The prosodic structure of single words and word combinations: Evidence from the early multiword stage in German

Angela Grimm

Abstract

This study investigates prosodic characteristics of single words and word combinations in early multiword speech. Utterances of four normally developed German children (mean 19 months, 1 day) were examined with respect to a) the occurrence of Final Syllable Lengthening (FSL) in single words and word combinations and b) the prosodic size and accent pattern of single words and word combinations. It turned out that the rime duration at phrase-final positions was significantly increased as compared to phrase-internal positions ($p < .05$). This indicates that early word combinations are bound to prosodically coherent phrases. Furthermore, word combinations were less restricted in their maximal size and accent patterns than lexical words. The results support recent findings showing that children are aware of the prosodic constraints targeting the word vs. phrasal levels of the prosodic hierarchy, and that they differentiate between these constraints.

1. Introduction

In several studies, it has been shown that prosodic phonology provides an insightful theoretical framework that accounts for the prosodic patterns of children's word productions. For example, it has been argued that children - like adults - organize utterances into syllables, syllables into feet, and feet into prosodic words. Syllables are omitted in children's productions if they cannot be bound into a foot (Gerken 1991, 1996; Fikkert 1994; Archibald 1995; Demuth 1995, 1996). Furthermore, children seem to be aware of prosodic restrictions targeting the internal structure of syllables and feet (Demuth 1996; Salidis and Johnson 1997; Ota 2001).

An open question is how children develop their prosodic system. In this study, I provide support for the recent view that children master different levels of the prosodic hierarchy at the same time as assumed in the *prosodic constraints approach* (Demuth 2001a, 2001b). The evidence comes from the

observation that children's early word combinations were prosodically complex while lexical words still were limited to a single foot. Apparently, prosodic development does not simply proceed stepwise from the low-level units to higher-level units of the prosodic hierarchy (Demuth and Fee 1995, but see Demuth 1995) because in the case of the children investigated here, the intermediary prosodic word level was restricted in shape and size when the children entered into the early multiword stage.

2. Prosodic phonology and language acquisition

Cross-linguistic research reveals that children pass through comparable stages when acquiring word-level prosody (see Kehoe and Stoel-Gammon 1997; Ota 2003: 27-46 for an overview). These stages have been characterized as a gradual extension of the size of prosodic words along the prosodic hierarchy provided in Fig. 1 below:

U	(Utterance)
IP	(Intonational Phrase)
PPh	(Phonological Phrase)
PW	(Prosodic Word)
F	(Foot)
σ	(Syllable)
(μ	(Mora))

Figure 1. The prosodic hierarchy

One principle of the prosodic hierarchy states that a given constituent *n* is immediately dominated by a constituent *n+1* (*strict layer hypothesis*; Selkirk 1984). The strict layer hypothesis requires e.g., that syllables should not be associated directly to the prosodic word layer, but first should be parsed into a foot. However, it has turned out that the formulation of the strict layer hypothesis provided above is too restrictive because it cannot account for cross-linguistic variation in the prosodification of function words (Selkirk 1995: 443, and references therein). Therefore, in Selkirk (1995), the strict layer hypothesis has been split into the primitive constraints LAYEREDNESS, HEADEDNESS, EXHAUSTIVITY, and NONRECURSIVITY. This reformulation of the strict layer hypothesis as a set of violable constraints has important consequences for approaches to prosodic development. For example,

Lleó and Demuth (1999), and Lleó (2001) found cross-linguistic variation in the emergence of determiners among children: The authors reported that German children before 20 months of age consistently omitted determiners. By contrast, 17 month-old children acquiring Spanish already produced determiners. These differences were captured by the respective position of EXHAUSTIVITY in the constraint hierarchy:[1] If EXHAUSTIVITY is ranked at the top of the hierarchy, unfooted syllables (e.g., determiners or weak initial syllables in monomorphemic words) are omitted in children's productions because they must not be associated directly to the prosodic word. This was the case in German. In Spanish, however, EXHAUSTIVITY was ranked low – therefore allowing syllables (here: determiners) to attach directly to the prosodic word level.

Furthermore, Lleó and Demuth (1999) reported cross-linguistic differences in the acquisition of monomorphemic tri- and quadrisyllabic words in German and Spanish. In the earliest word productions, the maximal size of prosodic words corresponded to a single foot in the two languages. However, Lleó and Demuth observed that the German children produced lexical words larger than a single foot *after* they started to combine words, while the Spanish children realized weak initial syllables *before* the early multiword stage. Lleó and Demuth (1999) argued that children's productions of determiners resemble those of monomorphemic tri- and quadrisyllabic words as long as they are prosodified in a similar way in children's grammars.

Lleó and Demuth (1999) also considered that the proportion of tri- and quadrisyllabic word tokens was much higher in the productions of the Spanish than of the German children.[2] Given that children's early vocabulary largely reflects properties of adult speech, the authors suggested that the Spanish children were more exposed to monomorphemic tri- and quadrisyllabic words than German children. Probably, the frequency of (monomorphemic) tri- and quadrisyllabic words in the target language may additionally help to overcome the restriction to a single foot.

For the present study, the data of Lleó and Demuth (1999) and Lleó (2001) are of special interest because they covered the early multiword stage of the German children. The crucial point is that the German children started to combine words while at the same time tri- and quadrisyllabic lexical words were truncated to single feet. Apparently, lexical words were target to a prosodic size restriction – while grammatical contexts allowed for a more complex prosodic structure. A similar pattern has been observed in the acquisition of Spanish: Demuth (2001b) reported that the maximal size of

lexical words in Spanish was constrained to a foot with an optional preceding syllable. In contrast, grammatical structure as e.g., verbal phrases, which are bound into a higher phonological phrase, could exceed the restriction to three syllables. Demuth concluded that there are prosodic constraints applying to the different levels of the hierarchy and that the Spanish children were aware of them (*prosodic constraints approach*, Demuth 2001a, 2001b).

