reverse order in the acquisition of codas is attested in Spanish according to Lleó (2003). Nuñez-Cedeño (2007) did not find differences by position in child Spanish.

medial codas (for the acquisition of medial codas in child Greek see Kula & Tzakosta 2006; Kappa 2009b), finding which is also attested in the cross-linguistic studies cited above. Examples are given in (2):

(2)	Target	Output	Gloss	Age	Child
a.	<i>ba.'bas</i>	<i>ba.'ba</i>	'dad.M.NOM.SG'	1;10	S.
b.	<i>'mar.kos</i>	<i>'ma.kos</i>	'Marko-.M.NOM.SG'	2;02.28	S.
					(Kappa 2002b: 320)
c.	<i>'kar.ta</i>	<i>'kal.ta</i>	'car-F.NOM.SG'	2;09.25	B.
					(Kappa 2009b: 481)

Kappa's (2000, 2002a) case studies on the acquisition of FRICATIVE consonants provide evidence that there is a link between the (i) acquisition of the target final coda /s/, which is a morphological marker in Greek, and (ii) the emergence of FRICATIVES in the child's typically developing phonological system. In both case studies, Kappa focused on the longitudinal data of the same monolingual child acquiring Greek as L1. In the first case study, she considered data from the age of 2;0 until the age of 3;5.8 and in the second one she focused on data from the age of 1;10 until the age of 2;10. Both studies show that FRICATIVES do not emerge simultaneously in all word-positions, namely they emerge first in the final coda position and later in (non)-initial onsets of (un)stressed syllables. In the abovementioned studies, it is claimed that the earlier emergence of FRICATIVE [s] at the right edge of the word is morphologically conditioned since this consonant assigns the morphological information regarding the person in verbs and gender and case in nouns, e.g. the faithful realization of the target form /*ba.'bas*/ 'dad' as [*ba.'bas*] provides the morphological information that the realized form is a masculine noun in nominative case⁷. Also, Kappa (2002a) claims that the emergence of the [+continuant] consonant word-finally is attributed to POSITIONAL FAITHFULNESS effects (for POSITIONAL FAITHFULNESS see Beckman 1998). Additionally, Kappa (2002b) reaches the same conclusions based on the data from four typically developing Greek-acquiring two-year-old children. The order of acquisition of FRICATIVES in Kappa's (2000, 2002a, b) studies is summarized below (3):

(3) The order of acquisition of FRICATIVES in Kappa's (2000, 2002a, b) studies

word-final coda position >> (non)-initial onset position

(>>: earlier acquisition)

Finally, in Kappa (2009b), it is reported that the longitudinal data of eleven children acquiring Greek as L1 show that a CORONAL FRICATIVE consonant appears as the final coda segment. Specifically, [s], [θ], [ç] or [ʃ] emerge in the final coda position.

⁷ Lleó (2003) and Prieto & Bosch-Baliarda (2006) show that, in Spanish, final codas are acquired relatively late despite the fact that they are morphological markers.

In this case study, we focus on longitudinal data from the intermediate phase of the phonological acquisition of a monolingual child acquiring Greek as L1 and we show that the learning path that the child adopts during the process of the acquisition of FRICATIVES and of the final coda position is different from that which is attested in Kappa (2000, 2002a, b). Hence, taking the findings of Kappa's studies and of this study into consideration, we provide evidence that there are various learning paths available in the process of the acquisition of FRICATIVES and of the final coda consonant in child Greek.

We show that the child has acquired the CVC syllabic shape word-finally but, at first, he favors a STOP rather than a FRICATIVE at the right edge of the word. Interestingly, the child's intermediate grammar anchors the morphological information in the child's realizations, but it does not tolerate a word-final segment with the marked [+continuant] MANNER OF ARTICULATION (henceforth MOA) feature in the prosodically weak coda position. Therefore, POSITIONAL NEUTRALIZATION occurs. Hence, the realized final coda segment is the STOP [t], which is faithful to the CORONAL PLACE OF ARTICULATION (henceforth POA) and to VOICING of the target /s/, but it is not faithful to the marked [+continuant] MOA. Later in the acquisition, the AFFRICATES [t^h] and [t^s] co-occur with [t] at the right edge of the word. Interestingly, [t^h], [t^s] and [t], are not allowed word-finally in the ambient language. In the final stage, the child's realizations are adult-like with respect to the final coda consonant, namely [s] is realized. We claim that as long as a consonant appears word-finally, the morphological information is evident in the child's realizations.

