The Relevance of Metrical Information in Early Prosodic Word Acquisition: A Comparison of Catalan and Spanish

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Abstract

This paper focuses on the development of Prosodic Word shapes in Catalan, a language which differs from both Spanish and English in the distribution of PW structures. Of particular interest are the truncations of initial unstressed syllables, and how these develop over time. Developmental qualitative and quantitative data from seven Catalan-speaking children reveal that maximality constraints are active at two stages, namely, the moraic trochee stage, and the bisyllabic foot stage. One of the noteworthy differences between Catalan and Spanish is the rate of acquisition of weak initial syllables in WS words, as Catalan learners omit initial syllables in WS target iambs for a significantly longer time than Spanish learners, despite the fact that Catalan is a language where the bisyllabic iambic WS pattern is more frequent than in Spanish. We claim that this asymmetry in the course of development of PWs can be attributed to the frequency of exposure to different metrical models. In Catalan (and also in English), the high

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frequency of CVC structures boosts the availability of the moraic trochee in initial stages. Thus the data provide crucial evidence that children at early stages of PW production are especially sensitive to the frequency distribution of foot structure in the input. In general, the behavior of Catalan PW acquisition significantly supports the idea that the course of PW development is strongly influenced by language-specific distributions of prosodic structures (especially feet) in the target language (see Demuth, 1996a, 2001a, 2003; Lleó, 2002; Prieto, Bosch-Baliarda, & Saceda-Ulloa, 2005; and Zamuner, Gerken, & Hammond, 2004, among others).

1 Introduction

In recent years, research on phonological development has convincingly shown that early Prosodic Word (henceforth, PW) production across different languages is largely guided by prosodic conditions and that children's words are circumscribed to consistent size and rhythmic patterns (Demuth, 1996a, 1996b, 2003; Demuth & Fee, 1995; Fikkert, 1994; Kehoe, 1999/2000; Levelt, Schiller, & Levelt, 1999/2000; Lleó & Demuth, 1999; and Pater, 1997, among others). For example, at an initial stage of development, children's productions are minimally a binary foot (or a "minimal word") which tend to conform to a trochaic stress pattern (see Demuth & Fee, 1995; Salidis & Johnson, 1997). Similarly, at later stages (around the age of 2), children's words are maximally bisyllabic (Demuth, 1996a, 1996b; Fikkert, 1994, Kehoe, 1999/2000; Pater, 1997, among others).

Recent evidence indicates that language learners are also sensitive to the properties of the input and that language-specific prosodic evidence is also reflected in the children's early word shapes (Demuth, 2003; Lleó, 2002, 2003; Vihman, Depaolis, & Davis, 1998). For example, Demuth (2003) and Demuth and Johnson (2003) have shown that early PW production in French is characterized by an extended period of development where half of the words consist of a binary foot and the other half of subminimal CV forms which can come from the production of either monosyllabic or bisyllabic targets (e.g., ['pɛɲ] *peigne* > ['pɛ] 'comb', [ma'dam] *madame* > ['da] 'lady', ['pɔm] *pomme* > ['pɔ] 'apple', [ʃo'sɔ̃] *chausson* > ['tɔ̃] 'slipper'; Demuth & Johnson, 2003, p. 223). This violation of the minimality constraint is attributed to language-particular evidence from French, characterized by very few codas and high frequency of subminimal words of the CV type. Similarly, researchers of phonological acquisition have long recognized a contrast in the production of weak initial syllables by Spanish and English children which can be predicted by the exposure to frequent prosodic structures in the target language: while pretonic syllables are acquired very early in Spanish (before 1;6), in English they are often omitted until the age of 2;6 (Demuth, 2001a, 2001b; Gennari & Demuth, 1997; Kehoe, 1999/2000; Lleó & Demuth, 1999; Roark & Demuth, 2000).

The first purpose of this investigation is to examine the acquisition of early words in Catalan and to determine whether early PW production is guided by unmarked maximal and minimal size prosodic restrictions or rather that language-specific statistical properties of the input play an important role in shaping children's early words. The primary empirical basis of this investigation consists of a longitudinal analysis of four Catalan children. This data set corresponds to the Serra-Solé Catalan corpus in the CHILDES website. Systematic longitudinal recordings of four children

(Gisela, Guillem, Laura, and Pep) were collected and transcribed by a team under the direction of Miquel Serra and Rosa Solé in the 1990s. The children were recorded from the one-word stage until four years of age. This corpus is supplemented with early examples from three other children, which belong to a corpus of diary phonetic transcriptions of three children (Lluís, Anna, and Ot) made by the author from ages 1;1 to approximately 2;2. As we will see in Section 2, the Catalan data show evidence for the presence of two maximality constraints which are partly determined by the frequent metrical structures in the language. At an initial stage (between 1;1 – 1;3 years of age) Catalan children display an asymmetry between the production of bisyllabic SW words, which are not truncated (e.g., ['glɔβus] *globus* > ['βɔβu] 'balloon'), and bisyllabic WS words with final stress, which are usually truncated as (W)S ([ə'ki] *aquí* > [ɐ'tʰi] or ['tʰi] 'here'). At the same time, trisyllabic WSW words (amphibrachs) are also truncated by deleting the initial unstressed syllable: [sə'βatə] *sabata*, is pronounced ['batə] 'shoe' and [pi'lɔtɐ] *pilota* > ['tʰɔtɐ] 'ball'. Thus in this period of early PW acquisition, Catalan children display a maximality effect to a moraic trochee. At a later stage (between 1;10 and 2 years of age), Catalan children show a sharp contrast in the production of bisyllabic WS and trisyllabic WSW words: while the former are fully produced, the latter are truncated to conform to a bisyllabic trochee (*pilota* ['tʰɔtɐ] 'ball'). Thus in this late period, Catalan children display a maximality effect to a bisyllabic foot, be it trochaic or iambic. In fact, other prosodic shapes such as ['lampərə] *làmpara* 'lamp', [kuku'ðɾil] *cocodril* 'crocodile' or *hipopòtam* [ipu'pɔtam] 'hippopotamus' are truncated to conform to a bisyllabic output (['ampɐ], [ku'kil], and ['kɔtam] respectively).

Another purpose of this investigation is to examine the crosslinguistic differences in the development of PW shapes between Catalan and Spanish and to test whether the course of PW development can be partly explained by the freqüent prosodic structures found both languages. Catalan provides a good test case for exploring this issue, as this language is prosodically distinct from Spanish and English. In comparison with Spanish, Catalan has more monosyllabic and iambic WS words due to the historical loss of word-final masculine vowel markers (Span. ['kaɾo] *caro* 'expensive' > Cat. ['kar] *car,* Span. [ka'βaʎo] *caballo* 'horse' > Cat. [kə'βaʎ] *cavall*, Span. [ka'βeʎo] *cabello* 'hair' > Cat. [kə'βɛʎ] *cabell*). Given the prosodic structure of Catalan and following the frequency-based hypothesis, we expect young Catalan learners to differ from Spanish in the course of development of PW structures. A recent study about coda acquisition in Catalan and in Spanish has shown that children are extremely sensitive to the frequency distribution of codas in the language: the fact that Catalan-speaking children acquire codas in word-final position earlier than Spanish children can be attributed to the fact that words with final codas are far more frequent in this language (Prieto, Bosch-Baliarda, & Saceda-Ulloa, 2005). Indeed, quantitative data from Catalan and Spanish reveals crosslinguistic timing differences in the appearance of initial unstressed syllables in WS and WSW forms. This data allows us to test the predictions of two competing hypotheses regarding the prosodic domains children are attuned to in early stages of production: specifically, the data will assess whether young learners tend to produce frequent PW structures from the onset of acquisition (what we will call the *PW Frequency hypothesis*) or, instead, tend to be more sensitive to the frequent metrical (foot) structures (what we will call the *Foot Frequency hypothesis*). As

we will see, these two hypotheses make different predictions about what the children's output forms should be. The data demonstrate that foot structure plays a crucial role in early phonological development: the frequent availability of CVC monosyllabic words in Catalan provides a moraic trochee prosodic model that explains why young learners of both languages omit initial unstressed syllables. Taking into consideration metrical patterns succeeds in explaining why Catalan young learners omit the unstressed syllable in WS forms for a significantly longer time than Spanish children, even when bisyllabic WS forms are more frequent in Catalan than in Spanish. In this case, Catalan-speaking children are more sensitive to the availability of common foot structures in the language than to PW shapes.

In sum, the Catalan patterns of early PW truncation differ both from the long-lasting binary foot maximality effects found for English or Dutch (see Demuth, 1996a, 1996b; Fikkert, 1994; Pater, 1997) and from the situation reported for Spanish, where children acquire pretonic syllables of both iambs and amphibrachs quite early (Lleó, 2002; Saceda-Ulloa, 2005). We will argue that both the availability of maximality constraints and the timing differences in the appearance of initial unstressed syllables in Catalan, Spanish, and English can be explained by the different exposure to frequent prosodic patterns of the language.

The article is organized as follows. Section 2 reviews the main properties of Catalan prosodic structure and reports the results of a study about the distribution of PW shapes based on child-directed speech in Catalan and Spanish. Section 3 reports recent results of early PW acquisition in Peninsular Spanish, in particular the acquisition of weak initial syllables. Section 4 describes the methodology used to collect and analyze the longitudinal data. Section 5 presents a qualitative (and partly quantitative) analysis of the production of early PW structures by seven Catalan-speaking children, focusing on size restrictions and the timing of appearance of the initial unstressed syllable. Finally, Section 6 presents a discussion of the Catalan data and a crosslinguistic comparison of early PW development in English, Spanish, and Catalan, in an attempt to establish which factors influence the timing differences in the development of PW structures. The results suggest that language-particular prosodic differences can be successfully predicted by the relative frequencies of metrical structures in the target languages and thus advocate in favor of the *Foot Frequency hypothesis*.