In this study, the prosodic characteristics of single words and word combinations in child German have been investigated. The study deals with the following two questions: First, can the early word combinations indeed be considered as prosodically coherent phrases? Alternatively, early multiword utterances could represent two independent prosodic units which do not conjoin to complex phonological phrases (successive single word utterances; Bloom [1973] 1976: 39-55). This is the topic of Analysis I. The utterances of four German children were examined with respect to the occurrence of Final Syllable Lengthening (FSL). If the duration of phrase-final syllables is increased compared to phrase-internal syllables, it can be hypothesized that the utterances form prosodically coherent phrases because FSL is an indicator of phrasal boundaries in the speech of adults (Delattre 1966; Klatt 1976; Lindblom 1978) and children (Halle, de Boysson-Bardies, and Vihman 1991; Levitt and Wang 1991; Vihman and DePaolis 1998).[3] It further indicates that the children have mastered the phrasal layers of the prosodic hierarchy. The second question is: How does the prosodic pattern of single words differ from that of word combinations? This question will be answered in the second part of the study (Analysis II). Here, the prosodic size and accent patterns of single word utterances will be compared to that of word combinations. If the prosodic development proceeds basically from lower prosodic units to higher ones, word combinations should not be richer in their prosodic structure than single words. On the other hand, if children master the prosodic hierarchy at multiple levels at the same time, richer prosodic structure can be expected in word combinations compared to single word utterances because children can operate upwards and downwards along the prosodic hierarchy.

3. Analysis I: Final syllable lengthening as an indicator of prosodic phrasing

3.1 Introduction

FSL refers to the lengthening of the final syllables of major phrases and sentences. It has been proposed that FSL provides a cue to phrase boundaries (among other cues, e.g., the decrease in F0, see Klatt 1976). Alternatively, FSL is regarded more broadly as an effect of temporal structuring associated with the termination of a structural event (Lindblom 1978). Perception studies showed that young infants are aware of the relationship between FSL and clausal boundaries (Jusczyk et al. 1992) or phonological phrase boundaries (Soderstrom et al. 2003).

However, the extent of FSL is language-specific (e.g., Delattre 1966). Therefore, if children adopt the FSL patterns of their ambient language, cross-linguistic differences are predicted in the strength of FSL in children's productions. Accordingly, in studies comparing English and French, the French children consistently showed a stronger effect of FSL than the English children because the two adult languages make use of FSL to a different degree (Levitt and Wang 1991; Vihman and DePaolis 1998). Also, Japanese children produced almost no FSL since Japanese lacks it (Halle, de Boysson-Bardies, and Vihman 1991).

According to Delattre (1966), adult speakers of German showed a very clear effect of FSL. Therefore, if children's productions reflect the prosodic characteristics of their mother tongue, German children should produce FSL at phrasal boundaries. The prediction is that the final syllables of single word utterances and word combinations should display a longer duration compared to word- and phrase-internal syllables.

3.2. Method

3.2.1. Participants and data

The data were extracted from a longitudinal corpus of four children acquiring German collected by the author: There are three girls (Sandra, Eleonora, and Nele) and a boy (Wiglaf). The children are being raised in middle class

environments with parents who have either a university degree or other professional training. All parents come from Northern Germany.

The children were recorded at home in the presence of a parent and the author. Recordings were made for approximately one year starting with the onset of meaningful speech. The frequency of the recording sessions depended on the children's progress in development. During the earliest phase when the number of word productions increased very slowly, bi-weekly speech samples were taken for 45 - 60 minutes. As soon as the parents reported a rapid increase of the productive vocabulary weekly recordings took place for 30 - 40 minutes.

Table 1 summarizes the recorded period in total, and the periods regarded in Analysis I and Analysis II for each participant respectively (Note: Age of participants is provided in *year; month. day*).

Table 1. Age ranges: Total recording period; in Analysis I, and in Analysis II; per child.

Participant	*Begin and end of recordings*	*Age range Analysis I*	*Age range Analysis II*
Sandra	1;02.10 - 1;11.0	1;07.15 – 1;08.14	1;06.11-1;09.24
Eleonora	1;0.07 – 1;10.25	1;07.15 – 1;08.24	1;07.08-1;09.06
Nele	1;01.22 - 2;0.19	1;07.25 – 1;08.29	1;07.08-1;09.09
Wiglaf	1;03.21 - 2;01.07	1;09.19 – 1;10.13	1;08.06-1;11.03

3.2.2. Apparatus

The speech samples were recorded on a SONY TCD-D8 DAT-recorder using a SONY ECM-MS957 microphone. The microphone was placed in front of the child while she or he was playing with toys or looking at picture books. As far as possible, the utterances are naturalistic and spontaneous. But in order to elicit tri- and quadrisyllabic words, the following plastic animals were introduced into the spontaneous interaction: *Papagei* [pàpagáɪ̯] 'parrot', *Krokodil* [kʁòkodíːl] 'crocodile', *Elefant* [èlefánt] 'elephant', *Kamel* [kaméːl] 'camel', *Giraffe* [giʁáfə] 'giraffe'.

The utterances of the children were digitized with Cool Edit Software at a sampling rate of 44100 in 16bit stereo mode and were transcribed phonetically by the author according to the International Phonetic Alphabet (IPA 1993).

3.2.3. *Methodological considerations*

The analysis of FSL is based on the duration of rimes instead of complete syllables to exclude undesirable effects of syllable onsets. Arguments in favor of measuring rime duration are the following: First, the corpus offered more comparable rimes than comparable syllables. Consider for example the final rimes in *Mama* [máma] 'mommy' or *Opa* [ʔó:pa] 'grandfather': The two word-final rimes were transcribed as [a] – thus the phonetic properties of the rimes should be largely identical. In contrast, the final syllables [ma] and [pa] cannot be conflated because the two different consonantal onsets have different intrinsic properties – which might influence the final result. A second argument against syllables as the basic unit of analysis is the uncertain sub-syllabic status of intervocalic consonants in child German. Intervocalic consonants may either pattern with onsets or codas or as unique (Kehoe and Lleó 2002).[4] Third, in adult German, short vowels are always followed by an ambisyllabic consonant if they occur in open stressed syllables (Becker 1998: 49-58; Féry 2001). For example, the first vowel is short and appears in an open stressed syllable in words such as *Mama* [máma] 'mommy', *Papa* [pápa] 'daddy', *Teddy* [tɛ́di] 'teddy' – thus the intervocalic consonant is ambisyllabic. Ambisyllabic consonants are problematic for the present study because a) there is no syllable boundary in ambisyllabic contexts and b) it is not clear how and when German children learn to produce ambisyllabic consonants. For these reasons, rimes were regarded instead of syllables.

