Positions Are Defined on the Input: Evidence from Repairs in Child Phonology

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1. Introduction

Positional faithfulness constraints (Beckman 1997, 1998, Casali 1996, Lombardi 1999) have been widely used in the Optimality Theoretic literature to account for asymmetries in the licensing of marked structures.

(1) Positional faithfulness – traditional version: Assign a violation mark to any deviation between the input and output strings, when that deviation is associated with designated output position *P*.

As defined in (1), these constraints have a crucial property in common with positional markedness constraints (e.g., Itô, Mester & Padgett 1995, Walker 2001, 2005, Zoll 1996, 1998): they both define the key position *P* relative to the output. This is unsurprising in the case of markedness constraints, given that violations of markedness constraints are, by definition, assessed solely against output candidates. The rationale for defining positions against the output is less clear, however, in the case of positional faithfulness. Input-output correspondence constraints (McCarthy & Prince 1995) make reference to both the input and output strings in assessing violations, raising the possibility that positions might instead be defined with respect to the input, as in (2). I will refer to this alternative definition of positional faithfulness as “input-based”.

(2) Positional faithfulness – input-based version: Assign a violation mark to any deviation between the input and output strings, when that deviation is associated with designated input position *P*.

Input-based definitions of privileged positions have long played a role in various OT analyses, particularly those where positions are altered over the course of the derivation (e.g., Yip 2004). Explicit reference to input positions is also often found in the child-language literature (e.g., Rose 2000, Jesney & Tessier 2011). Still, relatively few arguments distinguishing between the definitions in (1) and (2) have been explicitly stated. This paper looks at patterns of onset and coda cluster repairs in child phonological acquisition, and argues that the input-based definition in (2) is the correct one. Adequate analyses of the attested data can only be generated if input positions are referenced by positional faithfulness constraints.

The rest of the paper is structured as follows. Section 2 presents the data that forms that basis of the argument, focusing particularly on epenthesis vs. deletion in target onset and coda clusters and the specific deletion preferences seen in onset and coda. Section 3 argues that these patterns can only be captured if prominent input positions are accorded a particular privilege. Section 4 further considers the nature of the input to which positional faithfulness constraints make reference, and briefly discusses the implications of this type of definition for models of adult phonology. Section 5 concludes.

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2. Repair patterns for onset and coda clusters

2.1. Accuracy in onset and coda

The data discussed in this paper come from Trevor, an English-acquiring child whose productions were transcribed in a diary study by his speech-pathologist mother (Compton & Streeter 1977, Pater 1997). For this study all target forms with an utterance-initial onset cluster or an utterance-final coda cluster were extracted from the database. Clusters formed through morphological concatenation (e.g., through plural or past tense suffixation) were omitted. To control for effects of stress, only clusters in target stressed syllables were included.

The final dataset covered an age range of 0;11 to 3;01. It comprised 997 tokens with target onset clusters distributed across 143 word types, and 636 tokens with target coda clusters distributed across 80 word types. The target onset and coda clusters attempted by Trevor in this dataset are given in (3).

(3) a. Target onset clusters: pl pr bl br tr dr kl gl fl fr θr sl sm sn sp st sk
    b. Target coda clusters: rp rb rt rd rk rs rz lp lt ld lk lf mp nt nd ŋk nʧ nʤ ns ps ts ks dz

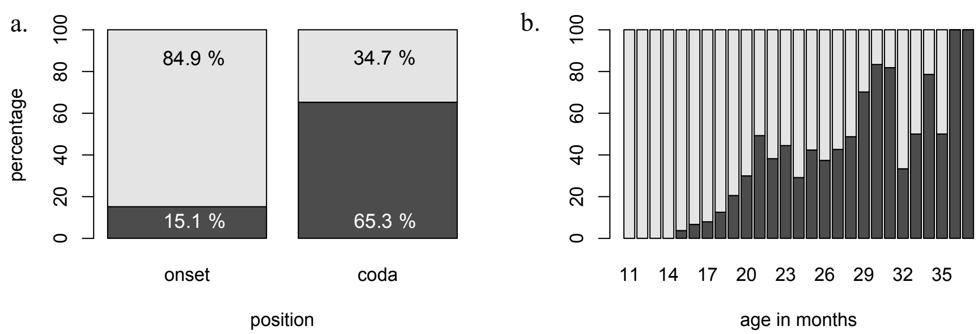
All tokens were coded for realization of the target cluster. For the purposes of this study segmental repairs were ignored; clusters were considered to be accurately realized if a sequence of two consonants was produced at the beginning of the word (onset clusters) or at the end of the word (coda clusters). Target clusters were considered to be repaired if the two input consonants were reduced to a single output consonant (deletion), or if a vocalic element was inserted so that the two input consonants were no longer syllabified in the same position (epenthesis). Examples are given in (4).

(4)

Target onset clusters				Target coda clusters			
1;07	*clock*	[kaːk]	repair (deletion)	1;06	*bird*	[bɛp]	repair (deletion)
2;03	*present*	[pɛːsɛnt]	repair (deletion)	1;08	*hand*	[hæn]	repair (deletion)
1;10	*frogs*	[hʌwaːgs]	repair (epenthesis)	1;05	*help*	[habop]	repair (epenthesis)
1;09	*sleep*	[ʃliːp]	accurate	1;10	*woods*	[wiːdʃ]	accurate
2;04	*try*	[traiː]	accurate	1;10	*milk*	[nɪlk]	accurate

As Figure 1a shows, across the dataset, Trevor realized target coda clusters accurately more frequently than target onset clusters (65.3% coda cluster accuracy vs. 15.1% onset cluster accuracy). Overall cluster accuracy increased with age – ranging form 0% at age 0;11 to 100% at age 3;01 (Figure 1b).

