PROSODIC LICENSING, ELABORATION OF SEGMENTAL STRUCTURE AND CHILD CONSONANT HARMONY*

Chen Qu
McGill University

Consonant harmony (CH) (1) across major place features is perhaps the most extensively discussed phenomenon in child language (see e.g. Smith 1973, Goad 1997, Rose 2000, Pater & Werle 2003, and references cited therein).

(1) CH (Amahl at 2;60: Smith 1973)[1]
   a. Regressive dorsal harmony: duck [gʌk]
   b. Regressive labial harmony: table [be:bu]

Previous researchers of child CH almost all assume that children share the same phonological representation (hence after, PR) with adults (cf. Levelt 1994), and none of them have ever assumed that feature representations develop over time. Following from this, the difference between child and adult grammar rests solely either on rule ordering or on constraint ranking. However, whether children have the same PR as adults is an open question. If children do not have adult-like PR, and the children's PR instead develops through time, then previous analyses of child CH where the explanatory burden rests only on rules or constraint ranking would be inadequate. Research on the development of major place contrasts among consonants will surely shed light on our understanding of child CH. Unfortunately, there seems to be no study that analyzes child CH processes in light of the development of children's phonological system of consonantal contrasts. This work intends to fill up this gap by focusing on the development of supra-laryngeal place contrasts.

On one hand, I follow Rice & Avery (1995) in regarding children's early PR as under-specified.[2] I argue that children's segmental structure is initially minimal; more structure is then added monotonically at each stage, following the hypothesis of minimality and monotonicity proposed by Rice (1996a). On the other hand, following the spirit of Steriade (1995), Piggott (1996, 1997), Zoll (1998), Rose (2000) and Goad (2001) in regarding harmony as a process triggered by phonological licensing (Harris 1994, 1997), I argue that most assimilation and substitution processes attested in children's outputs including CH are driven by phonological licensing. Specifically, I propose the following:

* The work presented here is part of my second evaluation paper. My special thanks go to Heather Goad. Many of my ideas are inspired by our discussions in her office or long messages via email. She guided me through every stages of the research including the analysis of the data as well as writing up the paper. It is fair to say that without her help, there will be no paper presented here. I also want to thank Glyne Piggott for his invaluable comments on each draft of this paper. My thank you also goes to the audience at CLA 2010 annual meeting who shared with me their insightful questions and comments.

[1] The age format for children mentioned in this work follows the original sources.

[2] See Fikkert & Levelt (2008) for an alternative view on the under-specification and elaboration of children's PR.

Actes du congrès annuel de l'Association canadienne de linguistique 2011.
Proceedings of the 2011 annual conference of the Canadian Linguistic Association.

(1) children's major place contrasts develop through time. (2) When acquiring languages with a three-way place contrast among labial, coronal and dorsal with labial and dorsal being equally marked, there are three stages that children go through with two learning paths being possible for stage 2. (3) In child grammar, the back oral stop /K/ is velar (placeless) for some children at certain stages in development.[3] (4) The amount of structure present in a representation reflects the markedness of that segment. The more structure a segment has, the more marked the segment is. (5) Prosodic licensing constraints (onsets): onsets of prosodic heads support more structures than onsets of prosodic dependents. Onsets of prosodic dependents cannot be more complex than onsets of prosodic heads. Onsets of prosodic heads are specified for PLACE. (6) Almost all assimilation and substitution processes attested in children's outputs are driven by phonological licensing coupled with the different segmental structures children build at different developmental stages.

The paper is structured as follows. In section 1, I focus on the status of the back consonant /K/ in child language. Drawing on analogy from adult language, I argue that /K/ must be velar (placeless) for some children at certain stages in development. In section 2, I raise the hypothesis concerning the possible developmental paths circumscribed by Universal Grammar (UG) that children may take in acquiring the major place contrasts of their target language especially languages having a dorsal /K/. In section 3, I provide evidence for the hypothesis raised in section 2 by analyzing the processes of velar fronting (VF) as well as different patterns of CH attested in two children's productions, namely, Julia and Trevor. At last, section 4 concludes the paper.

1. The status of /K/

In this section, I first discuss Julia's productions of /K/.[4] I show that /K/ cannot be specified as dorsal for Julia. Then in section 1.2, I argue that /K/ is velar (placeless) in some adult languages, in contrast to dorsal in other languages like English. In section 1.3, I propose that /K/ is velar for some children including Julia at certain stages of development.

1.1 Julia's productions of /K/

Julia systematically avoids /K/ at prosodic head position, but favors it at prosodic dependent position when she is 2;28-2;145. This asymmetrical distribution raises questions concerning the status of /K. If /K/ is specified as dorsal, the most marked place of articulation, as has been commonly assumed in the child language literature, it would be mysterious that it can only occur in

[3] Here and below, I use /K/ to stand for back oral stops, /T/ for coronal oral stops and /P/ for bilabial oral stops. Voicing distinctions are ignored. "Back oral stops" refer to the oral stops produced at the back part of the oral cavity. The reason that I opt for this term over the conventional term "velar" or "dorsal" is because I regard velar and dorsal as different, following Rice (1996b). More discussion on this is provided in section 1.2.

