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Metathesis in Language Acquisition of Greek

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Abstract

This study investigates metathesis in children so that to see if it facilitates their language development and in which way. For this reason, thirteen Greek-speaking children are examined varying in age from 2;6.9 to 6;1.26. The data come from picture naming and spontaneous speech. Their examination reveals that its emergence lies to segmental, prosodic and phonotactic reasons. More specifically, metathesis helps children avoid specific sequences of consonants by switching them positions. It also assists them to avoid clusters located in unstressed syllables or illicit structures in the ambient language, as complex codas in loanwords. All metathesized segments are located in positions that can occupy according to the rules of Greek. For the data analysis, Optimality Theory is used (Prince & Smolensky, 1993), while we adopt the Multiple Parallel Grammars model (Revithiadou & Tzakosta, 2004) for the two different patterns attested in their speech.

Keywords: language acquisition, metathesis in Greek, phonology, Optimality Theory.

1. Introduction

During phonological development children employ many phonological processes in order to acquire their mother tongue. One among them is *metathesis*, which is the reversal of the expected linear order of segments (cf., Hume, 2004: 203), as illustrated in the example (1).

Adult's Form	Child's Form	
1) [faneelah]	→ [faleenah] (t-shirt)	(Arabic, Qasem, 2023: 224)

Metathesis has received little attention due to the fact that it is not very productive. In adult's speech, it arises under two specific conditions. First, the outcome of metathesis must be a sequence which is familiar and frequent in the speaker's ambient language. The second factor is related to indeterminacy of the signal, which is affected by the listener's experience of specific sounds or sequences of them or by the lack of sufficient phonetic cues for some segments in a given context (Hume, 2004). In child speech, it is equally ignored due to the lowest degree of appearance in comparison to other processes, such as *substitution* of segments (Qasem, 2023). One common feature in adults and children's metathesis lies to its systematic emergence when two non-default *distinctive features* participate (Gerlach, 2010).

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- The examination of metathesis from longitudinal data of children allows us to make generalizations for this peripheral process.
- Metathesis facilitates children in the acquisition of their mother tongue.
- It helps them avoid specific sequences of consonants, clusters in unstressed syllables and consonants located in codas.
- Its main advantage lies to the preservation of all segments traced in the aforementioned structures.

In the literature, three are the most common types of metathesis noted. In particular, it can contain the reversal of a consonant and a vowel, of two consonants or the movement of one consonant to another position. Representative examples of each case are given below (2-4).

Adult's Form Child's Form Child: Age

2) /klot'**ax**+ji/→ [klot.**xa**.ji] (to be burned) adult's language (Nivaclé, Gutiérrez, 2010: 122)

3) [nezumi] → [nemuzi] (mouse) Eugene: 2;5

4) [klink] → [kinkl] (ice) Loftur: 2;5-3;5 (Icelandic, Fukazawa & Miglio, 2008: 31)

These examples show additionally that the movement can be local (2, 3) or from distance (4). In adults, metathesis is usually traced in adjacent segments (Hume, 2004). On the other hand, in children the shift of only one segment constitutes rare case of metathesis (Bernhardt & Stemberger, 1998). However, it can occur together with other processes, such as *deletion* (Qasem, 2023). The present study investigates the purpose of metathesis in Greek-speaking children and how it facilitates them to acquire their mother tongue.

The structure of the paper is organized with the following way: in section 2 cross-linguistic findings of metathesis are presented. Section 3 includes the methodology conducted for this research. In section 4 the results of the study are presented, while in section 5 the data showing metathesis are analyzed. Section 6 concludes the paper and at the end of it, the *tokens* with metathesis of each child are cited in appendix.

2. Research on metathesis

Cross-linguistically, the appearance of metathesis is suggested to be due to articulatory, morphological, phonological, prosodic or phonotactic reasons depending on the language examined. We begin with the findings in adults. In several languages, metathesis leads to the avoidance of *complex* structures, such as *codas* (Gutiérrez, 2010, example 5).

5) /jijax+/-s/ → [jij.xas] (pumas) (Nivaclé, Gutiérrez, 2010: 119)

In Nivaclé, complex codas are not allowed. So, in (5) the consonant [x] moves to the *onset* position before the vowel [a] in order for an illicit structure to be avoided ([*ji.jaxs]). Another reason for the emergence of this process constitutes the satisfaction of the *Syllable Contact Law*, according to which in any sequence of the form C1.C2, there is a preference for C1 to exceed in *sonority* C2 (Murray & Vennemann, 1983: 520). As far as sonority is concerned, every segment has its own value on a scale proposed by Kiparsky (1979, figure 1).

Figure 1. Sonority Scale (drawn from Kiparsky, 1979: 432)

stops>fricatives>nasals>liquids>glides>vowels

less sonorous more sonorous

Based on the sonority scale, Selkirk (1984) suggests the *Sonority Sequence Principle*, which states that the sonority of segments decreases steadily from the *nucleus* to the edges of a syllable. There are several researches (e.g., Gutiérrez, 2010; Alqahtani, 2018), in which metathesis serves as a repair strategy for the satisfaction of the Syllable Contact Law (examples 6-7).

6) /fi.nak/(tobacco) → [fin.ka.meʧ] (to have power over tobacco) (Nivaclé, Gutiérrez, 2010: 120)

7) /mad.re.se/ → [mar.de.se] (school) (Persian, Alqahtani, 2018: 93)

In (6), the consonant [n] is syllabified in coda position of the first syllable, while the vowel [a] moves after the consonant [k]. This way the form [fi.nak.meʧ] is avoided, which violates the Syllable Contact Law. The same holds for (7) with the difference that two consonants must reorder their position in order for the initial syllable to have a more sonorous consonant than that of the second syllable. In other surveys (e.g., Hock, 1985; Alqahtani, 2018, among others), metathesis arises in cases where the Sonority Sequence Principle is violated in complex onsets or codas (examples 8-9).

