Do Dutch-speaking children prefer trochees? A reevaluation of the trochaic template hypothesis of Dutch truncations.

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ABSTRACT

According to the trochaic template hypothesis (TTH), young Dutch- and English-speaking children prefer to produce trochaic word renditions. In this article, we analyze the data of 12 Dutch children that were formerly used to support the TTH, and the dense data of one additional child. Our analysis confirms the existence of a rhythmic preference: iambs are more often truncated than trochees. But other observations are incompatible with the TTH: (1) Trisyllabic words do not exhibit a uniform pattern that complies to the TTH; (2) truncation does not always result in a more optimal (trochaic) rhythm; and (3) non-rhythmic factors account for a considerable amount of truncations: vowel type, syllable structure, and sonority.

(112 words)

Key words

Dutch child language

Multisyllabic words

Prominence

Prosodic preference for trochees

Truncation

INTRODUCTION

The trochaic template hypothesis

Children's early multisyllabic words are often highly simplified. Consider the words of the Dutch child Cato in (1). In (1a) the first syllable of the target is lacking. In (1b) the onset of the second syllable is reduplicated. Moreover, main stress has shifted from the last syllable to the first one. In the last example, the second syllable of the target is lacking.

(1)	a flamingo /flaˈmɪŋgo / (flamingo, wSw)	→	[ˈhɪxɔ]	(Ca, 2;1.3)[i]
	b kapot /kaˈpɔt / (broken, wS)	→	[ˈpa:put]	(Ca, 1;11.22)
	c heleboel /ˌheləˈbul / (many, Sws)	→	[ˈhepu]	(Ca, 2;0.6)

Whether the rhythm of the target word is wSw, wS or Sws (S=main stress, s=secondary stress, w=weak), the child's realizations have the trochaic rhythm Sw. This observation is in accordance with the 'trochaic template hypothesis' (henceforth TTH), which states that young children prefer trochees in the early stages of word production: i.e. rhythmic units of a strong syllable (optionally) followed by a weak syllable. Children use a predefined rhythmic output template in the form of one trochee, onto which they map their word renditions. Target words that do not fit in the output template directly, are adapted by removing one or more syllables, or by shifting a stress, as illustrated in (1).

The first formulation of a TTH can be found in Allen & Hawkins (1978), who studied English-speaking children's data. Later, also Iverson & Wheeler (1987), Schwartz & Goffman (1995), and Fee (1996) found corroborating evidence for the TTH in English-speaking children. Fikkert (1994) and Wijnen, Krikhaar & den Os (1994) provided additional evidence for Dutch. Recent studies of Japanese, Finnish, and Hebrew also support the TTH (Ota, 1999; Adam, 2002; Kunnari, 2002; Savinainen-Makkonen, 2000).

Fikkert (1994), Demuth (1995) and Fee (1996) incorporated the TTH in models of prosodic development, where children's preference for trochees is situated in the early stages of prosodic development: a mono-trochaic stage is followed by a period in which Dutch- and English-speaking children produce words consisting of two (or more) trochees. During this second stage, they realize a word like 'ooievaar' (/ˈojəˌvar/, 'stork') with the appropriate rhythm Sws without deleting syllables since it consists of a disyllabic trochee followed by a monosyllabic trochee, which nicely fits their prosodic template. But targets with the rhythm swwS/Swws like 'locomotief' (/ˌlokəmoˈtif/, 'locomotive') that do not fit into a sequence of trochees, are still accommodated into a sequence of two trochees through truncation of the third syllable. This second stage roughly corresponds with what Gerken (1994a) observed in her experiments with two year old English-speaking children (see also McGregor & Johnson, 1997). When asked to imitate foursyllabic pseudo-words like 'zampakasis' (/ˈzæmpəkəˈsɪs/, SwwS) or 'pazamkasis' (/pəˈzæmkəˈsɪs/, wSwS), children often omitted weak syllables in order to change the rhythm into a sequence of trochees: 'zampakasis' turned into 'zampasis', 'pazamkasis' into 'zamkasis'.

The TTH was supported by research on perceptual development and by linguistic theory. Research on infants' perceptual development revealed a perceptual bias toward trochees. It turned out that infants are highly sensitive to the rhythm of speech from very early on (i.a. Mehler, Jusczyk, Lambertz, Halsted, Bertoncini & Amiel-Tison, 1988). English-speaking infants pick up the statistical tendency of English words to be trochaic (Cutler &

Carter, 1987) easily. As a result, they prefer to listen to disyllabic trochaic words like 'kitchen' over words like 'balloon' with an iambic rhythm, i.e. an unstressed followed by a stressed syllable (Jusczyk, Cutler & Redanz, 1993). This perceptual bias was incorporated into the explanation of the TTH (Gerken, 1994b; Wijnen et al., 1994; McGregor & Johnson, 1997).

Other researchers like Fikkert (1994) and Demuth (1995) explained the production data on the basis of linguistic theories of word rhythm, in which the trochee is taken as the unmarked prosodic unit in the languages of the world: all languages have a prosodic system based on the trochee, except when there is a contraindication (in terms of quantity sensitivity, cfr. the iambic-trochaic law, Hayes, 1985; Demuth, 1995). From this fact, Fikkert (1994) and Demuth (1995) concluded that the trochee must be a basic unit in children's language acquisition as well. In their opinion, this is an instantiation of the general rule that unmarked structures are available to children earlier than marked structures (Jakobson, 1968; Levelt & Van de Vijver, 2000). This linguistic explanation entails that the trochaic preference is an innate bias that emerges in all children's first words, irrespective of the rhythmic structure of the ambient language.

Contraindications and alternatives

The universal character of the TTH was tested in studies of non-trochaic languages such as French. They revealed that French children produce disyllabic babbling strings and first words with an acccent on the last syllable (by means of pitch and lengthening), in contradiction to the TTH, but conforming to the intonational pattern of the target language (Vihman, DePaolis & Davis, 1998). Moreover, French-speaking children were reported to apply a wS output template to their early attempts at multisyllabic words (Paradis, Petitclerc & Genesee, 1997; Kilani-Schoch & Dressler, 2000; Veneziano & Sinclair, 2000).