Furthermore, it might be problematic to conflate different vowels in the analysis because vowel height correlates with vowel duration (Lehiste 1970). That is, intrinsic duration decreases with vowel height such that /i/ has the shortest intrinsic duration and /a/ the longest. Therefore, the results could be affected if vowels of different types are distributed differently with respect to their word positions. For example, if the majority of /a/-rimes occurs in final position while /i/-rimes predominantly occur in non-final position, a significant difference between the positions could be due to the distribution of the vowel phonemes. To account for differences in intrinsic vowel duration, the analysis is based on the means for each rime type and position in word.

Finally, to define words and word combinations, a morphosyntactic criterion was applied. Every single instance of a lexical word counted as a word. Word combinations consisted of two or more lexical words. This non-prosodic definition should avoid the circular method of using a prosodic criterion (e.g., pause duration) to find prosodic evidence later on.[5]

3.2.4. *Items analyzed*

Single word utterances and word combinations were extracted from the database and compared according to the following three conditions: The WORD condition includes the word-final rimes of single word utterances e.g., the rime /a/ in (*Mama* [máma] 'mommy'; *Oma* [ʔó:ma] 'grandmother'; *Opa* [ʔó:pa] 'grandfather').[6] The PHRASE-FINAL condition involves word combinations where the rime under investigation occurs in the final position of the rightmost word e.g., the rime /a/ in *da Mama* [da máma] 'there mommy'; *meine Mama* [mâɪnə máma] 'my mommy'; *Eis Mama* [ʔâɪsi máma] 'ice-cream mommy'). The PHRASE-INTERNAL condition contains multiword utterances where the rime occurs in non-final position (e.g., the rime /a/ in *Opa Auto* [ʔòpa ʔâʊto] 'grandfather car'; *Mama auch* [màma ʔâʊ] 'mommy too'; *Gela macht* [gé:la màxt] 'Gela (for 'Angela', proper name) makes'). The study includes the five rime types: /a/, /i/, /o/, /ə/, /m̩/ (m̩ representing a syllabic nucleus).[7]

3.2.5. *Criteria for selection of single words and word combinations*

Only those single word utterances were included in the study which were uttered in parallel to or after the emergence of word combinations. Further selection criteria were:

- Lexical status: To avoid possible effects of the lexical status on duration, only rimes of content words were regarded.
- Word stress: To exclude effects of stress on the rime duration, only rimes in unstressed positions were included. In German, contrasts in vowel quantity are neutralized in unstressed positions, i.e., only vowels in stressed syllables display a long-short contrast (Becker 1998: 52). Due to the restriction to unstressed syllables, differences in rime duration cannot be due to stress or lexical long-short contrasts.
- Intonation: Only those utterances were considered which showed a fall in pitch at the end.
- Time limit: To diminish effects of articulatory improvement over time (Snow 1994), the investigation of FSL was limited to a four-week period. It started with the first recording session containing at least one instance of a given rime occurring in each condition. The mean period of time between the emergence

of the very first word combinations in the data and the first utterances included in the FSL analysis was 11.7 days.

3.2.6. *Acoustic analysis*

The acoustic analysis was performed using PRAAT 4.1 software (Boersma and Weenink 2003). In sum, 368 items were analyzed, 248 in the WORD condition, 56 in the PHRASE-FINAL, and 64 in the PHRASE-INTERNAL condition.

3.3. Results

First, the mean duration was calculated for each rime type and each child separately to control for a) the intrinsic durations of the different rime types, b) the unequal number of rimes per condition and rime type, and c) the different speech rate of the participants. In Table 2, the rime types, their mean durations and standard deviations and the number of rimes per condition are provided.[8]

Table 2. Mean duration (ms.), standard deviation and # items for rime types in WORD, PHRASE-FINAL, and PHRASE-INTERNAL condition.

	WORD			PHRASE-FINAL			PHRASE-INTERNAL		
Rime type	Mean	SD	N	Mean	SD	N	Mean	SD	N
/a/	273.8	55.2	95	276.5	56.4	21	227.6	43.0	36
/i/	331.2	91.3	53	335.9	54.6	11	167.5	66.5	4
/ə/	249.4	47.3	89	259.5	40.18	18	220.9	63.0.0	17
/o/	263.6	1.7	10	277.8	16.1	5	217.1	47.1	6
/m̩/	350.0	0	1	333.0	0	1	260.0	0	1

Taking the mean value for each rime type and condition corrects for the unequal number of values in the raw data. ANOVA was performed based on the means of the mean values with DURATION OF RIME TYPE (i.e., the duration of /a/, /i/, /o/, /ə/, /m̩/) as the dependent variable and CONDITION (WORD, PHRASE-FINAL, PHRASE-INTERNAL) as the independent variable. The results are presented in Fig. 2:

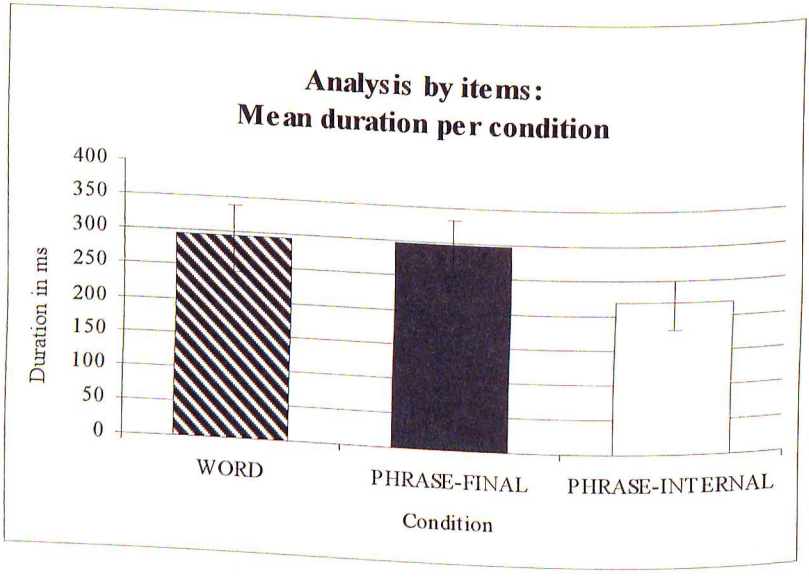

Figure 2. Mean durations of the rimes and standard deviations (ms.) in the WORD, PHRASE-FINAL and PHRASE-INTERNAL conditions in the analysis by items.

A one-way ANOVA revealed a significant difference in the three conditions ($F1$ (2,12) = 6.785, $p < .05$). A post-hoc test (Sheffé) showed that the PHRASE-INTERNAL condition differs significantly from the WORD and PHRASE-FINAL conditions ($p < .05$). The results indicate that the duration of the rimes was significantly shorter at phrase-internal positions than at word- or phrase-final positions.

Analysis by participants: Fig. 3 provides the mean values and standard deviations for the analysis by participants. ANOVA with repeated measures resulted in a significant difference between the three conditions (F (2,6) = 20.516; $p < .005$). The pair-wise comparison again reveals a significant difference between the WORD and PHRASE-FINAL conditions on the one hand and the PHRASE-INTERNAL condition on the other ($p < .05$). The results show that the rime duration is greater at the word- and phrase-final position compared to the phrase-internal position.

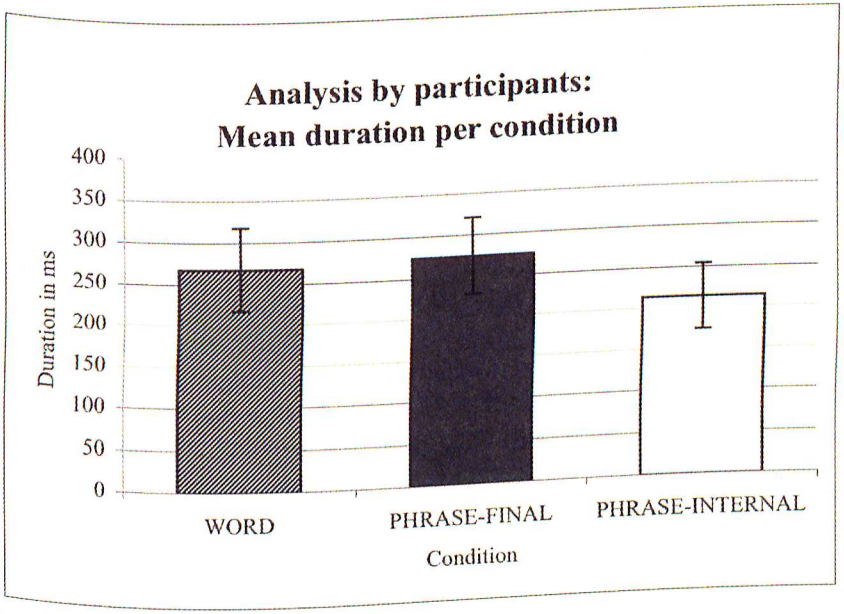

Figure 3. Mean durations of the rimes and standard deviations (ms.) in the WORD, PHRASE-FINAL and PHRASE-INTERNAL position in the analysis by participants.

3.4. Summary and discussion

The occurrence of FSL was investigated to explore whether word combinations form phrasal units. The results indicate that this is the case: Word-final rimes in single word utterances as well as phrase-final rimes in word combinations had a significantly longer duration than phrase-internal rimes.

The results show that the German children were able to realize phrase-level phonetic features when they entered into the early multiword stage. This is contrary to Bloom's (1976) observation that many of the early multiword utterances appear as successive single word utterances with each word forming a separate prosodic unit (although Bloom reported considerable individual differences in the use of such utterances). Instead, it can be concluded from the results above that the German children have acquired phrasal prosody and that

they were "aware of the link between phonology and syntax" (Snow 1994: 8) at the early multiword stage.

The results also correspond to previous work supporting children's sensitivity to the phonetic properties of phrasal boundaries (Jusczyk et al. 1992; Soderstrom et al. 2003). The German children seemed to correlate FSL with phrasal boundaries, and they produced it in the appropriate contexts. This is in line with earlier studies showing that children adopt FSL according to their native language (Levitt and Wang 1991; Halle, de Boysson-Bardies, and Vihman 1991; Vihman and DePaolis 1998).

However, the small number of participants and the restricted time window of this study suggest that caution is required when generalizing the results to an obligatory pattern in the acquisition of German. That the four participants investigated here all produced FSL does not exclude the possibility of individual trajectories. Other German children might realize word combinations predominantly as single successive word utterances – as some of the English children did (Bloom 1976: 43-44).

The main conclusion from Analysis I is that the children had access to prosodic categories higher than the word level because they bound their single word utterances and word combinations into prosodically coherent phrases. However, according to Lleó and Demuth (1999), there are considerable differences between the prosodic structure of single words and word combinations in child German. Therefore, the following analysis will explore the prosodic size and the accent patterns in single words (Analysis IIa) and early multiword utterances (Analysis IIb).