8) /suxr(a)/ → [surx] (red) (Persian, Hock, 1985: 534)

9) /pudr/ → [purd] (powder) (Persian, Alqahtani, 2018: 93)

The explanation of the movements in (8-9) is the same. They change the position of the consonants in the clusters so that the more sonorous to be closer to the nucleus. This way, two well-formed clusters are created.

Now, we move on to metathesis in child speech. It is observed to occur in specific sequences, such as [DORSAL]-[LABIAL] (Gerlach, 2010, example 10).

Adult's Form	Child's Form	Child: Age	
10) [kʌp]	→ [pʌk] (cup)	Grace: 1;8	(English, Gerlach, 2010: 14)

In this case, the switching between distinctive features and not whole segments is proposed to take place, that is, the consonants [k] and [p] shift their *place* as the child cannot utter [DORSAL] consonants in initial syllables. When the child produces [DORSAL] consonants with higher frequency, metathesis begins steadily to fade away (Gerlach, 2010). In addition, the advantage of metathesis lies to the preservation of both segments together with the distinctive features they bear. A similar conclusion is drawn in another study (Leonard & McGregor, 1991), where a child is unable to utter fricatives in initial position of words (example 11).

Adult's Form	Child's Form	Child: Age	
11) [su]	→ [us] (shoe)	W: 2;0	(English, Leonard & McGregor, 1991: 262)

This type of metathesis is related to the order of acquisition of fricatives, which are usually acquired earlier in coda position than in onset (e.g., Edwards, 1996). In Arabic, the frequency of metathesis is higher when a sibilant consonant participates (examples 12-13).

Adult's Form	Child's Form	Child: Age	
12) [nafesi]	→ [nasefi] (myself)	Maryam	
13) [manshafah]	→ [masnafah] (towel)	Salama	(Arabic, Qasem, 2023: 225)

This is attributed to the children's preference to move acquired consonants, since in Arabic sibilants emerge frequently and as a result they are easier to be produced by them in comparison to others. Furthermore, metathesis is mostly triggered when two side by side consonants located word medially share some distinctive features, such as place or *manner* (Qasem, 2023). One more environment where this process is observed is in clusters (examples 14-15).

Adult's Form	Child's Form	Child: Age
14) [nudnɔ]	→ [jun.dɔ] (boring)	Ola: 4;0-4;4 (Polish, Łukaszewicz, 2007: 65)
15) [i.po.ˈ**vr**i.çi.o]	→ [i.po**l**.ˈ**v**i.çi.o] (submarine)	S.1: 4;9 (Greek, Gatsou, 2022: 54)

In (14), the consonants [d] and [n] have switched positions satisfying the Syllable Contact Law, as the consonant [n] is more sonorous than the consonant [d] and all the segments are retained (Łukaszewicz, 2007). In (15), the same strategy is employed in order for both members of the cluster to be preserved and for the Syllable Contact Law to not be violated, as the consonant [l] bears higher sonority in regard to the consonant [v]. Metathesis is additionally traced in syllables containing consonants in coda position (examples 16-17).

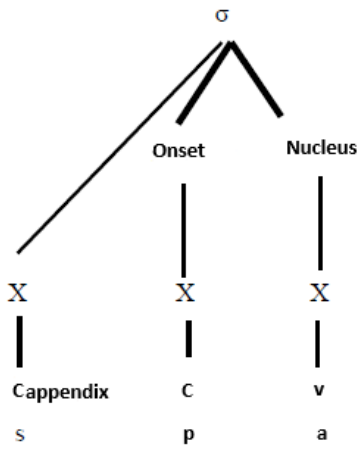
Adult's Form	Child's Form	Child: Age
16) [fo**r**.ti.ˈɣo]	→ [**fr**o.ti.ˈɣo] (truck)	S.28: 4;9
17) [a**r**.ˈvi.la]	→ [a.ˈ**vr**i.la] (combat boot)	S.4: 5;11 (Greek, Gatsou, 2022: 41, 43)

As illustrated in (16), the reorder of [r] creates a well-formed cluster and leads to the highest possible sonority distance between the first and the second syllable, as vowels bear the highest sonority. Further, the type of *markedness* changes instead of its level and quantity, since CVC and CCV syllables are equally marked as they both come from the *unmarked* CV syllable with the addition of one consonant in different though position. In addition, the movement of [r] turns the initial syllable from open to closed (Gatsou, 2022). This conforms to the view that in Greek open syllables are more frequent than closed ones (see Setatos, 1974, among others). The reasons of [r] movement in (17) are the same but its characteristics differ, as the shift is accomplished from initial to medial syllable. Children seem to be sensitive to segments located at the beginning of words which disallow the presence of other segments in front of them for their faithful utterance (Gatsou, 2022). The faithfulness of initial segments is attributed to their position, as it is considered perceptually salient (see Beckman, 1998, among others). Metathesis in (17) changes the type of markedness between the participating syllables, as the initial becomes less marked, while the second is more marked. In the next example (18), an alternative way for the avoidance of cluster is represented.

Adult's Form	Child's Form	Child: Age	
18) [**p**sa.ˈli.ði]	→ [**s**pa.ˈli.ði] (scissor)	S.1: 4;9	(Greek, Gatsou, 2022: 68)

The consonant [s] goes to a position, in which it is licensed as *appendix* in the node of syllable (see Kappa, 1995, among others), as shown from figure (2).