Non-corroborating evidence was also found in studies of trochaic languages like English (and Greek: Tzakosta, 2004). For instance, Johnson, Lewis & Hogan (1997) did not observe a trochaic preference in the longitudinal data of an English-speaking child. This child evolved from a monosyllabic phase, during which he did not produce multisyllabic words, directly into a phase during which words counted up to three or four syllables. Johnson et al. suggested that the trochaic stage is not a general trait of children acquiring a trochaic language.

Moreover, some studies found truncation patterns that could not be explained by a rhythmic preference. In an experimental study with English-speaking children by Kehoe & Stoel-Gammon (1997), swS words were truncated frequently to wS instead of the expected Sw. Furthermore, wS words were more often truncated than sS words, although the TTH predicts equal truncation rates since neither structure is compatible with the trochaic template. Kehoe et al. also observed truncation patterns that did not result in a better rhythmic structure: attempts at swSw target words were often produced without the second syllable (sSw, such as [ˌæˈk^{h}ɑdo] for ‘avocado’), although the target rhythm (swSw) as well as the rhythm of the truncated form (sSw) fit in a sequence of two trochees. Finally, in some truncations other factors than rhythm appeared to play a role for which the TTH could not account. In targets with the rhythm Sww, swS and Sws the likelihood of truncation was determined by the sonority of the onset of the second syllable. If the onset consisted of a sonorant (/m n l r j w/) as in ‘elephant’, this syllable was more often omitted than if the onset contained an obstruent as in ‘crocodile’. Lewis, Antone & Johnson (1999) found similar results. In their case study Sw words were more often truncated than Ss words, a difference that cannot be explained within the framework of the TTH. Moreover, the child produced more truncations in Sw target words than in wS target words, although the TTH predicts the reverse pattern: wS targets should be truncated more often than Sw targets.

An alternative explanation of truncation was offered by the acoustic prominence hypothesis (henceforth APH), which states that syllables are truncated due to their lack of prominence (i.a. Vihman, 1980; Echols & Newport, 1992; Schwartz & Goffman, 1995; Lohuis-Weber & Zonneveld, 1996; Snow, 1998; Kehoe, 1999/2000; Lewis et al., 1999). A syllable's acoustic prominence is defined in terms of its prosodic status and its position: weak syllables are acoustically less prominent than strong syllables, and non-final syllables are acoustically less prominent than final syllables. Thus, the APH predicts that children more easily preserve stressed syllables, and unstressed syllables in wordfinal position, whereas unstressed and nonfinal syllables are vulnerable to truncation, irrespective of other factors such as word rhythm or word length. To some extent, this model's predictions correspond with those of the TTH: for instance, Sw words are predicted to be invulnerable to truncation because all syllables are salient, whereas wS words are truncated frequently because of the first syllable's lack of salience. Furthermore, if the unstressed and non-final syllable is omitted in wSw words, Sww words, and Sws words, this truncation automatically results in a trochaic rhythm. But this model can explain observations that the TTH cannot, for instance the observation of Kehoe & Stoel-Gammon (1997) that wS words are more vulnerable to truncation than sS: the first syllable is less prominent in wS than in sS. The same researchers observed that children tend to omit the second syllable in swSw/Swsw words, which can be explained by the low prominence of the second syllable, due to its lack of stress and its non-final position. Finally, the APH does not conflict with iambic truncations.

The case of Dutch

Many models and analyses in the international research on prosodic development have been inspired by an elaborate Dutch study in support of the TTH: Fikkert (1994). Fikkert analyzed longitudinal data of 12 Dutch children, aged between 1;0 and 1;11 at the start of observations. The period of observations spanned approximately one year. She found five stages in these children's prosodic development, which are illustrated in Table 1. In stage 0, the children were not able to produce multisyllabic words (stage 0). In the next two stages, they started to produce Sw and S trochees. Non-trochaic words were avoided: non-trochaic targets were altered into a trochee by means of truncation (stage 1-2), and stress shift (stage 2). In stages 3 and 4, the children succeeded to produce words consisting of two trochees. In stage 3, the two trochees had equal stress (SwSw). In stage 4, primary and secondary stress were distinguished so that patterns like Sws or Swsw emerged. Moreover, the children started to produce words with an initial unstressed syllable (a degenerate foot) as in wS and wSw. During stages 3 and 4, truncations only occurred in attempts at Sww targets and attempts at swwS/Swws targets as these patterns do not fit in a sequence of two trochees. Occasionally, truncations also occurred in words with other prosodic patterns: these were frozen forms stemming from earlier stages.

Insert table 1 about here

Additional support for the TTH in Dutch-speaking is provided by Wijnen et al. (1994), who analyzed the data of two Dutch children. Both children passed through a period during which at least 61% of the word tokens were trochaic. Truncation was the preferred strategy to change the rhythm of non-trochaic words.

Together the studies of Fikkert and Wijnen et al. appear to offer solid evidence for the TTH in Dutch, and they are often interpreted in that way (e.g. Kehoe, 1999/2000). Nevertheless there are reasons to be cautious. First of all, these studies did not aim at contrasting the TTH with alternative explanations such as the APH. This is problematic since the TTH and the APH share some predictions: Sw target words are resistant to truncation, whereas wS target words are vulnerable. Sww, Sws, and wSw are prone to truncation of the non-final, weak syllable, resulting in a trochaic word form. As these categories of words have a high frequency in children's spontaneous speech, one can easily get the general impression of a trochaic preference even if it is absent, when one does not conduct a contrastive quantitative analysis.