4. Analysis IIa: Prosodic size and accent patterns of single word utterances

4.1. Introduction

Previous studies on children's word structure have noted that the early productions correspond to a single foot in many languages (Fikkert 1994 for Dutch; Gerken 1994; Demuth 1995, 1996; Salidis and Johnson 1997 for English; Demuth 1996 for Sesotho and K'iche'; Lleó and Demuth 1999 for Spanish and German; Ota 2001, 2003 for Japanese). Apparently, in many languages, a maximality constraint limits the upper size of words in early speech.[9] The examples below illustrate that the productions of the German

children of this study also were restricted to a single trochee or a monosyllabic form. As in the German data of Lleó and Demuth (1999), truncation of target words bigger than a single foot took place through the early multiword stage. The following data, which are representative for the structure of single words, provide examples of how target trochees (Table 3), monosyllabic targets (Table 4), multisyllabic target words with non-initial stress (Table 5) and compounds (Table 6) are realized by the children. They are all produced at the early multiword stage.

As the examples in Table 3 show, trochees corresponded to the adult target in their prosodic shape and stress pattern.

Table 3. Production of trochees at the early multiword stage[10]

child production	**adult target**	**written form**	**gloss**
[vás:a] (Wiglaf, 1;09.19)	/vásɐ/	Wasser	'water'
[páta] (Nele, 1;07.25)	/bágɐ/	Bagger	'excavator'
[téla] (Sandra, 1;07.15)	/tɛ́lɐ/	Teller	'plate'
[ʔáfə] (Eleonora, 1;07.15)	/áfə/	Affe	'ape'
[té:sə] (Nele, 1;10.0)	/kǽ:zə/	Käse	'cheese'
[sa͡ufəl] (Wiglaf, 1;10.28)	/ʃa͡ufl̩/	Schaufel	'shovel'
[mó:lə] (Eleonora, 1;08.15)	/mý:lə/	Mühle	'mill'
[núli] (Sandra, 1;08.05)	/ʃnúlɐ/	Schnuller	'dummy'

The prosodic size has also been maintained in monosyllabic words, as shown in Table 4.

Table 4. Production of monosyllabic target words at the early multiword stage

child production	**adult target**	**written form**	**gloss**
[vʊs] (Nele, 1;07.25)	/vʊɐst/	Wurst	'sausage'
[hʊn] (Nele, 1;08.24)	/hʊnt/	Hund	'dog'
[bal] (Eleonora, 1;07.08)	/bal/	Ball	'ball'
[ha͡us] (Eleonora, 1;07.15)	/ha͡us/	Haus	'house'
[ʔa:m] (Sandra, 1;07.08)	/aɐm/	Arm	'arm'
[mɪç] (Sandra, 1;07.15)	/mɪlç/	Milch	'milk'
[ma:k] (Wiglaf, 1;09.19)	/maɐkt/	Markt	'market'
[vɔx] (Wiglaf, 1;09.26)	/lɔx/	Loch	'hole'

In contrast to trochaic and monosyllabic words, targets accented on a non-initial syllable were truncated to a single foot, as shown in Table 5.

Table 5. Production of target words exceeding a single foot at the early multi-word stage

child production	**adult target**	**written form**	**gloss**
[máːnə] (Eleonora, 1;07.15)	/banáːnə/	Banane	'banana'
[meːl] (Sandra, 1;07.29)	/kaméːl/	Kamel	'camel'
[fant] (Wiglaf, 1;09.19)	/èlefánt/	Elefant	'elephant'
[gaɪ̯] (Nele, 1;08.12)	/papagáɪ̯/	Papagei	'parrot'
[háfə] (Sandra, 1;08.05)	/giʁáfə/	Giraffe	'giraffe'
[kaʊ̯] (Eleonora, 1;07.15)	/kakáʊ̯/	Kakao	'cocoa'
[piːɐ] (Wiglaf, 1;09.26)	/papíːɐ/	Papier	'paper'
[máta] (Nele, 1;09.24)	/tomáːtə/	Tomate	'tomato'

The truncation pattern in monomorphemic words as illustrated in Table 5 is well-attested in child language (Fikkert 1994; Gerken 1994; Wijnen, Krikhaar, and den Os 1994; Demuth and Fee 1995; Demuth 1995, 1996; Ota 2001, 2003: 153-158). In contrast, less is known about the development of compounds. Fikkert (2001) reports that compounds initially undergo truncation as monomorphemic tri- and quadrisyllabic words, but that the Dutch acquiring children vary in whether they produce the first or the second part of a target compound. Some of the children realize compounds as two separate feet with equal stress (also called level stress) or merge the two feet to a single trochee. However, although subject to different strategies, early compounds always appeared as a single foot. The examples provided in Table 6 indicate that German children use the same strategies in compounds (except level stress) to keep the single foot limit: They realize the first or the second unit, or they merge the two units of the compound.

In sum, the prosodic structure of the single word utterances confirms Lleó and Demuth's (1999) observation that German children do not produce words comprising more than a single foot until they enter into the early multiword stage. But when do the children start to overcome this restriction on words? To answer this question, the following analysis investigates the development of final prominence in single word utterances.

Table 6. Production of compounds at the early multiword stage

child production	**adult target**	**written form**	**gloss**
[hí:sn̩] (Wiglaf, 1;09.19)	/rí:zn̩rà:t/	Riesenrad	'giant wheel'
[tí:bə] (Sandra, 1;08.14)	/fi:bʊtɛʊmomè:tʊ/	Fieber-thermometer	'clinical thermometer'
[hʏ:ɸ] (Eleonora, 1;07.15)	/bá͡ʊʊnhò:f/	Bauernhof	'farm'
[ʔá͡ɪəʊ] (Nele, 1;07.25)	/ó:stʊá͡ɪʊ/	Ostereier	'easter egg' (colored egg)
[nápa] (Nele, 1;08.29)	/bá͡ʊxnà:bəl/	Bauchnabel	'navel'
[hát:çə] (Sandra, 1;07.15)	/hántʃù:hə/	Handschuhe	'gloves' (pl.)
[pʰé:ti] (Nele, 1,08.12)	/ʃpí:lplá͡ts/	Spielplatz	'playground'
[pʰí:las] (Eleonora, 1;08.26)	/ʃpí:lplá͡ts/	Spielplatz	'playground'

4.2. Criteria for the selection of time period and data

The period considered in the Analyses IIa and IIb started with the first emergence of a word combination in the corpus and was limited to approximately three months thereafter (mean: 2 months, 28 days).[11]

No fixed criterion (as e.g., age in months) has been applied for the analysis because the children entered into the early multiword stage at different ages. Instead, referring to the time window used in Analysis I above provided a more flexible criterion to compare children's productions independently of individual ages. Thus, in Analyses IIa and IIb, the data were grouped into the following four points in time in accordance to the FSL study of Analysis I: Point 1 (P1) covers all data between the emergence of the first word combinations and the onset of the FSL study (mean duration: 11.7 days). Point 2 (P2) includes the data uttered in the first half of the FSL study (mean: 11.2 days) and P3 the second half (mean: 11.5 days). Finally, P4 summarizes three weeks of subsequent recording sessions (mean: 22.5 days).