Figure 2. Appendix [s] (drawn from Gatsou, 2022: 14)



This way the onset of the initial syllable is not complex. Regarding the properties of metathesis in examples (16-18), it is ascertained that the direction of the metathesized segment can be leftwards or rightwards, while the movement usually takes place to the next or previous syllable or even in the same syllable.

Finally, in a survey examined metathesis both in adult and child speech (Fukazawa & Miglio, 2008), it is proposed that in the former it is applied at the level of the syllable (example 19), while in the latter at the level of the segment (example 20).

Adult's Form	Child's Form	Child: Age
19) [taburakasu]	→ [tarabukasu] (deceive)	adult's language
20) [nemaki]	→ [menaki] (pajama)	Eugene: 2;5 (Fukazawa & Miglio, 2008: 31)

3. Methodology

Before the research an ethnical approval to conduct it was obtained by the departmental research ethnics committee and consent forms were signed by the parents of the participating children as well as by themselves. Children's consent form was simpler in order for them to be clear what they were going to do. In addition, children who selected to participate in the survey met the researcher in order for both sides to be familiarized with each other before the recordings. In total, 13 monolingual Greek-speaking children with typical linguistic development and without suffering from any hearing problem were recorded. The meetings took place in a nursery and a kindergarten. For the data collection, the professional tape recorder Marantz PMD661MKII was used. All tokens gathered come from picture naming via a book, which includes laminated images showing animals, foods, plants, vehicles, professions, household utensils, buildings, characters from cartoons and generally every day words, which give the children the possibility to utter all consonants and vowels in every position within a word. Their spontaneous speech was also recorded which resulted from activities, such as playing with puzzles, balls, dolls, cars, bricks, painting with markers, reading fairy tales and so on. The process was always done between the researcher and one child each time in a room granted for this purpose so that their productions do not come from hesitation or to get distracted from other activities happening in the nursery or kindergarten during the recordings.

Children's age varies from 2;6.9 to 6;1.26 years old. Their speech was recorded on a weekly basis for those that were younger than 4;5 years old and every 14 days for those older than 4;5 years old. The duration lasted about 7 months, while each recording ranges from 8 to 20 minutes for every child. We rely our assumptions on 32 tokens presenting metathesis. All children are observed to be in the intermediate phase of acquisition but at a different substage. Thus, complex structures such as consonantal clusters, consonants in coda position, trisyllabic and longer words, consonants specified as liquid appear in all the children. These features are proposed to indicate the transition of the initial to the intermediate stage of language acquisition (see for Greek, Tzakosta & Kappa, 2008; Kappa, 2009). For the reproduction and conversion of audio material into phonetic tokens the Audacity software was used. The processing and analysis were done in Microsoft Excel Worksheets. Due to the transcription done perceptually, only data with high certainty of children's outputs are included. The adult's and child's outputs are written according to the *International Phonetic Alphabet*.

4. Results

We classify our data in three different categories based on the reasons of metathesis emergence. More specifically, it is used in order for specific sequences to be avoided and in order for the consonants of clusters located in unstressed syllable or consonants traced in coda position to be maintained. In addition, we observe two types of metathesis to appear. The first involves the switching between two consonants and the second the movement of a consonant.

We begin with the shift between two consonants. Representative examples are given below (21-24).

Adult's Form	Child's Form	Child: Age
21) [ˈka.ti]	→ [ˈta.ci] (something)	#076B-A[1]: 4;9.10
22) [ˈci.ta]	→ [ˈti.ka] (look)	#077G-A: 5;1.13
23) [ˈnu.me.ɾo]	→ [ˈɾu.me.no] (number)	#094B-A: 5;11.22
24) [a.ne.mi.ˈsti.ɾas]	→ [a.me.ni.ˈsti.ɾas] (fan)	#094B-A: 6;1.26

Metathesis in tokens (21-24) helps the children to avoid sequences containing specific consonants regarding their distinctive features. In (21-22), a [DORSAL] consonant in initial syllable shifts position with a [CORONAL] consonant located in the next syllable. This is attributed to two reasons. The first lies to *input* frequency. In both children, tokens starting with [CORONAL] consonant are more systematic (#076B-A: 1.431 tokens, #077G-A: 849 tokens) than those beginning with [DORSAL] consonant (#076B-A: 185 tokens, #077G-A: 162 tokens). The second lies to faithfulness. Children utter faithfully in higher degree tokens that begin with [CORONAL] consonant (#076B-A: 1.428/1.431 (99.8%), #077G-A: 849/852 (99.7%) in comparison to those beginning with [DORSAL] consonant (#076B-A: 166/185 (89.7%), #077G-A: 161/162 (99.4%)[2]. In (23-24), metathesis applies for the same reasons but with different consonants involving, as in (23) the consonants [ɾ] and [n] change position, while in (24) the [n] and [m]. This child seems to struggles more with sequences of [n] followed by [m]. Words including both nasals show that the sequence [m] followed by [n] appears to be more frequent (36 tokens) than the reversed (15 tokens). In addition, words in which [m] precedes [n] have been acquired (35/36, 97.2%), while words in which [n] precedes [m] have not (9/15, 60%). Examples (21-24) show that metathesis is triggered by consonants presenting *similarity*, as [k] and [t] differ only in place, [r] and [n] differ only in *manner* and [n] and [m] differ only in place. Also, it can be accomplished to consecutive syllables (21-22, 24) or from distance (23). Next, a similar pattern is observed (examples 25-26).

