In Santelmann, Lynn, Maaike Verrips & Frank Wijnen (eds., 2002) The Annual Review of Language Acquisition, vol. 2. Amsterdam: John Benjamins. 117-155.

Paper Title:

Relations between Segmental and Prosodic Structure in First Language Acquisition

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Segmental and Prosodic Structure in Acquisition

Author note:

This paper summarises some of the findings discussed in my dissertation, Headedness and Prosodic Licensing in the L1 Acquisition of Phonology, which was defended at McGill University in December 2000. I am deeply grateful to Heather Goad for being a constant support throughout my graduate studies at McGill, as well as for her numerous and thorough readings of my work, challenging questions and very helpful suggestions. I am also indebted to Glyne Piggott for his support as well as for useful comments on many aspects of my analyses. The methodology used for the gathering and sampling of the French data was elaborated within the Acquisition of Phonology Research Project, which took place under an FCAR grant to H. Goad at McGill University. Part of the funding also came from the Harmony Research Project, funded by a SSHRCC grant to G. Piggott and H. Goad. Finally, I would like to thank two ARLA reviewers for their feedback on the original version of this paper. Of course, I am solely responsible for all errors or omissions. This research was supported by a SSHRCC doctoral fellowship #752-95-1415 and postdoctoral fellowship #756-2000-0235. E-mail address: yrose@mun.ca.

Abstract

In this paper, I discuss a number of relations that take place between melodic content and higher prosodic structure in first language phonological development. I explore acquisition patterns found in data on the acquisition of Québec French. Starting with the observation that prosodic structure and, more specifically, stressed syllables, play a central role in phonological acquisition, I hypothesise that the inter-relations between prosodic and segmental structure posited by formal models of phonological organisation should be witnessed within and across developmental stages. I support this hypothesis through two findings from the French data. First, complex onsets emerge in stressed syllables before unstressed ones. Second, different types of consonants (placeless versus place-specified) emerge in word-final position at different stages. From these observations, I argue that the phenomena observed in these data are best captured in an analysis based on constituent structure and relationships between feature specification and prosodic constituency, which are governed by universal markedness.

Relations between Segmental and Prosodic Structure
in Phonological Development

1. Introduction

In this paper, I demonstrate that relations that hold between segments and higher prosodic structure enable an explanation for a number of processes found in child language. I demonstrate this based on longitudinal data from two learners of Québec French, Clara and Théo.

The hypothesis entertained throughout the paper comes from the observation that many aspects of prosodic structure have determining consequences for phonological patterning across languages. For example, syllable weak positions (e.g. syllable codas) can accommodate fewer segmental contrasts than strong positions (e.g. onsets). Similarly, at the level of metrical organisation, stressed syllables are the site of greater segmental faithfulness across languages. In English, for example, stressed syllables have greater phonetic duration and prevent neutralisation processes such as flapping and vowel reduction. These processes are instead confined to unstressed syllables, which are prosodically weaker domains.

While an incorporation of prosodic factors in phonological analyses enables a fairly refined understanding of the segmental properties of adult phonology, as well as of the prosodic shape of output forms attested in child phonology, which display processes such as compensatory lengthening (e.g. Ota, 1999), syllable truncation (e.g. Curtin, 2001; Fikkert, 1994), and word minimality effects (e.g. Demuth, 1996; Fikkert, 1994), the prosodic factors on segmental acquisition are not yet clearly understood. Indeed, most of the research published in the literature focuses on either segmental or prosodic aspects, without explicitly discussing the links between these two aspects of phonological development. The research presented in this paper is an attempt at filling (part of) this gap.

Starting from the general hypothesis that prosodic structure and, more specifically, stress location, is central in speech development (e.g. Echols, 1996 and references cited therein), and given that segmental and prosodic structure are inter-related in most frameworks of theoretical phonology, I further hypothesise that these inter-relations should be witnessed in the course of development.

Two main findings will support this hypothesis, which are discussed in depth in sections 4 and 5, where the focus is on different yet related issues about the relationships that hold between the melodic content of the segments produced by the children and higher prosodic structure. In section 4, we will see a top-down effect of this relationship. I will focus on a positional faithfulness pattern found in the acquisition of branching onsets. The main observation to be discussed is that branching onsets are mastered in stressed syllables before unstressed syllables. I will analyse this pattern through a faithfulness constraint referring specifically to stressed syllables, i.e. heads of metrical feet. In section 5, I will discuss a bottom-up effect between segments and prosodic structure, more specifically, a relationship between place feature specification and word-final consonant syllabification. I will argue that placeless and place-specified segments yield different syllabification patterns in word-final position.

Before I introduce the detail of these sections, I first discuss, in section 2, the methodological aspects of the French data and, in section 3, the theoretical background and assumptions.

2. Methodological Aspects of the Québec French Data

As already mentioned, I will focus primarily on the longitudinal corpora from Clara and Théo, both of whom are learners of Québec French. The data on these children were gathered in their homes, in a naturalistic setting, mainly while looking at picture books or playing with toys. The children's productions were recorded on TDK SA90 tapes using an analogue recording machine Marantz PMD221 with a multidirectional table-top microphone SoundGrabber P2M-12-SG. During the recording sessions (20-45 minutes, depending on the child's mood), conducted approximately every second week, spontaneous word production by the child was encouraged, in order to avoid a speech sample consisting of repeated words which may overestimate the child's abilities. The collection of Clara's data started at the child's age of 1;00.28 until age 2;07.19.[1]

During this period, 34 recording sessions took place. The data collection for Théo cover age 1;10.27 to 4;00.00, a period during which 45 recording sessions took place. For both Clara and Théo, the starting ages correspond to the time when the children were producing their first words other than the canonical mama / papa.

The tapes were digitised using SoundEdit™ in 16 bit sample size at a rate of 22.050 kHz. The tokens extracted from the tapes were labelled and later imported into a computerised database specifically designed for transcription and coding. All tokens were phonetically transcribed by a trained linguist, and subsequently verified by at least one independent transcriber, who are native speakers of the target language. In cases where the two transcribers were in disagreement on some aspect of a given transcription, the point of contention was discussed until agreement was reached.

The French data from Clara and Théo constitute a nice addition to the empirical base currently available in the literature, which comes primarily from English, Dutch, and German, all of which are trochaic languages. (An example of the effects of the right-headedness of the French foot with regard to the way that word-final consonants are prosodified in this language will be discussed in greater detail in section 5.3.2.) Before I discuss the relevant patterns found in these data, I will first introduce the framework in which the analysis is couched.

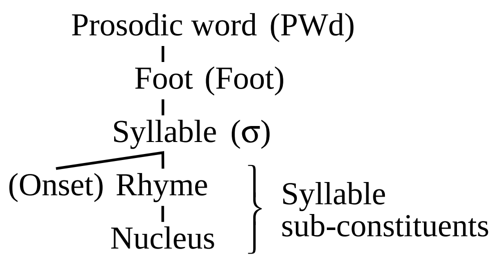
3. Theoretical Framework

In this section, I outline the theoretical background and assumptions necessary before a satisfactory account of the developmental patterns overviewed above can be proposed. As alluded to in the introduction, much importance is attributed to phonological representations, which are at the core of the arguments proposed below. All aspects of the representations to be discussed are assumed to be available to the child, provided by Universal Grammar (henceforth, UG), i.e. the speaker’s innate linguistic competence. In order to regulate both the type of structures allowed in surface representations, and the input-output mapping of these representations, I also appeal to phonological constraints, cast in the framework of Optimality Theory (e.g. Prince & Smolensky, 1993), which are assumed to be part of the UG endowment as well.

3.1 Prosodic Phonology

As already mentioned, the focus of this paper is on relationships between segmental features and higher prosodic structure. This approach is based primarily on the view that segments are integrated into the prosodic hierarchy in (1), after, e.g. McCarthy & Prince (1986), Selkirk (1980a,b).[2]

(1) Prosodic hierarchy



In order to constrain how segmental information is incorporated into the prosodic hierarchy in (1), I adopt Itô's (1986, p. 2) Licensing principle, whose definition is given in (2).

(2) Licensing principle
All phonological units must be licensed, that is, belong to higher prosodic structure.

According to this principle, in order to be implemented on the surface, melodic material must be licensed by some constituent within the prosodic hierarchy. Material that is not licensed cannot surface in output forms.

3.2 Optimality Theory

In order to constrain how segments and the features that they contain are realised in output forms, I adopt the constraint-based framework of Optimality Theory. Within OT, the linguistic competence (grammar) of a speaker is viewed as a universal set of violable constraints (e.g. Prince & Smolensky, 1993). Cross-linguistic variation, as well as the different stages of acquisition observed in language development, are accounted for by specific rankings of these constraints. As the requirements of highly-ranked constraints take precedence over lowly-ranked constraints, different constraint rankings predict different grammars, or different developmental stages.

