Constraints conflict on the onset deformity words produced by Japanese and English L1 infants : Markedness vs. faithfulness constraints

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1. Introduction

This paper reconsiders the previous studies regarding articulatory phenomena produced by both L1 Japanese and L1 English-speaking infants, which seem to violate constraints of adult target words in the process of native language acquisition. From an Optimality Theoretical point of view, in the L1 acquisition process for a child, faithfulness representing distinctive L1 features from other languages and markedness representing L1 linguistic rules compete with each other by passing through gradual stages, leading to the child finally acquiring adult-like L1 words. This study focuses on the initial stage of acquisition of L1 consonants in the onset of words. The dominance of markedness constraints over faithfulness constraints in the initial stage will be discussed. It is expected that applying Optimality Theory (OT) to the child L1 acquisition in this paper might lead to better understanding Japanese learners' phonological interference in an L2 English articulation system.

In child language, errors that children may produce before they acquire the target adult-like L1 words are divided into common patterns that children of any language tend to transmit, and individual patterns that vary according to children's L1 acquisitional systems. The latter patterns are attributed to the differential ranking of constraints of the L1 language. Barlow and Gierut (1999) reported *fronting*, *stopping*, and *final-consonant deletion* as common error patterns, and *singletons*, *reduction*, *epenthesis*, and *coalescence* as individual error patterns. This paper observes English L1 infants' *singletons* before they acquire consonant clusters, their articulatory development of English phonemes and Japanese L1 infants' truncated words (Ota, 1998) regarding not only acquisition of phonemes, but also language-specific prosody and an influence of the temporal emergence of L1 infants' distinct

language. The comparison between these similar phenomena is indispensable to elucidate whether these two linguistic errors that infants commit in producing the onset phonemes of L1 words is attributed to universal constraints or L1 linguistically intrinsic constraints.

2. General phonological theory in infants' L1 acquisition

Before young children produce the adult-like forms of L1 words, they tend to omit or truncate sounds of words (Lust, 2006). This implies that the L1 production of young children is different from that of adults'. According to Jakobson's (1968) 'hierarchy of development', a child's early production is typically unmarked in structure. The unmarked sounds are acquired first and most easily by children of all languages of the world. In order to substantiate Jakobson's hierarchy, Lust (2006) explains common substitutions that are likely to occur cross-linguistically in (1).

(1)

	adult target		child form
Serbian infant; Swedish infant :	kaka	→	tata
German infant:	kopf	→	topf
French infant:	garçon/cochon	→	tosson
English child:	cut	→	tut

(Lust, 2006, p. 161)

The onset consonants velar [k] or [g] of the adult words above are substituted by alveolar [t]. This is consistent with Jakobson's (1968) hierarchical development where the first L1 consonants that infants acquire are bilabial stops [b] and [p] with vowel [a] which is the lowest central position of the tongue. A voiceless alveolar [t] is acquired earlier than [k] and [g] which are articulated closer to the larynx (Lust, 2006; Roca & Johnson, 1999). Thus, it is assumed that infants' vocal function is still in the developmental process as they have difficulty in producing consonants articulated closer to the larynx. This attests to the fact that

bilabial stops are less marked than velar sounds for infants (Takeyasu, 2009). It is a question, however, while universal constraints are existent cross-linguistically, that individual linguistic features should also be concerned.

In terms of OT, markedness constraints are highly ranked in L1 child production (Stites, Demuth, & Kirk, 2004). Thus, unmarked output forms are likely to surface in a child's speech. If this output surface form were so much different from adult forms, a child's articulation system would change to approximate L1 language over time. Presumably this may lead to an unstable reranking of constraints in which the higher ranked markedness constraints do not change, but certain faithfulness constraints do (Barlow & Gierut, 1999). In the next section, common onset error patterns produced by both Japanese and English L1 children are observed. In the following section, the relationship between markedness and faithfulness constraints in the L1 acquisitional process will be discussed.

3. Cross-linguistically phonological phenomena on the onset words

3.1 Word truncation produced by Japanese children

Two Japanese infants' word truncation was observed by Ota (1998), as seen in (2).