Adult's Form	Child's Form	Child: Age
25) [ˈfra.u.la]	→ [ˈfla.u.ɾa] (strawberry)	#060B-A: 4;7.15
26) [o.ˈbre.la]	→ [o.ˈble.ɾa] (umbrella)	#060B-A: 4;7.22

This child cannot produce faithfully sequences of [r] and [l] with one of them traced in cluster. The reason lies to the faithfulness observed in sequences [l] and [r] when [l] is located in cluster, which are always preserved (100%) despite their low frequency of emergence (2 tokens, one includes [stop + l] cluster and the other [fricative + l]). On the other hand, when [r] is observed in cluster and is followed by [l], then it is not always produced (6/8 tokens (75%) in [stop + r]

[1] The children's names are coded to keep anonymity. The higher the number the higher the age of the child. B: boy, G: girl, A: Athens.

[2] There are several views regarding the percentages a segment or structure must have in order for it to be considered as acquired by the children (see, Papadopoulou, 2000). In the present study we follow the strictest, namely, a segment or structure has been acquired if it presents ≥ 90% faithfulness.

cluster and 1/2 tokens (50%) in [fricative + r]). Once again, the features of metathesis regarding the domain and similarity of participating segments remain the same. In addition, the cluster is maintained due to its position since the stressed syllable is considered as psycholinguistically prominent position (see Smith, 2002, among others).

All the remaining tokens include the movement of one consonant. The second environment of metathesis concerns the avoidance of clusters in unstressed syllable. Three different strategies are employed by the children for this reason. Examples of the first are cited next (27-28).

Adult's Form	Child's Form	Child: Age
27) [ˈci.tri.no]	→ [ˈkli.ti.no] (yellow)	#052G-A: 2;7.4
28) [ˈva.tra.xos]	→ [ˈvla.ta.xos] (frog)	#055G-A: 3;3.2

As shown from (27-28), the second member of the cluster moves to a strong position, namely, in the initial stressed syllable in order to be retained. In this position it increases its chances of being produced, since both children have not yet acquired this kind of clusters (tokens preserved in [stop + liquid] cluster: #052G-A: 244/273 (89.4%), #055G-A: 17/21 (81%)[3]. This change does not violate the Syllable Contact Law between the participating syllables and it creates a well-formed cluster as that in the unstressed syllable. Further, the type of markedness change but not its quantity, as in adult's outputs the stressed syllable is unmarked CV and the syllable with the cluster is marked. The opposite happens in children's outputs where the stressed syllable becomes marked, while the syllable with the cluster becomes unmarked. The second strategy is shown in examples (29-30).

Adult's Form	Child's Form	Child: Age
29) [ksi.ˈno]	→ [sçi.ˈno] (sour)	#052G-A: 2;11.9
30) [ˈfu.ksi.o]	→ [ˈfu.sci.o] (magenta)	#052G-A: 3;0

Clusters with [stop + fricative] consonants have not yet been acquired by this child (120/187 tokens preserved (64.2%). So, the consonant [s] moves before the first member of the cluster and is licensed as appendix. This way it does not constitute part of the onset which is not considered complex anymore. In the following example (31) two strategies are applied in order for all the consonants of the cluster to be uttered.

Adult's Form	Child's Form	Child: Age
31) [struŋ.ˈfa.ca]	→ [stu.ˈfra.ca] (smurfs)	#078G-A: 4;10.10

In (31), the consonant [s] is licensed as appendix, while the consonant [r] moves to the stressed syllable creating a well-formed cluster. These two changes alter the type of markedness between the first and second syllable, as the former is less marked and the second more marked than the corresponding of the adult's output. Below the final strategy is represented (examples 32-33).

Adult's Form	Child's Form	Child: Age
32) [kra.ˈsi]	→ [kar.ˈsi] (wine)	#056G-A: 3;10.4
33) [ˈci.knos]	→ [ˈcin.kos] (swan)	#080G-A: 4;11.22

[3] The substitution of [r] to [l] is beyond the scope of the paper and is not discussed. However, it reveals that metathesis can emerge together with other processes, as has been suggested in other surveys (Qasem, 2023). Generally, other processes that appear and do not affect the application of metathesis are not discussed.

In (32), the second member of the cluster moves to a position which can be licensed and, more specifically, in the coda of the initial syllable. In Greek, the consonants [n], [l] and [r] are allowed in initial or medial syllable (see Kappa, 1995, among others). However, tokens as (32) constitute exemptions, as this child have acquired clusters with [stop + liquid] consonants (44/46 tokens preserved (95.7%). In (33) respectively, the consonant [n] moves to coda position of the initial syllable so that to not be deleted, as clusters with [stop + nasal] have not been acquired (2/3 tokens preserved (66.7%). In (32) the quantity of markedness does not change, as CCV and CVC syllables are equally marked, while in (33) the first syllable turns into more marked and the second into less marked. In both examples though the Syllable Contact Law is still satisfied after the accomplishment of metathesis, but the sonority distance between the two syllables is not the highest possible, since in the adult's outputs the first syllable ends with a vowel. The next token is more complex as two strategies need to take place for the avoidance of cluster in unstressed syllable (example 34).

Adult's Form	Child's Form	Child: Age
34) [sfra.ˈʝi.ðes]	→ [sfar.ˈʝi.ðes] (stamps)	#094B-A: 6;1.26

First, this is the only token containing a cluster with three members in this child's speech. In order for its consonants to be maintained, the consonant [s] is licensed as appendix and the consonant [r] is metathesized in coda position of the initial syllable. Additionally, the markedness is altered as the consonant [s] has been removed from the onset's node resulting in a simpler structure.