These basic premises of OT are consistent with Pinker's (1984) continuity assumption: At every stage in their development, early grammars reflect possible adult grammars. Consequently, all of the constraints used in the account of child language phenomena should find independent motivation in adult languages (cf. Pater, 1996, 1997). Such support is provided below, through parallels between child and adult phonology. For the sake of clarity, the constraints required to capture the processes found in the children's productions will be introduced only when necessary, where their effects will be demonstrated in evaluation tableaux.

In the next section, I briefly discuss the general assumptions regarding child language and phonological development.

3.3 Additional Assumptions

Cross-linguistic observations on early children's productions point to a strong generalisation: Only unmarked structures are found in children's early productions (e.g. Bernhardt & Stemberger, 1998; Ferguson & Farwell, 1975; Fikkert, 1994; Ingram, 1974, 1988, 1989, 1992; Jakobson, 1941/68; Leopold, 1947; Macken, 1979; Smith, 1973; Stampe, 1969; Velten, 1943). In accordance with this generalisation, I assume the initial organisation of the grammar as formalised by, e.g. Demuth (1995), Gnanadesikan (1995), and Smolensky (1996), in (3).[3]

(3) Initial organisation of the grammar
Markedness constraints » faithfulness constraints

The ranking in (3) focuses on the constraint ranking which yields unmarked outputs at the onset of phonological development. In addition to this, I argue that the way children assign prosodic representations in their inputs is driven by UG default options. This position is best supported in section 5, where I discuss the different syllabification options for word-final [ʁ] entertained by Clara and Théo. This leads us directly to the next point.

Regarding the shape of inputs, most OT studies typically assume that, at the level of segmental representations, the child's inputs are essentially similar to the adult's (e.g. Gnanadesikan, 1995; Goad & Rose, in press; Hale & Reiss, 1998; Pater, 1996, 1997; Smolensky, 1996), modulo perceptual problems (Macken, 1980).

At the level of prosodic representations, the proposals are less explicit. However, both Gnanadesikan (1995) and Goad & Rose (in press) provide empirical support for the position that constituent structure is present in children's inputs. On the one hand, Gnanadesikan reports patterns of faithfulness to input syllables, i.e. to entire prosodic constituents. On the other, Goad and Rose demonstrate, from cluster reduction patterns observed in the acquisition of West Germanic languages, that children are faithful to the head of the onset constituent. Both of these papers thus provide support for the position that inputs are fully prosodified.

This proposal also has a direct implication for adult phonology. Starting from the standard assumption that children will learn the phonology of their language based on the positive evidence available (Chomsky, 1981), and given that there exists no evidence for the absence of prosodic structure in adult languages, the consequence should be that prosodic structure should also be present in underlying representations in the adult lexicon. While this proposal departs from the standard assumption that predictable information such as syllable and metrical structure should not be present in underlying representations, there appears to be strong arguments for it in the literature. Without elaborating on this issue in great depth, I will refer to the work by Golston (1995), who assembles a compelling set of evidence from adult phonology, for the validity of this proposal. Indeed, Golston argues that there is no empirical evidence against underlying prosodic structure but, rather, that there exists very compelling evidence supporting the presence of prosodic structure in the lexicon. Among others, Golston discusses facts such as: Speakers often refer to syllables in a number of tasks such as word elicitation and/or recognition; tip of the tongue situations where the speaker is aware of the number of syllables present in the word that s/he wants to produce; the existence of several writing systems are based on syllables (syllabaries); as well as a number of generalisations about adult phonological systems such as the fact that many reduplication systems are based on syllable and/or foot shapes (see Golston for additional discussion and references concerning these various related issues). This evidence strongly suggests that prosodic structure is stored in underlying representations. There is the possibility, however, that at some later stage in development, the learner performs some pruning of her / his underlying forms in order to get rid of predictable information. This process would be comparable to, for example, the one required in order to determine a unique underlying representation for a set of allophonic variants of a given morpheme (e.g. English plural suffix [s, z, əz]), in the sense that such a process requires an abstract comparison of linguistically related forms. However, I am not aware of any evidence for such a developmental stage in phonological acquisition.

In line with Golston (1995), and consistent with the conceptual problem posed by the fact that there is no evidence to 'unlearn' prosodic structure in input representations, I will assume that underlying representations are fully prosodified in both child and adult phonologies. While this position proves useful for the analysis of the data to be covered in the next sections, its implications for a number of current approaches to adult phonology remain to be explored more in depth. This issue is left for further research.

When the two assumptions outlined above are combined (domination of markedness constraints over faithfulness constraints and fully-prosodified inputs), the consequence is that while children's <u>inputs</u> are basically as complex as adult's inputs, children's <u>outputs</u> initially display structures that are unmarked, as well as restrictions on licensing relationships. This will be demonstrated in the next two sections, to which we now proceed.

4. Positional Faithfulness in the Development of Branching Onsets

In this section, I focus on the second stage in the development of branching onsets in Clara's and Théo's grammars. At this stage, in both children's outputs, target branching onsets are fully realised in stressed syllables only; in unstressed syllables, branching onsets are reduced to singletons. I will account for this asymmetry through a constraint predicting faithfulness to the segments present in input stressed syllables only.

4.1 Data

Given the assumption in (3), at the initial state, or the first stage in the development of any complex constituents, input branching onsets are predicted to undergo reduction to unmarked singleton onsets. This is confirmed by the data in (4): Target branching onsets are initially reduced to singletons by the two children, through deletion of the liquid consonant.

(4) Acquisition of branching onsets, stage 1: Liquid deletion

a) Clara: 1;00.28 to 1;09.01 (14/16 examples; 88%)

pleure	[plœʁ]	→	[pœː]	1;07.27	'(s/he) cries'
Cracra	[kχakχa]	→	[kaˈkæ]	1;07.27	'Cracra'
grelot	[gʁəlo]	→	[tɔˈjo]	1;09.01	'little bell'

b) Théo: 1;10.27 to 2;05.11 (10/17 examples; 59%)[a]

brisé	[bʁize]	→	[pɪˈz̥e]	2;04.06	'broken'
clé	[kle]	→	[ke]	2;04.28	'key'
clown	[klʊn]	→	[kʊɲ]	2;05.11	'clown'

a. Five of the seven counter-examples are from variation in the data at 2;05.11, at which early productions of branching onsets are attested.

During the second stage in development, which is the focus of the analysis proposed below, we can see that while input branching onsets are fully realised in stressed syllables, in (5a), they still undergo liquid deletion in unstressed syllables, in (5b).

(5) Acquisition of branching onsets, stage 2: Positional faithfulness

a) Target-like realisation of branching onsets in stressed syllables

i. Clara: 1;09.29 to 2;03.05 (70/70; 100%)

biberon	[bibʁɔ̃]	→	[paˈpχɔ]	1;09;29	‘baby bottle’
glisse	[glɪs]	→	[klɪs]	1;10.04	‘(s/he) slides’
citrouille	[sitχʊj]	→	[θəˈtχuːj]	1;10;04	‘pumpkin’

ii. Théo: 2;05.29 to 2;11.29 (221/227; 97.4%)

gros	[gʁo]	→	[gʁo]	2;05.29	‘big’
train	[tχɛ̃]	→	[kχɛ]	2;06.12	‘train’
clown	[klʊn]	→	[klʊn]	2;06.12	‘clown’

b) Liquid deletion in unstressed syllables

i. Clara: 1;09.29 to 2;03.05 (20/21; 95.2%)

brûlé	[bʁyle]	→	[biˈle]	1;09.29	‘burned’
glissade	[glisad]	→	[kaˈsæd]	1;10.04	‘(a) slide’
trouvé	[tχuve]	→	[tʊˈve]	2;03.05	‘found’

ii. Théo: 2;05.29 to 2;11.29 (19/31; 61.3%)[a]

crème glacée	[ˈkχɛmglaˈse]	→	[ˈkχaˈnaˈse]	2;06.30	‘ice cream’
tracteur	[tχaktœʁ]	→	[taˈtœʊ̯]	2;08.22	‘tractor’
trouvé	[tχuve]	→	[kʊˈβi]	2;11.29	‘found’

a. Most of the variation comes from the last week of the period covered. 8/12 counter-examples are attested at ages 2;11.23 and 2;11.29.

Finally, at stage 3, exemplified in (6), branching onsets are fully realised in both stressed and unstressed syllables.