(2) Truncated words produced by Japanese infants A & B

Japanese Child A (age 2;1 - 2;4):	/ip.pai/	[pai]	/to.ɾak.kɯ/	[tak.kɯ]
	/poŋ.ki.ki/	[poŋ. ki]	/çi.koː.ki/	[koː.ki]
	/ʃɯp.pa.tˢu/	[pa.tʃu \ ʃɯp.p]	/dʒidoː.ʃa/	[doː.ʃa]
Japanese Child B (age 1;9 - 2;1):	/ka.tai/	[tai]	/o.toː.ɸɯ/	[toː]
	/ra.dʒi.o/	[ra.dʒi]	/kom.peː.toː/	[peː.to]
	/go.han/	[gjon]	/ha.jai/	[jai]

(Ota, 1998, p. 600)

The truncated part of the words in (2) produced by two Japanese infants are likely to be the phonemes that Japanese infants have not acquired, or that are still in the transitional process. For example, it is predicted that palatal fricative [ç] of /çi.ko:.ki/, glottal fricative [h] of /ha.jai/, and velar stop [k] and [g] are problematic for Japanese infants to pronounce adult-like sounds. This is because Japanese infants' speech organs are still in the motoric transitional process. Therefore, the palatal and velar sounds are laborious for Japanese infants to produce.

It is crosslinguistically common that the first sounds infants acquire are bilabial [p], [b], and [m]. Kent (1981) gives four major differences between the vocal tracts of infants-and-adults': (1) an infant's tract is undoubtedly shorter than an adult's, (2) an infant's pharynx is relatively shorter than an adult's, (3) the infant's tract is relatively wider in comparison to its length, (4) due to non-teeth during that period, the oral cavity is flatter than in the adult's. Additionally, in regard to the sonority, Clements (1990) identifies glides as the most sonorous and stops as the least sonorous phonemes. The onset sounds of /ka.tai/ and /kom.pe:.to:/ may be results of the children's undeveloped perceptibility. In other words, children may not be able to hear the velar stop [k] well enough. Tanaka (2009) explains that the lower sonority tends to be the shorter acoustic duration of the sounds, while the higher sonority, such as vowels, has a longer acoustic duration. As a result, vowels are better heard by infants. Furthermore, Ota (1998) classified these truncated words in terms of their prosodic structure into the eight prosodic distinct types shown in (3) and (4): L / H / LL / HL / LH / HH / LLL / LHL[1].

Among the truncated words that both of the two children produced, the three prosodic patterns H, LL, and HL are more truncated than other types. It is interesting to observe that, while H and HL types have the first syllable stressed, they also seem to be sonorous for infants to perceive, and truncation occurs. This contradictory question attributes to the fact that the favorable tendency of L1 English infants' production of words is trochaic syllables

structure, strong-weak-strong form (Gerken, 1996). This fact is associated with the linguistic feature of Japanese prosody that Japanese infants need to surmount and that are probably different from prosodic features of other languages.

Table 1.

(3) *Japanese Child A's truncated words classified into prosodic types*

	L	H	LL	HL	LH	HH	LLL	LHL	
2;0	2	3	5	4				1	
2;1	1	4	2	11		1			
2;2		1	4	10					
2;3		4	9	20		2		1	
2;4		2	4	12	1		2		
Total	3	14	24	57	1	3	3	1	106
%	2.8	**13.2**	**22.6**	**53.8**	0.9	2.8	2.8	0.9	100

(4) *Japanese Child B*

	L	H	LL	HL	LH	HH	LLL		
1;9		2		3	1				
1;10			1	6		1			
1;11		2	3	11			1		
2;0				6					
2;1				6					
Total	0	7	9	32	1	2	1		52
%	0	**13.5**	**17.3**	**61.5**	1.9	3.8	1.9		100

(Ota, 1998, pp. 600-601)

Ota's (1998) analysis was conducted based upon an idea that the basic mechanisms of constraint evaluation in child grammars are the same as those in adult grammars. This is opposed to Demuth's (1996, 1997) proposals that violations among equally ranked constraints are evaluated categorically, and extremely low-ranked constraints are not evaluated (Ota, 1998). Ota's assumption is that violations are always evaluated in gradient

and that all constraints are assigned in the evaluation. These truncated words produced by Japanese children will be considered in OT in the following sections.

