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*Approaches to Bootstrapping:
Phonological, lexical, syntactic and neurophysiological
aspects of early language acquisition. Volume 2.*

APPROACHES TO BOOTSTRAPPING

PHONOLOGICAL, LEXICAL, SYNTACTIC
AND NEUROPHYSIOLOGICAL ASPECTS OF
EARLY LANGUAGE ACQUISITION

VOLUME 2

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Prosodic Constraints on Morphological Development

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1. The acquisition of grammatical morphology

Since Roger Brown's (1973) influential work on the acquisition of grammatical morphology by Adam, Eve, and Sarah, the issue of how and when children come to acquire grammatical morphemes has presented a challenge to the field. Since that time there have been several proposals for how and why grammatical morphology might be missing from children's early speech. These proposals have ranged from the primacy of semantics in early grammars (e.g. Braine 1971; Bowerman 1973) to the impoverishment of early syntax (e.g. Guilfoyle & Noonan 1988; Lebeaux 1989; Radford 1990). Yet many syntacticians note that children seem to 'know' that grammatical morphemes exist even if they don't produce them (e.g. Demuth 1992, 1994; Hyams 1992). If this is true, then there needs to be an explanation for this phenomenon.

It has recently been proposed that children's early omission of grammatical morphology is due to *rhythmic production constraints* (e.g. Gerken, Landau & Remez 1990; Gerken 1991; Gerken & McIntosh 1993; Demuth 1994). Under this proposal stressed or strong (S) syllables and the unstressed, or weak (w) syllables that follow them form *trochaic feet* — structures which are seen as playing an important role in determining which syllables will be retained or omitted in children's early speech. Given a wSw sequence of syllables such as in the word *banana*, the *rhythmic production constraints* approach would predict that the second and third syllables — i.e. the Sw trochaic foot *nana*, would surface, the initial weak syllable being deleted unless it could combine with a stressed syllable from a preceding word to form a trochaic foot. This approach seems to account for much of the data around the ages of 2;6–3;6, especially in stress-timed

languages like English and Dutch. It is unclear, however, how it generalizes to earlier stages of acquisition, and how it accounts for the acquisition of grammatical morphology crosslinguistically. To address these issues Demuth (1995, 1996a) and Demuth & Fee (1995) have developed a model of *Prosodic Constraints* which appeals to higher-level prosodic structures such as phonological words and phonological phrases, and shows how early words may be constrained at these different levels of structure. This approach provides a framework for examining earlier stages of prosodic word development not only in stress-timed languages like English, but also in morphologically rich languages where 'stress' or 'syllable prominence' is represented at higher levels of prosodic structure such as the phonological phrase (e.g. French, Sesotho). Furthermore, a theory of *Prosodic Constraints* offers a developmental account of how children eventually move to a more adult-like phonological and morphological grammar.

The purpose of this paper is to account for syllable omission and the emergence of grammatical morphology in early Spanish. The data are drawn from spontaneous productions of Sofia, a child learning Argentinian Spanish, between the ages of 1;8 and 1;9 (Gemari & Demuth 1997). Interestingly, we find that a *rhythmic production constraints* approach makes the wrong predictions about where grammatical morphology should be included or omitted in early speech productions. However, if we determine the prosodic shape of the child's early monomorphemic words, we find that the inclusion of certain grammatical morphemes is actually predicted, providing further support for the presence of *prosodic constraints*.

The paper is organized as follows: After briefly outlining the theory of *Prosodic Constraints* and how it applies in acquisition, we report on the shapes of Sofia's early monomorphemic words and multimorphemic words and phrases, focusing on the emergence of articles, negation, and prepositions. The results of this study are interesting for several reasons. First, they demonstrate how the *Prosodic Constraints* approach to early acquisition can be extended to account for syllable/morpheme omissions in multimorphemic utterances. Second, they indicate that the *prosodic constraints* operating in early Spanish are somewhat different from those found in English. And finally, they provide an explanation for why certain types of grammatical morphology may appear earlier in the speech of Spanish-speaking children than in that of their English-speaking peers. The paper concludes with a discussion of how a theory of *Prosodic Constraints* contributes to a more general *Constraint-based Approach to Language Acquisition*.