(6) Acquisition of branching onsets, stage 3: Mastery

a) Clara: 2;03.15 (94/101; 93%)

trouvé	[tχuve]	→	[tχuˈve]	2;03.19	‘found’
plancher	[plɑ̃ʃe]	→	[plɑ̃ˈʃe]	2;05;25	‘floor’
gros	[gʁo]	→	[gʁo]	2;03.15	‘big’

b) Théo: 3;00.07 (420/472; 89%)

prenez	[pχəne]	→	[pʁəˈne][a]	3;00.07	‘(you) take (pl.)’
pleurer	[plœʁe]	→	[pløˈʁe]	3;05.06	‘(to) cry’
trouvé	[tχuve]	→	[kχaˈve]	3;00.07	‘found’

a. See footnote 8.

4.2 Analysis

While the first stage, in (4), supports the initial constraint ranking in (3), which bans complexity in output forms, and the last stage, in (6), corresponds to the adult one, where segmental faithfulness has precedence over structural markedness, I will focus here on the second stage, in (5), where we find a contrast between the target-like realisation of branching onsets in stressed syllables and their reduction in unstressed syllables.

I will analyse the branching onset reductions observed in (5b) through a high ranking of the constraint *COMPLEX(Onset) in (7), following Prince and Smolensky (1993, p. 87).

(7) *COMPLEX(Onset): No branching is allowed in onsets.

This constraint will interact with the faithfulness constraints MAX(Segment) and DEP(Segment), in (8a) and (8b). While MAX ensures preservation of input segments in output forms, DEP prevents insertion of segments in output forms.

(8) Segmental faithfulness constraints
a) MAX(Segment): Every input segment has an output correspondent.
b) DEP(Segment): Every output segment has an input correspondent.

Finally, in order to regulate faithfulness relations between input and output constituent heads, I adopt Goad and Rose's (in press) constraint MAXHEAD(Foot) defined in (9), which follows the spirit of Alderete (1995), Beckman (1998), Itô, Kitagawa, & Mester (1996), McCarthy (1997), and Pater (2000).

(9) MAXHEAD(Foot): Every segment prosodified in the head of the Foot in the input has a correspondent in the head of that Foot in the output.

A high ranking of this constraint will predict faithfulness to segments that are present in the head of the foot (stressed syllable) in the children's productions, which will capture the positional faithfulness pattern found at stage 2 in the development of branching onsets in (5).

At stage 2 in the development of branching onsets, the constraints defined above interact in the children's grammars following the ranking in (10).

(10) Branching onsets at stage 2: Constraint ranking
MAXHEAD(Foot) » DEP(Seg) » MAXHEAD(Onset) » *COMPLEX(Onset) » MAX(Seg)

I will support this ranking through a comparison of the way that input branching onsets are realised in both stressed and unstressed syllables in the data in (5), with the words gros [gʁo] 'big' and brûlé [bʁyˈle] 'burned', which are analysed in the tableaux in (11) and (12), respectively.

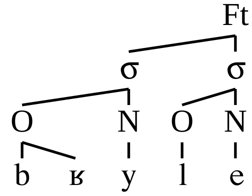
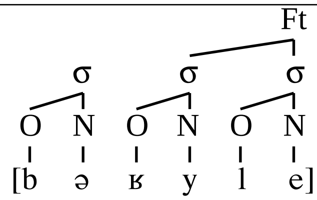
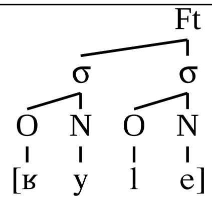
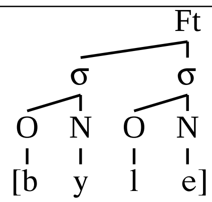
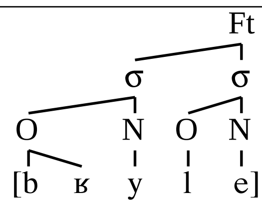
Since *COMPLEX(Onset) is ranked below MAXHEAD(Foot) in (10), none of the first three candidates in (11), all of which satisfy *COMPLEX(Onset) at the expense of MAXHEAD(Foot), can be selected as optimal. The first candidate, which violates DEP(Seg) through vowel insertion, fatally violates MAXHEAD(Foot) because one of the segments present in the head of the foot in the input ([g]) is prosodified outside this domain in this candidate. The second and third candidates both fatally violate MAXHEAD(Foot) through deletion of one of the input onset segments. The target-like candidate in (11d) is thus selected as optimal. Only in this candidate are all segments from the input foot head, [gʁo], present in the output.

(11) Branching onsets at stage 2: Stressed syllables

Input: Ft – σ – O (g ʁ) N (o)	MAXHD (Foot)	DEP (Seg)	MAXHD (Onset)	*COMPLEX (Onset)	MAX (Seg)
a) [gəˈʁo]: Ft – σ σ – O N O N – [g ə ʁ o]	*!	*			
b) [ʁo]: Ft – σ – O N – [ʁ o]	*!		*		*
c) [go]: Ft – σ – O N – [g o]	*!				*
☞ d) [gʁo]: Ft – σ – O (g ʁ) N (o) – [g ʁ o]				*	

Because *COMPLEX(Onset) outranks MAX(Seg), the branching onset in the unstressed syllable cannot be preserved in (12), since the constraint that would force preservation, MAXHEAD(Foot), has scope only over heads of feet (stressed syllables). Thus, any segmental deletion outside the input stressed syllable vacuously satisfies this constraint. Candidate (12c) can therefore be selected as optimal, in spite of the fact that it displays segmental deletion; this candidate only incurs a minimal violation of MAX(Seg). The other candidates all fatally violate higher-ranked constraints.

(12) Branching onsets at stage 2: Unstressed syllables

Input: 	MAXHD (Foot)	DEP (Seg)	MAXHD (Onset)	*COMPLEX (Onset)	MAX (Seg)
a) [bəʁy'le]: 		*!			
b) [ʁy'le]: 			*!		*
☞ c) [by'le]: 					*
d) [bʁy'le]: 				*!	

As we can conclude from this last tableau, undominated MAXHEAD(Foot) at this stage in development is a factor only in inputs which, like gros in (11), contain a branching onset in the stressed syllable. I will now turn to a similar process found in adult phonology, in order to provide additional support for the analysis proposed for stage 2.

4.3 Parallel with Adult Phonology: Brazilian Portuguese

The pattern analysed above is similar to the one observed in languages like southeastern Brazilian Portuguese. In this language, input branching onsets are realised in output stressed syllables only; in unstressed syllables, input branching onsets are reduced to singletons, as exemplified in (13).

(13) Branching onsets in southeastern Brazilian Portuguese (Harris, 1997, p. 363)

a)	[ˈpratu]	(*[ˈpatu])	‘plate’
	[paˈtʃiɲu]	(*[praˈtʃiɲu])	‘small plate’
b)	[ˈlivu]	(*[ˈlivru])	‘book’
	[liˈvretu]	(*[liˈvetu])	‘small book’

Goad and Rose (in press), from which the analysis proposed above is inspired, argue that both MaxHead(Onset) and MaxHead(Foot) are necessary in order to account for the positional faithfulness pattern in (13). Their analysis is illustrated in (14).

(14) Southeastern Brazilian Portuguese (Goad and Rose, in press)[a]

Inputs:	Candidates:	MaxHead (Foot)	MaxHead (Onset)	*Complex (Onset)	Max (Seg)
a) li(ˈvre.tu)	☞ i. li.(ˈvre.tu)			*	
	ii. li.(ˈve.tu)	*!			*
b) (ˈli.vru)	i. (ˈli.vru)			*!	
	☞ ii. (ˈli.vu)				*
	iii. (ˈli.ru)		*!		*

a. Parentheses mark the edges of feet, and periods, the edges of syllables.

The effect of MaxHead(Foot) is exemplified in (14a). A high ranking of this constraint requires that the stressed syllable surfaces with all of its input segments ([vre]) in the optimal candidate, at the cost of violating the lower-ranked constraint *Complex(Onset). In contrast to this, we can see that the branching onset does not appear in the input unstressed syllable in (14b). MaxHead(Foot) cannot protect this branching onset, which must be reduced to a singleton onset, as required by the ranking of *Complex(Onset) above Max(Seg). This is where the effect of MaxHead(Onset) can be seen: The segment that survives in the optimal candidate in (14b) is the input head ([v]), not the dependent consonant ([r]).

4.4 Discussion

As we can see from the preceding subsections, stage 2 in the development of branching onsets found in Clara's and Théo's outputs can be correlated with a similar pattern found in Brazilian Portuguese. Additional remarks must however be made, about two issues. The first regards the prediction of the segment which undergoes deletion in the reduction cases. The second concerns the nature of the constraints used in this analysis, more specifically about the constraint MAXHEAD. I will address these points in turn.