Also, we demonstrate that the child systematically realizes FRICATIVE consonants in initial and non-initial onsets of stressed and unstressed syllables. We show that, in the child's grammar, FRICATIVES emerge first in onset position and later in the final coda position, namely in the present study the reverse order of acquisition is attested compared to the previous studies on child Greek, e.g. of Kappa's (2000, 2002a, b). Hence, we provide evidence for a different learning path in the acquisition of FRICATIVES based on the data of a single child. We claim that the earlier realization of FRICATIVES in onsets is attributed to POSITIONAL FAITHFULNESS effects, i.e. in psycholinguistically strong positions the contrasts are preserved⁸, and that the unfaithful realization of the final coda consonant is attributed to POSITIONAL NEUTRALIZATION⁹, i.e. in psycholinguistically weak positions the contrasts are reduced.

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 longitudinal data. Section 3 describes the attested developmental patterns in the acquisition of the final coda position. Section 4 provides the theoretical analysis in light of the Optimality Theory (Prince & Smolensky 1993/2004). Concluding remarks are provided in Section 5.

⁸ Previous studies on the acquisition of phonology show that POSITIONAL FAITHFULNESS effects are well-attested in children's typically developing system, see e.g. Rose (2000) and Tessier (2006, 2009) for the acquisition of clusters in French, Pater & Werle (2003) for consonant harmony in child French, Revithiadou & Tzakosta (2004a, b) for child Greek. Also, for a discussion on positional effects in child speech see Parsons (2006).

⁹ Evidence for POSITIONAL NEUTRALIZATION effects during the acquisition of Phonology of English is provided by Inkelas & Rose (2008).

2. Methodology

The data are drawn from a longitudinal study of a monolingual typically developing Greek-acquiring child (3;04.06-3;07.07, boy). The child was recorded once or twice a week by a trained linguist, the author of this study, who visited the child in 20–45-minute-long sessions. The experimental stimuli were designed to elicit all segments, possible prosodic structures and stress patterns in Greek. The data obtained 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 (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.

3. Data presentation

The child was recorded between the ages of 3;04.06 and 3;07.07. He is a representative of the intermediate phase of the phonological acquisition. The child’s intermediate-state grammar gradually suppresses the unmarked structures and starts allowing the realization of marked forms. Specifically, the child’s typically developing system does not allow the emergence of consonant clusters in initial and non-initial onsets of stressed and unstressed syllables (4a-c). Also, in onsets, NASALS and LIQUIDS are realized (4d-i) whereas AFFRICATES are not produced (4k). Moreover, the realization of codas word-medially is prohibited (4d-e, j) whereas it is allowed at the right edge of the word (4i).

(4)	Target	Output	Gloss	Age
a.	<i>ble</i>	<i>be</i>	‘blue-N.NOM.SG’	3;04.02
b.	<i>'ci.tri.no</i>	<i>'ci.ti.no</i>	‘yellow-N.NOM.SG’	3;04.02
c.	<i>spi.ti</i>	<i>'pi.ti</i>	‘house-N.NOM.SG’	3;04.06
d.	<i>'for.ma</i>	<i>'fo.ma</i>	‘jumpsuit-F.NOM.SG’	3;04.02
e.	<i>bal.'ko.ni</i>	<i>ba.'ko.ni</i>	‘balcony-N.NOM.SG’	3;04.19
f.	<i>'li.yo</i>	<i>'li.yo</i>	‘a little’	3;04.13
g.	<i>me.'ya.lo</i>	<i>me.'ya.lo</i>	‘big-N.NOM.SG’	3;04.13
h.	<i>'fe.ne.te</i>	<i>'fe.ne.te</i>	‘seem-PRS.3SG’	3;05.12
i.	<i>fa.'kos</i>	<i>fa.kot</i>	‘torch-M.NOM.SG’	3;04.13
j.	<i>'kal.tʰa</i>	<i>'ka.ta</i>	‘sock-F.NOM.SG’	3;04.06