2. Prosodic constraints in children's early words

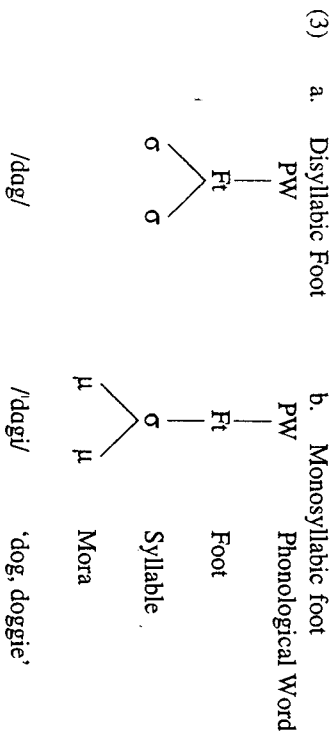
Demuth & Fee (1995) develop a prosodic approach to early phonological word development, showing how English- and Dutch-speaking children gradually learn to exploit units of the Prosodic Hierarchy (Selkirk 1984; Nespor & Vogel 1986), focusing initially on the levels of structure at and below the Phonological Word (e.g. the mora, syllable, Foot, and Phonological Word). These and higher levels of the Prosodic Hierarchy are illustrated in (1) below, along with sample pieces of phrase structure.

(1)	The Prosodic Hierarchy	
	Ut (Phonological Utterance)	<i>I think Sue likes bananas</i>
	IP (Intonational Phrase)	<i>Sue likes bananas</i>
	PP (Phonological Phrase)	<i>likes bananas</i>
	PW (Phonological Word)	<i>bananas</i>
	Ft (Foot)	<i>nanas</i>
	σ (Syllable)	<i>nas</i>
	μ (Mora)	<i>na</i>

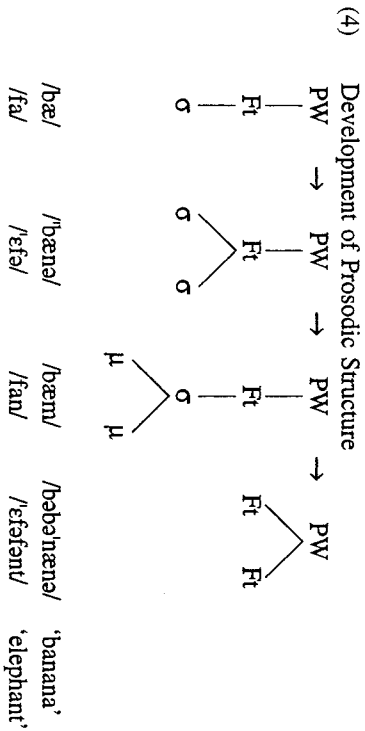
Demuth & Fee (1995) identify four major stages of prosodic word development below (see Fikkert 1994 for similar proposals). Interestingly, epenthetic syllables are sometimes found with trisyllabic targets during later stages of development, resulting in prosodic words composed of two feet.

(2)	Stages in the Development of Phonological Words	
	(e.g. for target = <i>banana</i>)	
	Stage I Core (CV) Syllables	<i>ba, na</i>
	Stage II Minimal Words	<i>nana, bana</i>
	Stage III 1 Stress-Foot	<i>nana, nanas</i>
	Stage IV 2 Stress-Feet	<i>babanana</i>

Many children seem to spend several months at the Minimal Word stage, where the majority of their early Phonological Words take the shape of binary feet, either disyllabic feet like /'dag/ 'dogge/ (3a), or monosyllabic bimoraic feet like /dag/ 'dog/ (3b), where the first mora is the nucleus (vowel) of the syllable, and the second mora either a vowel or coda consonant.



