Acquiring variable stress in Greek
An Optimality-Theoretic approach*

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The present study treats the acquisition of stress in Greek. The goal is the investigation of the mechanisms through which children manage ultimately to acquire the stress system of their native language. The Greek data were drawn from the natural speech of five children ages 1;10 to 3;0 years. The findings of the research emphasize interesting similarities to and differences from the data of children who acquire other languages. More specifically, the children who acquire Greek show a systematic faithfulness to the stressed syllable, which, for the most part, they preserve in their realizations, however not in trochaic feet, even though they are considered the most natural structures in child speech crosslinguistically. As a result, iambic and trochaic structures are manifested in parallel fashion in the speech of different children (inter-child variation) or even in the speech of a single child (intra-child variation). The analysis of the data, done within the framework of the model of Optimality Theory (Prince & Smolensky 1993), demonstrates that children use parallel grammars throughout the different stages of development.

Keywords: phonological acquisition, stress, developmental stage, trochee, iamb, markedness, faithfulness, variation, unranked constraints, co-phonologies

1. Introduction

Crosslinguistic child language research has demonstrated that truncation, whether segmental or syllabic, is the main strategy that children adopt when faced with the task of acquiring longer words in their language. Syllabic truncations seem to be mostly trochaic in shape, and the disyllabic trochee has proven to be the unmarked, that is, the most natural and most frequently attested pattern in child speech. The predominance of trochees over iambs is
further demonstrated by cases in which iambic forms, namely forms stressed on the final syllable, are reversed into trochees (cf. Fikkert 1994, for Dutch child language).

During their phonological maturation in the acquisition process, children go through developmental stages. The fundamental characteristic of each stage is the uniformity of children’s utterances. For example, in the so-called *subminimal word stage*, children (cf. Demuth & Fee 1995) extensively truncate polysyllabic forms to monosyllabic ones, while in the *minimal word stage* truncations primarily take the shape of the disyllabic trochaic word minimum, which is highly unmarked not only in child, but also in adult, speech (cf. McCarthy & Prince 1994a).

In this article I investigate the stress patterns occurring in Greek L1 and the developmental paths Greek children follow on their way to acquiring the stress system of their native language. Truncation is reported to be the most dominant strategy used during language development in Greek as well. However, Greek children exhibit extensive intra- and inter-child variation with respect to the patterns found in their productions, which I attribute to the non-predictable non-fixed character of Greek stress. Consequently, trochees do not seem to be as predominant in Greek child speech as they are in English or Dutch child language. As a result, metrically ambiguous forms, such as trisyllabic $W_1SW_2$, target words, surface truncated to either iambics or trochees or both iambics and trochees across children or within one and the same child.

Put differently, children tend to follow more than one developmental path during the acquisition of Greek stress. For example, they build their feet from either the left or the right edge. Additionally, feet can be left- or right-headed. Within those limits, I further discuss the validity of the trochaic bias hypothesis, which has been assumed to be more powerful. Moreover, I test several ideas that apply to child speech regarding the shape that truncated forms take. For instance, Echols & Newport (1992) claim that stressed and rightmost syllables tend to surface in children’s produced forms, whereas Gerken (1994, 1996) argues that it is the stressed syllable and the syllable adjacent to it that surface. The Greek data provide evidence in support of both models.

Moreover, I adopt Optimality Theory (Prince & Smolensky 1993, hereafter OT) for the analysis of the data under discussion. I show that this framework provides an explanatory mechanism that sufficiently accounts for the variable patterns that emerge extensively in Greek child speech. The virtue of OT is that universal constraints predict as well as explain the emergence of certain
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For the purposes of this study I draw on longitudinal data from five children, Bebis (B), Felina (F), Melitini (Me), Dionisis (D), and Marilia (Ma), who vary in age between 1;10 and 3;5.24. The periods during which the children were recorded overlap only partly. In other words, not all of the children were recorded for the same period of time or at the same age. This is not considered to be problematic for the analysis, because some children give evidence for the initial stages of language development and some for the later stages, while others give evidence for the transition from one stage to the other. The data are drawn from a database of eleven children acquiring Greek as their native language covering the same age range (1;10–3;6). The database was set up at the University of Leiden Center for Linguistics.

The remainder of the article is organized as follows: in §2 I provide a brief overview of the literature on the acquisition of stress and the trochaic bias hypothesis, and then present the Greek child data in §3. Section 4 provides the analysis within the framework of OT as well as a general discussion, and I close the article with the conclusions in §5.

2. Brief overview of the literature on the acquisition of stress

Previous studies that focused on both perception experiments (cf. Echols & Newport 1992) and longitudinal production data (cf. Hochberg 1988 and Garrett 1994 for Dutch) basically tried to answer the question of whether stress is acquired lexically (cf. Klein 1984) or in terms of rules (cf. Hochberg 1988). Researchers further investigated the developmental patterns found in child language. What was observed is that children go through certain developmental stages during which they exhibit relative uniformity in the forms they produce. As a result, the fundamental characteristic of earlier stages of phonological development is the high rate of truncation of target words to monosyllabic forms, irrespective of the number of syllables the targets consist of. In more advanced stages, children's forms expand with respect to the number of the produced forms; in other words, children's forms become more faithful to the input form, but the latter are still truncated in order to conform to the disyllabic word maximum. It is only in later stages that target forms are faithfully produced.

Trochees seem to be so powerful that they force iambic forms, i.e. forms stressed on the final syllable, to surface as trochees, that is, stressed on the initial syllable. As a result, disyllabic forms stressed on the final syllable are reported to always undergo stress shift in child Dutch in stages where iambs are not accurately realized. Furthermore, it is argued that this trochaic bias hypothesis is supported by two additional facts: first, disyllabic trochaic forms are faithfully realized, while the corresponding iambic forms are truncated to monosyllables; and, second, iambic forms, if not truncated, occur with level stress, that is, stress on both syllables.

Hayes (1995) argues that due to the fact that the majority of the languages of the world are trochaic, a trochaic bias is universal; in other words, it is imposed by Universal Grammar (hereafter UG). However, the trochaic bias hypothesis raises important questions. One is how it would account for iambic stress patterns found, for example, in French, both in adult and child language, as well as how stress is realized in the speech of children acquiring lexical accent systems, such as Greek or Russian. Another important issue is how the same hypothesis would account for truncated forms stressed on the final syllable. If there is a bias required or imposed by UG, then it should also be found in the child speech of languages that are iambic in nature or that get word/phrase-final stress.

In response to this debate, Gerken (1994) argues that stress patterns are parametrized. Additionally, Paradis et al. (1997) and Rose (2000) claim that there is a trochaic bias at the earliest stage, but it disappears quickly in languages where the child is exposed to evidence in favor of iambic footing. Nevertheless, the above researchers do not provide data from such a stage, something that weakens their claim. In the next sections I present the Greek data aiming
at providing evidence about the developmental paths that children acquiring lexical accent systems follow as well as the powerfulness of the trochaic bias.