2 Prosodic structure of Catalan and Spanish

In this section, we present the main features of Catalan prosodic structure, focusing on syllabic and prosodic word structure. Catalan syllable structure is relatively simple. The examples in (1) present a typology of the possible syllable structure types found in the language. First, Catalan allows a maximum of two consonants in the onset and a maximum of three consonants in the coda (1d). By far the most common syllable structure type in the language is CV and then CVC, and the presence of more than one consonant in syllable-final position can be considered quite infrequent. Even though the most common consonants in the coda are alveolar (viz., the nasal [n], the fricative [s], the rhotic [r] and the lateral [l]), other consonants are also possible

(especially, in word-final position), namely, plosives /p, t, k, b, d, ɡ/, fricatives /f, ʃ, ʒ/, affricates /d͡ʒ, t͡ʃ/, nasals /m, ɲ/, laterals /ʎ/, and glides /j, w/.

(1)

a. No coda			b. Simple coda		
u	['u]	'one'	*ham*	['am]	'fish hook'
bo	['bɔ]	'good.ms'	*sol*	['sɔl]	'sun'
tro	['tɾɔ]	'thunder'	*gat*	['ɡat]	'cat'
c. Complex coda (2 C)			d. Complex coda (3 C)		
art	['art]	'art'	*erms*	['erms]	'uncultivated.mpl'
part	['part]	'part'	*text*	['tekst]	'text'
trens	['tɾɛns]	'trains'	*bruscs*	['bɾusks]	'abrupt.mpl'

The literature on PW in Catalan has reported some quantitative results about the relative frequencies of different prosodic word shapes. Guasti and Gavarró (2003) and Guasti, de Lange, Gavarró, and Caprin (2004) calculated the prosodic properties of content words in the early Catalan lexicon using a subset of the Serra-Solé Catalan CHILDES data.[1] They report that early Catalan vocabulary has many monosyllabic content words (27%) while multisyllabic words (trisyllabic words or words with more than 3 syllables) are quite infrequent (19%). On the other hand, from the total of disyllabic words (54%), 41% are iambic WS words and 59% are trochaic SW words.

On the other hand, basing her results on the analysis of nominal lexical items beginning with the letters 'b' and 'c' from Diccionari General de la Llengua Catalana (DGLC), a dictionary of Catalan available in digital form, Cabré Monné (1993, p. 89) concludes that the number of SW trochees is approximately double than that of WS iambs.

To be able to strictly compare the relative frequency of PW shapes in Catalan with reports of other languages like Spanish (Roark & Demuth, 2000; Saceda-Ulloa, 2005) or English (Roark & Demuth, 2000), we performed an analysis of the distribution of PW shapes based on child-directed speech. The database consisted of 22,311 words uttered by the mother and the experimenter in 17 files of the Serra-Solé corpus in CHILDES (Pep 1;1.28 to 2;8), extracted using the 'freq' command.

The classification was done manually by the author. From a total of 22,311 words, 7,094 were unstressed clitics (verbal and nominal clitics of the type *ho* 'object clitic', *hi* 'locative clitic', *la* 'the.fem', *el* 'the.masc' and high-frequency prepositions such as *per* 'for'): that is, 31% of the total number of words were unstressed. For the final analysis, only stressed lexical items were included (e.g., nouns, verbs, adjectives, adverbs), leaving out the unstressed words with very high-frequency tokens. This strategy allows for a broader distribution of what the lexicon of a language really looks like. Table 1 provides examples of the word-types used in the classification procedure. In order to test the relevance of the metrical patterns, it was important to code word-types according to stress position (WS, SW, etc.):

[1] The analysis is based on the target content words of 23 files of one child's speech. No child-directed speech was used in the calculations.

Table 1

Word-types used for the classification procedure

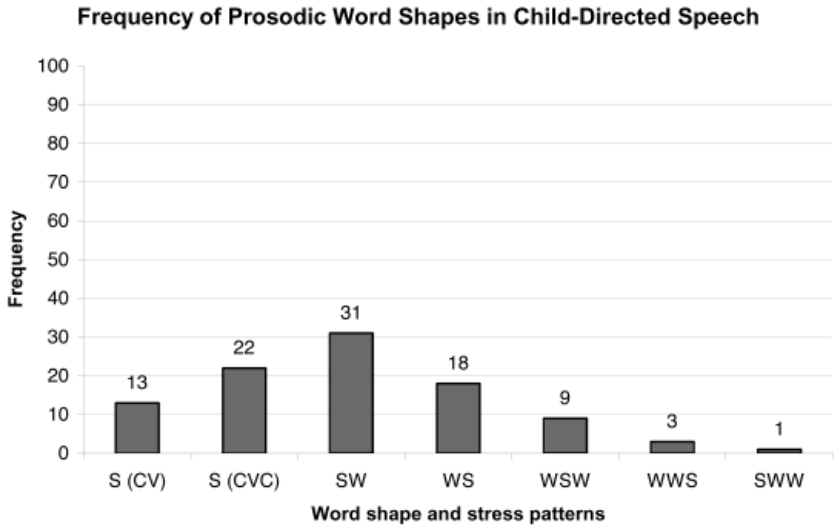
Prosodic word type	*Examples*
Monosyllables (CV)	*pa* 'bread', *vi* 'wine', *bo* 'good'
Monosyllables (CVC)	*tren* 'train', *són* 'they are', *van* 'they go'
Bisyllabic SW (trochees)	*pera* 'pear', *poma* 'apple'
Bisyllabic WS (iambs)	*tractor* 'tractor', *mirar* 'to look at'
Trisyllabic WSW	*pilota* 'ball', *cullera* 'spoon'
Trisyllabic WWS	*angelet* 'little angel', *elefant* 'elephant'
Trisyllabic SWW	*última* 'last', *pàgina* 'page'
Multisyllabic (other)	*animalets* 'little animals', *hipopòtam* 'hippopotamus'

W = weak (unstressed) syllable; S = strong (stressed) syllable

Figure 1 summarizes the relative distribution of PW types in Catalan when only stressed lexical items are included. The total number of words included in this analysis is 15,317. Monosyllables constitute a total of 35%, bisyllables a total of 49%, and trisyllables a total of 13%. Note that the remaining 3% of the data are not accounted for here, as these belong to longer words ('other' in Table 1). Within the monosyllabic group, the majority of words (around 63%) are of the CVC type and the rest (37%) of the CV type. In agreement with previous findings in the literature (Cabré Monné, 1993), among the bisyllabic forms, 63% are trochees and 37% iambs. Finally, among the trisyllabic forms, 72% are WSW words.

Figure 1

Frequency distribution of prosodic word shapes in Catalan child-directed speech.
W = weak (unstressed) syllable; S = strong (stressed) syllable

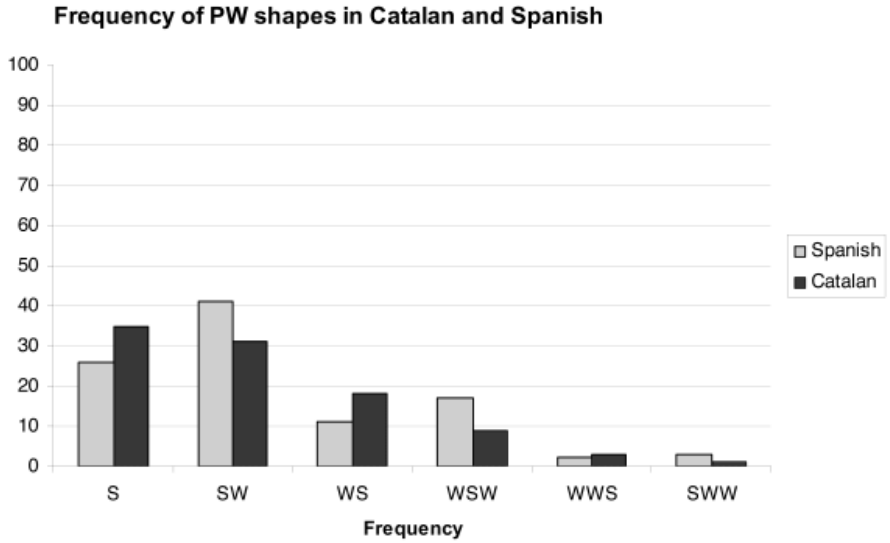


Catalan provides an interesting basis of comparison with the acquisition of PWs in other languages. In comparison to Spanish, Catalan has more monosyllabic and WS words and fewer WSW words due to the systematic historical loss of word-final masculine vowel markers. In fact, many Spanish WSW amphibrachs are equivalent to WS iambs in Catalan (Span. [ka'βaʎo] *caballo* 'horse' > Cat. [kə'βaʎ] *cavall*, Span. [ka'βeʎo] *cabello* 'hair' > Cat. [kə'βɛʎ] *cabell*) and many Spanish trochees are equivalent to Catalan monosyllabic words (Span. ['karo] *caro* 'expensive' > Cat. ['kar] *car*, Span ['mano] *mano* 'hand' > Cat. ['ma] *mà*, Span. ['ramo] *ramo* 'bouquet' > Cat. ['ram] *ram,* Span. ['palo] *palo* 'stick' > Cat. ['pal] *pal*).