FRICATIVE consonants are allowed in initial and non-initial onsets of stressed and unstressed syllables. Hence, CORONAL, LABIAL and DORSAL FRICATIVE consonants are faithfully realized in onsets (5a-c). Regarding the target sibilant /s/, it surfaces as [θ] in onsets (5d-e). The realization of the marked [+continuant] MOA feature in psycholinguistically strong word-positions, namely in onsets, is attributed to POSITIONAL FAITHFULNESS (see Beckman 1998). Hence, it seems that in onsets the [±continuant]

contrast has been acquired, namely STOPS and FRICATIVES consonants are realized. Only later in the course of acquisition, [s] is realized in onsets (5f).

(5)	Target	Output	Gloss	Age
a.	<i>ka.'ra.vi</i>	<i>ka.'la.vi</i>	'ship-N.NOM.SG'	3;04.19
b.	<i>ka.tsa.'vi.ði</i>	<i>ka.ta.'vi.ði</i>	'screwdriver-N.NOM.SG'	3;05.19
c.	<i>for.ti.'yo</i>	<i>fo.ti.'yo</i>	'track-N.NOM.SG'	3;05.25
d.	<i>'si.me.ra</i>	<i>'ði.me.la</i>	'today'	3;04.19
e.	<i>'me.sa</i>	<i>'me.θa</i>	'inside'	3;05.25
f.	<i>'so.ba</i>	<i>'so.ba</i>	'heater-F.NOM.SG'	3;07.07

The data show that the CVC syllabic shape has been acquired word-finally. In Greek the sibilant /s/ is a morphological marker for inflection, namely it assigns the morphological information for person in verbs and case and gender in nouns, e.g. *ka.'fes* 'coffee-MASC.NOM.SG' and *kra.'tas* 'keep-2PRS.2SG'. Our data demonstrate that in the final coda position, FRICATIVES are not realized. Thus, the input /s/ is realized as [t]. The child's form is faithful to the CORONAL POA and to VOICING. However, it is not faithful to the marked [+continuant] manner feature. Thus, the realized coda consonant is unmarked in MOA, i.e. it is [-continuant]. It seems that the [+continuant] feature has not been acquired at the right edge of the word. Taking the findings together, it seems that the occurrence of the [±continuant] MOA feature in the child's realizations is predicted based on the context, namely the [±continuant] feature is contrastive in onsets, whereas there is not the [+continuant] contrast at the right edge of the word. These findings are interesting given that these realization patterns are attested in the child's data even at the age of 3;04-3;06. In previous studies in child Greek, it has been reported that the continuant manner is acquired earlier at the right edge of the word and later in onsets (e.g. Kappa 2000, 2002a, b; 2009a). Hence, it seems that the child of this study follows an alternative learning path in the process of the acquisition of FRICATIVES in onsets and in the final coda position.

We argue that in the final coda position, which is psycholinguistically weak (see Beckman 1998), the manner contrasts are neutralized, i.e. they are not preserved in the produced forms. This realization pattern represents an example of POSITIONAL NEUTRALIZATION. We claim that the realization of [t] word-finally is morphologically conditioned, namely the child's typically developing system demands the morphological information regarding the person in verbs and the case and gender in nouns to be evident in the realized forms. For example, in (6a) the input form /'sci.los/ 'dog' is realized as /'ci.lot/. Thus, the produced form is a masculine noun in the nominative case. Also, this pattern cannot be attributed to input frequency effects, since [t] is not a final coda in adult Greek. Additional representative examples are provided in (6).

(6)	Target	Output	Gloss	Age
a.	<i>'sci.los</i>	<i>'ci.lot</i>	'dog-M.NOM.SG'	3;04.02
b.	<i>mi.'kros</i>	<i>mi.'kot</i>	'small-M.NOM.SG'	3;04.13
c.	<i>fa.'kos</i>	<i>fa.'kot</i>	'torch-M.NOM.SG'	3;04.13

d.	<i>'kse.ris</i>	<i>'te.lit</i>	'know-PRS.2SG'	3;04.21
e.	<i>pa.'tas</i>	<i>pa.'tat</i>	'press-PRS.2SG'	3;05.25