3. Acquisition of stress in Greek

Before I go into a detailed presentation of the data, it is essential to report briefly on the characteristics of the accentual system of Greek.6

3.1 The accentual system of Greek

Greek is considered to be a trochaic language, with extrametricality at the right edge of the word. Stress is assigned due to a rule (or a constraint, in terms of Optimality Theory) that requires stress to fall at the right edge of the word (End Rule Right).7 This does not mean that stress has to fall on the rightmost syllable; rather, it has to be assigned to the rightmost foot. Consider the word *anthropos* “man”, which is metrically analysed as consisting of a trochaic foot and an extrametrical syllable at the right edge of the word, [(an.θro).pos]. As for Greek child language, Malikouti-Drachman & Drachman (1976), Kappa (2000), and Tzakosta (1999, 2003a) have argued for a preference for the trochaic stress pattern. Greek is a language with rich morphology, and stress is determined in the lexicon. More specifically, morphemes are stressed in the lexicon but stress of the output form is realized on the morphological head of the word (cf. Revithiadou 1999). For example, in derived forms, the derivational suffix is considered to be the head of the word and receives stress (for example, /an.θro.pos/ → [an.θro.'p#a.kos], where ‘#’ indicates a morphological boundary).

In this article the term lexical stress refers to the variable non-fixed position of stress in Greek and its metrical ambiguity; however, I do not refer to its morphological nature, given that morphology does not seem to have an effect on stress assignment in Greek child language. To be more specific, I follow Tzakosta (in prep.) in claiming that production data do not provide enough evidence as to whether morphology is acquired or, if acquired, plays an influential role in the shape of child productions. As is shown from the data presentation and the OT analysis, Greek child data can be dealt with using only phonological constraints. This implies that it is basically phonological principles that govern child language.8
As a consequence of the above, I do not make a categorical distinction between nominal and verbal stress. Following the acquisition literature, I assume that children perceive raw sequences of syllables and stress falling on one of these syllables (cf. Jusczyk 1997 and more references therein). Consequently, children are exposed to both trochaic and iambic forms, which they, in turn, try to produce. There are numerous word segmentation tasks that have revealed the importance of prosodic categories in word segmentation (cf. Cutler 1994, 1996, Cutler & Norris 1988). To my knowledge, there are no studies that highlight the different role that nominal and verbal stress patterns may play in child production. Also, given my claims (Tzakosta, in prep.) that morphology does not play a prominent role in stress assignment, there is no reason to distinguish between nominal and verbal stress.

In what follows, I challenge the idea that trochees are as unmarked as they have been claimed to be in child language. Trochees are prevalent in languages that are clearly trochaic, such as English and Dutch. As already mentioned, there is no evidence whatsoever from lexical stress systems about the validity of trochaic templates. I believe that the Greek child data significantly contribute to this debate.

3.2 The child data

In the following section, I provide detailed data that clarify my claims about how Greek stress is acquired and the order in which this is done. In this article I further adopt the stage-like model of acquisition. Therefore, after presenting the data I propose the stages Greek children go through during the acquisition of the stress system of their language.

In the subminimal word stage, the main characteristic of which is the emergence of monosyllabic forms, iambic and trochaic target words are truncated to monosyllables. What has been argued for English and Dutch child language (cf. Pater 1997 and Fikkert 1994, respectively) is that only iambic words are truncated, whereas trochaic disyllabic words are accurately produced. This is considered to be one of the arguments for the trochaic bias hypothesis. Interestingly, in Greek child language both trochaic and iambic words are truncated to a monosyllabic form.

Disyllabic and polysyllabic forms undergo extensive truncation. Evidence is provided in (1). Marilia, who is the eldest child under investigation, truncates polysyllabic forms to monosyllabic ones, even at the age of 2;8.7, during which children are considered already to target and accurately produce at least
trisyllabic words. Roughly speaking, children tend to reduce their target forms between the ages of 1;7 and 3;0.

In examples (1b–d) and (1f–g) the intended words are truncated to the stressed syllable.\(^{11}\) Such examples illustrate that stressed syllables are more prominent in Greek child speech than unstressed ones.

\[(1)\]
\[a. /\text{siko}/ \rightarrow [\text{ko}] \quad “\text{fig}” \quad \text{(nom.neut.sg.)} \quad \text{(B.1;10)}\]
\[b. /\text{a.fia}/ \rightarrow [\text{ta}] \quad “\text{those}” \quad \text{(acc.neut.pl.)} \quad \text{(B.1;11.29)}\]
\[c. /\text{pe.zi}/ \rightarrow [\text{pe}] \quad “\text{to play}” \quad \text{(3sg.pr.)} \quad \text{(F.1;11.7)}\]
\[d. /\text{ka.ro.tsi}/ \rightarrow [\text{jo}] \quad “\text{carriage}” \quad \text{(nom.neut.sg.)} \quad \text{(F.1;11.21)}\]
\[e. /\text{ti.le.fo.no}/ \rightarrow [\text{to}] \quad “\text{telephone}” \quad \text{(nom.neut.sg.)} \quad \text{(Me.1;7.5)}\]
\[f. /\text{me.sa}/ \rightarrow [\text{me\theta}] \quad “\text{inside}” \quad \text{(adv.)} \quad \text{(D.2;2)}\]
\[g. /\text{a.po}/ \rightarrow [\text{po}] \quad “\text{from}” \quad \text{(prep.)} \quad \text{(Ma.2;8.7)}\]

It is worth mentioning that there are cases such as those in (1a) and (1e) where it is not the stressed syllable that is retained. In (1a) the rightmost unstressed syllable is maintained, while an ‘invented’ syllable is preserved in (1e).\(^{13}\) The preserved unstressed syllable of (1a) consists of more unmarked segments than those of the stressed syllable. To be more specific, the obstruent /k/ is less difficult to produce than the fricative /s/, because the former is \([-\text{cont}]\). Moreover, back vowels like /a/ and /o/ rather than mid and high vowels are preferred.\(^{14}\) Accordingly, children tend to prefer the ‘invented’ syllable of (1e) which consists of consonant and vowel segments that are less marked than other consonants and vowels in the word\(^{15}\) and that, additionally, occupy word edges.\(^{16}\)

Such examples are representative of the fact that both prosodic and segmental factors are responsible for the position of stress in Greek child speech. The segmental make-up of certain syllables facilitates or prohibits their production.\(^{17}\) However, the study of the interaction of segmental and prosodic effects in child speech goes beyond the scope of this study, which is restricted to the purely prosodic factors involved in the acquisition of stress in Greek L1. The interested reader is referred to work by Revithiadou & Tzakosta (in press) and Tzakosta (in prep., to appear) for more discussion on this issue.