Figure 2 compares the distribution of PW shapes in Catalan and Spanish child-directed speech. The Spanish results have been taken from Saceda-Ulloa (2005), and it is directly comparable to the Catalan counts. In her study, Saceda-Ulloa downloaded 12 Spanish files from Irene (0;11–2;6.12, Llinàs-Ojea corpus in CHILDES) and extracted a total of 14,287 words with the CLAN "freq" command. The amount of Spanish data analyzed is less than the Catalan data (Span 14,287 words vs. Cat. 22,311 words). Only stressed lexical items were included in the data analysis and were classified following the same procedure used for the Catalan analysis. Word types were manually counted and distributed into the following metrical classes: S, SW, WS, WSW, SWW, WWS, and so forth.[2] As expected, Catalan contains more

Figure 2

Distribution of PW shapes in Catalan and Spanish child-directed speech (data from Spanish is taken from Saceda-Ulloa, 2005)



[2] We should note that Roark and Demuth's (2000) counts on Spanish child-directed speech are not directly comparable with the Catalan and Spanish data presented here, as these materials included grammatical function items in the monosyllabic forms, thus inflating the monosyllabic counts and depressing all others.

monosyllabic words than Spanish (Cat. 35% vs. Span. 26%), but fewer trochaic SW words (Cat. 31% vs. Span 41%) and trisyllabic WSW words than Spanish (Cat. 9% vs. Span. 17%). The graph also shows that Catalan has more bisyllabic WS iambic words (Cat. 18% vs. 11%).

Unlike Catalan and Spanish, most words in child-directed English speech are monosyllabic binary feet (Roark & Demuth, 2000). Even though the monosyllabic counts in the English results by Roark and Demuth are somewhat inflated because of the inclusion of unstressed monosyllabic items, one of the most remarkable differences among the three languages is the proportion of monosyllables (Eng. 80% versus Cat. 35% and Span. 26%). Another crucial difference is the exposure to bisyllabic SW and WS forms, as well as the exposure to WSW forms. For example, WSW plus WS forms represent less than 10% of all English words.

Our goal will be to test two competing hypotheses regarding the linguistic structure young learners are most sensitive to, namely, the so-called the *PW Frequency hypothesis* and the *Foot Frequency hypothesis*. If children are sensitive to PW shapes directly, we predict that: (a) Catalan-speaking children will produce WS iambic patterns earlier than Spanish-speaking children, as WS words are more frequent in Catalan (Cat. 18% vs. 11%); and (b) Catalan-speaking children will produce WSW amphibrach patterns later than Spanish-speaking children, as WSW words are less frequent in this language (Cat. 9% vs. Span. 17%). By contrast, if language learners are sensitive to metrical structure (rather than precise PW shapes), we would expect a different outcome. Contrary to the prediction of the *PW Frequency hypothesis*, Catalan-speaking children will truncate WS iambic patterns longer than Spanish children, as the larger proportion of monosyllabic forms in Catalan provides the metrical/prosodic model of a moraic trochee for early PW integration.

At this point, let us clarify the theoretical differences between the two hypotheses and the predictions of each for Spanish and Catalan early PW acquisition. On the one hand, the *PW Frequency hypothesis* expects children to be directly sensitive to the frequency of surface PW shapes. The predictions are as follows:

(2) *Predictions of the PW Frequency hypothesis*

1. Earlier acquisition of WS patterns in Catalan than in Spanish, as Catalan has more iambic WS words than Spanish (Cat. 18% vs. Span. 11%).
2. Earlier acquisition of WSW patterns in Spanish than in Catalan, as Spanish has more WSW words than Catalan (Cat. 9% vs. Span. 17%).

On the other hand, the *Foot Frequency hypothesis* predicts that the children's first words will reflect the frequent foot units in the language. The high frequency of monosyllabic words in Catalan provides a metrical model for the integration of early PW shapes, namely, the *moraic trochee* (Catalan 35% vs. Spanish 26%). Moreover, if we assume that iambic WS words are metrified as a moraic trochee preceded by an unfooted syllable (Cabré Monné, 1993), this metrical model is again more frequent in Catalan than in Spanish (18% in Catalan vs. 11% in Spanish). On the other hand, almost half of all words the young Spanish and Catalan learners hear consist of a *bisyllabic foot*, either iambic or trochaic (around 51% in Spanish and 49% in Catalan).

This is why the bisyllabic foot is predicted to be a readily available model of prosodic integration in the two languages.

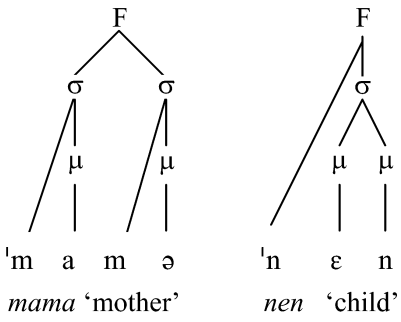
(3) *Predictions of the Foot Frequency hypothesis*

1. Earlier acquisition of WS words in Spanish than in Catalan, as the unmarked foot in Catalan is the moraic trochee.
2. Earlier acquisition of WSW words in Spanish, as SW feet are more frequent in Spanish.

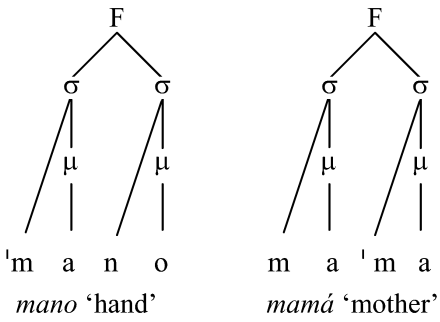
Thus the Catalan and Spanish early preferred Foot structures are exemplified in tree form—that is, Spanish as disyllabic foot, Catalan as moraic trochee:

(4) Early preferred foot structures

a. Catalan: moraic trochee



b. Spanish: disyllabic foot



In the following sections, I will test the different predictions made by the two hypotheses regarding the acquisition of weak initial syllables in WS words.

3 Early PW acquisition in Spanish

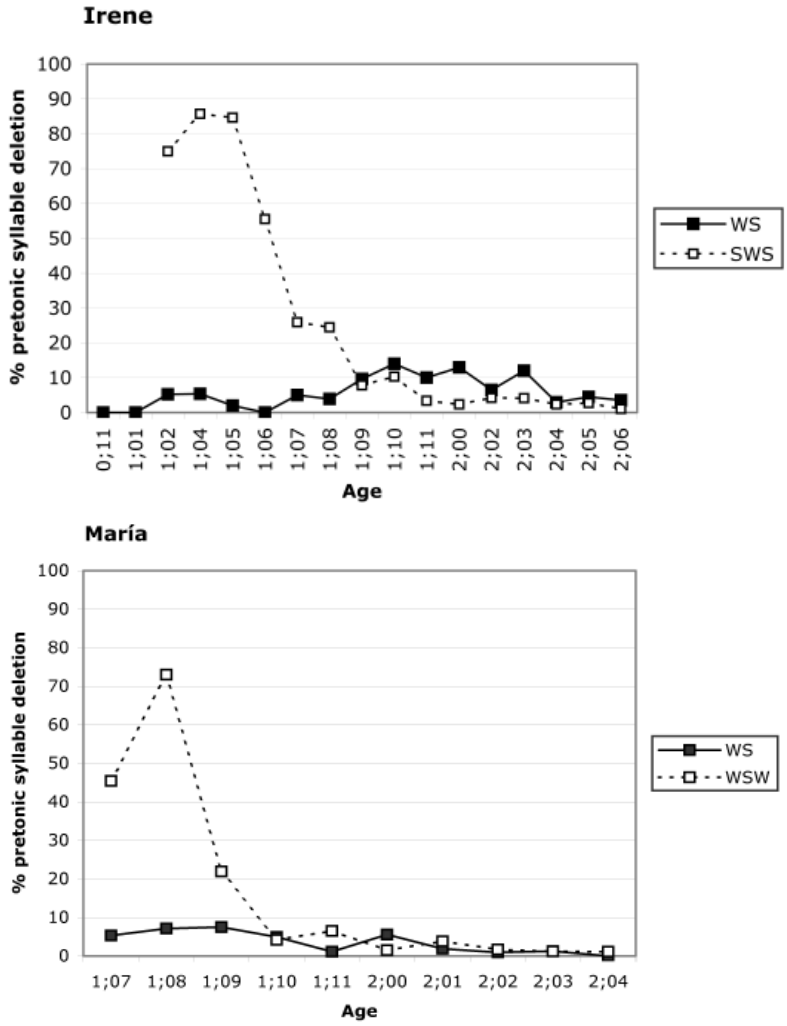
Given the frequency findings for Catalan, and the difference with Spanish and English, we expect crucial differences in PW development. With respect to the timing of appearance of the initial unstressed syllable, it is predicted that English-speaking children should omit the weak syllable for a longer period of time than Romance-speaking children, as the availability of this prosodic model with initial unfooted syllables is very low. As mentioned, this timing difference in the acquisition of weak initial syllables has indeed been reported for Spanish and English (Demuth, 2001a, 2001b; Kehoe, 1999/2000; Gennari & Demuth, 1997; Lleó & Demuth, 1999; Roark & Demuth, 2000).