Secondly, Lohuis-Weber & Zonneveld (1996) questioned the TTH for Dutch on the basis of a case study of a Dutch boy between age 1;8 and 2;11. This boy proceeded directly from a monosyllabic stage to a stage in which he produced multisyllabic words with two or more syllables. Moreover, the incidence of truncation was not only determined by a word's rhythm, but also by each syllable's vowel type and syllable structure. Of all weak syllables, syllables with a coda were least vulnerable to truncation, and syllables with a schwa were truncated most often and for the longest time. It remains to be seen whether this Dutch boy displayed idiosyncratic behaviour or not.

Last but not least, Fikkert's elaborate analysis lacks a quantitative base. Except for a quantitative comparison of the truncation rates in Sw and wS targets, no other figures were included. As a consequence, we cannot estimate the empirical coverage of her model, unless we re-analyze her data.

Aim of this study

We will re-evaluate the TTH for Dutch children's words on the basis of a large data set of 13 children. Included are the data that underlied Fikkert's formulation of the TTH. Our focus will be on the process of truncation in Dutch, which is considered to be the most common strategy for obtaining a trochaic rhythm (Wijnen et al., 1994). We will investigate whether trochaic words are more often truncated than non-trochaic words, and whether truncation always yields a more optimal trochaic word rhythm. Furthermore we will determine to which extent truncation is a purely rhythmic phenomenon.

METHOD

Databases

This study is based on two Dutch longitudinal databases with a phonemic transcription: the CLPF database and the Maarten database (both available through CHILDES, MacWhinney, 2000). The CLPF database (Fikkert, 1994; Levelt, 1994) contains the data on which Fikkert's analyses were based: i.e. longitudinal observations of 12 Dutch-speaking children, within the age range 1;0 - 2;9. They were recorded twice a month for approximately 30-45 minutes during spontaneous interactions with one of the observers. The children's age, MLU and vocabulary size can be found in Table 2, as well as the total number of word tokens over the entire period.

The Maarten database (Gillis, 1984) contains 19 observation sessions of the boy Maarten from age 1;8.29 until age 1;11.15 (approximately twice a week), while he was playing and interacting with his parents and an investigator. As each session lasted about 2 hours, the resulting database contains a high number of word tokens. Maarten's MLU and vocabulary size are provided in Table 2.

Insert table 2 about here

Coding

The first author of this study identified all truncated words in the CLPF and the Maarten database. A child's rendition of a multisyllabic target word was coded as a truncation if it contained less syllables than the target item. For all truncated words, she indicated the target syllables that were retained in the child's attempt. In cases where she had not enough phonemic clues to link target syllables with realized syllables, she classified the target syllables as 'unanalyzable'. For instance, in Maarten's rendition in (2) it cannot be decided whether the [ə] is a remnant of the first or of the second syllable of the adult target form, and hence the first and second syllables are classified as 'unanalyzable'. Across data, 1.1% of all target syllables were unanalyzable (on 44750 syllables). These syllables were omitted in all analyses performed on the level of the syllable.

(2) telefoon /ˌteləˈfon/ (telephone, swS) → [əˈɣon] (Maa, 1;10.25)

A random selection of 10% of all attempts at multisyllabic words (n=2000) were coded by a second annotator, who was unfamiliar with the aims of this study. She obtained a high level of agreement with the first annotator: 97% of the words were coded in exactly the same way (kappa=0.90).

The prosodic pattern of each target word was extracted from the CELEX lexical database (Baayen, Piepenbrock & Gulikers, 1995). The CELEX information on the location of primary stress was supplemented with the location of secondary stress on the basis of the description of Booij (1995). The prosodic structures of the children's word renditions were already annotated in the original CLPF database, but not in the Maarten database. Hence, the first author added a prosodic annotation on the basis of acoustic analysis of the audio files. In order to check the reliability of this new annotation, a random sample of 10% of all attempts at multisyllabic words in the Maarten database (n=600) was annotated by a second annotator. In 91% of the cases, the annotators found the same stress patterns (kappa=0.81).

RESULTS

Truncation is a frequent phonological process in the data of the 13 children, which affects on average 14% of all renditions of multisyllabic words. Nevertheless, Table 3 reveals considerable differences in the truncation frequency per child, from 7 to 27% (across sessions). Apart from a general measure of the truncation frequency across sessions, Table 3 also provides the percentage of truncations at the start and the end of observations. Eight children show a decrease over time.

Insert table 3 about here

Are trochaic words more often truncated than non-trochaic words?

The TTH predicts a large difference between the disyllabic patterns Sw and wS since the first are trochaic and hence resistant to truncation, whereas the latter are non-trochaic and hence very vulnerable to truncation. Sw words are only truncated in a very early stage, in which all words are rendered as monosyllabic. We will test this prediction first on Maarten's data and then on the CLPF database. Afterwards, we will formulate predictions for the trisyllabic words.

Insert figure 1 about here

In the Maarten database, wS targets and Sw targets have almost equal truncation rates: 16% (n=334) versus 15% (n=4885). The difference is not statistically significant ($x^2(1)=2.1$ n.s.). The evolution of the attempts at Sw and wS target words is displayed in figure 1 at the ages 1;8, 1;9, 1;10 and 1;11. Figure 1 reveals that the truncation rate of the Sw words changes dramatically. At age 1;8 no less than 69% of the Sw words is truncated. Afterwards there is a sharp decrease to 4% at age 1;11. The evolution of the wS words is less spectacular. It is only from age 1;9 onward that the child begins to produce wS target words (n=13 at age 1;9), but with a relatively low truncation percentage: 8% (1 token). At later ages the percentage of truncations remains relatively stable, between 18% and 8%.

This constellation differs from the predictions in that the wS words never have really high truncation rates: Maarten does not pass through a stage in which truncation is the preferred strategy to obtain trochees. Furthermore, the truncation rates of the wS words do not always outnumber the truncation rates of the Sw words: they are higher at ages 1;10 and 1;11 (age 1;10: $x^2(1)=4.4$ $p<.05$; age 1;11: $x^2(1)=25.6$ $p<.001$), but lower at age 1;9 (Yates'

$x^2(1)=6.6$ $p<.05$). We will explain later that the high truncation rate of Sw words is due to interference of a non-rhythmic factor (the presence of a schwa).