Going back to the issue of the unmarked stress patterns, a trochaic bias has been argued for on the basis of the emergence of stress errors and level stress in disyllabic forms in child Dutch (Fikkert 1994), as shown in (2a). Words characterized as having level stress bear stress on all of their syllables, as illustrated in (2b). It appears that Dutch children are more likely to make stress errors, particularly with iambic forms which are produced as trochaic, and the percentages Fikkert provides seem to be statistically significant.
In Greek child speech, on the other hand, examples of stress reversal/er-
rors are not indicative of a trochaic bias. Both iambic and trochaic forms
are reversed to trochaic and iambic ones respectively, as exemplified in (3). More-
over, the percentages of stress errors/reversals are not statistically significant, as
discussed later. None of these patterns seems dominant, at least judging by the
cases of stress errors.

In disyllabic truncations of trisyllabic SW₁W₂ target forms in the Greek data,
two patterns are found. On the one hand, the stressed and the rightmost sylla-
bles are preserved, and on the other, the stressed and the adjacent syllables are
realized. These two patterns correspond to two dominant models that address
the issue of which syllables surface in children's truncations. The first was de-
developed by Echols & Newport (1992) who, based on phonetic/psycholinguistic
experiments, claimed that children preserve the stressed and the rightmost syl-
lables. The second was put forth by Gerken (1994, 1996), who claimed that it is
the stressed and its adjacent syllable that are preserved.

As seen above, the data from Greek support both models. Nevertheless,
even though Echols & Newport’s model seems to be crosslinguistically more
prevalent, the Greek data significantly favor Gerken’s model. In (4a–b) we see
cases of stressed and rightmost syllables being preserved, whereas in (5a–c)
we see examples in which it is the stressed and its adjacent syllable that are
maintained. In both cases trochaic patterns emerge, but this is expected given
that, first, the target forms are stressed on the initial syllable and, second, stress
errors do not occur systematically in Greek, especially with this word type.
Nevertheless, there are cases in which such forms surface as truncated and
stressed on the final syllable (as shown in 5d). In such examples segmental
factors influence stress placement.
In trisyllabic $W_1SW_2$ target forms, i.e. those that carry stress on the medial syllable, the picture is quite confusing. This word type is truncated to a disyllabic form with stress falling on either the initial (6a–e) or the final syllable (6f–h). In other words, both iambic $W_1S$ and trochaic $SW_2$ truncation patterns emerge. The variable ways that target words of this word type surface provide the strongest evidence against the trochaic bias hypothesis. If trochees were biased, they should appear when targeting any word type. However, this linguistic behavior is rather problematic for a model, such as the one supporting the trochaic bias hypothesis, that cannot account for this type of variation. I come back to this issue after presenting all of the data.

(6) a. /ka.'re.kla/ → [te.ca] “chair” (nom.fem.sg.) (F.1;11.21)
b. /xri.'stu.lis/ → [tu.lic] “Jesus Christ” (dim.) (Me.1;7.5)
c. /ba.'na.na/ → [ba.na] “banana” (nom.fem.sg.) (B.1;11.10)
d. /a.'xla.ði/ → [a.ði] “pear” (nom.neut.sg.) (B2.1;10)
e. /ku.'ku.la/ → [ku.la] “hat” (nom.fem.sg.) (Me.2;0.2)
f. /lu.'lu.ði/ → [lu.lu] “flower” (nom.neut.sg.) (D.2;9)
g. /mo.'li.vi/ → [mo.li] “pencil” (nom.neut.sg.) (Me.1;7.14)
h. /ma.'c.eri/ → [ma.'c.e] “knife” (nom.neut.sg.) (F.3;2.12)

To sum up, the important characteristic of $WS$, $SW$, $SW_1W_2$, and $W_1SW_2$ word types discussed up to now is that Greek child data do not exhibit the degree of uniformity that English and Dutch child data do with respect to: first, the shape of the forms produced given a specific input form; and, second, the powerfulness of the trochaic bias hypothesis. I argue that this is basically due to the lexical, unpredictable (i.e. non-fixed) character of stress in Greek. My proposal is that the emergence of trochaic words prior to iambic ones is not attributed to a bias towards trochees, but, rather, to the frequency of trochaic patterns in the input forms. It is only because children tend to generalize their productions that trisyllabic words stressed on the final syllable are produced truncated to disyllabic trochees (7a). The same child, D, produces iambic words as iambic truncations some time later (7b–c).

(7) a. /for.ti.'yo/ → [lo.ci] “lorry” (nom.neut.sg.) (D.2;2.6)
b. /va.si.'las/ → [va.'laθ] “king” (nom.masc.sg.) (D.2;3)
c. /a.le.'pu/ → [ne.'pu] “fox” (nom.fem.sg.) (D.2;4.24)

In words longer than trisyllabic, the picture is basically the same. Quadrisyllabic $W_1SW_2W_3$ target words with ambiguous metrical structure are truncated to disyllables with stress on either the prefinal, as shown in (8a), or the final syllable, as illustrated in (8b–d).

(8) a. /for.ti.'yo/ → [lo.ci] “lorry” (nom.neut.sg.) (D.2;2.6)
b. /va.si.'las/ → [va.'laθ] “king” (nom.masc.sg.) (D.2;3)
c. /a.le.'pu/ → [ne.'pu] “fox” (nom.fem.sg.) (D.2;4.24)
Quadrisyllabic $W_1W_2SW_3$ target words are produced as trisyllabic or disyllabic trochaic forms, as illustrated in (9), or disyllabic or trisyllabic iambic forms, as exemplified in (10). Again, this is expected, given the behavior that the children under investigation demonstrate with respect to trisyllabic and quadrisyllabic target forms and the lexical character of the Greek stress system. To be more specific, since children may perceive Greek stress as being non-fixed, they produce their intended words with variable patterns. However, what is most interesting is that this variation is evident not only across children but also within one and the same child. A comparative examination of (9) and (10) proves this fact. For example, Felina produces $W_1W_2SW_3$ target words both as trochaic $SW_3$ and iambic $W_2S$ forms, as shown in (9g) and (10a), respectively. Accordingly, Melitini produces the same type of words as $W_{(1,2)}SW_3$, in which one of the pre-stress syllables is realized, as well as $W_1W_2S$ forms.

Finally, in advanced stages, even if longer attempted words are truncated, the stressed syllable is faithfully preserved (see examples in 11).
3.3 Statistical evidence

The goal of this paper is not to give detailed or exhaustive statistical reports on the attested patterns, but rather to give an idea of the emerging patterns in order to detect how the theory fits the data under investigation. For exhaustive statistical evidence consult Tzakosta (in prep.). Nevertheless, I provide the mean percentages of the patterns that occur in the data I have discussed. More specifically, I provide the statistical significance of monosyllabic, disyllabic, and trisyllabic truncations, trochaic and/or iambic, with or without faithfully produced stress.

What is evident in Table 1 is that reversals of iambs into trochees and of trochees into iambs do not provide evidence for a preferred stress pattern, iambic or trochaic. Both types of stress errors emerge. Additionally, their low rate is not indicative of any bias, at least in the data sample under discussion.