[4] Julia is a monolingual English acquiring girl in Montreal, Quebec, Canada. Data were collected as part of an FCAR grant (Quebec government) awarded to Heather Goad.

prosodic dependent position but cannot occur in prosodic head position. Below is the detailed discussion on Julia's /K/.

Most of Julia's outputs during the age range I focus on are in the shape of C_1VC_2V and C_1VC_2 with primary stress falls on the word-initial syllable. Therefore, the word-initial consonant is also foot-initial and thus is at the prosodic head position. From 2;28 to 2;145,[5] Julia systematically applies velar fronting (VF) foot-initially (27/34 tokens) as is shown in (2).[6]

(2) VF (Julia: 2;28-2;145)
   a. coat [dəʰt] (2;28)
   b. cookies [ˈdʌχis] (2;111 imitation)
   c. car [dʌχ] (2;60)

Following Goad (1996) and Goad & Brannen (2003), I regard word-final consonants as the onsets of empty-headed syllables (OEHS).[7] Therefore, both word-medial and word-final onsets are foot-internal onsets, and are at the prosodic dependent position. Julia produces foot-internal /K/ with a target-like place of articulation as in (3) (word-medially: 95% (19/20 tokens), word-finally: 90% (53/59 tokens).[8]

(3) Foot-internal onsets (Julia: 2;28-2;145)
   a. monkey [ˊmʌxi] (2;88)
   b. bike [bʌx] (2;81)

As Julia systematically avoids /K/ at prosodic head position, it is, therefore, impossible that /K/ is specified as dorsal, as otherwise the opposite pattern should be observed. In what follows, I show that in some adult languages, /K/ is not dorsal, but velar, less marked than labial and coronal. We will see, then, that it is not surprising that /K/ is velar for Julia during the age range we focus on.

1.2 /K/ in adult languages

Following Rice (1996b), I argue that adult languages are of two types with respect to the status of the back consonants: dorsal languages and velar languages. In dorsal languages such as English, assimilation targets coronal or neutralization of place yields coronal. On the contrary, in velar languages, assimilation targets velar and neutralization yields velar, indicating that velar is the least marked place of articulation. I regard markedness as correlating with the complexity of the structure. The more complex is the structure, the more marked is the segment. I will not go into detail on dorsal languages. Readers are referred to Avery & Rice (1989) and Paradis & Prunet (1991) for discussion of the unmarkedness of coronals in such languages. In what follows, I focus on one velar language in which processes are observed suggesting that /K/ is the least

[5] Julia's age is in the format of year;day.

[6] For the rest of the foot-initial /K/s, five are replaced by /P/ and two are subject to deletion. So none of the foot-initial /K/s are target-like when Julia is 2;28-2;145.

[7] Julia treats word-final consonants the same as word-medial onsets, as can be seen in the following examples: dentist [ˊdʌtʰɪs] (2;60), boat [pʊtʰ] (2;28).

[8] Notice that /K/ is produced as fricatives but the place of articulation remains the same.

marked place of articulation.

In Tlachichilco Tepehua (Watters 1988), stops neutralize to velar/uvular before a consonant other than an underlying glottal stop as is shown in (4).[9]

(4) Tlachichilco Tepehua: Neutralization to [k/q] (Watters 1988)

a. /ʃap/		b. /q'ut/	
ʃa^{w}k-ɬi	"X panted"	ʔoq-ɬɪ	"X drank it"
ʃap-'a	"X pants"	ʔot-'a	"X drinks it"

As adult languages are of two types as far as specification of place in back consonants is concerned, and if children's grammars are possible (adult) grammars (Pinker 1984), it is expected that this difference be reflected in children's languages as well. When viewed from this perspective, Julia's treatment of /K/ as velar is not surprising. I show below that Julia is not the only child who treats /K/ as velar. In fact, many children including children learning languages other than English behave like Julia.

1.3. /K/ in child languages

There are many children who behave like Julia in producing /K/, suggesting that /K/ must be velar for them.

First, E (Inkelas & Rose 2007), Hildegard (Leopold 1947), Joan (Velten 1943), Ruth (Hills 1914), and 67 normally developing English-learning children (Stoel-Gammon 1996) all behave like Julia in producing word-initial /K/ as /T/. Children learning languages other than English also use /T/ to replace /K/ in prosodic head position. Noortje (Fikkert & Levelt 2008) acquiring Dutch, Melanie (Berg 1992) acquiring German and Virve (Vihman 1978) acquiring Estonian are some of them.

Second, Julia produces /K/ earlier than any other stops foot-internally (5), but later than any other stops foot-initially (6). Note also that /K/ is produced earlier at prosodic dependent position (1;198) than at head position (1;250), different from that of /P/ and /T/.

(5) Julia: foot-internally	(6) Julia: foot-initially
a. dog [dɑ:x] (1;198)	a. key [gi$\int$] (1;250)
b. that [da:t^{h}] (1;315)	b. dog [dɑ:x] (1;198)
c. yup [jʌp] (2;97)	c. baby [bibi] (1;167)

Similar to Julia, Molly (Holmes 1927) produces final /K/ in 9/10 cases, but deletes /T/ in 5/9 cases and no word-final /P/ is ever attempted at 1;180. Wood (1995) reports that N uses /K/ and /ʔ/ interchangeably word-finally when both coronal and labial stops word-finally are subject to deletion.[10] Ruth (Hills 1914) is reported to have acquired /K/ word-finally by the age of 2;0 but still uses /T/ to replace /K/ word-initially (Ingram 1974:240).