3.2 Consonant reduction on the onset clusters produced by American children

Truncations or reduction in the onset clusters to singleton are frequently likely to occur to American infants. Pater and Barlow (2003) list examples according to the sonority pattern of cluster reduction in (5) and (6). In carefully observing these deleted words produced by American infants, in all of the forms in (5) and (6) the two children produce the onset segment but fail to produce the second consonant segment of the onset clusters, such as [kin] instead of 'clean' and [piz] instead of 'please.' Child D seems to have difficulty in articulating the velar [k] and [g] which are substituted with alveolar [d], such as [do] and [daɪ] instead of 'grow' and 'sky'. This suggests that Child D is still developing the consonant articulating system. In other words, Child D is in the initial stage of L1 phoneme acquisition. Furthermore, it is interesting to observe that in (5) both children articulated the onset fricative [s] but deleted the second phoneme that is adjacent to the onset fricative. In addition, the onset fricative in (6) is deleted, and the second phonemes of the onset cluster are articulated, such as [gɪn] instead of 'skin' and [bun] instead of 'spoon'.

(5) obstruent + sonorant → obstruent

Child C (age 2;3 - 2;9):	'clean'	[kin]	'draw'	[ɒ]	'please'	[piz]
	'snow'	[so]	'slip'	[sɪp]	'friend'	[fɛn]
Child D (age 4;10):	'queen'	[din]	'grow'	[do]	'play'	[bei]
	'snowing'	[sowɪŋ]	'sleep'	[sip]	'sweep'	[sip]

(6) fricative + stop → stop

Child C:	'sky'	[gai]	'skin'	[gɪn]	'spill'	[bɪw]
Child D:	'spoon'	[bun]	'sky'	[daɪ]	'stove'	[dov]

Notes: ' ' = adult target, [ ] = substantial output.

(Pater & Barlow, 2003, p.488)

As mentioned in §2, the onset /s/ is alveolar, which is more frontward to the lips than velar /k/. Nonetheless, this does not seem to mean that /s/ is less effortful to perceive or produce for infants. The "Speech Sound Development Chart" (Sander, 1972, p. 62) shows that /k/ is acquired between the ages of two and four, while /s/ is acquired between three and eight years old. Thus, it is assumed that the onset /s/ of 'spoon', 'sky', and 'spill' is deleted in (6). On the other hand, obstruents are articulated, but the successive sonorants are deleted in (5), such as [so] for 'snow,' and [sɪp] for 'slip'. Pater and Barlow (2003) point out that not all infants follow the sonority pattern and constraints conflict with onset sonority. For example, for the adult target 'clean', /k/ of the cluster /kl/ remains but /l/ is deleted. This conflicts with the sonority pattern above: a fricative is preferred to a liquid sound. The same deletion of [l] occurs in 'please', 'play', 'slip', and 'sleep'. An approximant [w] is also deleted after the first segment of the onset cluster.

In this section, phonological phenomena in the onset of words that Japanese and English L1 infants frequently fail to pronounce are observed. These observations illuminate two questions. Firstly, can these linguistic phenomena be explained in the same constraints? Secondly, are these phenomena likely to occur in the transitional process of developing the L1 so the reranking of constraints should be treated temporarily? In the next section, OT analyses of these two linguistic phenomena will be discussed.

4. OT analysis

4.1 Truncated words produced by Japanese infants

Ota (1998) explains that truncated words produced by Japanese infants are based on the idea that morphologically-related words stand in a correspondence relation. In the correspondence model of morphological truncation, input-output correspondence constraints (IO-Faithfulness) regulate the relationship between the *input* and the *base word* for the truncated form. This is governed by BT-identity, which principally can be ranked with respect

to IO-Faith. Thus, one possible ranking is shown in (7).

(7) IO-Faith >> Markedness Constraint (MC) >> BT-Identity

According to Ota (1998), Markedness Constraints (MC) have effects on the truncated forms that are satisfied in this context. As a result, structures unmarked with respect to MC emerge in the truncated output forms. Ota (1998) also emphasizes that prosodic hierarchy should be concerned in truncated words produced by Japanese infants. This is because these linguistic phenomena are captured as syllabic difference structures. Moreover, the difference of percentages of the observed words shown in Table 1 in the previous section (Child A: HL; 53.8%, HH; 2.8%, Child B: HL; 61.5%, HH; 3.8%) conforms to the fact that HL patterns are the most frequently used in Japanese infant language called 'Youji-go' (幼児語). Contrastively, HH patterned words are found frequently in Japanese adult language (Mazuka, 2009). Hence, supposing that Japanese infants have easy access to the prosodic hierarchy (Prosodic word - Foot - Syllable - Mora), Ota (1998) assumes that the three markedness constraints and a type of constraint that demand feet be trochaic, as shown in (8). This is related to the data observed in Table 1, where the percentage of LH truncated words produced by both Japanese infants is only 0.9% (Child A) and 1.9% (Child B).