Table 1. Disyllabic target forms

<table>
<thead>
<tr>
<th></th>
<th>WS as SW</th>
<th>SW as WS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2/614</td>
<td>1/614</td>
</tr>
<tr>
<td></td>
<td>0.3%</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

The important observation of Table 2 is that $W_1SW_2$ target words are truncated to disyllabic iambs or trochees. The percentages of their emergence are more or less the same. I assume that this is expected, given that words of this type are characterized by an ambiguous stress pattern. In other words, this word type can be footed as either iambic $(W_1S)W_3$ or trochaic $W_1(SW_2)$. Consequently, $W_1SW_2$ words can be perceived as being either trochaic or iambic. Correspondingly, the clear foot structure of $SW_1W_2$ forces them to be truncated to $SW_{(1,2)}$ words.24

Table 2. Trisyllabic target forms

<table>
<thead>
<tr>
<th></th>
<th>$SW_1W_2$ as $SW_{(1,2)}$</th>
<th>$SW_1W_2$ as WS</th>
<th>$W_1SW_2$ as $SW_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>67/614</td>
<td>1/614</td>
<td>179/614</td>
</tr>
<tr>
<td></td>
<td>10.9%</td>
<td>0.2%</td>
<td>30%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$W_1SW_2$ as $W_1S$</th>
<th>$W_1W_2S$ as SW</th>
<th>$W_1W_2S$ as $W_{(1,2)}S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>183/614</td>
<td>11/614</td>
<td>6/614</td>
</tr>
<tr>
<td></td>
<td>29.8%</td>
<td>1.8%</td>
<td>1%</td>
</tr>
</tbody>
</table>

The findings of Table 3 are comparable with those of Table 2. The closer to the edge the stressed syllable is, the more likely it is to fail to surface as unstressed in the child form.
Table 3. Quadrisyllabic target forms

<table>
<thead>
<tr>
<th></th>
<th>(W_1SW_2W_3) as (SW_{(2,3)})</th>
<th>(W_1SW_2W_3) as (W_1S)</th>
<th>(W_1W_2SW_3) as (SW_3)</th>
<th>(W_1W_2SW_3) as (W_{(1,2)}S)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>1/614</td>
<td>14/614</td>
<td>35/614</td>
<td>8/614</td>
</tr>
<tr>
<td></td>
<td>0.2%</td>
<td>2.3%</td>
<td>5.7%</td>
<td>1.3%</td>
</tr>
<tr>
<td>(W_1W_2SW_3) as (W_2SW_3)</td>
<td>(W_1W_2SW_3) as (W_1W_2S)</td>
<td>(W_1W_2W_3S) as (SW)</td>
<td>(W_1W_2W_3S) as (W_3S)</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>55/614</td>
<td>61/614</td>
<td>0/614</td>
<td>2/614</td>
</tr>
<tr>
<td></td>
<td>9%</td>
<td>10%</td>
<td>0%</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

3.4 Developmental stages

Given the above findings, and in line with the literature on the acquisition of stress, my proposal is that Greek children are sensitive to stress from the very beginning (cf. Allen & Hawkins 1980, Jusczyk et al. 1993, Jusczyk 1997, and Morgan & Saffran 1995 for a perceptual account of English; Pater 1997 for a production analysis; Fikkert 1994 and Wijnen et al. 1994 for Dutch). The ambiguous foot structure of the target forms highlights the fact that children build and expand their productions based on the stressed syllable, irrespective of the stress template the produced forms fit in. Therefore, the innovative characteristic of the Greek data is that the stressed syllable is preserved in the children’s productions regardless of the accentual template it fits into.

The primary goal is the preservation of the stressed syllable and not a template, part of which is the stressed syllable (unlike child Dutch; cf. Fikkert 1994). Consequently, contra crosslinguistic studies, which claim that the stressed syllable of the input is preserved mainly in a trochaic template in child output forms, Greek provides evidence for the opposite. Pater (1997) and Fikkert (1994), for English and Dutch respectively, do not provide cases in which stressed syllables are maintained in iambic patterns. This is an obvious case in the Greek data as was shown in their presentation, as well as in Table 1, 2, and 3.

One advantageous aspect of studying longitudinal data is the establishment of developmental stages in phonological acquisition. Stages are characterized by the uniformity that children exhibit in their productions during certain phases of their phonological maturation. The important factor for establishing developmental stages is that they provide generalizations about the way certain structures emerge and the order in which they are acquired. However, the stages are not necessarily followed by all children. It may be the case that children skip some of them, yet they reach the end point of the grammar of the target language (cf. Fikkert 1994).25 Crosslinguistically, researchers generally
agree that children go through at least three stages while acquiring the stress pattern of their language. The Greek data presented in §3.2 above and the statistical evidence presented in §3.3 allow me to establish four developmental stages in the acquisition of Greek.

The first stage, i.e. the subminimal word stage, is characterized primarily by monosyllabic truncations. The second stage is characterized by accurately produced disyllabic forms, as well as by disyllabic truncations of longer words. The third stage consists of faithfully realized trisyllabic forms, as well as trisyllabic truncations. Finally, the fourth stage is characterized by the full production of all word types. The stages are illustrated in (12).

(12) 1st stage → monosyllabic truncations of both iambic and trochaic words; preservation of the stressed syllable.

2nd stage → full production of SW and WS words, with a small percentage of reversal of trochees to iambs and of iambs to trochees. Truncation of trisyllabic SW\textsubscript{1}W\textsubscript{2} words to SW\textsubscript{(1,2)} and W\textsubscript{1}SW\textsubscript{2} words to SW\textsubscript{2} and W\textsubscript{1}S words. No production of longer words.

3rd stage → full production of SW\textsubscript{1}W\textsubscript{2} and W\textsubscript{1}SW\textsubscript{2} target forms. Quadrisyllabic target words are truncated to trisyllabic ones. W\textsubscript{1}W\textsubscript{2}SW\textsubscript{3} words are produced as W\textsubscript{(1,2)}SW\textsubscript{3} or W\textsubscript{1}W\textsubscript{2}S words.

4th stage → full production of longer words.

The Greek findings show that Greek children follow distinct developmental paths in the acquisition of stress. These developmental paths are schematized in (13) below.