Some children seem to permit Minimal Words of type (3a) first, and then begin to permit Minimal Words of type (3b), allowing for increased complexity at the sub-syllabic level. That is, it appears that children's use of prosodic structure becomes more complex over time. This is outlined in (4), where children's earliest Phonological Words (PWs) are often formed of Core (CV) Syllables, then disyllabic feet, then bimoraic feet, and finally two feet. It is at this later 'stage' that children's utterances become prosodically more complex, being composed of more than one word, and forming a larger Phonological Phrase (PP). We illustrate the development of such structure with the examples /bə'nænəl/ *banana* and /'ɛləfənt/ *elephant*, showing how these words, which have different structures, develop over time (see Fikkert 1994; Demuth & Fee 1995; and Demuth 1996b for specific examples from children's speech).



It would therefore appear that children's early words are *prosodically constrained*, with only a certain amount of prosodic structure permitted. This may be

due to the fact that syllable structure in languages like English and Dutch is especially complex — taking some time to learn, and that keeping words to a Minimal Word length provides the learner with the opportunity to explore the nature of that syllable structure more fully. Alternatively, it may be that Minimal Words are especially prominent in the acquisition of languages like English and Dutch because many of the high frequency words in both these languages tend to be monosyllabic. That is, the presence of a Minimal Word stage of development may have something to do with learnability and language planning factors (e.g. start with small syllables/words — cf. Elman 1991, 1993; Newport 1990) and/or it may reflect children's awareness of the frequency effects of the prosodic structures present in the ambient language.

The identification of these prosodic structures in the early development of languages like English and Dutch raises several questions. First, are these patterns of prosodic development universal? That is, are they found in all children and in all languages? Peters (1983, 1985) has suggested that some English-speaking children do not follow this pattern at all, but begin to speak in larger prosodic chunks where the identification of individual words is difficult at best. We suggest that some children may approach the acquisition of prosodic structure by focusing initially on higher levels such as the Phonological Phrase or the Phonological Utterance. Furthermore, we predict that such a strategy will have serious implications for the acquisition of grammatical morphemes. To test these hypotheses we turn to early words in Sofia's speech, examining the prosodic structure of both monomorphemic and multimorphemic utterances.

The data are drawn from Gennari & Demuth (1997) who report on the longitudinal development of Sofia's early words and utterances between the ages of 1;8 and 2;3 years. Sofia had already begun speaking a few months earlier, so the data do not include her earliest words. In this paper we examine the structure of Sofia's monomorphemic and multimorphemic words and utterances at 1;8 and 1;9 years, focusing specifically on the structure of her Phonological Words (PW) and Phonological Phrases (PP). In so doing we follow Hayes (1995) in determining the nature of Feet and Phonological Words.

3. Prosodic constraints in Early Spanish

Spanish is a language which permits stress on any of the last three syllables of a word (Harris 1983). The default (and most frequent) position for stress is the penultimate syllable of a word. At the lexical level there is no secondary stress: This arises only at the level of the Phonological Phrase, where unstressed

syllables can assume secondary stress, with an alternating SwSw pattern emerging. Given that Spanish exhibits high frequency of trochaic feet, we might expect young Spanish-speaking children to show evidence of trochaic feet in their early utterances.

At 1;8 years Sofia uses both trochaic (5) and iambic (6) words.

- (5) Trochaic Feet
- | | | |
|--------------|---------------------|----------------|
| <i>Child</i> | <i>Adult target</i> | |
| a. [óto] | /róto/ | 'broken' (1;8) |
| b. [káxa] | /káxa/ | 'box' |
| c. [néne] | /néne/ | 'kid' |
| d. [éta] | /ésta/ | 'this' |
- (6) Iambic Feet
- | | | |
|--------------|---------------------|---------------|
| <i>Child</i> | <i>Adult target</i> | |
| a. [papá] | /papá/ | 'daddy' (1;8) |
| b. [mamá] | /mamá/ | 'mommy' |
| c. [aká] | /aká/ | 'here' |
| d. [así] | /así/ | 'in this way' |

Although trochaic words are much more frequent in Spanish than iambic words, it would appear that Sofia has available to her the following prosodic structures.