The third environment of metathesis is related to consonants traced in codas. Indicative tokens are provided next (35-36).

Adult's Form	Child's Form	Child: Age
35) [ˈpir.ɣo]	→ [ˈpri.ɣo] (tower)	#056G-A: 3;8.15
36) [ˈtin.cer.bel]	→ [ˈtri.ce.bel] (Tinker Bell)	#078G-A: 4;9.26

In (35), the consonant [r] moves before the vowel [i] creating a well-formed cluster in a strong position, such as the stressed syllable (see Smith, 2002, among others). It additionally satisfies at the maximum degree the Syllable Contact Law and does not alter the quantity of markedness. Metathesis occurs due to the lowest degree of [r] acquisition in codas (19/24 tokens preserved (79.2%). The same features and reasons of metathesis apply also to (36). However, this child has acquired the consonant [r] in coda position in initial or medial syllable (57/59 tokens preserved (96.6%) in comparison to consonant [n] (2/3 tokens preserved (66.7%). Other cases with consonants in coda position are illustrated below (37-38).

Adult's Form	Child's Form	Child: Age
37) [ˈce.ik]	→ [ˈce.ci] (cake)	#051G-A: 2;8.3
38) [ˈel.sa]	→ [ˈle.sa] (Elsa)	#053G-A: 3;0.13

Both children here cannot handle these specific consonants in final or initial coda position (#051G-A: 2/3 tokens preserved (66.7%), #053G-A: 0/3 tokens preserved (0%). So, they move them in onset position forming a CV syllable, which is the least marked. Example (37) is unusual for the child, as it constitutes a loanword which bears a consonant in final position that is not permitted in Greek. Only the consonants [s] and [n] are allowed in final coda in Greek (see Malikouti-Drachman, 2001, among others). The last example includes a loanword with complex coda (39).

Adult's Form	Child's Form	Child: Age
39) [ˈpazl]	→ [ˈplas] (puzzle)	#059B-A: 4;8.24

Complex codas are also illicit in Greek making this structure unusual for the child. As a result, it cannot produce it most of the times (2/9 tokens preserved (22.2%). In (39), the reordering of [l] in the onset of the syllable creates a well-formed cluster. The child also substitutes the consonant [z] with [s] as the former is illicit in this position in Greek. Thus, both members of the cluster in coda position are maintained. One final observation ascertained from all the instances with metathesis (21-39) is that basic condition for its emergence is the final outputs of the children to form structures allowed in Greek.

5. Analysis

In *Optimality Theory* (Prince & Smolensky, 1993) the phonological component of the *Universal Grammar* consists of a generator, a set of constraints that are universal and a function that evaluates them. The input is fed into generator which generates candidate outputs. Constraints are universal and their ranking is language-specific. All candidate outputs of this language-specific ranking are evaluated and the optimal one which will best satisfy the requirements of constraints is chosen. In language acquisition, in the initial stage of children markedness constraints dominate faithfulness, in the intermediate stage some markedness dominate faithfulness ones, while in the final stage all faithfulness constraints dominate markedness ones, as in the grammar of adult's (e.g., Demuth, 1995; Gnanadesikan, 2004). For the children's different patterns in metathesis, we rely on the *Multiple Parallel Grammars* model (Revithiadou & Tzakosta, 2004), according to which *parallel* grammars next to the *core* are employed by the children, that is, different ranking of constraints which help them acquire their target grammar.

The constraints adopted for the analysis of the children's tokens in the first environment are the following: markedness constraints: *COMPLEX(unstressed syllable): prohibits consonant clusters in unstressed syllable (Demuth, 1995: 19). NoSequence(F1…F2): disallows sequences with specific distinctive features (Bernhardt & Stemberger, 1998; Gerlach, 2010: 6). Faithfulness constraints: MAXIMALITY-IO: requires input segments to have output correspondents. LINEARITY-IO: demands the order of segments to remain intact. (McCarthy & Prince, 1995: 264, 371). The ranking which leads to the optimal outputs of the children is NoSequence(F1…F2) > *COMPLEX(unstressedσ) > MAX-IO > LIN-IO, as illustrated in table (1).

Table 1. Metathesis between two consonants

[ˈka.ti][4]	NoSeq (DOR…COR)	*COMPLEX(unstressedσ)	MAX-IO	LIN-IO
☞ [ˈta.ci]				**
[ˈa.ti]			*!	
[ˈka.ti]	*!			
[a.ne.mi.ˈsti.ɾas]	NoSeq (COR…LAB)	*COMPLEX(unstressedσ)	MAX-IO	LIN-IO
☞ [a.me.ni.ˈsti.ɾas]				**
[a.e.mi.ˈsti.ɾas]			*!	
[a.ne.mi.ˈsti.ɾas]	*!			
[o.ˈbre.la]	NoSeq (RHO…LAT)	*COMPLEX(unstressedσ)	MAX-IO	LIN-IO
☞ [o.ˈble.ra]				**
[o.ˈbe.la]			*!	
[o.ˈle.bra]		*!		***
[o.ˈbre.la]	*!			

[4] We take as input the adult's output, which is the stimuli the children hear from their parents.

According to table (1), the faithful outputs [ˈka.ti], [a.ne.mi.ˈsti.ɾas], [o.ˈbre.la] are rejected due to specific sequences they keep that cannot handle the children for the reasons mentioned in previous section. The outputs [ˈa.ti], [a.e.mi.ˈsti.ɾas], [o.ˈbe.la] satisfy the highest ranked constraint with the deletion of a segment, something that is penalized by the MAX-IO constraint resulting to their rejection. The output [o.ˈle.bra] respects the sequence of consonants but with the movement of the cluster in unstressed syllable. Therefore, it is not selected. As optimal outputs the [ˈta.ci], [a.me.ni.ˈsti.ɾas], [o.ˈble.ra] arise, which bear only violations to the lowest ranked constraint due to the reordering of segments.