On the other hand, we also expect that Romance-speaking children will differ in their timing of the production of initial unstressed syllables. The two graphs in Figure 3 show the percentages of initial unstressed syllable omission in WS and WSW words in the course of acquisition for two Spanish children (Irene and María). The longitudinal analysis in Saceda-Ulloa (2005) is based on the speech of two Spanish children from

the Llinàs-Ojea corpus (Irene) and the López Ornat corpus (María) available through CHILDES. Irene and María were recorded one to three times a month. The total number of words analyzed is 12,835 for Irene and 10,887 for María.

Figure 3

Percentages of pretonic syllable deletion in WS words (iambs) and WSW words (amphibrachs) along the time course of development for two Spanish children (Irene and María)—graphs taken from Saceda-Ulloa (2005)



The two graphs in Figure 3 reveal the following. First, Spanish-speaking children produced the initial unstressed syllables of bisyllabic WS words from the start, as we find almost no cases of iambic truncation. This is in accordance with the *Foot Frequency hypothesis*, which predicts that bisyllabic feet will be acquired quite rapidly

in Spanish. Second, the initial unstressed syllable of trisyllabic WSW words appeared around the same period for both languages (perhaps slightly later in Spanish: between 1;10–1;11 in Spanish and 1;9–2;00 in Catalan). The Spanish data from Irene and María are in accordance with previous reports in the literature. In Lleó (2002), even though the data on pretonic syllable truncation in WS and WSW forms were collapsed, she concludes, regarding the rate of truncation of unfooted syllables, that "in Spanish, after the first point at 1;3, it hardly reaches 30% and after 1;8 it is gradually reduced to very low values" (Lleó 2002, p. 298). As Lleó (p.c.) points out, there was a small difference in the treatment of the pretonic syllables of WS and WSW forms: two of the Spanish children truncated the pretonic syllables of amphibrachs for a longer period of time than those of iambs; yet, the other child did not show any difference.

4 The case of Catalan: Database and Methodology

The primary empirical basis for this investigation is an extensive longitudinal corpus of transcribed speech of four Catalan children (Gisela, Guillem, Laura, and Pep) coming from the Serra-Solé corpus on Catalan available in the CHILDES site (MacWhinney & Snow, 1985). The children were selected because both parents used Central Catalan almost exclusively in their family context (they all are from Barcelona). However, they had slightly different degrees of contact with Spanish. While Gisela and Laura had Catalan as the exclusive language of the family setting and also in relation to babysitters, Guillem and Pep each had a Spanish babysitter in the early stages (Pep at 1;00 and Guillem at 0;01). With respect to their contact with Spanish, Pep could actually be considered the child with most contact with Spanish, since his Spanish babysitter took care of him until he went to school (at 2;8). On the other hand, Guillem had two Catalan babysitters after the first year of age. Finally, all children had more regular contact with Spanish after starting day care (Guillem at 1;0, Gisela at approximately 1;1 and Laura at 1;2).

Each child was video-taped on a monthly basis from the start of the 25-word period (between 1;1 and 1;8, depending on the child) up until four years of age. Data was collected following a naturalistic design, that is, spontaneous situations were recorded at home with the mother and the researcher. After recording, the data was transcribed in semiorthographic form by a team directed by Miquel Serra and Rosa Solé. Each child was transcribed by a main transcriber: if the transcriber had transcription doubts, he or she asked three different judges, and, if no consensus was reached, the sequence was considered unintelligible ('xx'). A second transcription round was assigned to another transcriber, who followed the same guidelines. The transcription was done in orthographic form and, if necessary, another level of semiorthographic form (marked with %) was used to codify phenomena such as syllable or coda omissions, and segmental substitutions, as the following examples show.

For our purposes, the level of semiorthographic form was used for three of the children, as it was found to be very reliable for truncation patterns. Currently we are segmenting and phonetically transcribing the Serra-Solé Catalan database using PHON (Rose, Byrne, Wareham, Hedlund, & O'Brien, 2005): for this study, only Pep and a small part of Guillem's data were phonetically transcribed.

(5) Transcription examples from the Serra-Solé CHILDES database

Transcription		Session	Target IPA	Gloss
*CHI: mira	[% 'mia']	Guillem 1;9.12	['miɾə]	'look'
*CHI: aqui	[% 'qui']	Guillem 1;9.12	[ə'ki]	'here'
*CHI: aigua	[% 'baba']	Guillem 1;9.12	['ajɣwə]	'water'
*CHI: aquest	[% 'tet']	Guillem 1;9.12	[ə'kɛt]	'this one'
*CHI: gelat	[% 'at']	Guillem 1;9.12	[ʒə'lat]	'ice-cream'
*CHI: aqui	[% 'ati']	Guillem 1;9.12	[ə'ki]	'here'

Table 2 presents a summary of the Serra-Solé CHILDES data used for this study, including information about the age range and the files and number of words analyzed for each child. For each of the sessions, the number of words was obtained with the 'freq' command in the CLAN program, leaving out the "pfc" and "xxx" transcriptions (not understood by the transcribers). Note that the age range analyzed is different for each child. The data analysis extended from the beginning of the 25-word stage up until the time when the acquisition of prosodic word structure was finalized and the children had achieved almost 100% accuracy in the production of longer words.

Table 2

Description of the Serra-Solé CHILDES Catalan corpus used in the study

Name	*Age Range*	*N of Sessions*	*N of Words*
Gisela	1;7.14–2;6	10	1,459
Guillem	1;1.29–2;5.25	25	2,367
Laura	1;7.20–2;11	13	4,710
Pep	1;1.28–2;8	16	2,626

A secondary source of data is a corpus from three other Catalan children, which consists of a set of phonetically transcribed longitudinal diary notes collected by the author of her two children (Lluís and Anna) and his nephew (Ot). All of them heard Catalan almost exclusively in the family context and only started to have contact with Spanish when they began going to day-care on a regular basis (Anna at 1;7, Lluís at 1;8, Ot at 1;5), although Catalan continued to be the predominant language in the day-care setting, and their babysitters also spoke Catalan to them. The diary data consists of copious notes of the intended target words and actual productions transcribed in IPA at different stages of the children's language acquisition, together with sporadic video recordings. The target words were produced in the course of communicative and home interactions and also include experimental recordings of the children naming a variety of words with different prosodic structures. Table 3 summarizes the diary data used in the study.

Table 3

Description of the diary data of three children (Anna, Lluís, and Ot) used in the study

Name	*Age Range*	*N of sessions*	*N of words*
Anna	1;0–2;6	6+ diary	545
Lluís	1;0–2;6	diary	340
Ot	1;0–2;0	5+ diary	330

Even though this data set is not as large as the Serra-Solé database and is not amenable to quantitative analysis, it supplements the Serra-Solé database in two ways: first, these diary notes were taken exhaustively at the one-word stage (1;1–1;5), which allows us to examine in detail the earliest stages of Catalan PW development. The main advantage of using this data is the access to the detailed phonetic transcriptions of every utterance.

In this study, the level of the prosodic word was used, with no clitics or protoarticles attached. In ambiguous cases, that is, when the pretonic syllable could be either part of the word or a protoarticle, a decision was made depending on the behavior of the protoarticle in other instances of the same session. Thus the following examples from Guillem (all uttered in the same session, 1;11.13) illustrate the coding procedure: the first case was counted as a WSW word and the second as a case of truncation to SW.

(6) a. *CHI: mira la sabata [% “mira a tatata”] ‘look at the shoe’

b. *CHI: la sabata [% “a tata”]? ‘the shoe’

5 Early prosodic word development in Catalan

This section examines the development of early PW structure in Catalan and analyzes size restrictions in early word production. It tries to assess whether either minimality or maximality requirements play a role in predicting early word shapes (§ 4.1 and § 42 respectively).

5.1 *Initial stage: Minimality requirements*

As pointed out above, recent research has shown that children learning a number of unrelated languages exhibit a minimal word stage of development, where early words are both minimally and maximally one binary foot (e.g., for Dutch — Fikkert, 1994; Spanish — Demuth, 2001a; Japanese — Ota, 2003). However, languages with few codas and a large number of monosyllabic forms of the CV type seem to constitute exceptions to the minimality requirement. For example, Rose (2000) shows that many of these CV subminimal forms appear in his longitudinal study of two children learning Québec French, Clara and Théo. Critically, there was no augmentation of CV targets to form a binary foot. Similarly, Demuth (2003) and Demuth and Johnson (2003) have shown that early PW production in Parisian French is characterized by few codas and the high frequency of subminimal CV truncations. As the examples in (7) illustrate,

these CV forms are obtained from target CVC words and from truncated bisyllabic and trisyllabic words. This violation of the minimality constraint is attributed to language-particular evidence from French, which is characterized by very few codas and high frequency of submininimal words of the CV type.

(7) Subminimal early words in French

Target	Child prod.	Orthog.	Gloss	Child and Age
['pɛɲ]	['pɛ]	*peigne*	'comb'	Suzanne 1;5
['pɔm]	['pɔ]	*pomme*	'apple'	Suzanne 1;5
[ʃo'sɔ̃]	['tɔ̃]	*chausson*	'slipper'	Suzanne 1;5
[paʀa'plɥi]	['pi]	*parapluie*	'umbrella'	Suzanne 1;5
[fʀo'maʒ]	['ma]	*fromage*	'cheese'	Suzanne 1;6
[ma'dam]	['da]	*madame*	'Mrs'.	Suzanne 1;6
['vaʃ]	['va]	*vache*	'cow'	Suzanne 1;8

Data from Demuth and Johnson (2003, pp. 223–224)

Let us now consider the lower bounds in early PW production in Catalan. As mentioned in Section 2, a good proportion of input words for Catalan children are monosyllabic (35% of the lexically stressed words are of this type). Of these, the majority are monosyllables with codas in the phonetic representation CVC (around 63%), with the rest (37%) of the CV type. Likewise, Cabré Monné (1993, pp. 87–88) analyzed the syllabic distribution of the monosyllabic nominal lexical entries in the DGLC Catalan dictionary. She concludes that the CVC configuration is the most frequent in monosyllabic words in Catalan (ex. *nen* ['nɛn] 'boy'), while the CV (both with a phonological underlying consonant and without it) is quite marked (ex. *pa* ['pa] 'bread').