There are also children who are reported to apply other processes to avoid

[9] According to Watters (1988), the apostrophe in the data indicates either a glottal stop or glottalization of oral stops.

[10] Sometimes, N also produces word-final coronal and labial stops as either glottal or velar stops. The same is attested in Julia's outputs.

/K/ in prosodic head position, implying that /K/ is velar. For example, Philip at 1;270 (Ingram 1974:236) applies metathesis to avoid word-initial /K/ (7).[11] Notice that the consonants that alternate with /K/ can be either coronal or labial, implying that this process cannot be due to labials being favored at the left edge of words, but must be induced by velar being disfavored in head positions.

(7) Metathesis (Philip: 1;270)
  a. alligator [dæge]
  b. gumby [bæŋki]
  c. coffee [baki]

It is now much clearer that /K/ is preferred in prosodic dependent position but disfavored in prosodic head position for many children including children acquiring languages other than English. In short, /K/ cannot be dorsal. Rather, it must be velar, less marked than both labial and coronal. If /K/ is velar for the children discussed above, the question that immediately follows must be: how do these children acquire languages in which /K/ is dorsal? In section 3 below, I take up this issue and introduce my proposal concerning the possible routes circumscribed by UG that children may take in acquiring the place contrasts among consonants of the target language. I focus on the supra-laryngeal contrasts only and will ignore children's acquisition of sub-coronal contrasts.

2. Elaboration of segmental structure

If children's grammars are possible (adult) grammars (Pinker 1984), it is expected that for all the stages that children go through in acquiring the place contrast of the target language, the place contrast system that children have at each stage should match with a certain type of place contrast systems of adult languages. Therefore, in this section, I examine the place contrast systems of adult languages, that is, the possible routes circumscribed by UG for children to take in acquiring the place contrast of the target language. It has been reported that there is no language that uses only one place of articulation for the series of stops (Maddieson 1984:31). Therefore, I propose that the initial stage of children's language acquisition, stage 1, is characterized by a two-way contrast. Following the hypothesis of minimality and monotonicity (Rice 1996a), I suggest that children only have minimal structures at stage 1, and the process of establishing L1 place contrasts is through monotonic addition of structure. The result of this is that different possibilities exist for how to elaborate the two-way place contrast at stage 1 into a three-way place contrast at stage 2. I argue that only two of them are legitimately circumscribed by UG. At stage 3, the two legitimate paths from stage 2 converge into the same three-way place contrast in which the labial and dorsal are equally marked. I discuss each of these three stages in detail below.

2.1 Stage 1: Two-way contrast (labial vs. non-labial)

Concerning a two-way place contrast in adult language, Hawaiian stands out as

[11] Please notice that truncation also applies in (7a).

having a contrast between labial and non-labial, as is shown by its consonantal inventory in Table 1.[12]

Hawaiian	Labial	Dental (Alveolar)	Velar	Glottal
Plosive	p	t~k		ʔ
Fricative				h
Nasal	m	n		
Sonorant	w~v	l		

Table 1 Hawaiian consonant inventory (Elbert & Pukui 2001)

The same contrast system should be attested in child language if children's grammars are possible (adult) grammars. And this is exactly what is reported in the early stages of children's outputs. For example, Daniel (Menn 1971:231) and Timmy (Vihman, Velleman & McCune 1994:22) are reported to have a two-way place contrast between labial and velar. Joan (Velten 1943:282) has a two-way place contrast between labial and coronal. Ingram (1976:18) reports that when children come to acquire about 50 words, the consonant inventory is characterized as having two sets of speech sounds: labial vs. coronal.[13] Wood (1995) also shows that N only has a contrast between labial and coronal word-initially before the age of two. Recall from the inventory above that in Hawaiian coronal and velar never contrast.

Back to Julia, she uses /T/ and /K/ interchangeably in her early outputs (8), implying that the contrast between /K/ and /T/ has not yet been established.

(8) Variation of /T/ and /K/ (Julia: 1;167-1;284)
a. truck [kax] (1;270)
b. truck [tax] (1;270)

Following the minimality hypothesis proposed by Rice (1996a) in (9) below, I propose that the initial segmental structures that young children have are in (10) (c.f. Rice 1996a).[14][15] I suggest that no specific place feature is present in children's PR at this stage.[16] (10a) is realized as labial by phonetic enhancement. I suggest that the early emergence of labial is due to factors other than language. See Qu (2011) for more detailed discussion on this.

[12] Mohawk (Michelson 1988) and Wichita (Maddieson 1984) have also been reported as languages with a two-way place contrast, where the contrast rests between alveolar (/T/) and velar (/K/). However, I regard Mohawk as a language of a three-way place contrast in disguise (see Postal 1969 for /k^w/ as /p/). As a series of labiovelar stops (/k^w/) are also attested in Wichita, I regard Wichita the same as Mohawk.