(13) a. SW, WS → S, SW → SW, WS → WS, SW\textsubscript{1}W\textsubscript{2} → SW\textsubscript{(1,2)}, SW\textsubscript{1}W\textsubscript{2} (all children)

b. W\textsubscript{1}SW\textsubscript{2} → SW\textsubscript{2}, W\textsubscript{1}W\textsubscript{2}SW\textsubscript{3} → W\textsubscript{(1,2)}SW\textsubscript{3} (B, D)

W\textsubscript{1}SW\textsubscript{2} → W\textsubscript{1}S, W\textsubscript{1}W\textsubscript{2}SW\textsubscript{3} → W\textsubscript{1}W\textsubscript{2}S (Me, Fe, Ma)

What is illustrated in (13) is that all children follow the same developmental path regarding the acquisition of SW, WS, and SW\textsubscript{1}W\textsubscript{2} words. In other words, SW and WS words are initially truncated to the stressed syllable and are fully produced in later stages. SW\textsubscript{1}W\textsubscript{2} words are truncated to SW\textsubscript{(1,2)} words and are later faithfully produced. The picture changes with respect to W\textsubscript{1}SW\textsubscript{2} and W\textsubscript{1}W\textsubscript{2}SW\textsubscript{3} target words, which have ambiguous stress structures. W\textsubscript{1}SW\textsubscript{2}
words are truncated to either SW$_2$ or W$_1$S words. Later, they are fully produced. W$_1$W$_2$SW$_3$ forms are truncated to W$_{(1,2)}$SW$_3$ or W$_1$W$_2$S words. These distinct paths are followed by separate groups of children or one and the same child employs different paths.

4. Optimality Theory: The theoretical development of the 1990s

OT provides a particular conception of how grammar is organized. The theory assumes that UG minimally consists of the following mechanisms: (a) CON, which provides a set of constraints out of which grammars are constructed, (b) GEN, which provides a range of possible candidates available to the input, and (c) EVAL, which evaluates forms with respect to a given constraint hierarchy. Apart from the above mechanisms, OT is characterized by the tenets of, first, *Universality*, which implies that constraints are universal; second, *Violability*, according to which constraints can be violated; third, *Ranking*, which denotes that constraints are hierarchically ranked; fourth, *Inclusiveness*, which forces outputs to contain part of the input; and, fifth, *Parallelism*, according to which candidate outputs are evaluated in parallel (cf. Prince & Smolensky 1993, McCarthy & Prince 1993a, b, 1994a, b, c, Kager 1999, McCarthy 2002).

Constraint families consist of, first, Markedness or well-formedness constraints, which require the emergence of unmarked structures; second, Faithfulness constraints, which require outputs to be as faithful to the input as possible; and, third, Alignment constraints, which demand the alignment or coincidence of certain morpho-phonological or syntactic categories with certain edges or categories of the produced forms.

The widely accepted view is that constraints are universal and universally present in the grammars of all languages (Prince & Smolensky 1993 and McCarthy 2002 for adult language; Goad 1997 and Rose 2000 for child language). Nevertheless, there are researchers who argue that constraints are not strictly innate/universal, but rather functionally grounded (Boersma 1998, Hayes 2004, Pater 1997, Levelt & van de Vijver 2004). In this article, I adopt the claim that constraints are universal and, consequently, emerge in the grammars of all languages of the world. Whether specific constraints are of crucial importance in the language is an issue decided by the grammar, i.e. the language’s constraint ranking in OT terms. If constraints were learned, a problem that would arise is how and at what point constraints emerge and how and when they are suppressed, that is, constraint genesis and extinction, especially in acquisition (see Pater 2001 for discussion).
Another crucial property of constraint universality is that languages differ in how constraints are ranked. The theory predicts that all possible constraint permutations reflect all possible languages of the world (language typology). Intra- and inter-language variation is dealt with in two ways: First, by means of unranked constraints, that is, constraints that are not ranked with respect to each other. In this case, distinct constraints can be ranked in the same constraint stratum. In the Prince & Smolensky (1993) version of OT, constraint hierarchies are total, i.e. one constraint occupies one stratum, as shown in (14).

But constraints need to be unranked where two output forms are equally grammatical, leading to partial rankings (cf. Antilla & Cho 1998), as shown in (15).

\[(14) \quad A >> B >> C\]

\[(15) \quad A, B >> C\]

The second means to deal with variation is in terms of co-phonologies, or multiple parallel co-grammars, where constraints are totally ranked (Kiparsky 1993). In the acquisition literature this has been linked to distinct developmental paths that children follow in the course of development (Levelt & van de Vijver 2004). Variation is also dealt with by means of conjoined constraints, which are violated only if both parts of the constraint conjunction are violated, but are satisfied when even one part is satisfied (Smolensky 1995).

My claim is that child variation is better dealt with by means of co-phonologies rather than one grammar/ranking where unranked constraints obtain. The major argument for co-phonologies lies in the fact that one grammar/ranking with unranked constraints provides an obscure, confusing picture of how acquisition proceeds. For example, such a grammar does not make predictions regarding the limits of variation. Additionally, it cannot explain why children's speech is characterized by regressions to earlier stages even at stages when they are expected to faithfully produce their target forms. How can reranking take place when children have reached the final, and (rather) firm, adult state of the grammar? Co-phonologies, on the other hand, provide a logical explanation as to how and why children adopt a certain grammar over another and how they move from one grammar to the other in their goal of acquiring the phonology of their mother tongue. Moreover, co-phonologies underline the fact that children may employ parallel grammars that justify the emergence of variable forms throughout phonological maturation.

Constraint interaction is an innovation of OT compared to previous theoretical models. It implies that constraints are not necessarily cancelled, or turned ‘off’ (to use a term better known from the Principles and Parameters...
framework), if they are ranked in a lower stratum. It may well be the case that
the optimal candidate is not selected on the basis of the higher-ranked con-
straints. If higher-ranked constraints are satisfied or violated by all candidates,
the evaluation procedure has to be transferred to the lower-ranked constraints.
In that case, lower-ranked constraints can be crucial. This is an instance of
minimal violation of constraints, as proposed by Pater (1997).

OT owes its 'success' to a great extent to its applicability as a learnability
theory. In OT, learning is interpreted by means of constraint reranking and
constraint demotion (Tesar & Smolensky 2000; see also Boersma 1998 for
another account). What is assumed is that children start acquiring struc-
tures that are phonologically less complex and articulatorily easier to produce
in their mother language. This is translated in an initial constraint hierarchy
where all markedness constraints are ranked above faithfulness constraints (cf.
McCarthy & Prince 1994a). In the course of language development, marked-
ness constraints are demoted and faithfulness constraints gain ground.