Given their moderate exposure to CV monosyllables, it is to be expected that Catalan children will produce more violations of the minimality constraint than children learning other languages with lower exposures to CV words like Spanish. However, if binary feet have a privileged status in children's early grammars, there might be a tendency to augment these to form a binary foot, either through lengthening of the vowel (CVV) or through reduplication (see Ota, 2003, for reports of early augmentation of subminimal words in Japanese). Indeed, the fact that the foot used for hypocoristic formation and minimal word phenomena in Catalan is the moraic trochee (Cabré Monné, 1993) leads us to expect that Catalan-speaking children will avoid the production of subminimal (CV) lexical words in their native vocabulary.

However, none of the Catalan children in this study exhibited minimality effects on outputs and thus easily targeted subminimal forms. Thus there was no evidence of augmentation of CV targets to conform to a binary foot, and most of the monosyllabic words were produced target-like in the early stages.[3]

[3] Please note that the examples given to illustrate the earliest word productions come from Lluís, Anna, Ot, Pep, and Guillem, as the first sessions from Gisela and Laura start later, at 1;7.14 and 1;7.20, respectively.

(8) Subminimal target words: CV > CV

Target	Child prod.	Orthog.	Gloss	Child and Age
['ma]	['ma]	*mà*	'hand'	Ot 1;5.4
['no]	['n̪o]	*no*	'no'	Ot 1;2, Anna 1;1.4
['te]	['tʰe]	*té*	'take this'	Anna 1;1.4, Laura 1;7.20
['pʰa]	['pʰa]	*pa*	'bread'	Lluís 1;3.20, Anna 1;1.4
['si]	['ʃi]	*sí*	'yes'	Lluís 1;3.20, Anna 1;1.4

Moreover, at this early stage Catalan-speaking children show variability in the production of CVC target monosyllables, meaning that some subminimal forms will come from CVC target words. Yet, CVC productions are more commonly targeted as such, as can be seen in the Appendix. This is not surprising, as Catalan young learners begin very early to produce target codas in CVC syllables, many of them with the first attempt.[4] In (9) we list illustrative examples of Catalan children's coda productions in the initial stages of word production. Notice that Laura's production of "light" does have a lengthened vowel which becomes long by compensatory lengthening from the deleted coda consonant. While this process is not uncommon, augmentation in CV targets is typically not found.

(9) CVC target words: CVC > CV(C)

Target	Child prod.	Orthog.	Gloss	Child and Age
['tot]	['tʰo]	*tot*	'all'	Lluís 1;2.20
['ʎum]	['bum]	*llum*	'light'	Lluís 1;3.20
[pər'nil]	['ni]	*pernil*	'prosciutto'	Lluís 1;4.10
['nɛn]	['n̪ɛn̪]	*nen*	'boy'	Anna 1;1.4
['karn]	['tan]	*carn*	'meat'	Anna 1;2; 1;5
['ɲam]	['am]	*nyam*	'to eat'	Guillem 1;4.26
['ʎum]	['buː],['bum]	*llum*	'light'	Laura 1:7.20
['mew]	['mew]	*meu*	'mine'	Pep 1;2.3

To summarize, the fact that early prosodic words in Catalan do not exhibit minimality restrictions on outputs might be indicating that in early periods of development children are specially tuned to the language-particular features of the input. That is, a sufficient exposure to CV word types provides a prosodic model for the production of subminimal words. As Lleó (p.c.), points out, the Catalan data, together with the

[4] For these four children, plosives and glides in coda position are acquired practically from the start and attain a 100% production quite early. In general, nasals are acquired before fricatives, laterals and rhotics, but we find individual variation in the acquisition of the other groups of consonants. For a detailed analysis of the development of codas in Catalan, see Prieto and Bosch-Baliarda (Forthcoming).

French results analyzed by Demuth (2003) and Demuth and Johnson (2003), seem to provide support in favor of the idea that minimality constraints are probably not active in quantity-insensitive languages (which also have subminimal inputs) like French or Catalan. In general, the presence of a minimality constraint in child language has generally been based on the acquisition of target languages that respect minimality, and which are quantity-sensitive languages, like English.

5.2
Maximality requirements

The Catalan-speaking children analyzed in this article produced target-like bisyllabic SW words from the beginning of word production. The data set in (10) shows typical productions of SW patterns in early stages of development of some of the children in this study.

(10) Bisyllabic SW target words: SW > SW

Target	Child prod.	Orthog.	Gloss	Child and Age
[ˈglɔβus]	[ˈβɔβu]	*globus*	'balloon'	Lluís 1;0.15
[ˈpipu]	[ˈpʰupʰu]	*pipo*	'pacifier'	Lluís 1;2.15
[ˈɔlə]	[ˈoːwɐ]	*hola*	'hello'	Lluís 1;2.15, Ot 1;1.15
[ˈmamə]	[ˈmamɐ]	*mama*	'mummy'	Lluís 1;0.10, Guillem 1;1.29
[ˈpapə]	[ˈpʰapʰɐ]	*papa*	'daddy'	Lluís 1;1.10; Ot 1;1.15
[ˈajɣwə]	[ˈβaβɐ], [ˈaβa]	*aigua*	'water'	Pep 1;2.3, Guillem 1;1.29
[ˈgɾasjəs]	[ˈatɐ], [ˈatɐ]	*gràcies*	'thanks'	Guillem 1;1.29, Pep 1;2.3
[ˈd͡ʒeɾe]	[ˈʒeʒe]	*Jere*	'first name'	Lluís 1;6.7
[ˈʎunə]	[ˈumɐ], [ˈunɐ]	*lluna*	'moon'	Lluís 1;6.7
[ˈtɛlə]	[ˈtɛlɐ]	*terra*	'earth'	Lluís 1;6.7
[ˈpomə]	[ˈʔm̥ma]	*poma*	'apple'	Lluís 1;6.7

By contrast, bisyllabic WS patterns were generally reduced to monosyllables, even though they could also be sporadically produced without truncation. For example, within the same session, Guillem (1;9.12) produced the common word [əˈki] *aquí* 'here' in two possible forms, as a bisyllabic iamb [ɐˈti] or with truncation of the pretonic syllable [ˈki]. The data set in (11) lists representative examples of bisyllabic WS, some of which are truncated (11a) and some are not (11b). As the quantitative analysis will show, Catalan children start by omitting the pretonic syllable in WS words in quite a systematic way (between 65% and 80% truncation, depending on the child).

(11) Bisyllabic WS target words: WS > (W)S

a. Truncated forms

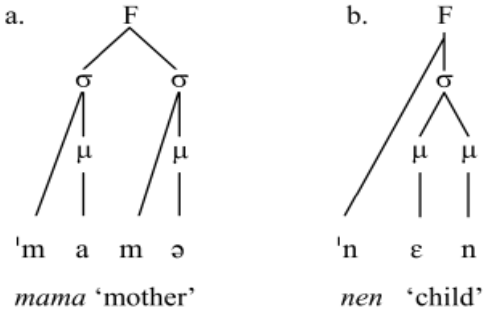
Target	Child prod.	Orthog.	Gloss	Child and Age
[ʒu'an]	['an]	*Joan*	'John'	Lluís 1;6.7
[ə'kɛt]	['kɛ]	*aquest*	'this one'	Guillem 1;4.26
[ʒə'lat]	['at]	*gelat*	'ice-cream'	Guillem 1;9.12
[tɾək'to]	['tʰo]	*tractor*	'tractor'	Laura 1;7.20, Lluís 1;3.20
[pə'pe]	['pe]	*paper*	'paper'	Pep 1;3.23
[sis'plaw]	['paw]	*sisplau*	'please'	Ot 1;6.24
[kə'βaʎ]	['taj]	*cavall*	'horse'	Ot 1;5:24
[kər'ɣɔl]	['kɔl]	*cargol*	'snail'	Ot 1;6.24

b. Nontruncated forms

Target	Child prod.	Orthog.	Gloss	Child and Age
[ə'ti]	[ɐ'tʰi],[ə'ti]	*aquí*	'here'	Lluís 1;6.7, Ot 1;3.4
[gə'tɛt]	[ə'tʰɛ]	*gatet*	'kitten'	Lluís 1;6.7
[ju'ɣur]	[βu'βu], [ɣu'ɣu]	*iogurt*	'yogurt'	Lluís 1;6.7, Anna 1;8.4
[piɲ'ta]	[pi'ta]	*pintar*	'to paint'	Lluís 1;6.7
[dur'mi]	[mi'mi]	*dormir*	'to sleep'	Laura 1;6.24
[βə'βɛ]	[βe'βe]	*bebé*	'baby'	Anna 1;8.4

We claim that, in an initial stage, Catalan-speaking children's early words are maximally a *bimoraic foot* (specifically, a *moraic trochee*), that is, they produce PWs that a maximally a bimoraic foot. This can take the form of either a bisyllabic CVCV word (12a), or a single bimoraic CVC word (12b). This resembles the binary foot maximality effect found for English or Dutch (see Demuth, 1996a, 1996b; Fikkert, 1994; Pater, 1997).