[13] Note that in the reported studies, researchers mainly focus on word-initial position. So children's preference for labial vs. coronal over labial vs. velar is probably only apparent.

[14] I follow the feature geometry proposed by Clements & Hume (1995). Irrelevant structures are omitted.

[15] Although glottal stops are also considered to be placeless, I regard glottal stop as lacking an articulator in the oral cavity, and the difference between velar and laryngeals, I assume, lies in the dependent of laryngeal node, following Halle (1989, 1992).

[16] I propose that V-Pl is projected only when vowel height becomes contrastive. Before V-Pl is projected, speech sounds, either consonants or vowels, are marked for Pl only.

(9) Minimality (Rice 1996a:12)
Initially the child has minimal structure.

(10) Stage 1: labial vs. non-labial

a. Place (/P/)	b. Placeless (/T/ or /K/)
R	R
|	
Pl	

2.2 Stage 2: Two learning paths

To elaborate the two-way contrast in (10) into a three-way contrast, three possibilities exist if we follow the hypothesis of monotonicity (Rice 1996a) (11),

(11) Monotonicity (Rice 1996a: 12)
Inventories are built up in a monotonic fashion as contrast is added.

Option 1: PLACE is added to the bare root node of (10b) resulting in a split into coronal and velar (12b-c). Then Labial is forced to be added as a dependent of PLACE of (10a) as in (12a) under the pressure of maintaining phonological contrast. The three-way contrast that results is thereby among labial, coronal and placeless with labial being the most marked place of articulation.

(12) Option 1 (learning path 1)

a. Labial (/P/)	b. Coronal (/T/)	c. Placeless (/K/)
R	R	R
|	↑	
Pl	Pl	
↑		
Labial		

One adult language that shows a contrast like (12) is Chukchi. In Chukchi, both dental and labial do not assimilate to following velars (13a-b). This pattern is expected if velar has no place feature to share with a preceding coda. Velars in consonant clusters assimilate to following labials, but not to following dentals (13c). Notice that /k/ in coda can acquire features since it is placeless. Even though /k/ has less structures than /t/, it fails to assimilate to the following /t/ because /t/ lacks a place specification in contrast to the representation of /p/.

(13) Place assimilation in Chukchi (Bogoras 1922)[17]

a. ɣe-tku-lin → ɣetkulin "he consumed it"

b. ɣe-pkir-lin → gepkirin "he came"

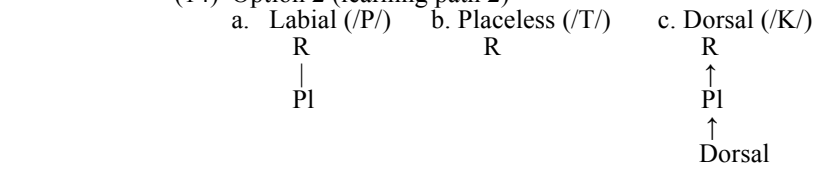
c. mykpenwel → mywpenwel "many two-year-old reindeer-bucks"

uwiktimnen → uwiɣtimnen "she killed herself"

[17] Bogoras (1922:652) indicates that the medial consonant cluster /pt/ is legal but no words containing this cluster are provided. In addition, he points out that /tp/ is an accidental gap. Concerning the nasal stops, the velar nasal is the least marked among the nasals at the three major places of articulation (see Rice 1996b for detailed discussion).

Option 2: PLACE is similarly added to the bare root node of (10b) resulting in a split (14b-c). Dorsal is added as a dependent of this PLACE node (14c), thus leaving (10a) intact (14a). The contrast that results is therefore among dorsal, labial and placeless with dorsal being the most marked place of articulation.

(14) Option 2 (learning path 2)



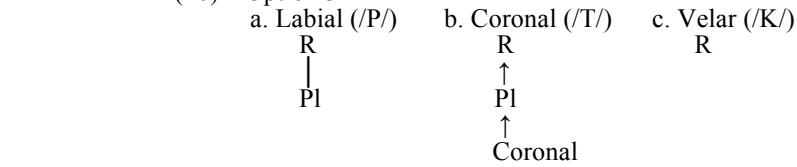
One of the adult languages in which dorsal is more marked than the other two places of articulation is Korean (Iverson & Kim 1987). In Korean, coronal in consonant clusters assimilates to following dorsal and labial (15a); labial assimilates to following dorsal, but not to coronal (15b), and dorsal assimilates neither to labial nor to coronal (15c), suggesting that dorsal is the most marked place of articulation and coronal the least marked place of articulation as is revealed from the structure in (14).

(15) Korean place assimilation (after Jun 1995:51–52)

a.	/mit + ko/	→ [mikko]	"believe and"
	/kot + palo/	→ [koppalo]	"straight"
b.	/ip + ko/	→ [ikko]	"wear and"
	/ip + ta/	→ [ipta]	"wear + SE"
c.	/ʧak + pha/	→ [ʧakpha]	"destruction"
	/ik + ta/	→ [ikta]	"ripe + SE"

Option 3: PLACE is added to the bare root node of (10b), coronal is then added as a dependent of this PLACE node (16b) leaving (10a) intact (16a).