Selection of the segment that undergoes deletion in the reduction cases was accounted for using a specific member of the MAXHEAD constraint family. However, for both the developing and adult phonologies under scrutiny, an approach referring to the acoustic properties of the segments involved could also be invoked. Because onsets must be, in the unmarked case, acoustically distant from the nucleus, it is possible that selection of the obstruent over the liquid arises as a consequence of relative sonority (e.g. Bernhardt & Stemberger, 1998; Fikkert, 1994; Gnanadesikan, 1995). While an explanation of this type can account for the data under investigation as well as for a number of reduction cases documented in the literature, Goad and Rose (in press) argue that an analysis of some patterns of cluster reduction, especially in left-edge sC clusters where headedness does not correlate with low sonority (e.g. snow → [no]; *[so]), must involve reference to structural heads (see, also, Spencer, 1986). However, in the context of this paper, no example can help us identify which of the two possibilities (sonority-based or head-based) yields the pattern observed, because the onset structural head is also the lowest sonority member of the cluster. And because there is no a priori reason to select a sonority-based account over a structural account or vice-versa, I maintain that the current proposal is valid, on grounds that it makes the right predictions in all of the contexts from the two corpora under investigation.

While the analysis of both stage 2 in the development of branching onsets and the pattern of onset reduction in Brazilian Portuguese relies on MAXHEAD(Foot), it is in fact possible to relate the problem found in these two contexts to the idea of licensing, namely that more complexity is allowed in prosodically strong environments, in line with most of the current theories of licensing, including positional faithfulness (Beckman, 1998), in which prominent positions are protected, and positional markedness (Zoll, 1998), in which marked (or complex) structure is licensed only in prominent positions, as well as more phonetically grounded 'cue-based' accounts in which the likelihood of a contrast in a given context is treated as a function of the relative perceptibility of this contrast in that context (e.g. Steriade, 2001). These approaches all share the assumption that phonological contrasts are neutralised precisely in phonetically or phonologically weak, rather than strong, positions. However, accounting for this possibility through reference to a licensing constraint, instead of through MAXHEAD, would create additional complications in the analysis. Indeed, licensing is interpreted in this paper in its traditional sense, i.e. as a formal relation between melodic content (segments or features) and the prosodic constituents that license it (see (2)). However, the licensing relation required to account for faithfulness to complex onsets in stressed syllables would depart from this view and instead relate two levels of prosodic structure so that, for example, a complex onset would be licensed by the head of the foot, independently of the melodic content of this branching onset. Nonetheless, the correlation between the fact that contrasts are better maintained in prosodically strong positions across languages and the behaviour of branching onsets discussed above for both child and adult phonologies remains compelling and could be part of an integrated theory of licensing involving complexity at both segmental and prosodic levels of representation.

In the next section, I will discuss another type of relation between segments and prosodic structure, namely how melodic content (place specification) affects word-final consonant syllabification.

5. Place Specification and Default Syllabification

In this section, I will discuss a relationship between input segmental place feature specification and its implications for syllabification in word-final position. I will first argue that Clara and Théo have different segmental representations for the French rhotic approximant [ʁ], and then discuss the consequences of these representations for the syllabification of [ʁ] in word-final position. I will also demonstrate that the patterns of word-final syllabification follow universal unmarkedness. In the last part of this section, I will propose an analysis of the patterns found in the children's outputs.

5.1 Segmental Representations

First, between the initial word productions and age 2;00.2, Clara's [ʁ] undergoes assimilation when it appears in onset heads: It takes on the place of articulation of another consonant in the word, as can be seen in (15a). However, during the same period, when [ʁ] is realised in branching onset dependent positions, in (15b), it is realised in a target-like fashion.

(15) Segmental behaviour of Clara's [ʁ]

a) Clara's [ʁ] in singleton onsets in early outputs: Assimilation (22/22; 100%)

carotte	[kaʁɔt]	→	[kaˈgɜ]	1;07.27	'carrot'
robe	[ʁɔb]	→	[wɔb̥]	1;10.10	'(a) dress'
rouge	[ʁuʒ]	→	[jʊʃ]	1;11.06	'red'

b) Clara's [ʁ] in branching onsets: Target-like realisation (12/16; 75%)

biberon	[bibʁɔ̃]	→	[paˈpχɔ]	1;09.29	'baby bottle'
citrouille	[sitχʊj]	→	[θəˈtχuːj]	1;10.04	'pumpkin'
trou	[tχu]	→	[tχu]	1;10.10	'hole'

The data in (15b) suggest that the pattern in (15a) isn't due to a problem in pronouncing [ʁ]. But rather that [ʁ] is truly placeless in Clara's phonology, and that placeless segments are allowed in onset dependent (weak) positions only, so that they are excluded from singleton onsets. In order to be realised in singleton positions, [ʁ] must acquire a place feature, which yields the pattern in (15a). This distribution between onset head versus dependent positions is parallel to that found in adult languages such as Miogliola (Ghini, 2002), in which nasal codas (dependent positions) are placeless (realised as nasal approximants) word-finally, but surface as coronal in onsets (head positions).

The patterning of Théo's [ʁ] differs from Clara's in two ways. First, apart for some voicing variation,[4] Théo's [ʁ] is realised as target-like in singleton onsets, in (16a). However, in branching onsets, in (16b), Théo's [ʁ] triggers Dorsal assimilation of the preceding Coronal consonant. Note that this Dorsal feature can only come from [ʁ], because no other dorsal consonants are present in these words. These two observations are very robust; they capture almost all of the data available in Théo's corpus.

(16) Segmental behaviour of Théo's [ʁ]

a) Théo's [ʁ] in singleton onsets in early outputs: Target-like (79/84; 94%)

roue	[ʁu]	→	[χu]	2;05.11	'wheel'
roche	[ʁɔʃ]	→	[χɔç]	2;06.12	'(a) rock'
oreille	[ɔʁɛj]	→	[ɑˈχɛj]	2;06.12	'ear'

b) Théo's Coronal-[ʁ] branching onsets: Dorsal assimilation (185/194; 95%)

train	[tχɛ̃]	→	[kχɛ]	2;06.12	'train'
drôle	[dʁol]	→	[gʁol]	3;04.19	'funny'
trop	[tχo]	→	[kχo]	4;00.00	'too much'

From the behaviour of [ʁ] as the target of assimilation in Clara's singleton onsets versus its role of trigger of Dorsal assimilation in Théo's data, I propose that the two children have different representations for target [ʁ]. As illustrated in (17), I propose that while Clara's [ʁ] is unspecified for place features, Théo's [ʁ] is specified for the feature Dorsal.[5]

(17) Representation of [ʁ]: Clara versus Théo

a) Clara's [ʁ]

Root

b) Théo's [ʁ]

Root
|
Place
|
Dorsal

The first question that must be raised in light of (17) regards the reason why Clara and Théo have arrived at different representations for target [ʁ]. Firstly, this variation cannot be explained through a difference in the ambient languages: Clara's and Théo's target dialects are for all intents and purposes identical. The problem must thus lie in how the two children encode the rhotic [ʁ] in their representations. In the field of adult phonology, a number of scholars consider rhotics, no matter their phonetic place of articulation (e.g. coronal, uvular), to be placeless across languages (e.g. Japanese: Mester & Itô, 1989; English: Rice, 1992; Québec French: Béland, Paradis, & Bois, 1993; German: Wiese, 1996; see, also, Avery, 1996 and Brown, 1997 for generalised /r/ placelessness). In accordance with the body of evidence provided by these authors, I assume that [ʁ] is inherently placeless in Québec French. I propose that Clara's representation for [ʁ] is target-like, i.e. placeless; Théo, by contrast, is mislead by the uvularity of [ʁ] and incorrectly assigns a Dorsal specification to this consonant.

As alluded to above, the representations proposed in (17) also have consequences on the way that word-final [ʁ] is syllabified in the two children's phonologies. I discuss these consequences in the next section.

5.2 Word-final Syllabification

I will now compare the development of word-final consonants in Clara's and Théo's outputs. As we will see, the two children, who have different segmental representations for their respective [ʁ], also show different developmental patterns for this consonant in word-final position.

5.2.1 Clara's word-final [ʁ] as coda.

I will start with Clara's data observed between ages 1;07.06 and 2;03.15-19. While 1;07.06 corresponds to the stage when word-final consonants other than [ʁ] emerge in Clara's outputs, 2;03.15-19 corresponds to the period when both word-final [ʁ] and word-internal codas emerge in her output forms.

Through a comparison of the data in (18), it can be seen that at the stage when word-final consonants other than [ʁ] are produced by Clara, in (18a), target word-final [ʁ] shows deletion, with lengthening of the preceding vowel, in (18b). Notice that systematic vowel lengthening is found in this context only (see further in section 5.3.2).