Later in the acquisition of the word-final coda consonant, an AFFRICATE emerges at the right edge of the word. Specifically, [t^θ] surfaces word-finally. An AFFRICATE is a phonetic sequence which begins as a stop but releases as a fricative. AFFRICATES are [-continuant] and [+delayed release] segments whereas FRICATIVES are [+continuant], [+delayed release] (see e.g. Hayes, 2009: 79). We claim that the realization of the AFFRICATE word-finally indicates that the child gradually acquires the [+delayed release] feature of the input FRICATIVE final coda consonant. It is as if the child's intermediate grammar gradually progresses towards the target /s/, namely the child combines the unmarked [-continuant] MOA feature of the dominant pattern, i.e. the realization of [t] as final coda segment, and the marked [+delayed release] feature of the target /s/. Nevertheless, we cannot make the strong claim that such data reflect a transitional stage during the acquisition of final codas in the child's system since this realization pattern is infrequent in the child's data. Also, this realization pattern co-occurs with the dominant pattern discussed above, namely [t^θ] and [t] co-occur at the right edge of the word for a brief period. Hence, intra-child variation is attested.

The emergence of the AFFRICATE [t^θ] at the right edge of the word coincides with the emergence of AFFRICATES in the initial and non-initial onsets of stressed and unstressed syllables (for the acquisition of AFFRICATES in child Greek see Kappa 1998, Papoutsakis 2018). Thus, it seems that the emergence of the AFFRICATES in onsets and in the final coda position is dependent on each other. Furthermore, the child's longitudinal data show that in onset position the AFFRICATE /t^s/ is realized faithfully with respect to the target consonant (/t^s/ → [t^s]) whereas [t^θ] is attested in the final coda position. Hence, it seems that in strong positions the contrasts are preserved whereas in the weak coda position the contrasts are neutralized. It is only later that [t^s] is realized word-finally. Moreover, we argue that the production of [t^θ] and [t^s] word-finally is not attributed to input frequency effects since AFFRICATES are not permitted in the final coda position in the ambient language. Rather, we claim that the realizations of [t^θ] and [t^s] are morphologically conditioned. Representative examples are given in (7):

(7) AFFRICATE consonant in final coda position

	Target	Output	Gloss	Age
a.	<i>'jor.yos</i>	<i>'jo.yot^θ</i>	'Jorgos-M.NOM.SG'	3;05.25
b.	<i>'sci.los</i>	<i>'ci.lot^θ</i>	'dog-M.NOM.SG3;05.25	
c.	<i>'ko.ko.ras</i>	<i>'ko.ko.lat^θ</i>	'rooster-M.NOM.SG'	3;05.25
d.	<i>ba.ta.'ri.es</i>	<i>'ba.ta.'li.et^θ</i>	'battery-F.NOM.SG'	3;06.01
e.	<i>'vri.ces</i>	<i>'vi.cet^s</i>	'find-PRS.3SG'	3;06.01

AFFRICATE consonant in onset position

	Target	Output	Gloss	Age
f.	<i>ka.'ro.tsa</i>	<i>ka.'lo.t^sa</i>	'trailer-F.NOM.SG'	3;05.25
g.	<i>'tsa.da</i>	<i>'t^sa.da</i>	'bag-F.NOM.SG'	3;06.15

During the final stage in the process of the acquisition of the final coda consonant, the child's developing grammar allows the realization of [s]. Therefore, during this stage the child's realizations are adult-like. Consequently, the effects of POSITIONAL NEUTRALIZATION are no longer evident. Relevant data are given in (8):

(8)	Adult form	Child form	Gloss	Age
a.	<i>ja.'tros</i>	<i>ja.'tos</i>	'doctor-M.NOM.SG'	3;07.00
b.	<i>'a.drás</i>	<i>'a.dás</i>	'man-M.NOM.SG'	3;07.07
c.	<i>'pa.ris</i>	<i>'pa.lis</i>	'take-PRS.2SG'	3;07.07
d.	<i>'pi.na.kas</i>	<i>'pi.na.kas</i>	'table-M.NOM.SG'	3;07.07