(16) *Option 3



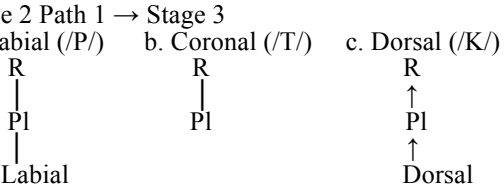
Note that coronal is the most marked place of articulation in this system. To my knowledge, there are no languages in which coronals are the most marked place of articulation for the stop series. In addition, the feature coronal is usually not present in PR unless sub-coronal contrasts are attested, and the latter is often the case when both labial and dorsal features are present. That is, there seem to be no languages with a three-way contrast between labial and two types of coronals

(e.g. p/t/c). Therefore, option 3, likely, must be ruled out by UG.[18] This leaves options 1 and 2 as the possible learning paths for children acquiring the major place contrasts of the target language.

2.3 Stage 3: labial, coronal & dorsal

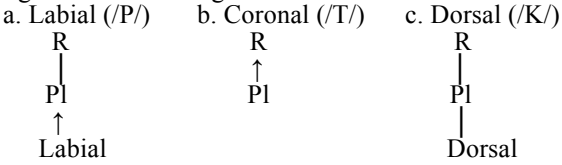
When the two learning paths at stage 2 are further elaborated at stage 3, they converge on the same three-way contrast among labial, coronal and dorsal, with labial and dorsal being equally marked. For children taking path 1 at stage 2, PLACE is added to the bare root node in (12c). Dorsal is then forced as a dependent under the pressure of maintaining phonological contrast, leaving (12a-b) intact (17a-b). The transition from path 1 of stage 2 to stage 3 will be triggered when children are exposed to evidence such as coronal assimilating to following dorsal.

(17) Stage 2 Path 1 → Stage 3



For children taking path 2, PLACE is added to the bare root node in (14b) forcing labial to be added as a dependent of PLACE in (14a) as in (18a-b). The transition from path 2 of stage 2 to stage 3 could happen when children notice that labial does not assimilate to dorsal in the target language.

(18) Stage 2 Path 2 → Stage 3



Note that the elaboration of both path 1 and path 2 lead to the same PR at stage 3. Labial and dorsal are now equally marked compared to the unmarked coronal, just like the major place contrasts in English.[19]

To briefly summarize, the hypothesis concerning children's development of major place contrasts is constrained by the principles of minimality and monotonicity, and the acquisition process is guided by UG. Stage 1 is characterized as having minimal structures with a two-way place contrast being realized between labial and non-labial. The rudimentary structures at stage 1 are then elaborated in a monotonic way through different paths and stages. It is

[18] It seems that option 3 cannot be formally ruled out. We leave this problem to future research.

[19] Please note that English has sub-coronal contrasts for obstruents, so coronal unmarkedness will only be observed with nasals.

therefore a natural outcome that in the process of acquiring major place contrasts, two-way place contrasts emerge earlier than three-way contrasts; velar and coronal emerge earlier than labial and dorsal. In section 3 below, I provide evidence for the hypothesized stages by analyzing some processes attested in children's early outputs, mainly the widely attested VF and CH.

3. Phonological licensing and processes in child languages

As almost all the CH processes attested in child language are assimilations across major place features, it should not be surprising to find that different systems of place contrasts may have an effect on child CH. I argue that there is nothing particularly special about child CH when compared with other processes attested in children's productions, e.g. VF, metathesis, etc. I suggest that almost all substitution and assimilation processes attested in children's outputs are induced by phonological licensing coupled with the segmental structures that children build at different developmental stages.

In section 3.1, I elaborate on the phonological licensing theory of Harris (1994, 1997). As my focus is on syllable onsets, I propose three particular prosodic licensing constraints for onsets. In section 3.2, I focus on Julia's VF. I propose that Julia takes path 1 at stage 2 when VF systematically applies in her outputs. In section 3.3, I examine Trevor's CH patterns, mainly the regressive CH (Compton & Streeter 1977, Pater 1997, Pater & Werle 2001, 2003). I show that the different patterns of CH attested at different ages in Trevor's dataset are due to the fact that Trevor went through different stages in acquiring the major place contrasts of English. In short, VF and different patterns of CH are all induced by phonological licensing coupled with the types of phonological representations that children build at different stages. I leave stage 1 aside in this section as it typically reflects the point when children's vocabulary is less than 50 words, and most outputs at this stage are core syllables or reduplicates.

3.1 Phonological licensing

Phonological licensing is of two different types: prosodic licensing and autosegmental licensing. Under prosodic licensing, each unit in the prosodic hierarchy is required to belong to some higher-order structure. Under auto-segmental licensing, the attachment of melodic material to skeletal slots is regulated (Harris 1994:154-155). As the focus of this work is on syllable onsets, I focus on the autosegmental licensing relations of onset consonants. Harris (1994:160) proposes that an onset head position must be licensed by a following nucleus position by the principle of onset licensing. He (1994:208) suggests further that the distributional asymmetry between the nuclei contained in a foot is potentially mirrored in the onsets they license at the inter-constituent level (licensing inheritance principle). As the dominant nucleus within a prosodic head support more complex structures than its dependent nucleus as is stated in the prosodic licensing principle in (19), the onsets of prosodic heads are expected to support more complex structures than those of prosodic dependents. So I propose two licensing constraints for syllable onsets in (20a-b).