(18) Clara's mastery of word-final consonants other than [ʁ] (1;07.06)

a) First realisations of word-final consonants other than [ʁ]

banane	[banan]	→	[məˈnæn]	1;07.06	'banana'
livre	[liv]	→	[lɪɸ]	1;07.27	'book'
bus	[bʏs]	→	[bʊs]	1;10.04	'bus'

b) Word-final [ʁ] deletion and vowel lengthening

canard	[kanɑʁ]	→	[næˈnæː]	1;07.27	'duck'
Babar	[babɑʁ]	→	[bɑˈbɑː]	1;09.29	'Babar'
Claire	[klaɪʁ]	→	[klæː]	2;01.05	'Claire'

In fact, Clara's target word-final [ʁ] emerges only when her word-internal codas are mastered, as can be seen in the data given in (19).[6]

(19) Clara's mastery of word-final [ʁ]: Parallel to word-internal codas (2;03.15-19)

a) First realisations of word-internal codas[a]

Gaspard	[gaspɑʁ]	→	[gæsˈpaʁ]	2;03.19	'Gaspard'
dormir	[dɔʁmɪʁ]	→	[dɔʁˈmiʁ]	2;03.19	'(to) sleep'
pansement	[pɑ̃smɑ̃]	→	[pæsˈmæː]	2;03.19	'band aid'

a. Only coda [s] and [ʁ] are found in these data, which reflect the frequency distribution of French codas, most of which are restricted to these segments.

b) First realisations of word-final [ʁ]

dort	[dɔʁ]	→	[dɔʁ]	2;03.15	'(s/he) sleeps'
chaussure	[ʃosʏʁ]	→	[ʃœˈʃyʁ]	2;03.15	'shoe'
chaudière	[ʃɔd̠z̠jaɪʁ]	→	[sɔˈdjaɪʁ]	2;03.19	'bucket'

The parallel observed between the emergence of word-final [ʁ] and word-internal codas suggests that Clara's placeless [ʁ] is syllabified in coda position word-finally.

In the next subsection, we will see that, in contrast to Clara's placeless [ʁ], the acquisition of Théo's dorsal [ʁ] does not correspond to that of word-internal codas.

5.2.2 Théo's word-final [ʁ] as onset.

In order to demonstrate the non-coda status of Théo's word-final [ʁ], I will again focus on the development of word-final consonants and compare it with that of word-internal codas. First, word-final consonants emerge in Théo’s outputs during a two-week period, between ages 2;03.20 and 2;04.06. As we can see in (20), Théo’s word-final [ʁ] is mastered at the same time as all of the other word-final consonants.

(20) Théo’s mastery of word-final consonant, including [ʁ] (2;03.20-2;04.06)

a) First realisations of word-final [ʁ]

<u>encore</u>	[ɑ̃kɔʁ]	→	[əˈkɔʊ̯ʁ]	2;03.20	‘again’
<u>voir</u>	[vwɑʁ]	→	[vwɑːχ]	2;04.06	‘(to) see’
<u>lumière</u>	[lʏmjaɪʁ]	→	[yˈmɥaɪχ]	2;04.28	‘light’

b) First realisations of other word-final consonants

<u>embarque</u>	[ɑ̃baʁk]	→	[əˈbak]	2;03.20	‘(he) embarks’
<u>bus</u>	[bʏs]	→	[pɔç]	2;04.06	‘bus’
<u>mitaine</u>	[mitɛn]	→	[pəˈtɛn]	2;04.06	‘mitten’

Moreover, the emergence of Théo’s word-final consonants — including [ʁ] — takes place much earlier in development than the mastery of word-internal codas, which is observed at age 3;07.06, as exemplified in (21).

(21) Théo’s first realisations of word-internal codas (3;07.06)

<u>escabeau</u>	[ɛskabo]	→	[ɛskaˈbo]	3;07.06	‘stool’
<u>fermer</u>	[fɛʁme]	→	[fɔʁˈme]	3;07.06	‘(to) close’
<u>coccinelle</u>	[koksinɛl]	→	[kɔksiˈnɛl]	3;07.06	‘ladybug’

We can thus conclude that Théo’s [ʁ], which bears a Dorsal specification, does not behave as a word-final coda, in contrast to Clara’s placeless [ʁ].

In order to account for these different behaviours between the two children’s word-final consonants, I introduce, in the next subsection, background information from adult languages.

<u>5.2.3 Background: word-final consonants as onsets.</u>

Many scholars analyse word-final consonants in the same fashion as consonants which must be syllabified word-internally outside the onset constituent, i.e. as codas (rhymal dependents).

This position, however, is controversial. For example, the tenets of Government Phonology (e.g. Charette, 1991; Harris, 1994, 1997; Kaye, 1990; Kaye et al., 1990) hold that word-final consonants should always be syllabified as onsets. Piggott (1999), on the other hand, argues that word-final consonants can be syllabified in two ways across languages, as onsets, or as codas. Piggott demonstrates that some languages, like Selayarese (Mithun & Basri, 1986), in (22a), display a distribution of word-final consonants that matches that of word-internal codas, in the sense that they cannot license place features (they are restricted to glottal stop and placeless nasal consonants). Word-final consonants in this language are thus argued to be real codas. Piggott further argues that languages such as Diola Fogny (Sapir, 1965), in (22b), have a distribution of word-final consonants that is more diversified than that of word-internal codas. On the one hand, in Diola Fogny, word-internal codas are restricted to the first halves of geminate nasals and sonorants that are homorganic with the following onset. From this distribution, we can infer that, similar to Selayarese, the codas of Diola Fogny cannot license place features. On the other hand, as opposed to what is observed in Selayarese, consonants with any place specification (Labial, Coronal, or Dorsal) can surface word-finally in Diola Fogny. From this behaviour, Piggott (1999) argues that Diola Fogny's consonants are syllabified word-finally as onsets.

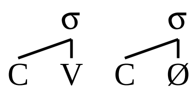
(22) Two types of syllabification of word-final consonants across languages (Piggott, 1999)

	Language	Evidence
a) Coda	Selayarese	• Codas (word-internal and word-final) cannot license place features.
b) Onset	Diola Fogny	• Word-internal codas cannot license place features. • All place features are licensed word-finally.

Because two syllabification options are available across languages ((22a) and (22b)), one of these options must be universally unmarked, i.e. the option that will be first entertained by a child acquiring a language with word-final consonants. Briefly addressing this issue, Piggott (1999, p. 180) suggests that (22b), i.e. the syllabification of word-final consonants as onsets, represents the unmarked case.

In the field of child language, Goad and Brannen (in press) demonstrate that word-final consonants in early grammars pattern according to Piggott's (1999) suggestion: The child initially syllabifies word-final consonants as onsets, independently of the syllabification constraints of the target language. This is illustrated in (23).

(23) CVC word in early grammars



(Ø = empty nucleus)

5.2.4 Current proposal.

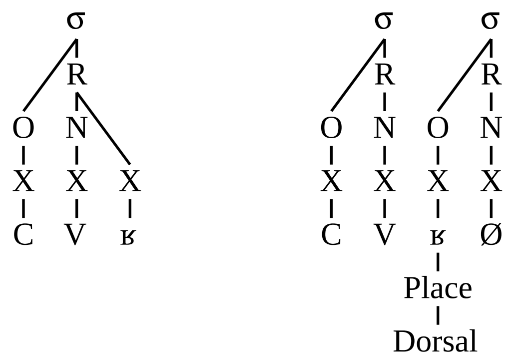
In order to explain the data from Clara and Théo, it is necessary to refine the hypothesis about the unmarked syllabification of word-final consonants. I propose a formal relationship between place specification and word-final consonant syllabification. As stated in (24), I propose that in the unmarked case, word-final placeless consonants are syllabified as codas (parallel to Selayarese), and that word-final place-specified consonants are syllabified as onsets (parallel to Diola Fogny).

(24) Default syllabification of word-final consonants
a) Placeless consonant: Coda.
b) Place-specified consonant: Onset.

This hypothesis enables an explanation of the acquisition facts from both Clara and Théo. While Clara's placeless [ʁ] is syllabified word-finally in coda position, as in (25a), Théo's Dorsal [ʁ] is syllabified word-finally as an onset, as in (25b).

(25) Clara’s versus Théo’s syllabification of word-final [ʁ]

a) Clara’s CV[ʁ]# b) Théo’s CV[ʁ]#



Importantly, notice that the different syllabification options entertained by the two children match the patterns observed in adult languages which were summarised in (22). On the one hand, Clara’s placeless [ʁ] in coda is parallel to the Selayarese placeless-only word-final codas. On the other hand, Théo’s dorsal [ʁ] is syllabified word-finally as an onset, similar to the Diola Fogny distribution, which allows for word-final onsets with any place feature specification (Labial, Coronal, Dorsal). Finally, the patterns covered in this section also support the view that when specified for place features, word-final consonants are syllabified as onsets, rather than as codas; if this were not the case, it would be difficult to explain why both children’s word-final consonants other than Clara’s placeless [ʁ] emerge word-finally at a different time than true (word-internal) codas.