3.1 Interim summary

Taking the findings together, our longitudinal data reveal that the child's developing grammar gradually suppresses the unmarked forms and starts permitting the realization of marked ones. In onsets, namely in psycholinguistically strong positions, FRICATIVES are realized faithfully. Hence, it seems that the [\pm continuant] MOA feature is contrastive in onsets only. This is not the case for the position of the word-final coda which is psycholinguistically weak. In the final coda position, the [+continuant] MOA feature is acquired later, as our data reveal. Despite the fact that the CVC syllabic shape has been acquired word-finally, various patterns are attested in the realization of the final coda consonant before the child's realization become adult-like, namely [t], [t⁰] and [t^s] emerge (in this order) before the faithful realization of [s] at the right edge of the word. The order of emergence of the coda consonants word-finally is summarized in (9):

(9) The order of emergence of the coda consonants word-finally

[t] >> [t⁰] >> [t^s] >> [s]

(>>: earlier emergence)

4. Data 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 types of constraints: MARKEDNESS constraints, which force the realization of unmarked forms, and FAITHFULNESS constraints which require identity between the input, namely the target form, and the output, namely the realized form. A grammar can be seen as 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 can be seen as follows: In the initial phase of the acquisition, there is a bias for MARKEDNESS constraints to dominate the FAITHFULNESS constraints (Demuth 1995, Gnanadesikan 2004, Pater 1997, Levelt & Vijver 1998). Hence, during this phase of the acquisition, unmarked structures and segments are realized, for instance universally unmarked CV syllables, STOPS and voiceless consonants surface. Gradually, in the course of the acquisition, marked structures/forms start being produced, for example CVC syllabic shapes, coda consonants, onset and coda clusters and FRICATIVES. Hence, the gradual convergence to the target language is theoretically expressed in terms of constraint reranking. As a result, in the intermediate phase of the 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. all movement of the MARKEDNESS constraints is downward (Tesar & Smolensky 2000, Adam 2002), constraint promotion, i.e. all movement of the FAITHFULNESS constraints is upward (Gnanadesikan 1995, Levelt & Vijver 1998, Ben-David 2001), or both constraint demotion and promotion (e.g. Boersma 1997, Tzakosta 2003, 2004). In the final phase of the acquisition, the child's and the adult's phonological system are identical and, thus, it is assumed that the FAITHFULNESS constraints dominate the MARKEDNESS ones.

In this case study, the investigation of the acquisition of the final coda consonant show that the radical reranking of constraints has already taken place and, thus, some FAITHFULNESS constraints dominate some MARKEDNESS constraints. Hence, the child's data reflect an intermediate-state grammar. At first, the focus is on an intermediate stage in which the unmarked consonant [t] appears at the right edge of the word. Later in the acquisition, the AFFRICATES [t^h] and [t^s] are realized word-finally. This realization pattern co-occurs with the aforementioned one. We do not provide a theoretical analysis for [t^h] and [t^s] since they represent a marginal pattern in our data. Finally, the child's productions become adult-like. Hence, [s] is realized word-finally. We adopt the constraints in (10-11) to analyze the gradual acquisition of the word-final coda position:

- (10) MARKEDNESS CONSTRAINTS
- *CODA: No CODAS
 - *[Cont]: No continuant OBSTRUENTS
 - *[Cont]_{WD-FIN}: No continuant OBSTRUENTS word-finally
 - *[s]: No SIBILANT [s]
- (11) FAITHFULNESS CONSTRAINTS
- MAX(I-O): Every segment in the input must have a correspondent in the output (McCarthy & Prince 1995)
 - ANCHOR-IO_(GR_{WD}R): No deletion at the right edge of a grammatical word (McCarthy & Prince 1995).
 - IDENT[CONT]: If an input segment has the feature value [α CONTINUANT], then its output correspondent must be [α CONTINUANT] (McCarthy & Prince 1995).
 - IDENT[PLACE]: If an input segment has the feature [α PLACE], then its output correspondent must be [α PLACE] (McCarthy & Prince 1995).

IDENT[VOICE]: If an input segment has the feature [α VOICE], then its output correspondent must be [α VOICE] (McCarthy & Prince 1995).