4.3. Data analysis and results

The analysis regarded all single word utterances with target final accent (e.g., *Papagei* [pàpagâi] 'parrot'; *kaputt* [kapút] 'defective') uttered within the three months as described above (total: N= 170; 100%). In other words, each attempt to produce a target accent-final word has been included in the analysis. Then, the number of word tokens that were indeed realized with final accent were counted (total: N= 26; 15.3%). However, the majority of such single word productions were disregarded because a) they were realized as a monosyllabic form, b) with equal prominence (level stress) or c) stress shifted to the initial syllable in disyllabic productions (total: N= 144; 84.7%). Fig. 4 illustrates the percentage of accent-final productions at the four points in time.

As Fig. 4 shows, the percentage of tokens with final accent started off low and increased slowly until P3. Towards the end of the three-month-period, still less than 50% of the target accent-final words were produced in an adult-like fashion. Crucially, at the onset of combinatorial speech, realizations with final accent were completely absent in the data. This provides support for the earlier finding that German acquiring children extend the prosodic word level after they have mastered phrasal prosodic units (Lleó and Demuth 1999). Furthermore, at the time children entered into the early multiword stage, lexical words were restricted to bear stress at the leftmost syllable while rightward stress was unattested.

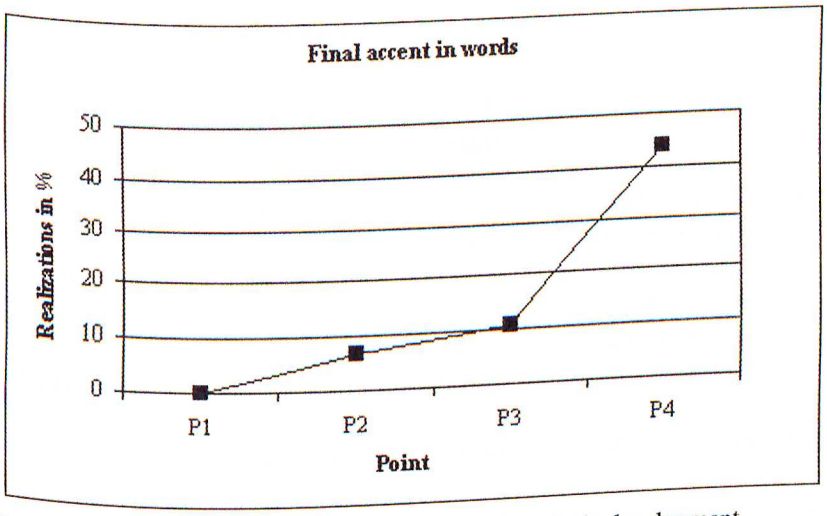

Figure 4. Percentage of accent-final realizations per point in development.

The question is whether the truncation pattern is due to a general inability to assign prominence to the right branch of a prosodic representation. Therefore, the accent pattern of word combinations has been examined to find out whether there was a general preference to stress the leftmost units.

5. Analysis IIb: Prosodic size and accent patterns of the early multiword utterances

5.1. Introduction

The following examples indicate that word combinations were prosodically less restricted than single words. Word combinations often contained more than a single foot, and they showed a more flexible accent pattern where the phrasal accent lay on the second (Table 7) or the first phrasal unit (Table 8).

Table 7. Productions of word combinations with final accent at the early multiword stage

child production	**adult target**	**written form**	**gloss**
[ʔòbm̩ tá͡ʊf] (Wiglaf, 1;10.13)	/o:bn̩ dra͡uf/	oben drauf	'at the top'
[ta vá:fm̩] (Wiglaf, 1;08.06)	/da: ʃla:fn̩/	da schlafen	'there sleep'
[ʔa͡ʊa háfə] (Eleonora, 1;07.15)	/a͡ua afə/	aua Affe	'Ow ape'
[jòna vék] (Eleonora, 1;07.15)	/jo:na vɛk/	Jona weg	'Jona away'
[ta pʌ́s] (Nele, 1;06.26)	/da: pɔst/	da Post	'there mail'
[sèsɛ báj] (Nele, 1;06.26)	/ɪst de:ɐ bal/	ist der Ball	'is the ball'
[gʏ̀nə mâ͡ɪs] (Sandra, 1;07.08)	/gry:nɐ ma͡is/	grüner Mais	'green maize' ('pea')
[ja míja] (Sandra, 1;07.29)	/ja: mari:a/	ja Maria	'yes Mary'

Table 8. Productions of word combinations with initial accent at the early multiword stage

child production	**adult target**	**written form**	**gloss**
[ʔa͡ɪ ʔèsn̩] (Wiglaf, 1;09.26)	/a͡i ɛsn̩/	Ei essen	'egg eat'
[va͡ɪ t̃i:χə] (Wiglaf, 1;10.13)	/ʦva͡i ti:rə/	zwei Tiere	'two animals'
[tá: t̀ɪn] (Eleonora, 1;07.15)	/da: drɪn/	da drin	'there inside'
[ʔána vèk] (Eleonora, 1;07.15)	/hana vɛk/	Hannah weg	'Hannah (proper name) away'
[ʔʌ́sə ʔàf] (Nele, 1;07.09)	/do:zə a͡uf/	Dose auf	'tin open'
[né:ti dà] (Nele, 1;07.09)	/kne:tə da:/	Knete da	'plasticine there'
[míç ʔèndə] (Sandra, 1;07.15)	/mɪlç ɛndə/	Milch Ende	'milk end'
[ʔa͡ɪnɐ tʊ̀ç] (Sandra, 1;07.15)	/a͡in ʃtu:l/	ein Stuhl	'one chair'

Apparently, word combinations could bear final or initial prominence from the onset of multiword speech on. In the following, possible preferences for a particular edge in word combinations will be highlighted.