In the next section, I propose an analysis of the patterns discussed above, namely, the substitution pattern found in Clara’s singleton onsets versus the absence thereof in branching onsets, the compensatory vowel lengthening concomitant with word-final [ʁ] deletion, and, finally, the Dorsal assimilation found in Théo’s Coronal-[ʁ] branching onsets.

5.3 Analysis of the Patterns

5.3.1 Clara's [ʁ] substitution in singleton onsets

Regarding Clara's substitutions for [ʁ] in onsets, two observations are central to the analysis. First, as mentioned above, the substitutions are attested across the board in singleton onsets, without any effect of directionality. Second, these substitutions occur only in singleton onsets.

To account for this asymmetry between head and dependent positions within syllable constituents, I appeal to the constraint HEADPLACE, which requires consonants which occupy head positions to bear place specifications. (This constraint is also taken as the source of the distribution between coda placeless and onset coronal nasals in Miogliola described in section 5.1.)

(26) HEADPLACE
Head consonants must bear place features

In order to illustrate the proposal, I will take the period during which the patterns summarised in (18a) and (18b) are simultaneously attested, between ages 1;09.29 and 2;00.02. As a starting point, I will use the ranking in (10), which was proposed in order to account for the emergence of Clara's first branching onsets. Keeping only the constraints relevant to the present discussion, I will supplement this ranking with two highly-ranked constraints, namely, HEADPLACE and DEP(Place). I will also add to this ranking the lowly-ranked constraint FAITH([ʁ]), which represents a collection of constraints responsible for [ʁ] faithfulness. This constraint, which will be violated in any instance of [ʁ] substitution, is invoked in order to encode the fact that [ʁ] surfaces in target-like fashion in the dependent position of an onset when branching onsets emerge in the child's outputs. The proposed ranking is given in (27).

(27) Clara's constraint ranking
MAXHEAD(Foot), HEADPLACE, DEP(Place) » MAXHEAD(Onset) » FAITH([ʁ]) » *COMPLEX(Onset)

In order to illustrate how this ranking captures the relevant generalisations, I will begin with the [ʁ] substitution pattern in singleton onsets, exemplified with the word *robe* [ʁɔb], which surfaces as [wɔb] '(a) dress' at 1;10.10. Consider the tableau in (28).

(28) Clara's [ʁ] substitution pattern in singleton onsets

Input: O N O N ʁ ɔ b Ø Lab	MAXHD (Foot)	HEAD PLACE	DEP (Place)	MAXHD (Onset)	FAITH ([ʁ])	*CPLX (Onset)
a) [ʁɔb]: O N O N [ʁ ɔ b Ø] Lab		*!				
b) [rɔb]: O N O N [r ɔ b Ø] Cor Lab			*!		*	
c) [ʁɔb]: O N O N [ʁ ɔ b Ø] Dor Lab			*!		*	
d) [ɔb]: N O N [ɔ b Ø] Lab	*!			*		
☞ e) [wɔb]: O N O N [w ɔ b Ø] Lab					*	

In (28a), the target-like candidate fatally violates HEADPLACE, which requires that consonants in head position bear place specifications; Clara's placeless [ʁ] cannot satisfy this constraint when it appears in singleton onsets. Feature insertion would satisfy this constraint but would also fatally violate DEP(Place), as shown in candidates (28b) and (28c). Deletion of the placeless input [ʁ] does not constitute a viable option either; while this strategy would (vacuously) satisfy HEADPLACE, it would also yield a fatal violation of MAXHEAD(Foot), as we can see in the candidate in (28d). Therefore, Labial sharing represents the optimal solution, as we can see with the winning candidate in (28e), which minimally violates FAITH([ʁ]).

As mentioned above, during the same period as [ʁ] in head position undergoes substitution, in contexts where [ʁ] appears in the dependent position of a branching onset, it surfaces as target-like. In the tableau in (29), I demonstrate how the proposed ranking captures this observation, using the word <u>biberon</u> [bibʁɔ̃] 'baby bottle', which surfaces as [pa'pχɔ] at age 1;09.29.

(29) Clara's [ʁ] target-like realisation in branching onsets

Input: O N O N b i 'b ʁ ɔ̃ Lab Lab	MAXHD (Foot)	HEAD Place	DEP (Place)	MAXHD (Onset)	FAITH ([ʁ])	*CPLX (Onset)
a) [bi'bɔ̃]: O N O N [b i 'b ɔ̃] Lab Lab	*!					
b) [bi'bwɔ̃]: O N O N [b i 'b w ɔ̃] Lab Lab					*!	*
☞ c) [bi'bʁɔ̃]: O N O N [b i 'b ʁ ɔ̃] Lab Lab						*

As we can see in (29a), consistent with the analysis proposed in section 4.2 for the emergence of branching onsets in stressed syllables, deletion of the dependent [ʁ] incurs a fatal violation of highly-ranked MAXHEAD(Foot). The dependent position must therefore be realised in branching onsets dominated by the foot head. The surface realisation of [ʁ] in this position is governed by FAITH([ʁ]), which militates against assimilation of this consonant, as we can see in (29b). Assimilation would only be motivated by HEADPLACE but since [ʁ] appears in a dependent position in the input, HEADPLACE has no effect on its realisation on the surface. Candidate (29c), which shows target-like realisation of placeless [ʁ] can thus surface as optimal, as it only violates lowly-ranked *COMPLEX(Onset).

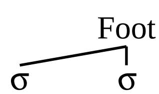
I will now turn to the second pattern described above, namely compensatory vowel lengthening concomitant with [ʁ]-deletion in word-final position.

5.3.2 Clara's word-final [ʁ] deletion and vowel lengthening

As we saw above in (18b), at the point when word-final consonants emerge in Clara's outputs, word-final [ʁ] still shows deletion, a process which is accompanied by compensatory lengthening of the vowel. As mentioned above, the compensatory lengthening triggered by Clara's word-final [ʁ] deletion is not observed in other consonant deletion contexts. First, at the stage when word-internal codas undergo deletion, no compensatory lengthening is found, because these codas are not in the stressed syllable in the input (e.g. ourson [ʊʁsɔ̃] → [ʊˈsɔ̃] 'teddy bear' at 2;03.05). Second, in contexts where consonants other than [ʁ] are deleted word-finally, prior to age 1;07.06 (e.g. sandale [sɑ̃dal] → [θaˈðæ] 1;04.14 'sandal'; peigne [pɛɲ] → [pɛ] 1;06.22 'comb'), no compensatory lengthening is observed.

In order to explain all of these observations in a unified fashion within Clara's grammar, I propose that the word-final [ʁ] context is, from a prosodic viewpoint, different than all of the other contexts. On the one hand, as illustrated in (25), only Clara's placeless [ʁ] is syllabified word-finally as a coda. On the other hand, the French stress foot is right headed, as illustrated in (30) for a disyllabic word.

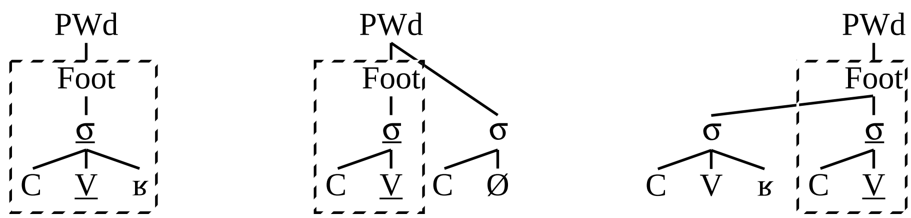
(30) French foot structure (right-headed)



As a consequence of Clara's syllabification of [ʁ] as a coda, input word-final [ʁ] falls within the head of the foot, as in (31a). This contrasts with the syllabification of both word-internal codas and Clara's word-final consonants other than [ʁ], which are word-final onsets. In (31b), word-final onsets are prosodified outside the foot, because of the right-headedness of the French foot; only a left-headed foot would allow for an integration of these consonants within the foot. Finally, as illustrated in (31c), word-internal codas appear outside of the head of the foot.