(8) ALLIGN-FT-L Align (Ft, L, PrWd, L); Align the left edge of every foot with the left edge of the Prosodic Word

FTBIN	Feet must be binary on morae or syllables.
PARSE-σ	Every syllable must belong to a foot.
TROCH	Align (Ft, L, H (Ft), L); Feet are left headed.

Ota (1998) ranks MAX-IO and MAX-BT that ensure that each element in the input correspondent to the output. MAX-IO is a faithfulness constraint that prohibits deletion.

MAX-BT is also a faithfulness constraint that the base and the truncated form are the same relationship as input and output applying Benua's (1995) analysis.

(9) MAX-IO Every element in the Input corresponds to the Output.
MAX-BT Every element in the Base corresponds in the truncated output.

Markedness constraints in (8) fall into the following ranking regarding Japanese infants' truncation as *emergent unmarkedness*.

(10)IO-FAITH (MAX-IO)>>ALIGN-FT-L, FTBIN, PARSE-σ, TROCH >> BT-IDENTITY (MAX-BT)

Emergent Markedness Constraints

Ota (1998) explains from this ranking that the markedness constraints become active and demand that the truncated output satisfy their requirements. Two tableaux of /dʒidoː.ʃa/ are shown in (11) and (12). It should be noted that tableau (11) and (12) take different standpoints of 'input' (morpheme) and 'base' (mora). Kager (1999) defines 'base' as follows: (a) a word which is a free-standing output form, and (b) a subset of the grammatical features of the derived form (p. 282). In tableau (11), the constraints MAX-IO, ALIGN-FT-L, FTBIN, PARSE-σ, TROCH, and MAX-BT are listed across the top. MAX-IO is ranked highest and MAX-BT is ranked lowest. The constraints ALIGN-FT-L, FTBIN, PARSE-σ, and TROCH are unranked constraints. The candidates (a), (b), (c), (d), and (e) violate MAX-IO, but the candidate (f) does not. Although the candidate (f) violates ALIGN-FT-L and PARSE-σ, these constraints are in the same ranking of emergent markedness constraints as FTBIN and TROCH. No candidate violates MAX-BT that is in the lowest ranking. Therefore, (f) is optimal without violating MAX-IO. This is the non-truncated form and is therefore an

adult-like word.

(11) Adult-like word
MAX-IO >> ALIGN-FT-L, FTBIN, PARSE-σ, TROCH >> (MAXBT)

Input. /ʤido:.ʃa/	MAX-IO	ALIGN-FT-L	FTBIN	PARSE-σ	TROCH	MAX-BT
a. (ʤi)	*!**		*			
b. (do:)	*!*					
c. (do:.ʃa)	*!*					
d. (do:.ʃa)	*!					
e. ʤido:	*!				*	
f. ☞ ʤido:.ʃa		*		*		

(Ota, 1998, p.606)

(12) Japanese infant truncated word:
MAX-IO >> ALIGN-FT-L, FTBIN, PARSE-σ, TROCH >> (MAXBT)

Base: ʤi.do:.ʃa	MAX-IO	ALIGN-FT-L	FTBIN	PARSE-σ	TROCH	MAX-BT
a. (ʤi)			*!			***
b. (do:)						**!
c. (do.ʃa)						**!
d. ☞ (do:.ʃa)						*
e. (ʤi.do:)					*!	*
f. ʤi.(do:)		*!		*(!)		*
g. ʤi(do:.ʃa)		*!		*(!)		

(Ota, 1998, p.606)

Note. The violation content is no longer relevant in the shaded cells.

On the other hand, tableau (12) shows that, although no candidate violates MAX-IO due to the 'base' definition (Kager, 1999), the candidates (a), (e), (f), and (g) violate unranked constraints. The candidates (b) and (c) are fatal, because these candidates violate MAX-BT.

Thus, these candidates are eliminated from competition for optimality. Although the candidate (g) does not violate MAX-BT, this candidate violates two constraints in a higher hierarchy. Therefore, the candidate (d) is optimal because no constraint is fatal to this candidate. The constraints that a Japanese infant's truncated word are clearly reversed to the input /dʒidoː.ʃa/. It is intriguing that OT analyses shift the previous idea that children's production constitutes 'errors or mistakes', and give way to a new standpoint where universally linguistic constraints are concerned.