My claim here is that it is not of crucial importance whether constraints are
demoted or promoted after the initial M >> F ranking. I would prefer to claim
that both demotion and promotion are activated. This can be proved by cases
where highly ranked markedness constraints of the initial ranking keep being
highly ranked in intermediate rankings, this time co-existing with faithfulness
constraints (as illustrated in 16 and 17). This can only be explained by con-
straint promotion (Tzakosta 2003b). As a result, marked structures, i.e. ones
that are faithful to the input forms, emerge. In the following section I provide
an OT analysis of the Greek child data discussed above.

\[
\begin{align*}
(16) & \quad M_1, M_2, M_3 \ldots M_n >> F_1, F_2, F_3 \ldots F_n \text{ (initial ranking)} \\
(17) & \quad M_1, M_2, M_3, F_1, \ldots M_n >> F_2, F_3, \ldots F_n \text{ (intermediate ranking)}
\end{align*}
\]

4.1 An OT analysis of the Greek child data

The constraints that are relevant to the analysis of the Greek data are drawn
from the families of both markedness and faithfulness constraints. They are
presented in (18):

\begin{align*}
(18) & \quad \text{a. FrBin: Output forms are binary at any level of analysis (McCarthy &} \\
& \quad \text{Prince 1994a, b). This constraint is violated by monosyllabic forms.} \\
& \quad \text{b. Align-L: The left edge of every stressed syllable must be aligned} \\
& \quad \text{with the left edge of the prosodic word (Align FOOT-L, McCarthy &} \\
& \quad \text{Prince 1994a, b).}
\end{align*}
c. **ALIGN-R:** The right edge of every stressed syllable must be aligned with the right edge of the prosodic word (**ALIGN Foot-R**, McCarthy & Prince 1994a, b).

d. **FAITHSTRESS:** An input stressed element must have as its output correspondent a stressed element (Pater 1997). Put differently, the constraint demands the preservation of the stressed syllable.

e. **MAX:** The prosodic structure of the input should be preserved in the output (McCarthy & Prince 1994b, c).

f. **MAX-L-EDGE:** The left edge of the input should be preserved in the output (Beckman 1998, Smith 2002).

g. **MAX-R-EDGE:** The right edge of the input should be preserved in the output (Beckman 1998, Smith 2002).

h. **I-O CONTIGUITY:** ‘No skipping’ (McCarthy & Prince 1994b, c).

The OT analysis of the data follows the developmental stages proposed in §3.4. In that way, the reranking that takes place during language development becomes more obvious.

As already mentioned in §4, in the initial ranking, markedness constraints override faithfulness constraints. In other words, the words produced are shaped on the basis of well-formedness. However, in the data discussed here, children show systematic faithfulness to the stressed syllables. The stressed syllable is actually the core on which children build their productions. Apparently, the ranking has reached a level where faithfulness constraints occupy a high position in the constraint hierarchy in the stages I discuss. As already mentioned, learning proceeds in terms of reranking and constraint demotion/promotion. Constraint reranking also highlights the transition from one stage to another.

Consequently, in the first stage during which monosyllabic forms are produced, the constraint ranking of the current state of the child’s grammar demands preservation of the stressed syllable. Given that monosyllabic forms occur in this stage, FtBin, MAX, and all versions of MAX, such as positional faithfulness, are low-ranked. The low ranking of these constraints automatically excludes disyllabic or fully faithful forms from the evaluation process. It is important to keep in mind that FtBin is violated only in the case of monosyllabic productions The preservation of only the stressed syllable further implies that the ALIGN constraints are ranked together with FAITHSTRESS in the higher stratum. Both ALIGN constraints are vacuously satisfied by the winner. Interestingly, none of the constraints demanding segmental contiguity or preservation of edges is relevant at this stage. The constraint ranking suggested for the
first stage is depicted in (19) below. Tableau 1 further displays the evaluation process given the ranking in (19). It is also worth mentioning that I do not assume footing at these stages. I assume, rather, that children perceive monosyllabic, disyllabic, trisyllabic, and longer forms rather than feet and extrametrical syllables.

(19) FaithStress, Align-R, Align-L >> FtBin, Max

Tableau 1.31

<table>
<thead>
<tr>
<th>/pe.zi/</th>
<th>FaithStress</th>
<th>Align-R</th>
<th>Align-L</th>
<th>FtBin</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>['pe.zi]</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[pe]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>[zi]</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>[pe.'zi]</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The transition to the second stage, during which disyllabic SW target words are fully produced and trisyllabic W₁SW₂ and SW₁W₂ target words are truncated to SW words, involves promotion of FtBin to the higher stratum, or demotion of all constraints of the higher stratum to the immediately lower stratum. The notion of constraint promotion is not new. In previous studies (Levelt & van de Vijver 2004, Tzakosta 2003b, Velleman & Vihman 2003), researchers have cast doubt on the notion of constraint demotion and have argued for constraint promotion on the basis of evidence showing that the target language is learned by satisfaction and not violation of constraints. An important characteristic of the state of the child’s grammar in stage 2 is that one of the Align constraints is essentially demoted to a lower stratum. This is attributed to the fact that in disyllabic outputs the stressed syllable is aligned with one word edge. Consequently, in trochaic disyllabic truncations, Align-L is highly ranked. High ranking of Align-L and low ranking of Align-R prohibits iambic forms from surfacing. The constraint ranking relevant to this stage is provided in (20) and Tableau 2.

(20) FaithStress, Align-L, FtBin >> Align-R, Max

Tableau 2.

<table>
<thead>
<tr>
<th>/a.xla.dí/</th>
<th>FaithStress</th>
<th>Align-L</th>
<th>FtBin</th>
<th>Align-R</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a.'xla]</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>[a.ó]</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>['a.xla]</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>[a.'xla.ó]</td>
<td>*!</td>
<td></td>
<td></td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>
Given that during the same stage children also produce the metrically ambiguous $W_1 SW_2$ words truncated to $W_1 S$ forms, the constraints need to be reranked. In this case I prefer to claim that constraints are not reranked but, rather, a second, distinct co-grammar is activated. In this grammar, Align-R is higher-ranked, while Align-L is lower-ranked. The ranking, which is responsible for iambic truncations, is demonstrated in (21) and is further depicted in Tableau 3. The same ranking accounts for the faithful production of disyllabic WS words. The rankings in (20) and (21) constitute distinct developmental paths that children adopt during the acquisition process. Interestingly, during this stage the constraints demanding contiguity or edge-preservation are still not crucial for the selection of the winning candidate.

(21) FaithStress, Align-R, FtBin >> Align-L, Max

Tableau 3.

<table>
<thead>
<tr>
<th>/mo.li.vi/</th>
<th>FaithStress</th>
<th>Align-R</th>
<th>FtBin</th>
<th>Align-L</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mo.li]</td>
<td>*!</td>
<td>*!</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>[mo.li]</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[mo.li.vi]</td>
<td>*!</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

When moving to the third stage, trisyllabic target forms are accurately produced, but $W_1 W_2 S W_3$ targets are produced as either trochaic $W_1 SW_2$ or iambic $W_1 W_2 S$ forms. In these cases, FaithStress is still highly ranked. In this stage we still have two co-emerging grammars, each of which promotes one of the aforementioned structures. In these co-grammars, it is again the position of the Align constraints that makes the difference. What allows the production of words that are longer and more faithful to the input is the promotion of Max not to the highest, but to an intermediate position in the hierarchy. Consequently, trochaic forms are allowed by the ranking in (22) and Tableau 4. What is also crucial is that the evaluation process is transferred to the second stratum, since the winner is not selected in the first ‘round’: The constraints Max-R-Edge and Align-L become crucial for the selection of the winning candidate. Interestingly, the fully faithful candidate fatally violates the Align-L constraint twice and is excluded from being the winning candidate.