For the analysis of the second environment three more constraints are added, as represented below: markedness constraints: *CODA: syllables are disallowed to have codas (Prince & Smolensky, 1993: 34). CODA CONDITION: prohibits the licensing of particular features in coda position (Beckman, 2004: 106). In our case all illicit consonants in Greek in this specific position. *APPENDIX: syllables must not have appendix (McCarthy, 2008: 300). From the previous constraints, we assume that the NoSequence is the lowest ranked and remains inactive for these data. The ranking which prohibits clusters in unstressed syllables is *COMPLEX(unstressedσ) > CODACOND > MAX-IO > *CODA > *APPENDIX > LIN-IO (table 2).

Table 2. Avoidance of clusters in unstressed syllable

[ˈci.tri.no]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [ˈcli.ti.no][5]						*
[ˈcir.ti.no]				*!		*
[ˈci.ti.no]			*!			
[ˈci.ti.nor]		*!		*		*
[ˈci.tri.no]	*!					
[ˈfu.ksi.o]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [ˈfu.sci.o]					*	*
[ˈfu.ci.os]				*!		*
[ˈfu.ci.o]			*!			
[ˈfus.ci.o]		*!		*		*
[ˈfu.ksi.o]	*!					
[kɾa.ˈsi]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [kar.ˈsi]				*		*
[ka.ˈsi]			*!			
[ka.ˈsir]		*!		*		*
[kɾa.ˈsi]	*!					
[struŋ.ˈfa.ca]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [stu.ˈfra.ca]			*		*	*
[stu.ˈfar.ca]			*	*!	*	*
[stu.ˈfa.ca]			*!*		*	
[stuŋ.ˈfa.car]		*!*		**	*	*
[struŋ.ˈfa.ca]	*!	*		*		
[sfɾa.ˈʝi.ðes]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞[sfar.ˈʝi.ðes]				**	*	*
[sfa.ˈʝi.ðes]			*!	*	*	
[far.ˈʝis.ðes]		*!		***		*
[sfɾa.ˈʝi.ðes]	*!			*		

[5] This optimal output violates also the constraint IDENTITY-IO due to substitution of [r] to [l], as this constraint requires faithfulness to distinctive features between input and output (McCarthy & Prince, 1995: 264). However, it is omitted as it does not affect the way metathesis applies.

Based on table (2), all faithful outputs [ˈci.tri.no], [ˈfu.ksi.o], [kɾa.ˈsi], [struŋ.ˈfa.ca], [sfɾa.ˈji.ðes] are not selected cause they contain a cluster in unstressed syllable violating this way the highest ranked constraint. The constraint CODACOND wipes out the tokens [ˈci.ti.nor], [ˈfus.ci.o], [ka.ˈsir], [stuŋ.ˈfa.car], [far.ˈjis.ðes], in which metathesis leads to unattested structures in Greek. The constraint MAX-IO ensures that the cluster is retained without the deletion of any member that constitutes it ([ˈci.ti.no], [ˈfu.ci.o], [ka.ˈsi], [stu.ˈfa.ca], [sfa.ˈji.ðes]). With the constraint *CODA is ensured that in some cases the movement of a consonant located in cluster in coda position will be the least preferable strategy if there are other options available that preserve all segments. Therefore, tokens such as [ˈcir.ti.no], [ˈfu.ci.os], [stu.ˈfar.ca] are rejected. So, as optimal the outputs [ˈcli.ti.no], [ˈfu.sci.o], [kar.ˈsi], [stu.ˈfra.ca], [sfar.ˈji.ðes] arise since they violate only the lower ranked constraints due to metathesis and in some cases due to licensing of [s] as appendix or metathesized segment located in coda position.

The same constraints and ranking are sufficient to account also for the third environment of metathesis (Table 3).

Table 3. Avoidance of cluster / consonant in coda position

[ˈel.sa]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [ˈle.sa]						*
[ˈel.sa]				*!		
[ˈe.sa]			*!			
[ˈe.sal]		*!		*		*
[ˈpir.ɣo]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [ˈpri.ɣo]						*
[ˈpir.ɣo]				*!		
[ˈpi.ɣo]			*!			
[ˈpi.ɣor]		*!		*		*
[ˈpi.ɣro]	*!					*
[ˈpazl]	*COMPLEX(unstressedσ)	CODACOND	MAX-IO	*CODA	*APPENDIX	LIN-IO
☞ [ˈplas]				*		*
[ˈpas]			*!	*		
[ˈpazl]		*!*		**		

In particular, the highest constraint in the hierarchy secures that the movement of coda will not create a cluster in a weak position ([ˈpi.ɣro]). The second constraint ensures that illicit codas are not formed ([ˈe.sal], [ˈpi.ɣor], [ˈpazl]), while the third constraint excludes all the tokens that delete the coda or part of it in case it is complex ([ˈe.sa], [ˈpi.ɣo], [ˈpas]). All faithful tokens are also excluded since they keep codas unchanged ([ˈel.sa], [ˈpir.ɣo], [ˈpazl]). The remaining tokens ([ˈle.sa], [ˈpri.ɣo]) emerge as optimal satisfying all the aforementioned features and if in some cases they keep a consonant in coda position ([ˈplas]) they do so with the preservation of one member of the cluster and the substitution of it with a consonant that fit into that position in Greek.