(19) Prosodic Licensing Principle
   a. Prosodic heads support more complex structures than non-heads (Harris 1997).
   b. The dependent in any constituent cannot be more complex than its head (Dresher & van der Hulst 1998)

Turning to place features of onset consonants, the focus of this study, in many languages, placeless segments can only occur in post-vocalic positions. For example, in Chamicuro (Peruvian) (Parker 2001), Tiriyo (Jones 1972) and Macushi (Hawkins 1950), placeless consonants (/ʔ/ or /h/) never occur in syllable onsets. Therefore, I propose one more constraints for syllable onsets in (20c) that onsets must be specified for PLACE.

(20) Prosodic Licensing Constraint (Onsets)
   a. Onsets of prosodic heads support more complex structures than onsets of prosodic dependents.
   b. Onsets of prosodic dependents cannot be more complex than onsets of prosodic heads.
   c. Onsets are specified for PLACE.

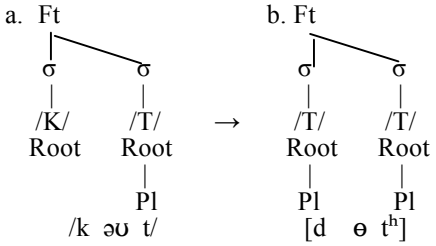
In child grammar, the combination of (20c) with (20a-b) means that onsets of prosodic heads will be specified for PLACE. That is, PLACE-less consonants are only prohibited foot-initially. In what follows, I provide evidence for the hypothesized stages proposed in section 2 by focusing on Julia's VF and Trevor's CH. I show that both processes are induced by the constraints in (20) coupled with the specific PR children build at different stages.

3.2 VF (Julia: Path 1 of Stage 2)

Recall that VF systematically applies foot-initially when Julia is 2;28-2;145. Recall also that during this age range Julia treats /K/ as velar, and a three-way place contrast has been established before Julia is 2 years old (see (5) above). Therefore, I propose that Julia is taking path 1 at stage 2 when VF applies. Note in (2) above, VF is attested in Julia's /KVT(V)/, /KVK(V)/ and /KVV/ words. For Julia's /KVT(V)/ words, the onsets of the prosodic dependents are more complex than the onsets of the prosodic heads as the markedness hierarchy for children taking path 1 at stage 2 is Labial>Coronal>Placeless. As the constraints in (20a-b) are violated, VF applies to "repair" this ill-formed structure (21)[20].

[20] I regard this process as involving feature copying, following Goad (1997), to ensure that the medial vowel is skipped.

(21) Prosodic licensing and VF



If Julia's VF is indeed induced by the prosodic licensing constraints (onsets) in (20), it is expected that labial harmony (LH) should be attested in Julia's /KVP(V)/ and /TVP(V)/ words as these are also the word forms which violate (20). In fact, LH is attested in Julia's /KVP(V)/ words (22).[21]

(22) LH (Julia: stage 2)
camel ['pamo] (2;145 imitation)

As far as Julia's /KVK(V)/ and /KVV/ words are concerned, VF applies because PLACE-less /K/ occurs in the onsets of prosodic heads, violating the constraint in (20c). Therefore, it is phonological licensing combined with Julia's PR at stage 2 that drives the application of VF attested in her dataset.

3.2 CH (Trevor: Path 2 of Stage 2 + Stage 3)

Turning to CH patterns attested in the outputs of Trevor (Campton & Streeter 1977, Pater & Werle 2003), I argue that Trevor follows learning path 2 at stage 2 and then enters stage 3; therefore, different patterns of CH are attested at these two stages.

Recall from section 2 that when a child leaves path 2 of stage 2 and enters stage 3, the segmental structure elaborates in the way shown in (18). As dorsal and labial are equally marked at Stage 3, dorsal harmony (DH) and labial harmony (LH) should only target coronal if both are attested. For children taking path 2 at Stage 2, however, DH should target coronal as well as labial as dorsal is more marked than both. That is to say, DH targeting labials ceases while DH targeting coronals still applies if children go through path 2 of Stage 2 to enter Stage 3.

Trevor is reported to apply DH to word-initial coronal in 41 out of 44 tokens at the age of 1;10,13-2;03 as is shown in (23) below, accounting for 93% of the potential targets. No other CH patterns are systematic during this period. DH targeting word-initial labials is attested in 5 out of 93 tokens accounting for only 5% of the potential targets (Pater & Werle 2003: 394). This is Trevor's stage 3 (age: 1;10,13-2;03) when only DH targeting coronals is attested.

[21] During the age range I focus on (1;167-2;145), no /TVP(V)/ targets are ever attempted by Julia and the target form in (22) is the only /KVP(V)/ word Julia tried to produce. I regard this as a case of selection and avoidance, which is due to prosodic licensing.