(12) Stage I: Moraic trochee



A word such as *pinta* '(s)he paints', with a first syllable as a bimoraic foot, is prosodically analyzed as a bimoraic foot plus an external syllable that is directly attached to the PW level, conforming also to a moraic trochee, (see Cabré Monné, 1993, p. 98, for such an analysis). Similarly, WS and WSW forms have an initial unfooted syllable. Following Cabré Monné (1993), we assume that syllables are mapped from right to left, demanding that there is a correspondence between the right edge of the truncated word and the right edge of the word. In this way we obtain a truncated word in WS patterns and a nontruncated word in WS patterns. Thus, it is expected that Catalan-speaking children will omit the initial unstressed syllable in bisyllabic WS and in trisyllabic WSW words during this period (see examples in (8) and (11)). Indeed, one should allow for sporadic violations of the maximality constraint, as there are WS forms attested in early stages together with (W)S (see examples in (8b)).

Interestingly, the moraic trochee is the active foot in Catalan adult productive truncation strategies, as Cabré Monné (1993) has demonstrated. In hypocoristic formation, WSW forms such as [kəˈmilə] *Camila*, [iŋˈnazi] *Ignasi*, or [əɲˈtɔni] *Antoni* are truncated to SW forms: [ˈmilə] *Mila,* [ˈnazi] *Nasi*, and [ˈtɔni] *Toni*. Similarly, (W)WS words such as [izəˈβɛl] *Isabel*, [səʒiˈmon] *Segimon*, or [miˈkɛl] *Miquel* are reduced to S forms: [ˈbɛl] *Bel*, [ˈmon] *Mon*, and [ˈkɛl] *Quel* (for a more complete analysis of truncated words in Catalan, see Cabré Monné, 1993, p. 94).

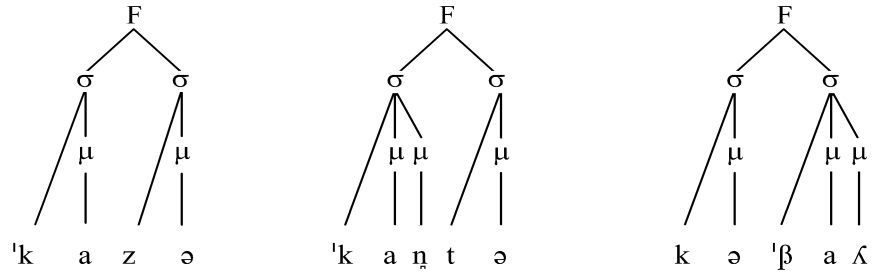
The stage involving truncation of the initial syllable in WS patterns is relatively short-lived, and Catalan-speaking children progressively produce the pretonic syllable over time. Between 1;10 and 2 years of age, all of the seven children in this study showed an asymmetry between the behavior of initial unstressed syllables in WS and WSW words: while the former were fully produced in early stages ([durˈmi] *dormir* > [uˈmi] 'to sleep'), the latter were consistently truncated to a bisyllabic trochee ([piˈlɔtə] *pilota* > [ˈtʰɔtɐ] 'ball').

(13) WSW target words: WSW > SW

[piˈlɔtə]	[ˈtʰɔtɐ]	*pilota*	'ball'	Lluís 1;7.18
[məˈrɪə]	[ˈiːɐ]	*Maria*	'Mary'	Lluís 1;8.23
[iˈɾenə]	[ˈnene]	*Irene*	'first name'	Lluís 1;7.18
[kuˈʎeɾə]	[ˈjejɐ]	*cullera*	'spoon'	Anna 1;6.9
[əˈkɛstə]	[ˈkʰɛkʰa]	*aquesta*	'this'	Anna 1;6.9
[səˈβatə]	[ˈtatɐ]	*sabata*	'shoe'	Anna 1;6.9, Guillem 1;11.13
[əsˈkɔlə]	[ˈkɔlɐ]	*escola*	'school'	Ot 1;6:24

The data suggests that, in this second stage, Catalan children's PWs exhibit a stage in development where their outputs are maximally a *bisyllabic foot*. Crucially, this size restriction has to be computed in number of syllables, and not stress patterns, because the process shows maximality effects to a binary foot, be it trochaic or iambic. Similarly, syllables can be both monomoraic or bimoraic, as (15) shows.

(15) Stage II: Bisyllabic



Not surprisingly, the bisyllabic upper bound in PW production shows up in multisyllabic words, which are also reduced to a bisyllabic foot. The data set in (16) illustrates how Anna consistently reduces her multisyllabic word targets to a bisyllabic foot, be it SW or WS. The words come from diary data transcribed when she was 2;1.10, all words produced in the same session.

(16) Multisyllabic target words (examples from Anna 2;1.10)

Target	Child	Orthog.	Gloss
Multisyllabic: (W)WSW > SW			
[pɾinˈsɛzə]	[ˈkɐ̯ɕɐ̯]	*princesa*	‘princess’
[kuˈɾonə]	[ˈkonɐ̯]	*corona*	‘crown’
[oˈliβjə]	[ˈjimjɐ̯]	*Olivia*	‘first name’
[ipuˈpɔtam]	[ˈkɔtɐ̯m]	*hipopòtam*	‘hippopotamus’
[təˈlɛfun]	[ˈkɐ̯fu]	*telèfon*	‘telephone’
[səˈβatə]	[ˈbatə]	*sabata*	‘shoe’
[əðɾiˈanə]	[ˈganɐ̯]	*Adriana*	‘first name’
[kəpuˈt͡ʃɛtə]	[ˈtɛtə]	*caputxeta*	‘little hood’
Multisyllabic: (W)WWS > WS			
[bəɲəˈðo]	[kɐ̯ˈjo]	*banyador*	‘swimming suit’
[kukuˈðɾil]	[kuˈkil]	*cocodril*	‘crocodile’
[ələˈfan]	[ɐ̯ˈɸan]	*elefant*	‘elephant’
[rətuˈlins]	[kuˈlin]	*ratolins*	‘mice’
[ˈʃupəˈʃup]	[kɐ̯ˈcu]	*xupa-xup*	‘lollipop’

In order to evaluate the strength of the bimoraic and bisyllabic word maximality effects across time, a quantitative analysis of the truncation of the initial unstressed syllable was performed. The following three graphs in Figure 4 compare the omission rates of pretonic syllables in WS iambs and WSW amphibrachs for three children (Laura, Gisela, and Guillem) in the course of their development. Importantly, these graphs are directly comparable to those produced for the young Spanish learners in Figure 3. These children are the ones for which we have systematic quantitative data recorded for almost every month. The data for Pep will be analyzed in the following section because of his special PW acquisition patterns, which we attribute to the fact that he had more contact with Spanish than the rest of the children. The period investigated for each child starts with the session containing a minimum of six representative examples of each word type and ends with the session where no pretonic deletion was found (note that in early stages graphs do not display data points for amphibrachs).

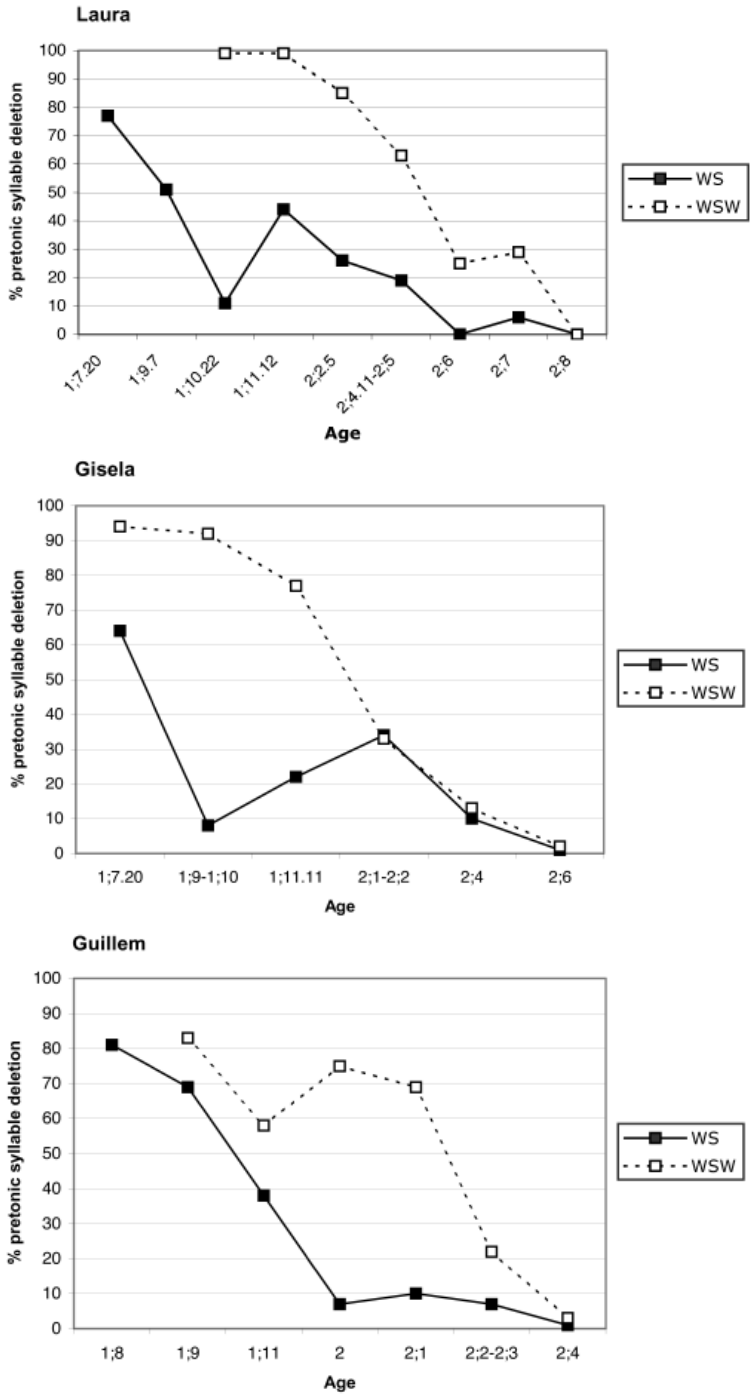
If these constraints on bimoraic and bisyllabic maximum on word size are active, we would expect Catalan-speaking children to exhibit direct evidence of this during development. In what we might call Stage I, we would expect high rates of pretonic syllable truncation in both WS and WSW forms. Indeed, the three graphs in Figure 4 reveal that between 1;7 and 1;9, young Catalan speakers start out with relatively high deletion rates of the pretonic syllable for both bisyllabic WS and trisyllabic WSW words, even though the omission rates tend to be higher for WSW forms than for WS (except for Guillem): Gisela has 64% of syllable omission in WS versus 94% in WSW, Laura has 77% versus 100%, and Guillem 81% versus 83%. This provides direct evidence in favor of this Stage I, a period where the word size maximum is the bimoraic foot.