Insert table 4 about here

The truncation percentages of wS and Sw in the CLPF database are displayed in the first two columns of table 4. Conforming to the predictions, all 12 children truncate wS target words more than Sw target words. In order to test the significance of this trend across the children of the CLPF database, we performed a paired t-test on the truncation rates of Sw and wS, as listed in table 4. The t-value was highly significant (t=5.1, df=11, p<.001). We refrained from analyzing these children's developmental patterns as there were not enough tokens to quantify them in a reliable way.

Let us now turn to an analysis of the most common trisyllabic patterns: Sww, Sws, swS, wSw, Ssw. Fikkert's developmental model predicts that the trisyllabic words are truncated until the end of stage 2, in order to accommodate them into a template of one trochee. But from the moment that the template is extended to two trochees (stage 3), all patterns except Sww are produced with the correct number of syllables. Sws, swS and Ssw targets fit the extended template of two trochees directly. wSw targets are accommodated into this template by stressing the first syllable. Only Sww words still loose a syllable. Hence, we expect that all patterns except Sww behave in the same way with respect to truncation. Sww words should be truncated most often and for the longest time.

In the Maarten database, Sww words (n=73) are truncated in 71% of the cases, whereas attempts at other trisyllabic targets are truncated in 32% (n=650) of the cases. So far, the predictions of the TTH are confirmed: Sww is the prosodic pattern that is most often truncated. Less expected is the observation that the other prosodic patterns have different truncation rates: wSw words (n=253) are truncated in 58% of the cases, and the truncation percentage of swS (n=126) is 33%. Sws and Ssw have truncation percentages below 10%. These words should all behave in the same way according to the TTH, but differences emerge in the overall analysis of the Maarten database.

Insert figure 2 about here

The development of the trisyllabic prosodic patterns in the Maarten database is depicted in figure 2. The figure shows the truncation percentages of each trisyllabic prosodic pattern at four ages. Data points that were based on less than 15 tokens were omitted from this figure. (The same frequency criterion will be used in all following analyses.) As expected on the basis of the previous analysis, the truncation rate of the Sww words is the highest at all ages (for which enough tokens were available). The evolution curves of both the wSw words and the swS words are below the evolution curve of the Sww words. The hierarchy between wSw words and swS words is unclear. Whereas wSw words are more often truncated at age 1;10, swS words are more often truncated at age 1;11. The truncation rates of the prosodic patterns Ssw and Sws are still a bit lower. In sum, this analysis suggests the following hierarchy: Sww > wSw/swS > Sws/Ssw.

The attempts at trisyllabic words in the CLPF database are displayed in the last five columns of table 4. Truncation percentages based on less than 15 word attempts are omitted from the table. Again, we expect the highest truncation rates for the Sww words, but this is only true for two children. In general, wSw words are significantly more liable to truncation than Sww words ($t=2.5$, $df=9$, $p<.05$). We do not observe consistent differences between Sww, swS and Sws over children. But as in Maarten's case, Ssw words are at the bottom of the hierarchy: wSw > Sww/swS/Sws > Ssw.

In sum, the prediction that Sww is more often truncated than the other trisyllabic patterns is confirmed for the Maarten database, and appears in two children of the CLPF database. But across children, wSw words are more liable to truncation in the CLPF database. In the two databases, we observe differences among prosodic patterns that were not expected on the basis of Fikkert's model: wSw words have higher truncation rates than most other trisyllabic patterns. Conversely, Ssw words have extremely low truncation rates.

Does truncation always yield a more optimal rhythm?

As the TTH holds that truncation is a means to fit a word into a rhythmic template, truncation patterns have to be shaped in accordance with this template. In Fikkert's version of this hypothesis, the successive prosodic templates are S (stage 0), S(w) (stage 1-2) or S(w)S(w) (stage 3-4).[ii] Consequently, truncation should never result in another prosodic pattern. The prosodic structure wS for instance does not correspond to any of these templates. But do children's truncation patterns ever result in an iamb?

The answer is positive. The Maarten database comprises 203 disyllabic truncations, 130 of which are iambic. This means that a bit more than half of the disyllabic truncations do not fit any of the proposed templates. Examples in (3) are renditions of swS target words. This is no accident: apart from the frequent iambic realizations of the word 'gevallen' (n=95), most other iambic truncations stem from swS words (n=19).

(3) a telefoon /ˌteləˈfon/ (telephone, swS) → [təˈfo] (Maa, 1;10.14)

b gevallen /xəˈvɑlə/ (fallen, wSw) → [xəˈvɑl] (Maa, 1;9.15)

Iambic truncations are not specific to the Maarten database. There are 166 truncations in the CLPF database with the prosodic structure wS or sS. We interpret both prosodic structures as iambs, since sS and wS are hard to distinguish perceptually (Booij, 1995). The proportion of iambs on the total number of disyllabic truncations (n=791) in the CLPF database is 21%. Table 5 shows the number of iambic truncations per child in the CLPF database. Each child produces between one and 35 iambic truncations (average=14). As in Maarten's case, many iambic truncations stem from swS target words (56%, n=93).

Insert table 5 about here

Another consequence of explaining truncations as a means to yield more optimal prosodic structures is that the deletion of a syllable should result in an improvement of the prosodic structure, and not in an equally well-formed pattern. When a target word already fits the template, there is no reason for changing the prosodic structure by means of truncation. Examples (4a-b) illustrate this point: in both examples the child is operating with a S(w)S(w) template, a template consisting of two trochees. Truncation was necessary to accommodate the prosodic patterns of the target words to the S(w)S(w) template: in (4a) the Swwsw pattern of the target word is changed into a Swsw pattern, in (4b) the wSsw pattern is turned into a Ssw pattern. Conversely, (4c) violates the expectation: a syllable is omitted although the target word already fits the S(w)S(w) template. The omission in (4c) was not necessary to bring the target word in correspondence with the prosodic template: before as well as after the omission the word fits the template.