- (7) a. Trochaic Feet b. Iambic Feet
- | | |
|-------|-------|
| PW | PW |
| | |
| Ft | Ft |
| / \ | / \ |
| σ σ | σ σ |

Alternatively, it could be that the 'iambic' forms are actually more prosodically complex structures which encompass a monosyllabic trochaic foot and a preceding syllable represented at a higher level of structure — i.e. at the level of the PW (8).

- (8)
- | | |
|--------|-------|
| PW | PW |
| / \ | / \ |
| Ft σ | σ σ |

Further support for the presence of PW structures like that in (8) come from Sofia's trisyllabic word targets (9).

- (9) Trisyllabic Targets: wSw > Sw ~ (wSw)
- | | | |
|--------------|---------------------|-----------------|
| <i>Child</i> | <i>Adult target</i> | |
| a. [máka] | /amáka/ | 'hammock' (1;8) |
| b. [manθána] | /mansána/ | 'apple' |
| c. [méka] | /muñéka/ | 'doll' (1;9) |
| d. [ána] | /benána/ | 'window' |
| e. [rba] | /arba/ | 'above' |

Many of the trisyllabic wSw targets are reduced to a Sw trochaic foot, but a few are realized in their full wSw form. Thus, though there seems to be a tendency to omit pre-tonic syllables, as predicted by the *rhythmic production constraint* approach, and to produce only a binary foot (or Minimal Word), Sofia is apparently capable of representing PWs at 1;8 years with the structure given in (10).¹

- (10)
- | | |
|--------|-------|
| PW | PW |
| / \ | / \ |
| σ Ft | σ σ |

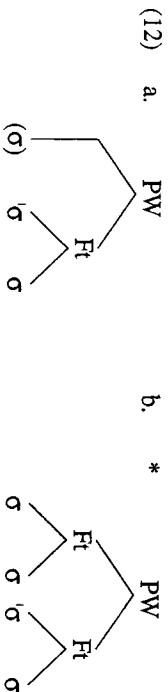
Note that this structure has an initial weak syllable. Lexical items with this type of structure are infrequent in languages like English and Dutch until after the age of two (cf. Smith 1973; Fikkert 1994; Wijnen, Kirrkhar & den Os 1994; Demuth & Fee 1995). Thus, although Sofia at 1;8 years frequently reduces her words to a disyllabic trochaic foot (9), she is also able to produce prosodically more complex structures similar to those found in English- and Dutch-speaking children after the age of 2. It is therefore possible that Sofia uses similar structures, such as that in (8), for representing so-called 'iambic' words rather than having two types of feet — trochaic and iambic.

There are few examples in Sofia's spontaneous speech corpus of trisyllabic targets. However, if she is capable of representing PWs that are larger than a Foot, this should be evidenced in larger PWs as well. Harris (1983) notes that Spanish lexical items undergo 'restructuring at the level of the Phonological Phrase, introducing secondary stress on alternating syllables'. This means that PWs with the lexical structure wSw become SwSw when embedded in a larger PP, or as the only word in an utterance. Consider the following quadrisyllabic targets, where secondary stress falls on the first syllable of the target word.

(11) Quadrisyllabic Targets: SwSw > wSw ~ (Sw)

- | | | | |
|----|--------------|---------------------|------------------|
| | <i>Child</i> | <i>Adult target</i> | |
| a. | [dóro] | /nodoro/ | 'lavatory' (1:8) |
| b. | [kaléra] | /eskalétra/ | 'stairs' |
| c. | [maléra] | /mamadéra/ | 'feeding bottle' |

Here we see that either the initial Sw foot of the word, or the initial S (secondarily stressed) syllable of the word, has been omitted. Under the *rhythmic production constraints* approach the omission of the initial Sw Foot would be completely unexpected, as would the omission of the initial S syllable. Under the *prosodic constraints* account, however, the forms in (11) are expected given what we have already seen with disyllabic and trisyllabic targets in (9) and (10). That is, PWs with the structure in (12a) are allowed, whereas PWs composed of two (binary) feet are not yet permitted (12b).