In section 3, it was shown that the CVC syllabic structure has been acquired word-finally and that the child's intermediate grammar allows a consonant at the right edge of the word. Thus, we argue that the constraint ANCHOR-IO_(GrWd,R) and MAX(I-O) are highly ranked. The former constraint ensures that a coda consonant is realized word-finally and the later ensures that deletions are prohibited in all word positions. These constraints are unranked with respect to each other since they are always satisfied by the optimal output form, i.e. the child's realization, and no evidence permits us to determine their relative ranking based on the available data. *CODA is lowly ranked given that a final coda consonant is realized. Also, given that sibilants are not allowed in the child's system, *[s] is highly ranked. The realized [t], which appears in the final coda position, is faithful to the input /s/ with respect to the POA and VOICING but it is not faithful with respect to the marked [+continuant] MOA. Hence, it seems that IDENT[PLACE] and IDENT[VOICING] are highly ranked in the constraint hierarchy and unranked with respect to each other since the child's outputs provide us no evidence for their relative ranking based on the data.

In our theoretical analysis, the MARKEDNESS constraint *[CONT]_{WD-FIN} is the crucial one since it is active in the child's developing system and prohibits the emergence of FRICATIVES word-finally only. This constraint is *context-sensitive*, namely it operates word-finally avoiding FRICATIVES at the right edge of the word. In our data, the context-sensitive *[CONT]_{WD-FIN} constraint constitutes a pair of constraints with the context-free *[CONT] constraint which prohibits the emergence of FRICATIVES in all word positions, namely in onsets and in the final coda position. These constraints are crucially ranked with respect to each other. Panini's Theorem on Constraint Ranking determines the ranking between the two markedness constraints such that a specific context-sensitive constraint, *[CONT]_{WD-FIN}, dominates the general context-free constraint, *[CONT] (Prince & Smolensky 1993/2004 for constraint ranking based on *Panini's Theorem*). Hence, we argue that the specific *[CONT]_{WD-FIN} is higher ranked to ensure that FRICATIVES do not emerge word-finally, i.e. in a non-salient position, and that the general *[CONT] is lowly ranked to ensure that FRICATIVES emerge in initial and non-initial onsets of stressed and unstressed syllables, i.e. in strong positions. Recall that CORONAL, LABIAL and DORSAL FRICATIVES are produced faithfully in initial and non-initial onsets of stressed and unstressed syllables.

In (12) we demonstrate the constraint hierarchy during this intermediate stage of the acquisition of the final coda position. In (13) we present the OT tableau. Due to space limitations, we do not include *[s], IDENT[PLACE], IDENT[VOICE] and MAX(I-O) in the tableau, given that they are undominated and always satisfied by the (optimal) output form. In this tableau, 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.

(12) Constraint ranking

ANCHOR-IO_(GRWD, R), *[s], IDENT[PLACE], IDENT[VOICE], MAX(I-O) >>
*[CONT]_{WD-FIN} >> IDENT[CONT] >> *CODA, *[CONT]

(13) Adult form: [fa.'kos] - Child form: [fa.'kot] 'torch-M.NOM.SG.', age: 3;04.13

Input: fa'kos	ANCHOR-IO	*[CONT] _{WD-FIN}	IDENT[CONT]	*CODA	*[CONT]
a. fa'kos		*!		*	**
b. fa' fa'kot			*	*	*
c. fa'ko	*!				*

The output candidates (13a-b) satisfy the undominated ANCHOR-IO_(GRWD, R) constraint since a coda consonant appears word-finally. The candidate (13c) fatally violates the aforementioned constraint since the final coda consonant is deleted. The satisfaction or the violation of the highest ranked context-sensitive *[CONT]_{WD-FIN} constraint determines the winning candidate, i.e. the optimal output. This constraint is fatally violated by (13a) and satisfied by (13b). Hence, the former candidate is excluded as the optimal output and the latter is selected as the winning one. In OT, constraints are ranked in a hierarchy of (strict) domination. Therefore, 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 optimal output, even if it outperforms the other candidates on the rest of the constraint hierarchy. Therefore, despite the fact that the output candidate (13b) violates the constraints IDENT[CONT], *CODA, *[CONT], these violations are not fatal and, thus this candidate is still selected as the optimal one. Also, note that *[CONT] is the lowest ranked constraint and, thus, the realization of FRICATIVES is permitted in onsets.