(23) DH (Trevor: stage 3)
a. d̲og [g̲ɔg] (1;11,12)
b. d̲uck [g̲ʌk] (1;11,12)

At an earlier age (-1;9,2),[22] however, DH systematically targets both word-initial coronal and labial. It is attested in 125 out of 132 tokens in /PVK(V)/ words applying to 95% of the potential targets, and in 69 out of 72 tokens in /TVK(V)/ words accounting for 96% of the potential targets (24).

(24) DH (Trevor: stage 2)
a. d̲og [g̲ɔg] (1;5,14)
b. t̲ickle [g̲ɪ:gu:] (1;7,26)
c. b̲ug [g̲ʌg] (1;5,18)
d. p̲ickle [g̲ɪgʊ] (1;9,2)

This is Trevor's stage 2. More evidence for this stage comes from Trevor's LH. When children take path 2 at stage 2, LH targeting word-initial coronal is predicted to apply as well. In Trevor's outputs, LH is attested in 5 out of 5 tokens before 1;6 (25), accounting for 100% of the potential targets.[23]

(25) LH (Trevor: Stage 2)
t̲op [p̲ap] (1;6,8)

Therefore, Trevor is at stage 2 and takes path 2 before 1;9,2. Note that DH targeting word-initial labials (in /PVK(V)/ words) ceases to apply at 1;10,13 when DH targeting word-initial coronal (in /TVK(V)/ word) still applies, conforming to the predictions made earlier in this section. Trevor's CH pattern attested at different ages lends further support to both the hypothesized stages that children go through and the phonological licensing account of child CH.

To briefly summarize, both Julia's VF and Trevor's CH lends support to the hypothesized stages proposed in section 2 and the proposal that most assimilation and substitution processes attested in child language are triggered by phonological licensing combined with the specific PR children build at certain stages.

4. Conclusion

This work has provided a unified account of VF and CH both of which are widely attested in child language. Previous accounts of CH failed to provide a grammatical account of VF because these analyses are all based on the

[22] As I do not have access to Trevor's complete dataset, it is not possible to determine when Trevor's stage 2 starts.

[23] Labial harmony targeting word-initial coronals ceases to apply at 1;7. According to Pater & Werle (2003:394), between 1;7 and 1;9, no labial harmony is attested in 16 tokens of /TVP(V)/ words. As there is no way of knowing what these tokens are, how many lexical forms are involved or what the lexical forms are, I have to leave the question open as to why labial harmony ceases earlier than dorsal harmony at Trevor's stage 2. Note that the number of /TVP(V)/ targets (16) is very small compared to the number of /TVK(V)/ targets (52) and /PVK(V)/ targets (73) at 1;7-1;9.

assumption that children share the same phonological representations with adults and coronal is the least marked place of articulation. By drawing parallels with adult languages, I have shown that /K/ is velar, less marked than coronal, for some children at certain stages in their language development. Therefore, children do not have adult-like phonological representations. In order to acquire adult-like phonological representations, they have to go through several stages.

As new as a field like phonological development, there are many questions than answers. For example, why CH across major place features is limited to child grammar? Why does LH cease earlier than DH when both target word-initial coronals and both are predicted to apply at stage 3? Why are so few tokens of LH attested targeting either word-initial velar (Julia) or word-initial coronal (Trevor)? It is unlikely to be due to the low frequency of these words in the target language. It is more likely instead because of some property of the child's grammar. Moreover, note that Julia does not have CH at stage 3. Is this unique to Julia or common to all children who take path 1 at stage 2? Clearly, more data and more work are needed in order to answer these questions, and these are also the directions of my future research.

References

Avery, P. & K. Rice. 1989. Segment structure and coronal underspecification. *Phonology 6 (2)*: 179–200.

Berg, T. 1992. Phonological harmony as a processing problem. *JCL 19*: 225-257.

Bogoras, W. 1922. Chukchee. *Handbook of American Indian languages*. Bureau of American Ethnology, Bulletin 40, Part 2. Washington: Government Printing Office. 631-903.

Compton, A. J. & M. Streeter. 1977. Child phonology: data collection and preliminary analyses. In *Papers and Reports on Child Language Development 7*. Standford: Stanford University, California.

Dresher, E. & H. van der Hulst. 1998. Head-dependent asymmetries in prosodic phonology: visibility and complexity. *Phonology 15*: 317–352.

Elbert, S. H & M. K. Pukui. 2001. *Hawaiian Grammar*. Honolulu: The University Press of Hawaiian, Hawaiian.

Fikkert, P. & C. Levelt. 2008. How does place fall into place? The lexicon and emergent constraints in the developing phonological grammar. In P. Avery, B. E. Dresher and K. Rice (eds.), *Contrast in phonology: perception and acquisition*. Berlin: Mouton.

Goad, H. 1996. Codas, word minimality, and empty-headed syllables. *Child Language Research Forum 28*: 113-122.

1997. Consonant harmony in child language: an optimality-theoretic account. In S. J. Hannahs and M. Young-Scholten (eds.) *Focus on phonological acquisition*. Amsterdam: John Benjamins. 113-142.

2001. Assimilation phenomena and initial constraint ranking in early grammars. In *Proceedings of the 25th BUCLD*. 307-318.

Goad, H. & K. Brannen. 2003. Phonetic evidence for phonological structure in syllabification. In J. van de Weijer, V. van Heuven and H. van der Hulst (eds.) *The phonological spectrum 2*. Amsterdam: John Benjamins. 3-30.