Thus, we see that Sofia's PWs are *prosodically constrained*, where the upper bound on prosodic structure permitted is a Foot optionally preceded by an unfooted syllable. The prosodic structure in (12b) is therefore apparently prohibited in Sofia's monomorphemic words at this stage of development.²

In this section we have shown that Sofia's monomorphemic PWs at 1;8-1;9 years are generally composed of an optional (unstressed and unfooted) syllable followed by a trochaic foot. Sofia has therefore gone beyond the Minimal Word stage by the age of 1;8 years — a time when the maximal structure found in the speech of many of her English- and Dutch-speaking peers is only a binary foot (Demuth & Fee 1995). There are (at least) two possible explanations for this apparently precocious behavior: First, it could be that Sofia is more advanced than her other Spanish-speaking peers, though Lleo (1997, 1998) reports similar findings of early trisyllabic wSw lexical items from several Spanish-speaking children of around the same age. It therefore appears that Sofia's prosodic word development is typical of other Spanish-speaking children of the same age. Alternatively, then, it may be that the prosodic structure of Spanish differs sufficiently from that of English and Dutch such that the development of Spanish PWs will take a different course. Note that this prosodic difference

would need to prevail despite the fact that the default and most frequent position of stress in Spanish creates a word-final trochaic foot. The data from Sofia are inadequate for fully addressing this hypothesis as they were not collected from the onset of her first words. However, given the higher frequency of polysyllabic words in Spanish, we predict that Spanish-speaking children will begin to represent more complex prosodic word structures at an earlier stage of development than their English- and Dutch-speaking peers. That is, we expect that all children will exhibit *prosodic constraints* in the development of their early words, but also that the prosodic characteristics of the target language will have a major influence in determining the nature of those *prosodic constraints* (cf. Demuth 1996a).

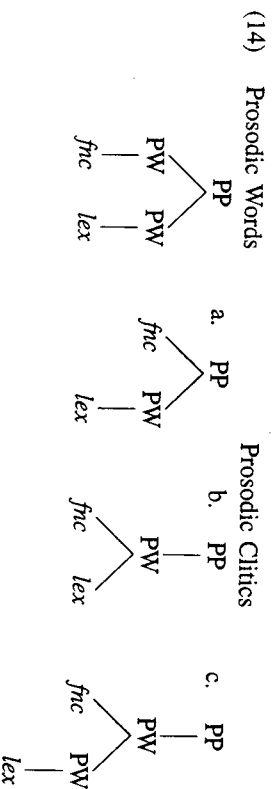
In the following section we explore the implications of the theory *Prosodic Constraints* for the emergence of grammatical morphology.

4. Prosodic constraints and multimorphemic words and phrases

In their theory of prosodic structure Selkirk (1984, 1996) and Nespor & Vogel (1986) show how grammatical morphemes and lexical items within an utterance are prosodically organized into Phonological Words and Phonological Phrases. Selkirk (1996) provides a 'typology' of prosodic structures that grammatical morphemes (or function categories) may assume within a larger Phonological Phrase. These are outlined below, where *fnC* = (closed class grammatical) functional item and *lex* = (open class) lexical item.

- (13) The prosodic status of grammatical function morphemes
- | | | |
|----|-------------------------|---|
| | <i>Prosodic Word</i> | ((fnC) _{PW} (lex) _{PW}) _{PP} |
| | <i>Prosodic Clitics</i> | |
| a. | free clitic | ((fnC (lex) _{PW}) _{PP}) _{PP} |
| b. | internal clitic | ((fnC lex) _{PW}) _{PP} |
| c. | affixal clitic | ((fnC (lex) _{PW}) _{PW}) _{PP} |

These structures can be schematized as follows.