5.2. Criteria for the selection of time period and data

The word combinations were selected and grouped according to the same criteria applied to the single word utterances before. This is, the word combinations analyzed here are produced within the same recording sessions as the single word utterances from Analysis IIa. Accordingly, the points in time (P1-4) cover sub-periods identical to those of the single word utterances.

5.3. Data analysis and results

The analysis has been restricted to word combinations showing final or initial prominence. Thus, word combinations with final or initial prominence uttered between the onset of multiword speech (P1) and three weeks after the end of the FSL study (P4) were extracted from the database (total: N= 464; 100%). Mere word repetitions were excluded from the analysis even if they displayed a phrase-like intonation. Then the percentage of word combinations displaying final or initial accent was calculated per period (total: N= 237; 51.1% vs. N= 227; 48.9%). Fig. 5 illustrates the percentage of tokens displaying final or initial accent.

Whereas initially the phrases with final accent predominated, the percentage of phrase-initial and phrase-final accents was more balanced in the last two periods. This shows that the children realized leftward and rightward prominence in word combinations: Even if accent-final word combinations are more frequent at the onset of multiword speech, the children produced accent-initial phrases in approximately 40% of the cases at that time.

To summarize, the comparison of single words and word combinations revealed two striking differences between their prosodic shapes: First, lexical words corresponded to a single foot at the onset of combinatorial speech while word combinations could exceed single foot size. Second, while stress had to be assigned to the left edge in lexical words, word combinations allowed for a leftward and rightward prominence. Therefore, it can be concluded that the truncation of longer words to a single foot is not due to a general inability to assign rightward prominence to a prosodic structure. Instead, the fact that lexical words are more constrained than word combinations suggests that the phonological grammar of the children is sensitive to word and phrasal levels of the prosodic hierarchy as proposed in Demuth (2001a, 2001b).

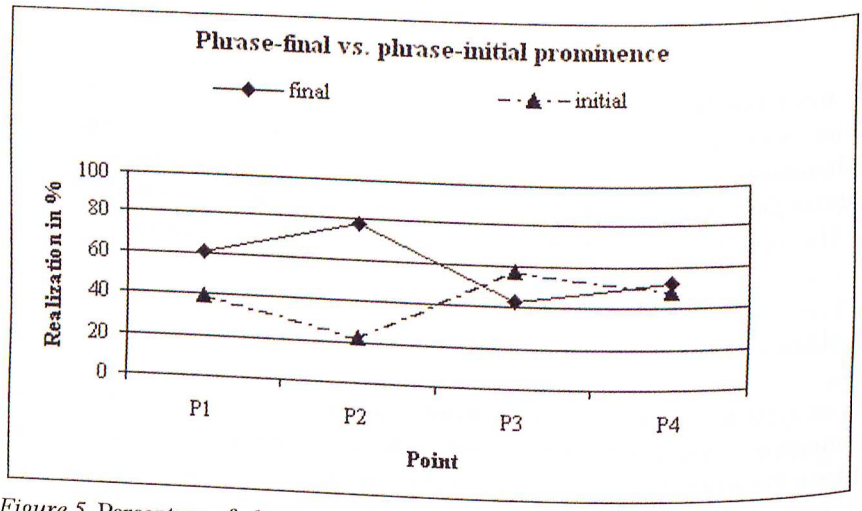

Figure 5. Percentage of phrase-final and phrase-initial accent per point in development

6. General discussion

The present study examined the prosodic characteristics of single words and word combinations at the early multiword stage. There are three main results: First, when starting to produce word combinations, German children were able to integrate utterances into a coherent prosodic phrase. Evidence for this claim comes from the fact a) that there was a graduation in prominence among the constituents forming a complex phrasal unit, and b) that word combinations showed FSL at their rightmost boundary. As Analysis I revealed, the rime duration increased significantly at utterance-final compared to utterance-internal positions. Apparently, the German children have learned from their ambient language that phrasal boundaries are marked by FSL (Delattre 1966). This is consistent with earlier findings showing that children were sensitive to phonetic cues of their mother tongue and that they adopt such features in their own speech (Levitt and Wang 1991; Halle, de Boysson-Bardies, and Vihman 1991; Vihman and DePaolis 1998).

Second, the German children examined here did not build up their prosodic system simply upwards along the prosodic hierarchy. If they did, one would expect an extension of the prosodic word onto more than a single foot before word combinations are attested. Instead, even at the onset of multiword speech, word combinations showed more variable prosodic patterns than words: Word

combinations could contain more than one foot while lexical words still were limited to a single foot. Also, word combinations were realized with various accents while at the same time, disyllabic single word utterances had to be realized with initial stress. This result indicates that the children investigated here could produce more complex structures than a single foot, and they did so in grammatical contexts. Apparently, there are prosodic restrictions on lexical words largely independent of those affecting syntactic phrases – similar to the findings of Demuth's (2001b) on the acquisition of Spanish. The results reported here reflect awareness of word and phrasal levels at the same time – in line with the prosodic constraints approach put forward in Demuth (2001a, 2001b).

Third, the data reported here show that the focus on single words as common in earlier studies (e.g., Fikkert 1994; Demuth 1995; Demuth and Fee 1995) could result in a wrong picture of German children's prosodic capabilities. For example, a 'pure' word-based analysis would lead to the conclusion that the German participants are not operating beyond sub-word levels as long as the word structure does not exceed a single foot. But as the results of this study demonstrate, children do have access to the prosodic hierarchy at more than one level simultaneously. Therefore, to capture prosodic development, a more flexible model is needed which allows for upwards and downwards acquisition of prosodic structure.