(4) a vogelverschrikker /ˈfoχəlvərˌsχrɪkər/ (scarecrow, Swwsw)
→ [ˈfoχəlˌχɪkə] (En, 2;6.11)

b betonmolen /bəˈtɔnˌmolə/ (concrete mixer, wSsw) → [ˈtɔˈmolə] (En, 2;2.14)

c televisie /ˌteləˈfisi / (television, swSw) → [ˌfiˈtisi] (En, 1;11.8)

How often are Swsw and swSw targets reduced to three syllables? The Maarten database does not contain any trisyllabic truncations of Swsw/swSw words, probably because these words are rare anyway (n=6). Swsw/swSw words (n=436) are attempted more often by the children of the CLPF database. The second column of table 5 provides the total number of attempts per child, and the number of times these attempts consists of three syllables: all children produce such trisyllabic truncations. As the examples in (5) illustrate, most trisyllabic renditions lack the second syllable (86 out of 93 across children).

(5) a macaroni /ˌmakaˈroni/ (macaroni, swSw) → [ˌmaˈkuni] (Ro, 2;0.4)

b televisie /ˌteləˈfisi/ (television, swSw) → [tɑiˈfisa] (No, 2;6.5)

c sinaasappel /ˈsinasˌɑpəl/ (orange, Swsw) → [tsinˈɑpɔ] (Ti, 2;0.18)

We can conclude that truncation does not always yield a more optimal rhythm: a part of the truncated words is iambic, others have an equally optimal rhythm before and after truncation.

Can truncation be explained as a purely rhythmic phenomenon?

Allthough the TTH entails that a word's stress pattern is sufficient to predict the likelihood of truncation, factors below that level in the prosodic hierarchy have also been shown to play a role. Lohuis-Weber & Zonneveld reported in their case-study that syllables with a schwa and with a coda behave differently from other weak syllables. Kehoe & Stoel-Gammon (1997) observed an impact of sonority in their experiment with English-speaking children. Since these observations are not yet widely recognized in the literature, we will try to replicate them.

Schwa In a footnote, Lohuis-Weber & Zonneveld mentioned that the Dutch boy in their study often truncates wordfinal syllables when they contain a schwa, and continues to do so for a long time (until about age 2;10). The same factor affects Maarten's pronunciations of Sw words to a high extent. If the final syllable of a Sw word contains a schwa, as in (6a-b), it is truncated in 22% of the cases (678 out of 3142). This proportion increases up to 35% (519 out of 1483) when we do not count words where the schwa syllable stands for an inflectional ending or a suffix, i.e. diminutives, declined adjectives, plurals, and infinitives on /ə/.[iii] In contrast, Sw words with a full vowel, as in (6c) are truncated in only 3% of the cases (55 out of 1743).

(6)	a sleutel /ˈsløtəl/ (key, Sw)	→	[ˈsøt]	(Maa, 1;9.21)
	b toren /ˈtorə/ (tower, Sw)	→	[ˈto]	(Maa, 1;11.8)

c koffie /ˈkɔfi/ (coffee, Sw) → [ˈkɔfi] (Maa, 1;9.27)

Insert figure 3 about here

In figure 3, the truncation rate of these two types of Sw words is plotted: the Sw words with a full vowel, henceforth Sv words, and the Sw words with a schwa, henceforth Sə words. Data points based on less than 15 tokens are omitted from the figure. A huge discrepancy shows up: Sv words are hardly ever truncated, whereas Sə words have a truncation rate of about 70% at the beginning. Even at age 1;11, Sə words are significantly more often truncated than Sv words ($x^2(1)=25.0$ $p<.001$). Thus, within the Sw pattern almost exclusively Sə words are vulnerable to truncation.

In fact, this factor is entirely responsible for the awkward observation mentioned before that the truncation rate of Sw words exceeds the truncation rate of wS words at age 1;9. Figure 3 demonstrates that if we exclude attempts at Sə words from the comparison, the evolution curve of the wS words always runs below the evolution curve of the Sv words.

Does the vowel type affects other Dutch children's realizations of Sw words? Table 6a contains the truncation rates of Sv words and Sə words for each child in the CLPF database. As in the analysis of the Maarten database, words that result in another well-formed word after truncation of the final schwa are omitted from the analysis. The table shows less extreme truncation rates of the Sə words than in Maarten's case, but they are significantly higher than the truncation rates of the Sv words across children ($t=3.2$, $df=11$, $p<.01$).

Insert table 6 about here

Coda Lohuis-Weber & Zonneveld (1996) found that the child in their case study tends to preserve closed syllables with a coda from early on. There is also a remarkable influence of the presence of a coda on the likelihood of truncation in the Maarten database, at least in initial, weak syllables.[iv] Initial, weak syllables with a coda (n=88) as in (7a-b) are never truncated, whereas initial, weak syllables without a coda (n=489) as in (7c) are truncated in 16% of the cases, a highly significant difference: ($x^2(1)=16.0$ $p<.001$). In the CLPF database, the difference between initial weak syllables with and without coda is less strong than in the Maarten database, but significant (t=2.3, df=7, p=.05). Table 6b reveals that none of the children always preserve initial weak syllables with a coda, but five children preserve them more often than initial weak syllables without a coda.