(31) Full prosodic structure of word-internal codas and word-final consonants in French

a) Word-final coda [ʁ] b) Word-final onset c) Word-internal coda [ʁ]



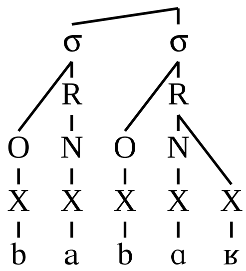
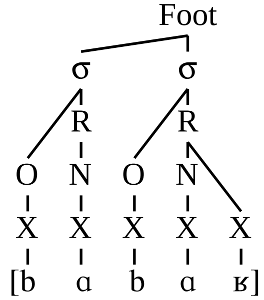
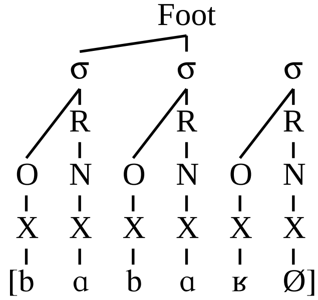
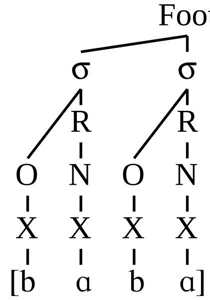
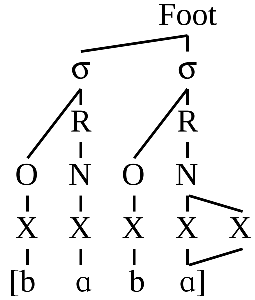
The different prosodic positions for the consonants in (31) thus enable an explanation for the fact that, at the stage where word-final coda [ʁ] is deleted from Clara's outputs, the vowel preceding [ʁ] in the input undergoes lengthening, a pattern which, as noted above, is found neither for the deletion of codas of unstressed syllables nor for the deletion of word-final onsets.

Turning now to how these representations, when combined with constraints, can capture the patterns, I will remove from the ranking initially used in (27) the constraints which are irrelevant to the issue presently discussed, namely, DEP(Place), as well as the three lowest-ranked constraints (MAXHEAD(Onset), FAITH([ʁ]), and *COMPLEX(Onset)). Also, to account for the patterns related to input codas, I will add the constraint *COMPLEX(Rhyme) whose high ranking will prevent the realisation of codas in early outputs, as well as two lowly-ranked constraints, *COMPLEX(Nucleus) and MAX(Seg), as in (32).

(32) Clara's ranking at the stage where word-final [ʁ] is deleted
*COMPLEX(Rhyme), MAXHEAD(Foot), HEADPLACE » *COMPLEX(Nucleus) » MAX(Seg)

To demonstrate how this ranking captures Clara's patterns, I will compare two cases of coda [ʁ] deletion, one in stressed syllables and one in unstressed syllables. The first context is illustrated in (33), with the input word Babar [baˈbɑʁ] 'Babar', which surfaces as [bɑˈbɑː].

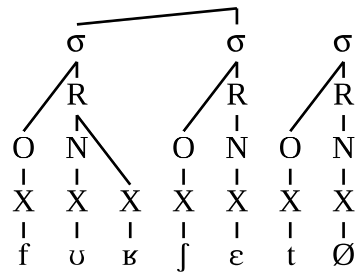
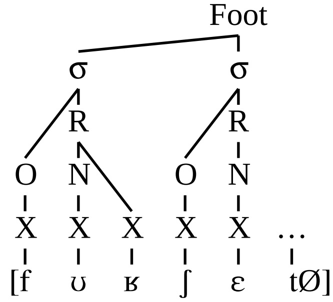
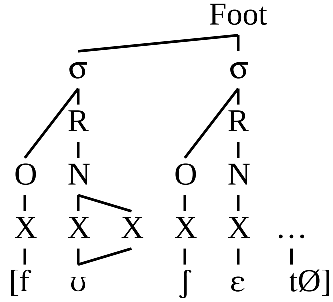
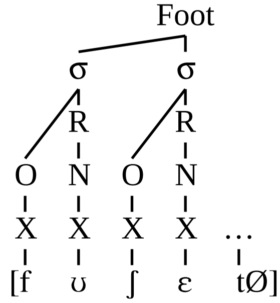
(33) Clara’s word-final [ʁ] deletion and vowel lengthening

Input: 	*CPLX (Rh)	MAXHD (Foot)	HEAD PLACE	*CPLX (Nuc)	MAX (Seg)
a) [bɑˈbɑʁ]: 	*!				
b) [bɑˈbɑʁ]: 		*!	*!		
c) [bɑˈbɑ]: 		*!			*
☞ d) [bɑˈbɑː]: 				*	

As we can see, the target-like candidate in (33a) fatally violates *COMPLEX(Rhyme). The second candidate, in (33b), is identical to target-like (33a) on the surface but syllabifies word-final [ʁ] as a word-final onset. This option is available to the child at this stage, since word-final onsets are allowed from age 1;07.06. However, in the case of [ʁ], this option involves a fatal violation of highly-ranked MAXHEAD(Foot), because of the fact that [ʁ], which is prosodified in the foot head in the input, falls outside of this constituent in (33b). This candidate also fatally violates HEADPLACE, as it contains placeless [ʁ] in an onset head. The candidate in (33c) fatally violates MAXHEAD(Foot) as well, through complete deletion of input [ʁ]. The candidate in (33d) therefore surfaces as optimal. This candidate, which shows preservation of one part of input [ʁ], its timing position, enables satisfaction of MAXHEAD(Foot) at the expense of lower-ranked *COMPLEX(Nucleus), and yields the lengthening observed in the data.

Turning now to branching rhyme reduction in word-internal position, I exemplify this context with the word <u>fourchette</u> [fʊʁʃɛt] 'fork', which surfaces as [ɸeˈdɛtʰ] at age 1;09.01, i.e. with word-internal coda deletion and no vowel lengthening. As we can see in (34), the ranking proposed in (32) captures these two observations.

(34) Clara's word-internal [ʁ] deletion

Input: 	*CPLX (Rh)	MAXHD (Foot)	HEAD PLACE	*CPLX (Nuc)	MAX (Seg)
a) [fʊʁ'ʃɛt]: 	*!				
b) [fuː'ʃɛt]: 				*!	
☞ c) [fʊ'ʃɛt]: 					*

In (34a), input-like syllabification fatally violates highly-ranked *COMPLEX(Rhyme), similar to what was observed in (33a). The candidate in (34b), showing partial faithfulness to input coda [ʁ] through preservation of its timing unit, fatally violates *COMPLEX(Nucleus), which is crucially ranked above MAX(Seg). This last constraint is minimally violated by the optimal candidate in (34c), despite the fact that this candidate shows deletion of the entire input consonant. Such a deletion is possible in this context because coda [ʁ] appears in the dependent position of the foot in the input and, thus, regardless of how this consonant behaves, the output will vacuously satisfy MAXHEAD(Foot).

The compensatory lengthening analysed in (33) is comparable to similar patterns documented by Ota (1999, pp. 99ff) on the development of Japanese rhymes. Children thus appear to be sensitive to rhymal content across languages at very early stages in development. However, one major distinction arises from a comparison between the French and the Japanese data: While compensatory lengthening is found in stressed syllables only in French, it is pervasive in Japanese, in both unstressed and stressed syllables. The difference between the two corpora, however, can be directly related to the phonology of the two target languages. Indeed, while vowel length is phonemically contrastive in adult Japanese (Vance, 1987), it is not in adult French. This suggests a direct relation between the properties of the target language and the processes found in the productions of an L1 learner of this language.

Finally, the French data on compensatory lengthening provide additional support for the view that inputs are fully prosodified. Indeed, it is only through full prosodification of inputs that we can draw a distinction between the vowel lengthening concomitant with the deletion of word-final coda [ʁ] and the absence thereof in contexts where word-internal codas and word-final onsets are deleted. Recall from (31) that word-final codas are part of the stressed syllable, as opposed to word-internal codas and word-final onsets (because of the right-headedness of the French foot). Word-final codas thus constitute the only context where the constraint MAXHEAD, whose effects were also seen on branching onsets in stressed syllables in section 4, predicts preservation of at least part of the input segment (here, the timing position).

I now turn to the assimilation pattern found in Théo’s Coronal-[ʁ] branching onsets. I will analyse this process through a licensing relationship which takes place between the head and the dependent position within the onset constituent.

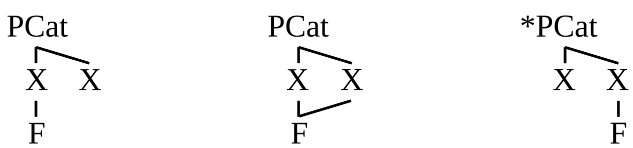
5.3.3 Théo's Coronal-[ʁ] assimilation in branching onsets

As we saw in (16b), in Théo's branching onsets, target Coronal-[ʁ] clusters surface as Dorsal-[ʁ]. In this section, I will analyse this pattern of assimilation using the representation of Théo's dorsal [ʁ], and the constraint License, defined in (35), which requires that Dorsal be licensed by the head of the onset.