The child's developing system prohibits the marked [+continuant] MOA feature in a non-salient position, i.e. in the final coda position. Therefore, we claim that POSITIONAL NEUTRALIZATION occurs due to the operation of the context-sensitive *[CONT]_{WD-FIN} constraint, which prohibits the realization of continuant consonants word-finally. As a consequence, the realization of [t] which is unmarked with respect to MOA is attested. Given that /t/ is not allowed in coda position in the ambient language, the child has not positive evidence for this consonant as a coda segment neither word-medially nor word-finally. Thus, this realization pattern cannot be attributed to input frequency effects (for the issue of whether the input frequency influences the acquisition see e.g. Brown 1973, Levelt et al. 1999/2000, Zamuner 2003, Babcock 2006, Stites et al. 2004, Demuth 2007, Rose 2009, Rose & Brittain 2011, Ambridge et al. 2015, Jarosz et al. 2017). Hence, we claim that the realization of [t] is morphologically conditioned. This realization pattern reflects a sub-stage during the acquisition of final codas in the child's developing system.

In (14) we provide the constraint hierarchy during the final stage in the acquisition of the final coda segment within the intermediate phase of the phonological acquisition. In this stage, the child's realizations are adult-like with respect to the final coda consonant, namely [s] surfaces word-finally. In (15) we present the OT tableau. The


constraint $\text{ANCHOR-IO}_{(\text{GRWD}, \text{R})}$ is undominated in the constraint hierarchy since it is always satisfied by the output form. In this stage of the acquisition of the final coda consonant, a crucial constraint reranking took place. $\text{IDENT}[\text{CONT}]$ and $*[\text{CONT}]_{\text{WD-FIN}}$ are ranked differently compared to the previous stage of the acquisition. Specifically, the former constraint has been promoted and thus, it is ranked higher compared to $*[\text{CONT}]_{\text{WD-FIN}}$ which is the lowest ranked constraint in the hierarchy in this stage. As a result, the reranking of these constraints enables the child's grammar to allow the faithful realization of [s] at the right edge of the word, namely the child's realizations are adult-like in this stage of the acquisition.

In this tableau, due to space limitations, we do not include the $\text{IDENT}[\text{PLACE}]$, $\text{IDENT}[\text{VOICE}]$ and $\text{MAX}(\text{I-O})$ given that they are undominated and always satisfied by the (optimal) output form. These constraints are unranked with respect to each other since no evidence is provided for their relative ranking based on the data. Also, we do not include the MARKEDNESS constraints $*\text{CODA}$, $*[\text{CONT}]$ and $*[\text{s}]$ since they are the lowest ranked and always violated by the (optimal) candidate.

(14) Constraint ranking

$\text{ANCHOR-IO}_{(\text{GRWD}, \text{R})}$, $\text{IDENT}[\text{CONT}]$, $\text{IDENT}[\text{PLACE}]$, $\text{IDENT}[\text{VOICE}]$, $\text{MAX}(\text{I-O}) \gg *[\text{CONT}]_{\text{WD-FIN}}$, $*\text{CODA}$, $*[\text{CONT}]$, $*[\text{s}]$

(15) Adult form: [fa.'kos] – Child form: [fa.'kos] 'torch-M.NOM.SG.', age: 3;07.07

Input:	fa'kos	ANCHOR-IO	IDENT[CONT]	*[CONT] _{WD-FIN}
a. 	fa'kos			*
b.	fa'kot		*!	
c.	fa'ko	*!		

As can be seen, the candidates (15a-b) satisfy the highest ranked $\text{ANCHOR-IO}_{(\text{GRWD}, \text{R})}$ constraint since a coda segment appears at the right edge of the word. The candidate (15c) fatally violates the abovementioned constraint since the final coda segment is deleted. During this stage of the acquisition of the final coda consonant, the crucial constraint is the $\text{IDENT}[\text{CONT}]$. This constraint is ranked higher compared to the previous stage, namely $\text{IDENT}[\text{CONT}]$ has been promoted and appears to be undominated and unranked with respect to $\text{ANCHOR-IO}_{(\text{GRWD}, \text{R})}$. The satisfaction or the violation of the highest ranked $\text{IDENT}[\text{CONT}]$ constraint decides the winning candidate, i.e. the optimal output. This constraint is fatally violated by (15b) and satisfied by (15a). Hence, the former candidate is eliminated as the optimal output and the latter is selected as the winning one. Hence, the promotion of $\text{IDENT}[\text{CONT}]$ results in the realization of the $\text{FRICATIVE} /s/$ word-finally, namely the child's final coda realizations are adult-like in this stage.