(7)	a pantoffel /pɑnˈtɔfəl/ (slippers, wSw)	→	[ˈpɔntɔ]	(Maa, 1;9.27)
	b Kristien /krɪsˈtin/ (Kristien, wS)	→	[kɪsˈtin]	(Maa, 1;10.25)
	c kalender /kaˈlɛndər/ (calendar, wSw)	→	[ˈlɛndə]	(Maa, 1;10.19)

Sonority Kehoe & Stoel-Gammon (1997) observed another segmental effect in their study of English-speaking children: they truncated Sws and swS words more frequently when the medial, weak syllable started with a sonorant than when it started with an obstruent. We checked whether this factor plays a role in our databases by analyzing the medial, weak syllable of Dutch swS and Sws words. In the Maarten database, this syllable is truncated in 38% of the cases if it starts with a sonorant (n=69). But if it starts with an obstruent (n=256), the truncation percentage is only 5%. Thus, the weak syllable in words like ‘telefoon’ and ‘Dominiek’ (8a-b) is more often truncated than the weak syllable in words like ‘papegaai’ (8c; $x^2(1)=57.3$ $p<.001$).

(8)	a telefoon /ˌteləˈfon/ (telephone, swS)	→	[ˈteˈfon]	(Maa, 1;10.14)
	b Dominiek /ˌdomiˈnik/ (Dominiek, swS)	→	[dəˈnik]	(Maa, 1;11.8)
	c papegaai /ˌpɑpəˈɣaj/ (parrot, swS)	→	[ˌpɑpəˈɣɑj]	(Maa, 1;10.10)

In the CLPF database, swS and Sws words are influenced by sonority as well (t=3.9, df=7, p<.01). Table 6c shows that weak syllables starting with a sonorant are more often omitted than weak syllables starting with an obstruent by eight out of 12 children.

Thus, we replicated three non-rhythmic factors in children’s truncations that cannot be accounted for by the TTH: (1) Sw words are more frequently truncated if the last syllable contains a schwa; (2) initial, weak syllables with a coda are less often truncated than those without a coda; (3) in swS words and Sws words, the medial syllable is more vulnerable to truncation if it starts with a sonorant. The higher impact of the first two factors in the Maarten database as compared to the CLPF database may be explained by the possibility that these factors are more active in an early stage of development. This stage is less well represented in the CLPF database than in the Maarten database due to differences in data density.

DISCUSSION

As an account for the prosodic development in Dutch-speaking children, the TTH is still the dominant explanation of truncations, whereas this model has been severely criticized in the international literature. Our analysis of Dutch-speaking children's truncations is in keeping with this criticism. At first sight, they seemed to prefer words consisting of one or two trochees. In accordance with the TTH, wS words have higher truncation rates than Sw words in all databases (although this factor only turns up in the Maarten database after taking into account the impact of schwa on Sw words), and Sww words have higher rates than most other trisyllabic words. But against the predictions, the trisyllabic words wSw, Ssw, Sws, swS do not have equal truncation rates: wSw words have higher truncation rates than most other patterns, Ssw words have extremely low truncation rates. Furthermore, disyllabic truncations are often iambic, which is a prosodic structure to avoid according to the TTH. Other truncation patterns do not improve the word's rhythm (Swsw/swSw -> SSw). Moreover, truncation is not only determined by a word's rhythm, but also by factors below that level: the type of the vowel influences truncation, the presence of a coda and the sonority of the onset.

Since these results stem from the same data that underlied the largest Dutch study in favor of the TTH (Fikkert, 1994), the empirical base for this hypothesis shrinks substantially from two studies of all together 14 children to one study of two (Wijnen et al., 1994). As Fikkert did not quantify her results, it is hard to pinpoint the exact reasons for the divergence between her and our results. The difference may be caused by the fact that we were inspired by later studies in Dutch and English to look for counterevidence in less frequent prosodic categories and truncation patterns. For instance, we tried to replicate the observations in the Dutch case-study of Lohuis-Weber & Zonneveld: their child's truncations did not emerge from a trochaic preference. He sometimes produced wS truncation patterns. Furthermore, the likelihood of truncation in his word renditions was influenced by syllable structure (coda vs. no coda) and vowel type (schwa vs. no schwa). Our detailed analysis of Fikkert's data extended with the Maarten database confirmed that.

The Acoustic Prominence Hypothesis that was proposed by Lohuis-Weber & Zonneveld as an alternative explanation, fits to a large extent with our data. The APH holds that children truncate unstressed and non-final syllables because they are unsalient. As a result, words that only contain salient syllables such as Sw words are not vulnerable to truncation. Indeed, we find few truncations in Sw words. On the other hand, wS words are truncated frequently, due to the fact that they start with a weak syllable in non-final position.

Another prosodic pattern that is relatively immune to truncation is the pattern Ssw. All syllables of the Ssw pattern have a high degree of salience, due to their prosodic status or their position: the first two syllables are salient because they are stressed, the last syllable is salient because of its final position (but see below for an exception). The other trisyllabic patterns, i.e. wSw, Sww, swS and Sws, contain one syllable with low prominence, i.e. the weak and non-final syllable, and hence the APH predicts more truncations in these prosodic patterns than in Ssw words. This prediction is confirmed by the data: in the CLPF database as well as in the Maarten database, Ssw words are rarely truncated. Other trisyllabic words have a higher truncation frequency (except the equal rate of the Sws words in the Maarten database).

The APH does not only explain which prosodic patterns are least vulnerable to truncation, but also makes correct predictions concerning the rhythm of the truncated words. First of all, the hypothesis is in keeping with the occurrence of iambic truncations. There is one specific case in which truncation of the non-salient syllable(s) automatically results in an iambic truncation pattern: when the word internal weak syllable is truncated in a swS target word. Indeed, most iambic truncations are attempts at swS target words. Most other prosodic patterns result in a trochaic rhythm after truncation of the word internal weak syllable: wS becomes S, wSw becomes Sw, and Sws becomes Ss. Moreover, the APH explains why target words with the prosodic pattern Swsw/swSw are often rendered without the second syllable (SSw): the second syllable is a non-salient syllable as it does not bear stress and is not in wordfinal position.