6. Conclusion

This research examined metathesis in thirteen monolingual Greek-speaking children in order to investigate if it facilitates language acquisition and if generalizations can be made, as it is a peripheral process in child speech. The results show that it is employed for three different reasons. The first has to do with specific sequences that children struggle to utter, the second with complex structures such as clusters in weak positions, namely, unstressed syllable and the third

with consonants located in coda position or with complex codas. The advantage of metathesis in these cases is the preservation of all the segments by reordering one consonant or two consonants each other in positions in which children feel more comfortable producing them. Another advantage is that in the majority of cases the metathesized segments retain all their distinctive features. For the analysis of children's tokens, the Optimality Theory is used (Prince & Smolensky, 1993) and for the two patterns ascertained in their data the Multiple Parallel Grammars model (Revithiadou & Tzakosta, 2004). The first pattern is shown in the ranking NoSequence(F1…F2) > *COMPLEX(unstressedσ) > MAX-IO > LIN-IO, which concerns the first environment. The second bears the ranking *COMPLEX(unstressedσ) > CODACOND > MAX-IO > *CODA > *APPENDIX > LIN-IO and is related with the second and the third environment of metathesis.

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References

Alqahtani, S. M. (2018). Phonological derivations of synchronic metathesis in Modern Persian. *Advances in Language and Literary Studies 9*(4), 92-97. https://doi.org/10.7575/aiac.alls.v.9n.4p.92

Beckman, N. J. (1998). *Positional faithfulness*. (Doctoral dissertation). Amherst: University of Massachusetts. https://scholarworks.umass.edu/dissertations/AAI9823717.

Beckman, N. J. (2004). On the status of CODACOND in phonology. *International Journal of English Studies 4*(2), 105-134. https://revistas.um.es/ijes/article/view/48001.

Bernhardt, H. B., & Stemberger, P. J. (1998). *Handbook of phonological development: From the perspective of constraint-based nonlinear phonology*. San Diego: Academic Press.

Demuth, K. (1995). Markedness and the development of prosodic structure. In J. N. Beckman (Ed.), *Proceedings of NELS 25*(2) (pp. 13-25). Amherst, MA: GLSA, University of Massachusetts. https://scholarworks.umass.edu/nels/vol25/iss2/3.

Edwards, L. M. (1996). Word position effects in the production of fricatives. In B. Bernhardt, J. Gilbert & D. Ingram (Eds.), *Proceedings of the UBC International Conference on Phonological Acquisition* (pp. 149-158). Boston, MA: Cascadilla Press.

Fukazawa, H., & Miglio, V. (2008). What metathesis reveals about L1 and L2 acquisition. In R. Slabakova, J. Rothman, P. Kempchinsky & E. Gavruseva (Eds.), *Proceedings of the 9th Generative Approaches to Second Language Acquisition Conference (GASLA 2007)* (pp. 30-36). Somerville, MA: Cascadilla Proceedings Project.

Gatsou, M. (2022). *The acquisition of marked syllable structures CVC and CCV in Greek L1: Children with specific language impairment*. (Master's thesis). Rethymno: University of Crete.

Gerlach, R. S. (2010). *The acquisition of consonant feature sequences: Harmony, metathesis and deletion patterns in phonological development* (Doctoral dissertation). The University of Minnesota.

Gnanadesikan, E. A. (2004). Markedness and faithfulness constraints in child phonology. In R. Kager, J. Pater & W. Zonneveld (Eds.), *Constraints in Phonological Acquisition* (pp. 73-108). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511486418.004

Gutiérrez, A. (2010). Metathesis in Nivaclé. In B. Rogers & A. Szakay (Eds.), *Proceedings of the 15th Workshop on Structure and Constituency in Languages of the Americas (WSCLA), UBC Working Papers in Linguistics 29* (pp. 115-125). Ottawa: University of British Columbia.

Hock, H. H. (1985). Regular metathesis. *Linguistics 23*(4), 529-546. https://doi.org/10.1515/ling.1985.23.4.529

Hume, V. E. (2004). The indeterminacy/attestation model of metathesis. *Language 80*(2), 203-237. https://doi.org/10.1353/lan.2004.0083

Kappa, I. (1995). *Syllable phonology in German and Modern Greek* (in German, unpublished doctoral dissertation). University of Salzburg.

Kappa, I. (2009). On the acquisition of liquids in Modern Greek: A developmental account. In M. Stavrou-Sifaki, D. Papadopoulou & M. Theodoropoulou (Eds.), *Studies in Greek Linguistics*, *Proceedings of the 29th Annual Meeting of the Department of Linguistics* (pp. 478-485). Thessaloniki: Aristotle University of Thessaloniki.

Kiparsky, P. (1979). Metrical structure assignment is cyclic. *Linguistic Inquiry 10*(3), 421-441. https://www.jstor.org/stable/4178120.

Leonard, B. L., & Mcgregor, K. K. (1991). Unusual phonological patterns and their underlying representations: A case study. *Journal of Child Language 18*(2), 261-271. https://doi.org/10.1017/S0305000900011053

Łukaszewicz, B. (2007). Reduction in syllable onsets in the acquisition of Polish: Deletion, coalescence, metathesis and gemination. *Journal of Child Language*, *34*(1), 53-82. https://doi.org/10.1017/S0305000906007707

Malikouti-Drachman, A. (2001). Greek phonology: A contemporary perspective. *Journal of Greek Linguistics 2*(1), 187-243. https://doi.org/10.1075/jgl.2.08mal

McCarthy, J. J. (2008). The gradual path to cluster simplification. *Phonology 25*(2), 271-319. https://doi.org/10.1017/S0952675708001486

McCarthy, J. J., & Prince, A. (1995). Faithfulness and reduplicative identity. In J. N. Beckman, S. Urbanczyk & L. W. Dickey (Eds.), *Papers in Optimality Theory, University of Massachusetts Occasional Papers 18* (pp. 249-384). Amherst, MA: GLSA.