(35) License(Dor, Ons)
The feature Dorsal must be licensed by the head of the onset

Following Piggott (2000), I argue that License is fulfilled if and only if a segment in the head position of PCat contains F, as schematised in (36a) and (36b). In other words, the dependent position of PCat plays no role in prosodic licensing. This implies that a feature that fails to be anchored to the head of PCat violates License, as illustrated in (36c).

(36) License(F, PCat) relations
a) Well-formed b) Well-formed c) Ill-formed



Thus, satisfaction of the constraint in (35) will require a Dorsal feature in a branching onset to be realised in the first consonant of this onset.

Lic(Dor, Ons) will interact with the three faithfulness constraints targeting place features, namely Max(Lab), Max(Cor), and Max(Dor). However, because Labial consonants resist Dorsal assimilation in Théo's outputs (e.g. bras /bʁɑ/ → [bʁɑ]; *[gʁɑ], prendre /pχɑ̃d/ → [pχɑ̃d]; *[kχɑ̃d]), Max(Lab) must be ranked higher than Lic(Dor, Ons). These data from Labial-[ʁ] branching onsets also enable us to determine the relative ranking of Max(Dor): In Labial-[ʁ] onsets, both of the input place features are preserved in output forms, at the expense of Lic(Dor, Ons). Thus, Max(Dor) must be ranked higher that Lic(Dor, Ons). Conversely, since Coronal undergoes Dorsal assimilation, MAX(Cor) must be ranked below LIC(Dor, Ons), following the ranking in (37).

(37) Théo's constraint ranking
MAX(Lab), MAX(Dor) » LIC(Dor, Ons) » MAX(Cor)

Notice as well that, apart from enabling us to account for the patterning observed in Théo's branching onsets, the ranking in (37) finds support on markedness grounds. Indeed, coronals are most often subject to assimilation in adult languages (see, e.g. contributions to Paradis & Prunet, 1991). The low ranking of MAX(Cor) reflects this tendency. Finally, additional constraints such as LINEARITY and PLACE would also be required as undominated in order to predict the absence of metathesis (violating LINEARITY) and debuccalisation (e.g. /t/ → [h or ʔ]; violating PLACE). As well, in order to avoid doubly-articulated consonants that would result from spreading Dorsal onto the input Labial consonant (yielding [k͜pχ / ɡ͜bʁ]) and thereby satisfying both LIC(Dor, Ons) and MAX(Lab), a more complete analysis would include a constraint like *COMPLEX(Place) as undominated, following the proposals of, e.g. Goad (1997) and Kawasaki (1998). However, these constraints are tangential to the argument and will not be discussed further.

In order to demonstrate how the ranking in (37) captures the right output forms in Théo's branching onsets, I will compare Coronal-[ʁ] branching onsets, which display Dorsal assimilation, with Labial-[ʁ] branching onsets, where no assimilation is found.

Starting with the Coronal-[ʁ] branching onsets, I exemplify this context with the word <u>trop</u> [tχo] 'too much', which is realised as [kχo] by Théo.

(38) Coronal-[ʁ] branching onsets: Dorsal assimilation

Input: O t χ o Cor Dor	MAX(Lab)	MAX(Dor)	LIC(Dor, Ons)	MAX(Cor)
a) [tχo]: O [t χ o] Cor Dor			*!	
b) [tro]: O [t r o] Cor		*!		
☞ c) [kχo]: O [k χ o] Dor				*

Candidate (38a) incurs a fatal violation of the constraint LIC(Dor, Ons), as the Dorsal specification found in this candidate is not realised on the onset head. Satisfaction of LIC(Dor, Ons) is observed in the last two candidates, through feature sharing. Because the candidate in (38b) shows Dorsal deletion, however, it fatally violates higher-ranked MAX(Dor), leaving (38c), which minimally violates MAX(Cor), as optimal.

Turning now to Labial-[ʁ] clusters, we can observe in (39) the effect of the ranking in (37) on a word such as pris [pχi] 'taken', which surfaces as target-like in Théo's outputs.

(39) Labial-[ʁ] branching onsets: No assimilation

Input: O p χ i Lab Dor	MAX (Lab)	MAX (Dor)	LIC (Dor, Ons)	MAX (Cor)
☞ a) [pχi]: O [p χ i] Lab Dor			*	
b) [kχi]: O [k χ i] Dor	*!			
c) [pwi]: O [p w i] Lab		*!		

As we can see from this tableau, a violation of LIC(Dor, Ons) is preferred over violations of the higher-ranked constraints MAX(Lab) and MAX(Dor), which are found in (39b) and (39c), respectively. Candidate (39a) therefore surfaces as optimal.

In short, we have seen that by comparing the tableaux in (38) and (39), the constraint ranking proposed above in (37) correctly captures the patternings observed in Théo's branching onsets. I will now briefly discuss two additional issues related to the analysis proposed above. The first concerns the fact that Théo's Dorsal assimilation does not apply outside the onset constituent (e.g. *tortue* [tɔʁt͡sy] → [tɔʁ'ʦ̮y] 'turtle'; *[kɔʁ'ʦ̮y], *[tɔʁ'ky]). This pattern of non-assimilation is predicted by the current analysis, through the fact that LIC(Dor, Ons) refers specifically to the onset constituent. This implies that this constraint is vacuously satisfied in all of the cases where a dorsal consonant is prosodified outside of the onset constituent. The second point regards the cross-linguistic observation that branching onsets showing place identity appear as cross-linguistically marked. For example, in English, branching onsets such as Coronal-Coronal *[tl] and Labial-Labial *[pw] are banned. A phonotactic of this type does not seem, however, to affect children's productions, which appear to contain a number of such clusters (e.g. Fikkert, 1994;

Smith, 1973). This suggests that more research needs to be done on this issue, on both adult and child languages, in order to determine what are the underlying causes for the relative markedness of these clusters across languages.

6. Conclusion

In this paper, we have witnessed interactions between segmental and prosodic levels of representation. These were demonstrated from two different perspectives, namely, the development of complex syllable onsets and the effects of feature specification on default syllabification options. In section 4, we saw a top-down effect of this relationship in the acquisition of branching onsets, which are mastered in stressed syllables before unstressed syllables. In section 5, we looked at a bottom-up effect between segmental place feature specification and the syllabification of word-final consonants. When the observations made in these sections are combined, they demonstrate how the melodic content of output segments is linked to higher prosodic structure in developing phonologies.

Finally, we also witnessed parallels between child and adult phonologies concerning the main patterns discussed in this paper. While the positional faithfulness effects in section 4 finds a correlate in adult Brazilian Portuguese, the syllabification options which I argued for in section 5 match the ones proposed independently for adult systems. These observations suggest that universal markedness constrains both output and input representations in a fairly narrow way. Related to this is the observation that word-final (place-specified) onsets appear to systematically emerge earlier in development than word-internal codas. Implications of this for both acquisition and formal models of phonological development, as well as how to represent the initial state of the child's grammatical organisation remain to be explored more in depth.

Footnotes:

1. Throughout the paper, the format Y;MM.DD is used to encode the children's respective ages at the different developmental stages observed.

2. As indicated by the parentheses, the onset is considered an optional constituent of the syllable. Following Kaye (1990) and Kaye et al. (1990), I reject the coda as a constituent of the syllable.

3. Virtually all acquisitionists working within the OT framework assume this ranking at the initial stage (cf. Hale & Reiss, 1998).

4. In French, input [ʁ] in branching onsets is realised as a voiceless fricative when it is preceded by a voiceless obstruent (e.g. trop /tʁo/ → [tχo] 'too much'). In most instances, the children's outputs follow this phonotactic (but see footnote 8). The [ʁ / χ] variation found in the two children's outputs is attributed to the fact that voicing is not fully mastered at early stages.

5. It follows from the current proposal that I reject the notion of 'Richness of the Base' as initially proposed by Prince & Smolensky (1993), which states that since constraints assess the well-formedness of outputs, inputs are free to contain any type of information (modulo the maintenance of contrasts). See further Kawasaki (1998), who also challenges Richness of the Base in her discussion of the Rendaku facts.

6. As noted by one of the anonymous reviewers, coronals appear to be amongst the first consonants acquired in both word-internal codas and in word-final position in Clara's outputs. While this observation could be related to the unmarked status of coronal consonants across languages (e.g. Paradis & Prunet, 1991), I suggest that the actual source of this fact comes from the frequency distributions in French where, for example, coronal [s] and uvular [ʁ] are the most frequent word-internal codas in this language. Furthermore, apart from the behaviour of [ʁ] as placeless in Clara's outputs, there does not seem to be any evidence for coronal underspecification in her output forms.

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