When we broaden our definition of prominence beyond the contrasts final-nonfinal and stressed-weak, we can integrate the effects of coda and schwa into the APH by locating syllables with a coda at the higher end of the prominence scale, and syllables with a schwa at the lower end. There are good arguments for doing so. First of all, syllables with a schwa have low prominence in adult Dutch. They are very vulnerable to vowel deletion, and they lack the capacity to bear stress (Booij, 1995). On the other hand, syllables with a coda often attract stress (because they are phonologically 'heavy' or 'superheavy' syllables (Kager 1989), and are less vulnerable to vowel reduction or deletion (Booij, 1995). Moreover, these levels of prominence are reflected in particular phonetic features of schwas and codas. The schwa is the shortest of all vowels (Rietveld & van Heuven, 1997: 76), and its formants are situated in the internal space of the vowel spectrum, in between the other vowels (Van Bergem, 1995). The lack of spectral expansion and the short duration diminish its acoustic salience. In contrast, syllables with a coda are perceived as longer and hence as more salient than syllables without a coda (Goedemans, 1998). A pertinent question is how these factors (or the acoustic features underlying them) interact. However, our data are not sufficiently balanced for determining all possible interactions.

The only factor that does not fit with the APH is the impact of sonority in swS and Sws words. Kehoe & Stoel-Gammon (1997) suggest that this effect originates from the way in which a word is syllabified: if we assume that the sonorant is syllabified with the preceding syllable, then the middle weak syllable is onsetless, hence acoustically less prominent, and thus very liable to truncation.

In conclusion, these Dutch children are probably not primarily guided by a rhythmic preference when they omit syllables from words. Their truncation patterns are better explained by the APH than the TTH. This does not mean that Dutch children do not have a trochaic preference at all. It remains to be evaluated whether rhythmic preferences play a role in other processes in Dutch child language, such as stress shift in words, or the omission of function words.

FIGURE CAPTIONS

Figure 1. The truncation rate of Sw target words and wS target words at four ages in the Maarten database

Figure 2. The truncation rates of swS, Sws, wSw, Sww and Ssw target words in the Maarten database

Figure 3. The truncation rates of Maarten's Sw words with a full vowel ('Sv'), Sw words with a schwa ('Sə') and wS words

TABLE CAPTIONS

Table 1. The four stages of prosodic acquisition according to Fikkert's developmental model

Table 2. Age range, MLU, cumulative vocabulary size, and total number of word tokens per child

Table 3. The number of attempts at multisyllabic words and the percentage of truncations per child

Table 4. The truncation rates of Sw, wS, swS, Sws, wSw, Sww and Ssw words. The number of word tokens of each prosodic pattern are indicated between brackets. Data points based on less than 15 tokens are omitted

Table 5. The number of iambic truncations out of the total number of disyllabic truncations and the number of trisyllabic renditions of Swsw/swSw words out of the total number of attempts at Swsw/swSw words in the CLPF database

Table 6. Impact of three non-rhythmic factors in the CLPF database

Table 1. The four stages of prosodic acquisition according to Fikkert's developmental model

	Sw *ˈpɪŋwɪn*	*wS* *koˈnɛin*	*swS* *ˌteləˈfon*	*Sww* *ˈtekənə*	*wSw* *kaˈbautər*	*swSw* *ˌteləˈfisi*	*swwS* *ˌlokomoˈtif*
0	ˈwɪn	ˈnɛin					
1	ˈpɪwɪn	ˈnɛin	ˈfon	ˈtekə	ˈbɑutə	ˈfisi	ˈtif
2	ˈpɪwɪn	ˈkonɛin	ˈtefon	ˈtekə	ˈbɑutə	ˈfisi	ˈlotif
3	ˈpɪˈwɪn	ˈkoˈnɛin	ˈteləˈfon	ˈtekə	ˈkaˈbɑutə	ˈteləˈfisi	ˈlokoˈtif
4	ˈpɪwɪn	koˈnɛin	ˈteləˌfon	ˈtekə	kaˈbɑutə	ˌteləˈfisi	ˈlokoˌtif

Table 2. Age range, MLU, cumulative vocabulary size, and total number of word tokens per child

Child	*Age range*	*MLU*	*Cumulative vocabulary*	*Word tokens*
Ca	1;10.11 – 2;7.4	1.09 - 3.89	84 – 983	5512
Da	1;11.8 – 2;3.25	1.23 - 1.83	179 – 561	2003
El	1;6.25 – 2;4.29	1.06 - 1.95	21 – 381	1854
En	1;11.8 – 2;6.11	2.06 - 4.82	134-1048	6023
Ev	1;4.12 – 1;11.8	1.05 - 2.30	40 –366	1292
Ja	1;4.18 – 2;4.1	1.00 - 1.50	8 –395	1843
Le	1;10.1 – 2;8.19	1.18 - 3.60	98 –923	5186
Li	1;8.0 – 1;10.3	1.32 - 1.09	44 – 193	535
No	1;7.14 – 2;11.0	1.33 - 2.32	2 – 608	2792
Ro	1;5.11 – 2;4.28	1.00 - 2.77	14 – 882	5089
Ti	1;7.9 – 2;6.12	1.17 - 2.93	5 – 727	3309
To	1;0.24 – 2;3.2	1.00 - 2.38	1 – 605	2272
Ma	1;8.29 – 1;11.15	1.28 – 2.55	49 - 933	19475

Table 3. The number of attempts at multisyllabic words and the percentage of truncations per child

	Attempts at multisyllabic words	*Percentage of truncations*	
		Across sessions	*Start-End*
Ca	2048	7%	18% - 6%
Da	680	8%	18% - 4%
El	636	27%	39% - 24%
En	1889	13%	16% - 17%
Ev	524	22%	16% - 25%
Ja	912	20%	18% - 24%
Le	1933	7%	13% - 2%
Li	265	9%	7% - 10%
No	960	14%	67% - 6%
Ro	1953	13%	27% - 11%
Ti	1345	13%	9% - 9%
To	969	17%	30% - 8%
Ma	6103	17%	63% - 6%