(22) FaithStress, FtBin >> Align-L, Max-L-Edge >> Max, Align-R
Accordingly, the second co-grammar that allows iambic trisyllabic faithful or truncated forms is schematized in the ranking in (23).\textsuperscript{32}

(23) FaithStress, FtBin, Align-R >> Max >> Align-L, Max-L-Edge

Tableau 5.

<table>
<thead>
<tr>
<th>/kara/meles/</th>
<th>Faith Stress</th>
<th>FtBin</th>
<th>Align-R</th>
<th>Max</th>
<th>Align-L</th>
<th>Max-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ka.ra.me.les]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[a.me.les]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[ka.ra.me]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[ka.ra.me]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[a.me]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<td>*</td>
</tr>
</tbody>
</table>

In the final stage, during which children accurately preserve the input form in their productions, all faithfulness constraints land in the higher stratum. This is the point at which the child grammar reaches the final state of the adult grammar, the point when we are sure that the child has acquired the phonology of its language. The ranking is illustrated in (24), and a representative example of selecting the correct output is given in Tableau 6. It is worth mentioning that at the final stage the selection of the optimal candidate is made on the basis of the general Max constraint. Contiguity emerges in the ranking when it becomes crucially relevant.

(24) FaithStress, Max, Max-R-Edge, Contiguity >> Align-R, Align-L

Tableau 6.

<table>
<thead>
<tr>
<th>/θe.sa.lo.’ni.ki/</th>
<th>Faith Stress</th>
<th>Max</th>
<th>Max-R</th>
<th>Cont</th>
<th>Align-R</th>
<th>Align-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>[sa.lo.’ni]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>[θe.θa.lo.’ni.ki]</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
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<tr>
<td>[sa.lo.’ni.ki]</td>
<td>*</td>
<td>*</td>
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<td>*</td>
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<td>*</td>
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<tr>
<td>[’ni.ki]</td>
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</tbody>
</table>
However, the analysis of how children’s grammar develops has not covered cases of reversals and regressions to previous phases of the development of stress. What would an OT analysis look like in cases such as that in (8a) above? The answer is that in such data Align constraints take over FaithStress. A representative example is given in the ranking in (25) and in Tableau 7. The ranking in (25) illustrates a grammar that can be activated throughout stress development together with the rankings representative of each stage. This phenomenon is an instance of the revised multiple parallel grammars model proposed by Tzakosta (in prep.).

(25) Align-L, FtBin, Max-R-Edge, Contiguity >> Align-R, FaithStress, Max

Tableau 7.

<table>
<thead>
<tr>
<th>/po.ði.ло.to/</th>
<th>Align</th>
<th>FtBin</th>
<th>Max</th>
<th>Cont</th>
<th>Align</th>
<th>FaithStress</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-L</td>
<td></td>
<td>-R</td>
<td></td>
<td>-R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[po.ði.ла.to]</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>[po.ði]</td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
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<td>*</td>
</tr>
<tr>
<td>[ði.to]</td>
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<td>*!</td>
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<td>*</td>
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<tr>
<td>[ði.ло]</td>
<td></td>
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<td>*!</td>
</tr>
</tbody>
</table>

The above analysis is aimed at showing that language learning within OT takes place in terms of the interaction of constraints of equal value. What differentiates certain structures from others is the position of constraints in the hierarchy, i.e. the state of the grammar. This does not mean that constraints are cancelled if they are low-ranked. On the contrary, they can be crucial irrespective of their position in the hierarchy. Higher-ranked constraints usually escape violation. Their high ranking means that they are, in principle, satisfied. Constraints can also go back and forth in a hierarchy, that is, they can be demoted and/or promoted on the evidence of data, until the final state of the grammar is reached.

5. Conclusions

One of the claims of this study is that Greek children acquire stress by preserving stressed syllables throughout their phonological development irrespective of the prosodic template stressed syllables fit in. This results in the occurrence of both trochaic and iambic stress patterns. However, trochees tend to be the
most frequently emerging patterns given that the input to which children are exposed is basically trochaic.

Both trochaic SW and iambic WS words are initially truncated to the stressed syllable, a move that eliminates the odds for a trochaic bias in Greek. Further, words with ambiguous metrical structure, such as \( W_1SW_2 \) ones, are truncated to both iambs and trochees. This is evidence for the complex and unpredictable character of the Greek lexical stress system, and strongly supports the idea that children follow distinct developmental paths in the order of their phonological acquisition. Data from languages such as Spanish and French support the above claims.\(^{33}\)

Contra my previous claims (Tzakosta 2003a), I do not assume that moraic trochees are possible in quantity-insensitive languages (following Hayes 1995). More specifically, in previous work I argued that children have access to all foot types provided by UG, and, consequently, may choose moraic trochees before they realize that this is not a possible foot type in Greek. I would rather claim that lengthening of stressed syllables is a phonetic effect. This empirical finding is supported by the phonological principle that wants prominent positions to be strong. This view is further supported by psycholinguistics and experimental studies (cf. Cutler & Norris 1988 and Smith 2002, and references therein).

In the OT analysis the notion was developed that constraint interaction, constraint reranking, and activation of parallel co-emerging grammars account for phenomena such as inter- and intra-child variation, change, and regression to patterns found in earlier stages of development, all of which are common in child speech. These considerations make OT a flexible and explanatorily adequate model of language acquisition.

Notes

\* A version of this paper was presented at the 1st International Linguistics Conference, organized by the School of English and the University of Athens. An elaborate version was presented at the Phonology Reading Group of University of Massachusetts, Amherst. I especially thank Gaberell Drachman, Angeliki Malikouti-Drachman, Ionna Kappa, Clara Levelt, John J. McCarthy, Joe Pater, Anthi Revithiadou, and Jeroen van de Weijer for useful comments and discussion. I also thank three anonymous reviewers of the *Journal of Greek Linguistics* for fruitful suggestions and comments. This research project was financially supported by the Leids Universiteit Fonts and the Faculty of Letters of the University of Leiden.

1. The children are referred to with the abbreviations in parentheses in the examples below.
2. For more details on the organization and the content of the database see Tzakosta (in prep.).

3. Due to the fact that English and Dutch are quantity-sensitive languages, and quantity sensitivity plays a crucial role in stress assignment, the trochaic minimal word template may consist of lengthened open syllables as well as closed CVC(C)(C) syllables. Such syllables occupy two moras on the skeletal tier and, consequently, 'fill in' the prosodic minimum. Given that quantity sensitivity is of no importance in Greek, the minimal word template can take the shape (C)V(C).(C)V(C); that is, syllables can have complex onsets and/or simple codas, or they can be codaless, onsetless, or both. Due to quantity insensitivity, the prosodic minimum is essentially disyllabic. Onsets are irrelevant to quantity sensitivity.