The transition from Stage I to a Stage II should be visually apparent at the point where WS are produced successfully and WSW forms are still truncated. Indeed, in the graphs, we witness a rapid acquisition of initial unstressed syllables in WS words after Stage I, while this syllable is deleted in trisyllabic WSW words for a longer time. Between ages 1;10 and 2;0, the three Catalan-speaking children exhibit a sharp contrast between the two patterns: while pretonic deletion occurs between 75% and 95% of the time in WSW words, in only occurs between 5% and 10% of the time in WS words, depending on the child. Again, this provides strong support in favor of a Stage II. Finally, Stage III represents the end state where both SW and SWS word shapes are produced target-like (with 9% truncation patterns).

In sum, the data in this section provides strong support for the idea that early PWs are limited by maximality constraints at different stages. At Stage I (between 1;7 and 1;9), Catalan PWs are maximally a moraic trochee. At Stage II (1;10 and 2;0), words are maximally a bisyllabic foot. The behavior of Catalan thus provides critical evidence of the importance of the frequency of metrical structures in the ambient language, as these prosodic units reflect the most frequent foot structures. Finally, the fact that early PWs in this language do not exhibit strong minimality restrictions on outputs provides evidence that in early periods of development children become specially tuned to the language-particular features of the input.

Figure 4

Percentages of pretonic syllable deletion in WS and WSW words in the course of acquisition for Laura, Gisela, and Guillem



6 Discussion

Crosslinguistic differences in the development of PW shape have been argued to be partly determined by the frequency of different PW shapes in the ambient language (see Demuth & Johnson, 2003; Roark & Demuth, 2000, among others). In Germanic languages, it has long been noted that early words display a binary foot maximality effect to a moraic trochee (either a CVC syllable or a bisyllabic SW foot) that is active before 2;4. This situation has been reported in the speech of Dutch, English, and German-speaking children (see Demuth, 1996a, 1996b; Fikkert, 1994; Lleó, 2002; Pater, 1997, among others). The data in (17) show examples of English early words: iambic patterns (WS) are consistently reduced to a bimoraic trochee CVC and trisyllabic WSW and SWW patterns to a bisyllabic SW pattern.

(17) English early words (examples taken from Pater, 1997)

Target		Child and age	Source
Bisyllabic WS pattern			
balloon	['bʊn]	Derek 2;2.25 ~ 2;4.26	Pater (1997, p. 217)
garage	['gaːd͡ʒ]	Trevor 1;10.5 ~ 2;0.24	Pater (1997, p. 218)
belong	['bɔŋ]	Julia 1;11.27 ~ 2;0.26	Pater (1997, p. 217)
police	['plis]	Julia 2;6.05	Pater (1997, p. 218)
guitar	['tar]	Sean 2;2.12	Pater (1997, p. 218)
Trisyllabic WSW words			
potato	['teːto]	Trevor 2;5.16	Pater (1997, p. 216)
spaghetti	['skɛbi]	Julia 1;11.19 ~ 2;3.8	Pater (1997, p. 216)
together	['gɛdbə]	Trevor 1;9.27 ~ 2;0.27	Pater (1997, p. 217)
delicious	['dɪʃəs]	Julia 1;11.27	Pater (1997, p. 216)
remember	['mɛmə]	Julia 1;10.8 ~ 3;0.1	Pater (1997, p. 216)
Trisyllabic SWW words			
elephant	['ɛfɛnt]	Sean 2;1.19	Pater (1997, p. 221)
animal	['amo]	Julia 1;9.8 ~ 2;1.2	Pater (1997, p. 221)
buffalo	['bʌfo]	Julia 2;0.14 ~ 2;3.9	Pater (1997, p. 221)
medicine	['mɛsɪn]	Julia 2;11.12	Pater (1997, p. 221)
camera	['kæmʌ]	Sean 2;0.13	Pater (1997, p. 221)

By contrast, Spanish-speaking children soon start producing the initial unstressed syllables in bisyllabic WS iambs and trisyllabic WSW amphibrachs (see also Lleó, 2002). Furthermore, Lleó demonstrates that there is a sharp contrast between early PW shapes produced by Spanish and German children: while Spanish-speaking children soon produce the initial unstressed syllables, German-speaking children truncate these words until 2;2 years of age.

In accordance with this observation, Spanish protoarticles or phonetic approximations of articles (which generally take the form of a schwa [ə]) make their appearance very early and definitely make their appearance earlier than in Germanic languages (see a comparison between Catalan and Dutch in Guasti & Gavarró, 2003; Guasti, de la Nge, Gavarró, & Caprin, 2004). Lleó and Demuth (1999) claimed that the frequent availability of a model of prosodic structure with unfooted syllables at the lexical level (WSW) boosts Spanish- (and Romance-) speaking children's production of articles. By contrast, such a prosodic model for the integration of articles is rarely available in German, Dutch or English.

As pointed out in the literature, the timing differences between Romance-speaking children and Germanic-speaking children can be accounted for by the relative frequency of prosodic patterns in the input language (Demuth, 2001a, 2001b; Gennari & Demuth, 1997; Kehoe, 1999/2000; Lleó & Demuth, 1999; Roark & Demuth, 2000). First, the fact that the vast majority of words in Germanic languages are monosyllabic acts as a strong prosodic model for the integration of an active moraic trochee in early phonology. Second, the high exposure to trisyllabic WSW words in Spanish provides a suitable prosodic model for the acquisition of weak initial syllables in WSW forms.

Let us now turn to the crosslinguistic differences between Catalan and Spanish. Given the distribution of PW shapes in Catalan and Spanish, two scenarios are possible, depending on the linguistic structure the children pay attention to. If young learners are sensitive to the distribution of PW shapes directly (the so-called *PW Frequency hypothesis*), as has been argued in the literature, it is to be expected that Catalan children will produce iambic WS patterns earlier than Spanish children and trisyllabic WSW forms later. On the other hand, if young learners pay attention to intermediate metrical structure (the so-called *Foot Frequency hypothesis*), the predictions are quite different. In this section, we will test the two hypotheses.

The most noteworthy difference between Catalan and Spanish is the rate of acquisition of weak initial syllables in WS words. How can we account for the fact that Catalan learners omit initial syllables in WS target iambs for a significantly longer time than Spanish learners, despite the fact that Catalan is a language where the bisyllabic iambic WS pattern is more frequent than in Spanish? Following the *PW Frequency hypothesis*, the fact that Catalan has more WS iambic words than Spanish (18% vs. 11%) would seem to predict that Catalan children will target iambic words at an earlier age. Yet, they systematically truncate iambic words, in contrast with Spanish children.[5] The key is to pay attention to frequent foot structures in the language, not PW shapes. Catalan children are frequently exposed to the bimoraic foot metrical pattern (the moraic trochee), given the high frequency of monosyllabic words in this language (Catalan 35% vs. Spanish 26%). Moreover, if we assume that iambic WS words are metrified as a moraic trochee preceded by an unfooted syllable, this metrical model is again more frequent in Catalan than in Spanish. This provides

[5] As K. Demuth points out, there is not a very big difference in the frequency of different PW structures in Catalan and Spanish — thus, it may be hard to test this prediction. In fact, as compared to the Germanic languages, there is very little difference between the two.

a clue as to why Catalan-speaking children truncate weak initial syllables of iambic WS words and Spanish children do not truncate them.

A competing explanation for the different truncation patterns of WS words in both languages is related to the Word Minimality hypothesis (Demuth, p.c.). First, as is well-known, Catalan has higher percentage of syllables with codas than Spanish and thus Spanish codas acquired later than Catalan codas (Lleó, 2003; Prieto & Bosch-Baliarda, forthcoming). Thus word-minimality can be met by monosyllables in Catalan, but not in Spanish (Catalan: CVC – monosyllabic heavy syllables vs. Spanish CVCV – disyllabic syllables). Thus, we find early truncation of WS disyllables in Catalan. Yet, this interpretation would be partially contradicting the fact that CV syllables are perfectly possible in this language, and that we find no cases of augmentation (see Section 5.1). As noted above, minimality effects are not strong in Catalan.