Murray, W. R., & Vennemann, T. (1983). Sound change and syllable structure in Germanic phonology. *Language*, *59*(3), 514-528. https://doi.org/10.2307/413901

Papadopoulou, K. (2000). *Phonological acquisition of Modern Greek* (Unpublished Bachelor's Honours thesis). University of Newcastle.

Prince, A., & Smolensky, P. (1993). *Optimality Theory: Constraint interaction in generative grammar*. (Master's thesis). Rutgers University, New Brunswick and University of Colorado Boulder.

Qasem, F. (2023). Phonological metathesis phenomenon in the early speech of Arabic-speaking children. *Saudi Journal of Language Studies*, *3*(4), 220-231. https://doi.org/10.1108/SJLS-07-2023-0030

Revithiadou, A., & Tzakosta, M. (2004). Markedness hierarchies vs. positional faithfulness and the role of multiple grammars in the acquisition of Greek. In J. van Kampen & S. Baauw (Eds.), *Proceedings of GALA 2003: Generative Approaches to Language Acquisition 2* (pp. 377-388). Utrecht: LOT.

Selkirk, O. E. (1984). *Phonology and syntax: The relation between sound and structure*. Cambridge, MA: The MIT Press.

Setatos, M. (1974). *Phonology of Modern Greek Koine* (in Greek). Athens: Papazisis.

Smith, L. J. (2002). *Phonological augmentation in prominent positions*. (Doctoral dissertation). Amherst: University of Massachusetts. https://scholarworks.umass.edu/dissertations/AAI3056278.

Tzakosta, M., & Kappa, I. (2008). Syllable types in child Greek: A developmental account. In A. Gavarró & M. J. Freitas (Eds.), *Language Acquisition and Development: Proceedings of Gala 2007* (pp. 467-471). Newcastle: Cambridge Scholars Publishing.

Appendix

#051G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈce.ik	ˈce.ci	2;8.3	cake

#052G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈci.tri.no	ˈkli.ti.no	2;7.4	yellow (neutral)
2	ˈci.tri.no	ˈkli.ti.no	2;7.4	yellow (neutral)
3	ˈci.tri.nos	ˈkli.ti.nos	2;7.4	yellow (masculine)
4	ˈci.tri.no	ˈkli.ti.no	2;7.4	yellow (neutral)
5	ˈpir.ɣo	ˈpi.ɣlo	2;8.8	tower
6	ksi.ˈno	sçi.ˈno	2;11.9	sour (neutral)
7	ˈfu.ksi.o	ˈfu.sci.o	3;0	magenta

#053G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈel.sa	ˈle.sa	3;0.13	Elsa

#055G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈva.tra.xos	ˈvla.ta.xos	3;3.2	frog

#056G-A

	Adult's Form	Child's Form	Age	Translation
1	va.tra.ˈxa.ci	var.va.ˈxa.ci	3;8.15	frog (diminutive)
2	ˈpir.ɣo	ˈpri.ɣo	3;8.15	tower
3	kra.ˈsi	kar.ˈsi	3;10.4	wine

#059B-A

	Adult's Form	Child's Form	Age	Translation
1	struŋ.ˈfi.ta	stru.ˈti.fa	4;7.24	Smurfette
2	pu.ˈka.mi.so	ku.ˈpa.mi.so	4;8.8	shirt
3	ˈpazl	ˈplas	4;8.24	puzzle

#060B-A

	Adult's Form	Child's Form	Age	Translation
1	ˈfra.u.la	ˈfla.u.ɾa	4;7.15	strawberry
2	o.ˈbre.la	o.ˈble.ɾa	4;7.22	umbrella

#075G-A

	Adult's Form	Child's Form	Age	Translation
1	pi.ʤa.mo.ˈi.ɾo.es	pi.sa.po.ˈɾi.a.su	4;10.3	PJ Masks

#076B-A

	Adult's Form	Child's Form	Age	Translation
1	ˈka.ti	ˈta.ci	4;9.10	something

#077G-A

	Adult's Form	Child's Form	Age	Translation
1	xri.ˈso.psa.ɾa	xri.ˈso.ska.ɾa	4;11.24	goldfishes
2	ˈci.ta	ˈti.ka	5;1.13	(you) look

#078G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈtin.cer.bel	ˈtri.ce.bel	4;9.26	Tinker Bell
2	struɱ.ˈfa.ca	stu.ˈfra.ca	4;10.10	smurfs

#080G-A

	Adult's Form	Child's Form	Age	Translation
1	ˈci.knos	ˈcin.kos	4;11.22	swan

#094B-A

	Adult's Form	Child's Form	Age	Translation
1	ˈnu.me.ɾo	ˈɾu.me.no	5;11.22	number
2	ˈnu.me.ɾo	ˈɾu.me.no	5;11.22	number
3	ˈnu.me.ɾo	ˈɾu.me.no	5;11.22	number
4	ˈnu.me.ɾo	ˈɾu.me.no	5;11.22	number
5	ˈnu.me.ɾo	ˈɾu.me.no	5;11.22	number
6	a.ne.mi.ˈsti.ɾas	a.me.ni.ˈsti.ɾas	6;1.26	fan
7	sfra.ˈji.ðes	sfar.ˈji.ðes	6;1.26	stamp


C O A S