Table 4. The truncation rates of Sw, wS, swS, Sws, wSw, Sww and Ssw words. The number of word tokens of each prosodic pattern are indicated between brackets. Data points based on less than 15 tokens are omitted

	Sw	*wS*	*Sww*	*wSw*	*swS*	*Sws*	*Ssw*
Ca	2%	11%	36%	18%	21%	33%	1%
	(1303)	(169)	(59)	(96)	(68)	(113)	(74)
Da	3%	15%	10%	25%	15%	8%	0%
	(419)	(52)	(58)	(20)	(20)	(39)	(16)
El	9%	91%	74%	75%	90%		
	(457)	(58)	(39)	(16)	(21)	(5)	(11)
En	4%	20%	12%	18%	59%	38%	7%
	(1053)	(155)	(105)	(78)	(95)	(65)	(104)
Ev	7%	71%		98%			13%
	(368)	(24)	(11)	(40)	(14)	(10)	(16)
Ja	10%	67%	64%	91%		53%	
	(695)	(46)	(47)	(33)	(5)	(17)	(11)
Le	1%	20%	12%	33%	23%	7%	3%
	(1183)	(172)	(84)	(86)	(62)	(96)	(65)
Li	6%	12%					
	(215)	(25)	(11)	(2)	(3)	(1)	(3)
No	4%	56%	28%	50%	39%	28%	0%
	(665)	(50)	(18)	(44)	(23)	(29)	(27)
Ro	2%	40%	51%	49%	61%	45%	4%
	(1203)	(82)	(70)	(80)	(46)	(109)	(101)
Ti	3%	39%	16%	64%	45%	38%	2%
	(810)	(80)	(61)	(44)	(49)	(66)	(84)
To	6%	42%	18%	43%	55%	67%	9%
	(621)	(84)	(49)	(30)	(29)	(52)	(23)
Ma	15%	16%	71%	58%	33%	6%	9%
	(4885)	(334)	(73)	(253)	(126)	(204)	(66)

Table 5. The number of iambic truncations out of the total number of disyllabic truncations and the number of trisyllabic renditions of Swsw/swSw words out of the total number of attempts at Swsw/swSw words in the CLPF database

	Iambic truncations	*Trisyllabic renditions of Swsw/swSw words*
Ca	8 (out of 82)	4 (out of 79)
Da	3 (out of 20)	7 (out of 27)
El	7 (out of 55)	1 (out of 6)
En	35 (out of 112)	26 (out of 79)
Ev	9 (out of 60)	1 (out of 16)
Ja	3 (out of 70)	5 (out of 9)
Le	16 (out of 56)	4 (out of 38)
Li	1 (out of 6)	3 (out of 5)
No	11 (out of 44)	14 (out of 36)
Ro	27 (out of 153)	14 (out of 81)
Ti	25 (out of 75)	9 (out of 44)
To	21 (out of 58)	5 (out of 16)
SUM	166 (out of 791)	93 (out of 436)

Table 6. Impact of three non-rhythmic factors in the CLPF database

	a Schwa		*b Coda*		*c Sonority*	
	Sv	*Sə*	*Coda*	*No coda*	*Sonorant*	*Obstruent*
Ca	5% (145)	3% (480)	24% (21)	13% (252)	30% (100)	16% (77)
Da	0% (51)	6% (143)	(11)	18% (62)	8% (26)	6% (33)
El	5% (129)	15% (173)	(3)	89% (71)	81% (21)	(4)
En	3% (207)	9% (226)	14% (64)	19% (178)	67% (100)	22% (59)
Ev	9% (88)	9% (99)	(4)	86% (59)	(9)	(14)
Ja	6% (229)	25% (171)	46% (15)	82% (66)	60% (15)	(7)
Le	2% (209)	2% (363)	18% (45)	24% (229)	17% (70)	5% (84)
Li	3% (37)	6% (50)	(2)	12% (25)	(3)	(1)
No	3% (140)	9% (210)	47% (15)	47% (77)	60% (15)	17% (35)
Ro	2% (310)	6% (280)	33% (21)	48% (148)	44% (64)	39% (69)
Ti	5% (110)	6% (224)	23% (22)	50% (106)	52% (52)	16% (58)
To	3% (127)	14% (246)	5% (22)	44% (95)	71% (41)	34% (32)

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ENDNOTES

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[i] 2;1.3 stands for 2 years 1 month and 3 days.

[ii] At stage 4, the child also allows wS(w) patterns, although they are not optimal. The child has learned that a word may start with a degenerate foot

[iii] The inclusion of this large group of words results in an underestimation of the likelihood of truncation, since it is impossible to identify truncations of their last syllable: if the child truncates the last syllable, she also removes the segmental material of the suffix, and hence her realization is identical to the base form of this word more than the suffixed variant. Consequently, it is impossible for the transcribers to recognize this word form as an attempt at a suffixed word. Instead, they will transcribe it as an attempt at the base form and the truncation will go unnoticed. For the same reason the words ‘ikke’ (emphatic variant of first singular pronoun ‘I’) and ‘ditte’ (emphatic variant of deictic pronoun ‘this’) are omitted in this and further analyses in this section: truncation of the last syllable results in the existing words ‘ik’ (‘I’) and ‘dit’ (‘this’).

[iv] In Dutch the linguistic status of a single consonant after a ‘short’ or ‘lax’ vowel is controversial. Phonologists (Kager, 1989; Booij, 1995) consider the intervocalic l in [bɑˈlɔn] (balloon) as ambisyllabic. However, empirical research shows that preliterate children syllabify [bɑˈlɔn] almost exclusively as bɑ – lɔn and not as bɑl – lɔn. These children’s syllabification patterns do not reveal an ambisyllabic consonant (Gillis & De Schutter, 1996). In this study we adhere to the latter position.