On the other hand, almost half of all words the young Spanish and Catalan learners hear consist of a bisyllabic foot, either iambic or trochaic (around 51% in Spanish and 49% in Catalan). This is why the bisyllabic foot is one of the most readily available models of prosodic integration in the two languages.

We therefore suggest that the high frequency of monosyllabic words and iambs in Catalan provides a metrical model for the integration of PW shapes in early phonological development in this language, namely, the moraic trochee. Interestingly, this metrical pattern, the *moraic trochee*, has a strong presence in productive hypochoristic formation in the adult Catalan grammar (see Cabré Monné, 1993). Not surprisingly, while the moraic trochee is active in Catalan, the bisyllabic foot are most commonly used in Spanish (see Prieto, 1992).

Finally, following the *PW Frequency hypothesis*, a higher percentage of amphibrachs in Spanish child-directed speech than in Catalan (Span. 17% vs. Cat. 9%, cf. Span. *caballo* > Cat. *cavall*) should trigger a facilitating effect on the acquisition of this PW structure by young Spanish learners. On the other hand, the *Foot Frequency hypothesis* would presumably predict the same outcome, as trochaic feet are more common in Spanish than in Catalan (Span 40% vs. Cat. 31%). Indeed, initial unstressed syllables in WSW forms are produced around six months earlier by Spanish children (90% production is attained at 1;08 by Irene and at 1;10 by María and, conversely, Laura attains this production rate at 2;8, Gisela at 2;4 and Guillem at 2;3).

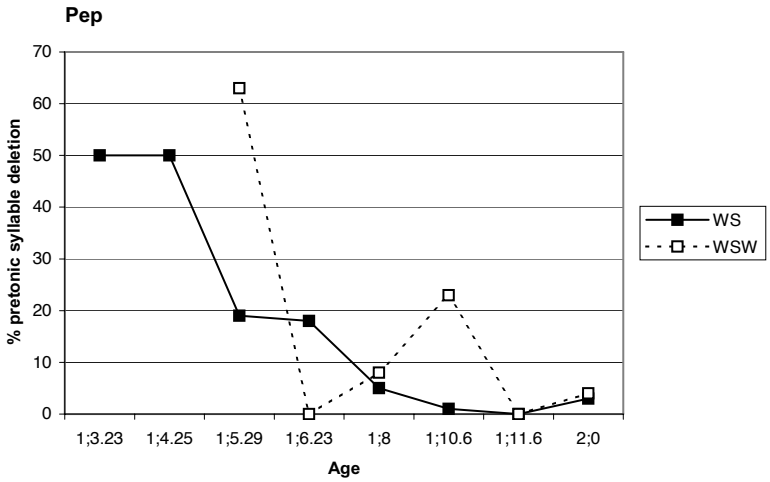
Interestingly, one of the children in our study, Pep, displays a pattern of acquisition of initial unstressed syllables that is closer to the one shown by the Spanish children. Figure 5 shows the percentages of pretonic syllable omission in WS and WSW words for Pep. Pep displays high truncation rates for WS (like the other Catalan children), but then he produced earlier WSW words like the Spanish children. Thus he shows a rapid acquisition of pretonic syllables in both iambs and amphibrachs. Strikingly, among the children included in the analysis, Pep was the one that had most contact with Spanish because of the presence of a Spanish babysitter between 1;00 and 2;8 (M. Serra & R. Solé, p.c.).[6] Interestingly, Pep shows the bilingual influence of keeping early codas from the high-frequency coda language (see Appendix, 80%

[6] According to M. Serra and R. Solé, Pep was the child who had the most contact with Spanish. At home he was taken care of by an Asturian babysitter who started when Pep was one year old, and who spent an average of six hours with him on weekdays.

of coda production at 1;2), but also picking up earlier on the higher frequency WSW prosodic structures from Spanish — showing influence on his Catalan (Demuth, p.c., for a similar behavior with German-Spanish bilinguals, see Lleó, 2003, and Lleó, Kuchenbrandt, Kehoe, & Trujillo, 2003).

Figure 5

Percentages of pretonic syllable deletion in bisyllabic WS words and trisyllabic WSW words in the course of development for Pep



In sum, the crosslinguistic comparison of initial syllable deletion in early PW development provides strong evidence in favor of the idea that children's linguistic structures reflect the predominant (i.e., high frequency) structures of the language being learned. Specifically, the timing differences in the acquisition of the pretonic syllable reflect the children's exposure to high frequency metrical structures. Finally, the Catalan results provide strong evidence in favor of the idea that metrical foot structure — and not PW structure — is a necessary ingredient of phonological development and that young learners are extremely sensitive to this level of the prosodic hierarchy.

7 Conclusion

In this article, we have examined developmental data from four Catalan-speaking children and analyzed the patterns of PW development over time. First, the Catalan data reported are consistent with the theory of prosodic constraints, as Catalan PWs are limited by two types of *maximality* constraints on outputs. In an early period of development (Stage I), Catalan PWs observe a word-size maximum of a *moraic trochee*. In a later period of development (Stage II), words observe a *bisyllabic maximum*. The truncation patterns of initial unstressed syllables provide direct evidence in favor of the strength of these constraints. In Stage I (between 1;7 and 1;9), Catalan children truncate pretonic syllables in both WS and WSW words ([pər'nil] *pernil* > ['nil] 'prosciutto' and [pi'lɔtə] *pilota* > ['tʰɔtɐ] 'ball'). In Stage II (between 1;10 and 2;0), they systematically produce the pretonic syllable in WS words and still truncate it in

WSW words ([pər'nil] *pernil* > [pə'nil] 'prosciutto' and [pi'lɔtə] *pilota* > ['tʰɔtɐ] 'ball'). On the other hand, in contrast with other languages, early PWs in Catalan do not exhibit strong *minimality* restrictions on outputs, suggesting that these constraints should not be active in quantity-insensitive languages with a sufficient exposure to CV subminimal words.

Importantly, the comparison of the Catalan results with the Spanish and English data provide clear evidence that crosslinguistic timing differences in the appearance of initial unstressed syllables can be explained by the different exposure to frequent *metrical* patterns of the ambient language, in accordance with the *Foot Frequency hypothesis*. The data demonstrate that foot structure plays a crucial role in early phonological development: The frequent availability of CVC monosyllabic words in Catalan and English provides a strong moraic trochee prosodic model which explains why young learners of both languages omit initial unstressed syllables. Taking into consideration metrical patterns succeeds in explaining why Catalan young learners omit the unstressed syllable in WS forms for a significantly longer time than Spanish children, even when bisyllabic WS forms are more frequent in Catalan than in Spanish. In this case, Catalan-speaking children are more sensitive to the availability of common foot structures in the language than to PW shapes. Therefore, an important conclusion that we must draw from our crosslinguistic comparison is that young children are specially tuned to the relative frequency of *metrical* structures in the ambient language and that their distribution is critical for predicting early linguistic structure. In general, the findings are consistent with results from infant speech perception studies showing that one-year-old language learners are sensitive to the statistical properties of the phonological structures they hear (e.g., Anderson, Morgan, & White, 2003; Saffran & Thiessen, 2003, among others).

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Appendix

Number of target codas and percentage of codas produced in each session for the four children

Guillem	N target codas	% of codas produced
1;1.29	1	0,00%
1;4.26	19	50,00%
1;7.15	4	80,00%
1;8	5	33,33%
1;9.12	13	57,89%
1;9.24	20	66,67%
1;11.13	12	63,16%
2;0.12	17	73,33%
2;1.14	36	61,76%
2;2.11	36	67,86%
2;2.28	58	69,05%
2;3.12	63	73,68%
2;3.18	43	57,78%
2;4.24	30	64,10%
2;5.25	42	68,42%
2;5.29	20	62,50%
2;6.10	49	72,92%
2;7.9	44	72,34%
2;7.25	41	60,00%
2;9.8	24	71,60%
2;10.3	51	78,79%
2;11.5	67	86,05%
2;11.21	51	94,74%
2;11.25	94	92,98%
3;0	7	100,00%

Pep	N target codas	% of codas produced
1;1.28	6	33%
1;2.3	10	80%
1;3.23	13	77%
1;4.24	16	94%
1;5.29	33	75%
1;6.23	22	59%
1;8	19	100%
1;8.30	16	81%
1;10.6	110	79%
1;11.6	54	87%
2;0	42	98%
2;1.1	98	98%
2;2.3	117	94%
2;3.10	185	93%
2;4.4	100	95%
2;5.4	193	99%

Gisela	N target codas	% of codas produced
1;8.3	7	57%
1;8.24	14	71%
1;9	7	57%
1;10.7	19	63%
1;11.11	15	73%
2;1.23	11	82%
2;2.6	46	79%
2;4.25	76	87%
2;6.23	32	88%
2;8	184	85%

Laura	N target codas	% of codas produced
1;7.20	14	71%
1;9.7	24	92%
1;10.22	24	75%
1;11.12	55	80%
2;2.5	45	66%
2;2.13	33	81%
2;4.11	41	85%
2;5.8	123	81%
2;6.25	64	80%
2;7.20	132	90%
2;8.30	121	96%
2;11.17	154	85%
3;0.2	200	93%