4.2 Onset cluster reduction produced by American infants

In the previous section, onset cluster reduction that frequently occurs to American infants was observed. Pater and Barlow (2003) assume that *COMPLEX constitutes the markedness constraints responsible for truncation on the onset of English words produced by American infants.

(13) *COMPLEX: Onsets are limited to a single segment.

This constraint conflicts with MAX, one of the faithfulness constraints that prohibit segmental deletion.

(14) MAX: Every input segment must have an output correspondent.

These two constraints, *COMPLEX and MAX compete as in the following tableaux. In (15), the American infant's production, *COMPLEX >> MAX, is reversed to adult target ranking MAX >> *COMPLEX in (16). This shows that the markedness constraint dominates over faithfulness constraints in the infant speech. Smolensky (1996) indicates that this is likely to occur in children's L1 system. Even though glide and liquid sounds are more

sonorous than fricative and stop sounds, we should take the process of a child's L1 sound acquisition into consideration.

(15) American infant English: *COMPLEX >> MAX

/pliz/	*COMPLEX	MAX
a. ☞ [piz]		*
b. [pliz]	*!	

(Pater & Barlow, 2003, p. 491)

(16) Adult target American English: MAX >> *COMPLEX

/pliz/	MAX	*COMPLEX
a. [piz]	*!	
b. ☞ [pliz]		*

(Pater & Barlow, 2003, p. 491)

The fact that infants acquire the labial sounds first can be universally unmarked, which assumingly dominates over sonority patterns in early child production. Pater and Barlow (2003) also claim that other universal constraints should be considered under children's cluster reduction that seem to have a reverse ranking to adult target words. According to Fukazawa (2009), in the L1 acquisitional process starting from the initial stage in which markedness constrains dominate faithfulness constraints, the relevant faithfulness constraints should be promoted gradually in the post-initial stages (the first and second stages). In the third stage when L1 children acquire the target adult-like L1 words, the faithfulness constraints are ranked higher than the markedness constraints.

For further understanding, Pater and Barlow (2003) describe a case of deletion in a different position in the onset cluster. For example, even though tableau (15) examines deletion of [l] in /pliz/, in another case the onset /p/ might be possibly deleted. Taking into

consideration the sonority hierarchy on the onset shown in (17), however, the liquid does not remain but is deleted. Thus, the optimal output is considered as shown in the following tableau (18) that obeys the onset sonority hierarchy shown in (17).

(17) Onset sonority hierarchy:
*G-ONS >> *L-ONS >> *N-ONS >> *F-ONS
(G = glide, L = liquid, N = nasal, F = fricative)

It is problematic, however, in the case of the cluster combination of fricative and liquid [l]. Because of the sonority hierarchy, it is expected that the liquid remains and the fricative [s] should be deleted, for example in the case of /slip/. Nevertheless, tableaux (18) and (19) show an impossibility of [l] remaining in the cluster. This is due to the ranking position of *Fricative which is ranked lower than other constraints.

(18) American infant English: ONSET >> *L-ONS

/pliz/	ONSET	*L-ONS
a. ☞ [piz]		
b. [liz]		*!

(Pater & Barlow, 2003, p. 494)

(19) American infant English: *L-ONS >> *Fricative

/slip/	*L-ONS	*Fricative
a. ☞ [sip]		*
b. [lip]	*!	

(Pater & Barlow, 2003, p. 497)

According to Pater and Barlow (2003), however, there is substantial data in which American infants delete the fricative. In this case, tableau (20) shows that *Fricative is reranked above *G-Ons. Both rerankings of *L-ONS >> *Fricative >> *G-Ons indicate that

OT's perspectives are flexible enough to apply L1 children's production in such an acquisitional process of the L1 phonological linguistic system as to strike a balance between markedness and faithfulness constraints.

(20) American infant English: *Fricative >> *G-Ons

/slip/	*Fricative	*G-Ons
a. [sip]	*!	
b. ☞ [jip]		*

(Pater & Barlow, 2003, p. 498)

According to Barlow (2001), the case of deleting /s/ on the onset and the adjunct sonorant remains. For example, (20) could be explained by *COR/#_ in (21).