The child's grammar allowing a marked MOA in salient positions, i.e. in (non)-initial onsets of (un)stressed syllables, provides evidence for $\text{POSITIONAL FAITHFULNESS}$ effects on [+continuant] MOA feature in onsets (see Beckman 1998 for $\text{POSITIONAL FAITHFULNESS}$). Taking the findings together, our data imply that FRICATIVES emerge first in onsets and later in the final coda position. In (16) we illustrate the order of acquisition of FRICATIVES in the child's typically developing phonological system:

- (16) The order of acquisition of FRICATIVES in the child's phonological system

(non-)initial onset position >> word-final coda position

(>>: earlier acquisition)

The reverse order in the acquisition of FRICATIVES is proposed by Kappa (2000, 2002a, b), namely she demonstrates that FRICATIVES are acquired earlier in the word-final coda position and later in (non-)initial onset positions, as can be seen in (3) repeated here as (17). She claims that the realization of the [+continuant] consonant in the final coda position is attributed to POSITIONAL FAITHFULNESS effects (for POSITIONAL FAITHFULNESS see Beckman 1998) and is forced by the acquisition of morphology, i.e. it is driven by the acquisition of inflection (person in verbs, case/gender in nouns, e.g. *kra.'tas* 'keep-PRS.2SG' and *ka.'fes* 'coffee-M.NOM.SG').

- (17) The order of acquisition of FRICATIVES in Kappa's (2000, 2002a, b) studies

word-final coda position >> (non-)initial onset position

(>>: earlier acquisition)

In this case study, we provide evidence that the process of the acquisition of the final coda consonant is a gradual process and involves intra-child variation. The realization of the unmarked STOP [t] in the word-final coda position suffices for anchoring the morphological information in the output form. Also, we demonstrated that even an AFFRICATE may appear at the right edge of the word as a coda consonant before the child's realization become adult-like. We claim that as long as a consonant is realized word-finally the anchoring of the morphological information in the child's realizations is obtained. Hence, taking the findings of the previous studies in child Greek (e.g. Kappa 2000, 2002a, b, 2009a) and of this case study into consideration, we argue that various learning paths are available in the acquisition of codas in child Greek. As a result, intra- and inter-child variation is attested.

5. Conclusions

This case study focused on the acquisition of the final coda position in child Greek based on the longitudinal data of a monolingual typically developing Greek-acquiring child (3;04.06-3;07.07, boy). The child's intermediate grammar allows the realization of the marked CVC syllabic structure word-finally. Our data indicate that the acquisition of the final coda consonant involves a gradual process and intra-child variation. Various developmental patterns are attested.

Initially, the unmarked voiceless CORONAL STOP [t] surfaces in the word-final coda position instead of the target voiceless sibilant /s/, which is a morphological marker in Greek. Hence, the produced consonant is faithful to the CORONAL POA and to VOICING but it is not faithful to the marked [+continuant] MOA. The child's intermediate-state grammar does not tolerate a word-final segment with the marked [+continuant] MOA feature in the prosodically weak coda position. Therefore, we argue that this realization pattern reflects a case of POSITIONAL NEUTRALIZATION. Later in the course of the acquisition, the AFFRICATES [t^h] and [t^s] appear at the right edge of the word as final coda segments. The realization of [t], [t^h] and [t^s] is morphologically conditioned, namely these realization patterns provide evidence that the morphological information is anchored in the child's realizations. These patterns cannot be attributed to effects of the input frequency since STOPS and AFFRICATES do not occur word-finally in the ambient language. Later in the acquisition, the child's realizations become adult-like, namely the sibilant [s] is realized at the right edge of the word.

Thus, we claim that as long as a consonantal segment appears word-finally, the anchoring of the morphological information in the child's realizations is obtained. Taking the findings of this case study together, we conclude that the acquisition of the final coda position is a gradual process which involves intra-child variation.

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