4. One of the reviewers suggests that the trochaic bias means that iambic surface forms are analysed as being trochaic. However, it does not seem to be only a matter of analysis, since it is explicitly claimed in the Dutch developmental data, for example, that children produce iambics as trochees during early stages (cf. Fikkert 1994). It is never the case that iambics surface correctly in the children's outputs, at least during these stages. Additionally, analysing iambic surface forms as being trochaic underlyingly does not provide any theoretical insight as to how these forms are eventually correctly produced as iambics in advanced stages. On the contrary, such an analysis implies that any form that does not conform to the trochaic bias hypothesis can be represented as being trochaic; nevertheless, this is not true, given that iambic languages are rare, but do exist, according to the language typology that Hayes (1995) provides.

5. There are hardly any studies on child speech in lexical accent languages.

6. Following Revithiadou (1999), by accent I mean stress. Accent is the abstract notion of prominence. Stress is the actual realization of prominence in Greek. Pitch and tone are other ways of realizing prominence in languages like Japanese or Mandarin.

7. See Malikouti-Drachman & Drachman (1989) and Revithiadou (1999), and more references therein, on stress in adult Greek.

8. See Tzakosta (in prep.) for discussion on the phonology-morphology interface.

9. Following the acquisition literature, in using the terms ‘iambics’ and ‘trochees’ I do not refer to strict foot structures, but rather to words stressed on the final syllable (iambic). Antepenultimate stressing is considered to be the default trochaic stress pattern in Greek (cf. Drachman & Malikouti-Drachman 1999, Revithiadou 1999, and more references therein). I take trisyllabic $W_1SW_2$ and longer words stressed on any syllable but the final to be metrically ambiguous.

10. I provide syllabification for the input form too, even though this is not common, especially in OT terms. I assume the input to the child's perception to be the adult surface form (cf. Smith 1973). Another reason for providing the input's syllabification is that I want to make all the changes taking place in the child output form at the segmental, syllabic, or suprasegmental level more explicit.
11. I do not indicate stress on monosyllabic full or truncated forms. Monosyllables are inherently stressed.
12. Adult/input forms are provided between slashes whereas child forms are provided in angled brackets.
13. See Tzakosta (in prep.) for more discussion.
15. Whether prominent syllables have to have an unmarked segmental composition is still under investigation, since such a claim needs to be checked against much more data.
16. [o] occupies the nuclear position of both the prefinal and final syllable. I assume that it is the nucleus of the final rather than the prefinal syllable that is retained, given psycholinguistic evidence that edges tend to be preserved (cf. Smith 2002 and references therein).
17. For a detailed discussion of these facts the interested reader is referred to Revithiadou & Tzakosta (in press).
18. For statistical details on this issue, see Tzakosta (in prep.).
19. Such facts may be attributed to phrasal/intonational effects, though further research is needed.
21. For exhaustive statistical results on input frequency rates see Tzakosta (in prep.).
22. With a very small percentage, though.
23. I do not assume moraic structures in such examples. The lengthening of the stressed syllable is a phonetic effect. Consequently, moraic trochees are not considered either. I take these forms to be iambic. For general discussion on moraic structures, see §5.
24. The numbers in parentheses indicate that one of the unstressed syllables surfaces in the output forms. As a result \( SW_{1,2} \) target words can surface as either \( SW_1 \) or \( SW_2 \) outputs.
25. The theoretical status of developmental stages is challenged by the fact that some of them are skipped during phonological acquisition. This is an issue taken up in Tzakosta (in prep.). There, it is argued that variation, the skipping of stages, and related problems are attributable to the fact that children do not necessarily go through developmental stages but rather access distinct developmental grammars in parallel.
27. In the data of the children under investigation the stage during which quadrisyllabic words are fully produced has not yet been reached.
28. For a revised version of the multiple grammars model see Tzakosta (in prep.).

29. Tesar & Smolensky (2000) provide all versions of the Constraint Demotion Algorithm. Nevertheless, there are different opinions, and researchers have claimed that learning can take place not just in terms of constraint promotion, but also in terms of simultaneous demotion and promotion of constraints (Bernhardt & Stemberger 1998, Boersma 1998, Velleman & Vihman 2002, Tzakosta 2003b).

30. The Constraint Demotion Algorithm (CDA) assumes that learning proceeds through constraint demotion all the way. However, the CDA is a learnability algorithmic model that addresses the ideal/machine learner. Dealing with actual data proves that this is not always the case.

31. I assume that the input forms children are exposed to can also be variable. However, here I take the children’s input to be invariable. I assume the children’s input to be the output of their interlocutors in the recording sessions. The interlocutors were very consistent, and were careful to always produce invariable forms.

32. A form such as [ri.’te.li] does not surface as the optimal candidate because Max-L-Edge is ranked higher than Contiguity. For a more refined account of these issues see Tzakosta (in prep.).

33. See Tzakosta (in prep.) for a comparative discussion of Spanish, French, and Greek data regarding the issue of the trochaic bias.

References


Tzakosta, Marina. in prep. *Multiple Learning Strategies in the Acquisition of Stress in Greek L1*. Ph.D. dissertation, ULCL/HIL.


**Περίληψη**

Η παρούσα μελέτη πραγματεύεται την κατάκτηση του τονισμού στα ελληνικά. Στόχος είναι η διερεύνηση των μηχανισμών μέσω των οποίων τα παιδιά καταφέρνουν τελικά να κατακτήσουν το τονικό σύστημα της μητρικής τους γλώσσας. Τα ελληνικά δεδομένα αντλήθηκαν από το φυσικό λόγο πέντε παιδιών ηλικίας 1;10 ως 3;0 χρόνων. Τα πορισματα της έρευνας υπογραμμίζουν ενδιαφέρουσες ομοιότητες και διαφορές από τα δεδομένα παιδιών που κατακτούν άλλες γλώσσες. Πιο συγκεκριμένα, τα παιδιά που κατακτούν την ελληνική επιδεικνύουν συστηματική πιστότητα στην τονισμένη συλλαβή, την οποία ως επί το πλείον διατηρούν στις πραγματώσεις τους, όχι όμως και στους τροχαϊκούς πόδες που θεωρούνται οι πλέον φυσικές δομές στον παιδικό λόγο διαγλωσσικά. Κατά συνέπεια, ιαμβικές και τροχαϊκές δομές εμφανίζονται παράλληλα στο λόγο διαφορετικών παιδιών (inter-child variation) ή ακόμη στο λόγο και ενός παιδιού (intra-child variation). Η ανάλυση των δεδομένων στα πλαίσια του μοντέλου της θεωρίας του Βέλτιστου (Optimality Theory, Prince & Smolensky 1993) καταδεικνύει ότι τα παιδιά χρησιμοποιούν παράλληλες γραμματικές κατά τη διάρκεια των διάφορων σταδίων ανάπτυξής.