(21) *COR/#_: Avoid coronal obstruents in word-initial position.

This markedness constraint conflicts with a faithfulness constraint that requires corresponding input and output segments. Although at first glance both optimal candidates (19) and (20) are inconsistent, the gradual process of the infant's development may sway the extent of the sonority and articulation constraints. Thus, the structural status of word-initial /s/-sequences in English has been much-debated (Barlow, 2001).

5. Discussion and Conclusion

Among L1 children's common error patterns, this study focuses on the onset truncation and onset reduction produced by Japanese and American infants. In both languages, L1 children frequently produce non-adult like words that seem to attribute to different constraint rankings from adult-target words. For Japanese infants, this is due to the prosodic difference

between Japanese infant language and adult-target words since adult prosodic morphology has not been acquired by the observed age of the children (Ota, 1998).

From the data of both Japanese and American infant it can be inferred, when analyzing infants' truncation and deletion on the onset, that we need not be concerned only about L1 linguistic constraints, but also cross-linguistic constraints. This is because the L1 infants are in the native language aquisitional process of acquiring unmarked sounds. Regarding this perspective, markedness and faithfulness constraints may well coexist. Moreover, the individual developmental process of the L1 articulation system may vary among children. Thus, it is not surprising that English L1 children's *vowel epenthesis* (e.g. [buɹɛd] as 'bread') in the consonant cluster occurs because markedness dominates over faithfulness constraints on the initial stage of L1 acquisition owing to the syllable structure (CV>>CCV). In the case of acquisition of English L1 children, input possibly has underlying representations that may violate L1 grammar, such as consonant clusters (CC). Regarding acquisition of English consonants, English L1 children acquire unmarked consonants first, which are voiceless, coronal as for the place of articulation, and stop consonants as for manner of articulation. Thus, it is likely that English L1 children substitute these acquired consonants for unacquired consonants (Vihman, 1996). This phenomenon is the same as that of Japanese L2 learners substituting some English phonemes that do not exist in Japanese, such as [s] as [θ], and [l] as [ɹ]. Tanaka (2009) and Kumagai (2011) sum up the initial stage of English L1 infants' acquisition of consonant:

(22) The initial acquisition stage of L1 English infants:
*Cont, *#dor, *D# >> Ident [Voi, place, cont]

This initial stage of English L1 infants substantiates that, while faithfulness is promoted, the markedness constraint is demoted. Tanaka (2009) interprets that *Cont

constrains to exclude the fricative (continuant) sound, *#dor constrains to exclude the dorsal sound, and *D# constrains voiced obstruents on coda. This agrees with the physiological viewpoint of how an infant's vocal tract develops as Kent (1981) points out that an infant's consonant articulation starts with bilabial stops [p] and [b] and nasal bilabial [m] to the inner parts of vocal tract. In contrast, in terms of Japanese L1 infants, although the L1 initial stage of consonants is the same as English L1 infants, the OT reranking (12) is attributed to not only syllable-mora structure, but also sonority and the difference of prosodic types (HL and HH) between the infants' words (幼児語) and adult words. These two initial stages of acquiring consonants suggest that children universally tend to articulate from unmarked sounds due to their undeveloped motor skills and physiological functions in the articulation system, as well as unmatured perceptibility. Therefore, as Barlow and Gierut (1999) summarize, children's L1 error patterns should be framed as relative rankings of markedness and faithfulness constraints.

The comparison of substantial data produced by Japanese and American infants regarding the concepts of OT constraints implies the interlinguistic phenomena that are likely to occur to Japanese L2 learners of English. As an implication for further study, it should be kept in mind that the phonological error patterns that Japanese and English L1 infants produced might be attributed to children's motoric undeveloped perceptional system, where children at this age may not be able to hear perfectly adult-like L1 words, especially the onset of such words. Furthermore, this reconsideration of previous studies may contribute to the analysis of interlinguistic phenomena that young Japanese L2 children may produce in articulating English sounds. Thus, factors of sonority patterns, perceptional ability, acoustic development, and linguistic constraints of L1 children cannot be ignored.

Footnote

1 As the prosodic structure of Japanese infants (pitch-accent patterns) is categorized into eight patterns: L (a light syllable with one short vowel) and H (a syllable with a long vowel, diphthong, or a coda consonant), LL, HL, LH, HH, LLL, and LHL (Kubozono, 2009).

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