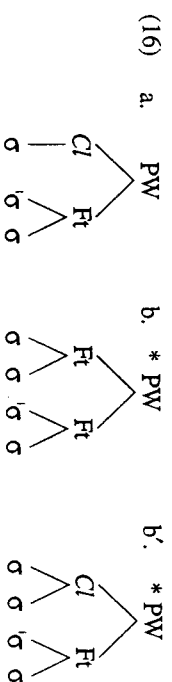


Selkirk (1996) shows that the prosodic structures permitted will vary both from language to language, as well as within a language, depending on the nature of the prosodic characteristics of the grammatical morpheme. For example, *unstressed* English function words such as prepositions, articles, auxiliaries, and pronouns take the structure in (14a), where the function word is prosodified at the level of the PP (e.g. *to Boston, a message, can cook, his picture*). In contrast, *stressed* auxiliaries and pronouns (e.g. *we CAN, HE knows*) are themselves PWs, and combine with lexical items at the level of the PP (14). The structures in (14b) and (14c) occur in other languages, but not in English. We use the above as a starting point for examining the shape of Sofia's multimorphemic Phonological Phrases, and show that she has both the structures in (14a) and (14b) (where function words are prosodified along with the lexical item as a PW), albeit for different grammatical morphemes.

Consider Sofia's quadrisyllabic multimorphemic forms in (15). These consist of either a trisyllabic lexical item plus a grammatical morpheme such as a determiner (*/la muɲéka/* 'the doll'), or a disyllabic lexical item plus a disyllabic determiner (*/una móto/* 'a motorbike'). These quadrisyllabic targets are prosodified in Spanish as SwSw at the level of the Phonological Phrase. Under the *rhythmic constraints* account we would expect such forms to be produced in full, with the determiner included. However, given what we now know about the prosodic constraints operating on Sofia's monomorphemic PWs, the *prosodic constraints* account would predict a trisyllabic wSw form to be produced, and this is exactly what we find.

- (15) Prosodic Clitics (Det): SwSw > wSw
- | | | | |
|----|--------------|---------------------|-------------------|
| | <i>Child</i> | <i>Adult target</i> | |
| a. | [namáka] | /una:amáka/ | 'a hammock' (1:8) |
| b. | [eméka] | /la muɲéka/ | 'the doll' (1:9) |
| c. | [amwéka] | /la muɲéka/ | 'the doll' |
| d. | [namóio] | /una móto/ | 'a motorbike' |

In all cases a maximum of three syllables was produced. When the indefinite article */una/* is used, the initial vowel/syllable is dropped (15a, d). In contrast, the vowel (or an approximation thereof) of the definite feminine article is maintained in (15b, c) and a syllable from the trisyllabic word */muɲéka/* 'doll' is omitted. Neither of these scenarios is expected under the *rhythmic constraints* account, whereas both are possible and expected under a *prosodic constraints* account. The structure that appears to be operative is that in (16a), a structure similar to that seen above in the discussion of monomorphemic PWs (cf. (10) and (12a)).



Cl refers to a *prosodic clitic*, equivalent to Selkirk's *fnc*. Note that the clitic appears to be limited to one syllable — it cannot have the phonological content of a foot. That is, the structure in (16b) is disallowed, as already shown in (12b) above, and its prosodic clitic equivalent in (16b') is no better. It therefore appears that the determiner is prosodified as part of the PW, but it is prosodically limited to one syllable. This is exactly what was found in Sofia's multisyllabic monomorphemic word targets (cf. (12a)).

In addition to noun phrases consisting of Det + Noun, Sofia uses some more complex structures involving either verbs and their complements (e.g. V + N, (Neg +) V (+ Adv)), or prepositions and their complements (e.g. Prep + Det + N). These structures are no longer merely Phonological Words but higher level Phonological Phrases. We might therefore expect more grammatical morphology to be represented. The data are presented in (17).

- (17) Phonological Phrases (V, Neg, Prep): (w)SwSw > (S)wSw
- | | | | |
|----|--------------|---------------------|------------------------|
| | <i>Child</i> | <i>Adult target</i> | |
| a. | [elakása] | /en la kása/ | 'in the house' (1:8) |
| b. | [akáasa] | /a la kása/ | 'to the house' |
| c. | [enóno] | /ase nóno/ | 'to go to sleep' |
| d. | [nonáda] | /no ai náda/ | 'there isn't anything' |
| e. | [egwardáda] | /esá gwardáda/ | 'it is put away' |

Here we see some variation in the shape of the forms actually produced, yet there is also some regularity. In all cases there are two types of constraints that must be satisfied: First, we have already seen that there is an upper bound on the