Harris, J. 1994. *English sound structure*. Blackwell: Oxford UK & Cambridge USA.

1997. Licensing inheritance: an integrated theory of neutralisation. *Phonology 14*: 315-370.

Hawkins, W. N. 1950. Patterns of vowel loss in Macushi (Carib). *IJAL 16*: 87-90.

Hills, E. 1914. Speech of a child two years of age. *Dialect Notes 4*: 84-100.

Holmes, U. T. 1927. The phonology of an English-speaking child. *American Speech 2*: 212-225.

Inkelas, S. & Y. Rose. 2007. Positional neutralization: a case study from child language. *Language 83*: 707-736

Ingram, D. 1974. Fronting in child phonology. *JCL 1*: 233-241.
1976. *Phonological disability in children.* London: Edward Arnold.
Iverson, G. K. & K. L. Kim. 1987. Underspecification and hierarchical feature representation in Korean consonantal phonology. *CLS 23*: 182-198.
Jones, M. W. 1972. Trio phonology. In J. E. Grimes (ed.) *Languages of the Guianas*. Norman: Summer Institute of Linguistics. 42-46.
Jun, Jongho. 1995. *Perceptual and articulatory factors in place assimilation: an optimality theoretic approach*. Ph.D. dissertation, UCLA.
Leopold, W. F. 1947. *Speech development of a bilingual child: a linguist's record*. V 1-4. New York: AMS Press.
Levelt, C. 1994. *On the acquisition of place*. Ph.D. dissertation. Leiden University. HIL Dissertation Series 8.
Maddieson, I. 1984. *Patterns of sounds*. Cambridge: CUP.
Menn, L. 1971. Phonotactic rules in beginning speech. *Lingua* 26: 225-251.
Michelson, K. 1988. *A Comparative study of lake-Iroquoian accent*. Kluwer Academic Publishers: The Netherlands.
Paradis, C. and J.-F. Prunet (eds.) 1991. *The special status of coronals: internal and external evidence*. San Diego: Academic Press.
Parker, S. 2001. Non-optimal onsets in Chamicuro: an inventory maximized in coda position. *Phonology* 18: 361-386.
Pater, J. 1997. Minimal violation and phonological development. *LA 6*: 201-253.
Pater, J. & A. Werle. 2003. Direction of assimilation in child consonant harmony. *CJL 48*: 385-408.
Piggott, G. 1996. Reconfiguring harmony. *McGWPL* 12: 61-98.
1997. Licensing and alignment: a conspiracy in harmony. *Phonology* 14: 437-477.
Pinker, S. 1984. *Language Learnability and Language Development*. Cambridge, Mass: Harvard University Press.
Postal, P. M. 1968. Aspects of phonological theory. Harper & Row, Publishers.
Qu, Chen. 2011. *Prosodic licensing, elaboration of segmental structure and child consonant harmony*. Ms, McGill University.
Rice, K. 1996a. Phonological variability in language acquisition: A representational account. In E. Clark (ed.) *Proceedings of the Child Language Research Forum*. Stanford: CSLI.
1996b. Default variability: the coronal-velar relationship. *NLLT 14*: 493-543.
Rice, K. & P. Avery. 1995. Variability in a deterministic model of language acquisition: A theory of segmental elaboration. In J. Archibald (ed.) *Phonological acquisition and phonological theory*. Hillsdale, NJ: Lawrence Erlbaum. 23-42.
Rose, Y. 2000. *Headedness and prosodic licensing in the L1 acquisition of phonology*. Ph.D. dissertation. McGill University.
Smith, N. V. 1973. *The acquisition of phonology*. Cambridge: CUP.
Steriade, D. 1995. Underspecification and Markedness. In Goldsmith, J. A. (ed.) *The handbook of phonological theory*. Oxford: Blackwell. 114-174.
Stoel-Gammon, C. 1996. On the acquisition of velars in English. In B. Bernhardt, J. Gilbert and D. Ingram (eds). *Proceedings of the UBC international conference on phonological acquisition*. Cascadilla Press. Somerville. 201-214.
Velten, H. V. 1943. The growth of phonemic and lexical patterns in infant language. *Language 19*: 281-292.
Vihman, M. M. 1978. Consonant harmony: its scope and function in child language. In J. H. Greenberg (ed.) *Universals of Human Language, vol. 2: phonology*. Stanford: Stanford University Press. 281-334.
Vihman, M. M., S. L. Velleman & L. McCune. 1994. How abstract is child phonology? Toward an integration of linguistic and psychological approaches. In M. Yavas (ed.) *First and second language phonology*. San Diego: Singular Publishing Group, Inc. 9-44.
Watters, J. 1988. *Topics in Tepehua grammar*. Ph.D. dissertation, University of California: Berkeley.
Wood, K. E. 1995. *Word minimality, coda and onset development: a case study in phonological acquisition over the word-spurt boundary*. Ms, McGill University.
Zoll, C. 1998. *Positional asymmetries and licensing*. Ms. Of paper presented at the annual meeting of the LSA, New York, January 1998. [ROA-282-0998]