But why is there a single foot limit for such a long time in child German? Lleó and Demuth (1999) suggested that the constraint EXHAUSTIVITY is ranked high in child German – thus, the initial unfooted syllables in monomorphemic target words such as *Giraffe* [gi[ʁáfə]$_F$]$_{PW}$ 'giraffe' or *Banane* [ba[ná:nə]$_F$]$_{PW}$ 'banana' are omitted. However, the ranking of EXHAUSTIVITY at the top of the hierarchy fails to account for the omission of the first foot in German monomorphemic targets such as *Papagei* [[pàpa]$_F$[gâi]$_F$]$_{PW}$ 'parrot', or *Elefant* [[èle]$_F$[fánt]$_F$]$_{PW}$ 'elephant' because EXHAUSTIVITY is not violated here. Nevertheless, as the examples in (3) illustrate, initial feet and unfooted syllables were subject to truncation in a similar way in tri- and quadrisyllabic words. Apparently, there are additional factors delaying the acquisition of monomorphemic tri- and quadrisyllabic words in German. One out of these factors seems to be their low frequency in German (Lleó and Demuth 1999), which provides little evidence to overcome the maximality restriction. However, the frequency issue needs a more detailed investigation because the frequency analysis provided in Lleó and Demuth (1999) was restricted to monomorphemic words, which represent only a subpart of the German tri- and

quadrisyllabic vocabulary. Apart from monomorphemic words, the German vocabulary contains numerous morphologically complex words all comprising more than a single foot. For example, a huge number of German nouns are compounds (Ortner et al. 1991). Apparently, German provides enough cues to children that prosodic words can exceed a single foot. I suggest that the late emergence of tri- and quadrisyllabic words might also be related to the interaction of word formation and stress patterns in German. In the unmarked case, German compounds are stressed on the leftmost element while stress in monomorphemic words is rightwards (Giegerich 1985; Féry 1998; Raffelsiefen 2000; Jessen 1999). Also, there are many exceptions to the regular patterns (Jessen 1999). Thus, the problem for children acquiring German is that they not only have to infer morphological structure from the surface structure but they must also infer how prosodic constraints apply to that structure (Grimm submitted). The rich number of exceptions to the regular patterns makes this task more complicated (Peperkamp 2004). Future research will show whether the acquisition of prosodic word structure is indeed more complicated in such languages where the word-internal morphological and phonological structure varies.

7. Conclusion

The present study investigated the prosodic characteristics of single words and word combinations at the early multiword stage in German. As the results indicate, German children bound their early word combinations into prosodically coherent phrases. Moreover, as a comparison of word and phrasal prosody revealed, different constraints were applied to word and phrasal levels of the prosodic hierarchy. Although further research is needed to assess individual trajectories, the data are in line with the prosodic constraints approach put forward by Demuth (2001a, 2001b), which proposes that children have access to different levels of the prosodic hierarchy at the same time.

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Notes

1. EXHAUSTIVITY requires a given prosodic category to be dominated by the next higher category in the hierarchy (Selkirk 1995).
2. Lleó and Demuth (1999) are not explicit in whether they counted type or token frequencies. However, because they calculated the '*proportions* of monosyllabic, disyllabic and multisyllabic (tri- and quadrisyllabic) words in the early target vocabulary' (p. 411), I assume that they regarded the token frequency.
3. There is an ongoing discussion about the prosodic characteristics of early word combinations, dealing mainly with the question of which prosodic diagnostics distinguish 'real' early multiword utterances from successive single word utterances (see Behrens and Gut (to appear) for an overview and recent results). Those studies, however, have not related their results to the function of the prosodic hierarchy in acquisition.
4. Kehoe and Lleó (2002) investigated the following intervocalic consonants: /f, ʃ, t͡s, k, l/. They found individual differences to which sub-syllabic unit a given consonants corresponded.
5. See also Behrens and Gut (to appear) for arguments against prosodic criteria of phrases, for example pause duration.
6. The comparison WORD vs. PHRASE and INTERNAL vs. FINAL actually had a 2x2 design and should contain four conditions: PHRASE-FINAL, PHRASE-INTERNAL, WORD-FINAL and WORD-INTERNAL. Unfortunately, WORD-INTERNAL cannot be investigated due to the lack of non-final unstressed syllables in the data. The condition called WORD thus is identical to WORD-FINAL.
7. In everyday speech, it is common that nasals form the syllable nucleus in unstressed syllables in German. For example, *haben* 'to have' can be pronounced as /háːbən/ or as /háːbm̩/ with /m̩/ as the nucleus of the second syllable. Likewise, *Regen* 'rain' can be pronounced as /ʁéːgən/ or as /ʁéːgŋ̍/ where /ŋ̍/ represents the nucleus, and *Tomaten* 'tomato' (Pl.) as /tomáːtən/ or /tomáːtn̩/ with a syllabic /n̩/ nucleus, and *Tomaten* 'tomato' (Pl.) as /tomáːtən/ or /tomáːtn̩/ with a syllabic /n̩/ representing the nucleus. In the study, only the syllabic /m̩/ is considered.

8. Not each child produced all of the five rime types /a/, /i/, /o/, /ə/, /m̩/. Wiglaf produced the rimes /a/, /o/, /ə/, /m̩/, Sandra /a/, /ə/, Nele /a/, /i/, /o/, and Eleonora /a/, /o/, /ə/. Table 2 provides the mean values per rime type, i.e. the duration and standard deviation and number of items of a particular rime type across all children.
9. The early productions of Portuguese children did not obey maximality restriction because they produced disyllabic iambic and trisyllabic forms from the onset of speech. See Santos (to appear) for Brazilian Portuguese and Freitas, Vigário, and Frota (2004) for European Portuguese.
10. Transcriptions are according to Mangold (2000). Secondary stresses are my additions.
11. As in Analysis 1, a morphosyntactic criterion has been used for the definition of word combinations.

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