Figure 1 – Cluster accuracy (dark grey) vs. repair (light grey)

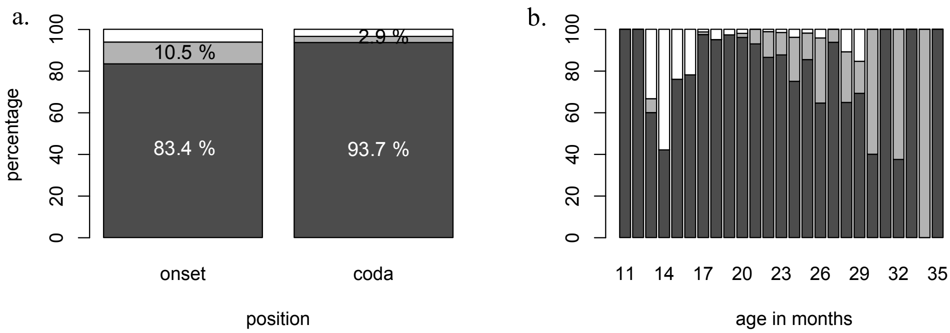


Logistic regression revealed a significant main effect of age in months, with the probability of accurate cluster realization increasing across time ($\beta = 0.487$, *S.E.* = 0.045, $p < .001$). The main effect of cluster position was not significant, but there was a significant interaction between age and cluster position. The probability of cluster accuracy increased across age more rapidly for coda clusters than for onset clusters ($\beta = 0.203$, *S.E.* = 0.052, $p < .001$), resulting in an overall higher rate of accurate coda cluster realization.

2.2. Epenthesis vs. deletion repairs

To further analyze the effect of onset vs. coda position, all repaired clusters from the dataset above were extracted. In order to control for syllabification, the dataset was limited to include only rising sonority onset clusters (n = 735) and falling sonority coda clusters (n = 205). As Figure 2 shows, deletion was Trevor's overwhelmingly preferred repair for all target consonant clusters (85.6%), consistent with descriptions throughout the child language literature (e.g., Dyson & Paden 1983, McLeod, van Doorn & Reed 2001, Preisser, Hodson & Paden 1988). Nonetheless, epenthesis and other repairs were observed throughout the dataset.[1] Epenthesis was more frequent in onset than in coda (10.5% vs. 2.9% – Figure 2a) and the rate of epenthesis increased with age (Figure 2b).

Figure 2 – Deletion (dark grey) vs. epenthesis (light grey) vs. other (white) repairs



Logistic regression showed both of these main effects to be significant. Onset position favours epenthesis ($\beta = 0.876$, $S.E. = 0.310$, $p < .005$), as does increasing age in months ($\beta = 0.085$, $S.E. = 0.023$, $p < .001$). There was no significant interaction between cluster position and age, indicating that the higher probability of epenthesis in onset is distinct from the age effect.

2.3. Deletion preferences

Analysis of tokens where the cluster was repaired by deletion showed that, in both onset and coda, the vowel-adjacent consonant was deleted at a higher rate than the more peripheral consonant. For the clusters considered here, these vowel-adjacent consonants – identified with M2 position by Baertsch (2002) – were consistently the more sonorous of the two target consonants. As Figure 3 shows, this preference for deletion of the more sonorous M2 consonant was significantly stronger for target onset clusters than for target coda clusters ($\beta = 1.715$, $S.E. = 0.249$, $p < .001$). The pattern was consistent across time; age exerted no significant effect on the pattern of deletion preferences.

Figure 3 – M1 deletion (dark grey) vs. M2 deletion (light grey)

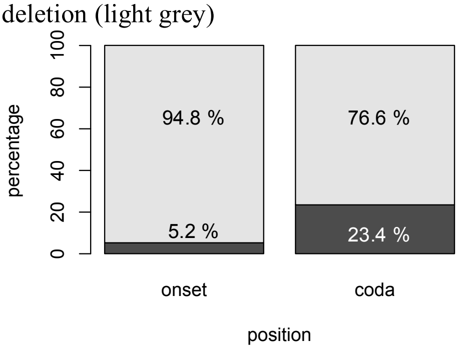
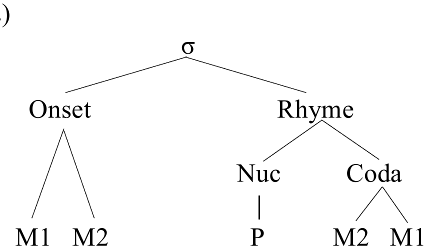


Figure 4 – Split Margin Hypothesis (Baertsch 2002)



[1] Other repairs involved deletion of both cluster segments – e.g., [iːs] *sneeze* 1;06 – or a combination of epenthesis and deletion – e.g., [əbo] *blow* 1;07. These patterns were relatively infrequent and are not analyzed further here.

3. Modeling repair preferences

There are three primary facts that a treatment of the data discussed in §2 must account for. First, coda clusters are acquired before, and at a faster rate than, onset clusters. Second, epenthesis repairs of onset clusters are significantly more frequent than epenthesis repairs of coda clusters. Third, there is a general preference for deletion of M2 consonants when deletion is the repair applied, but this preference is stronger in onset than in coda. This section argues that accounting for these facts requires both output-based markedness constraints and, crucially, input-based positional faithfulness constraints.

3.1. Modeling onset vs. coda accuracy

Onset and coda clusters are largely independent in the typology of fully-developed languages. Blevins (1995) gives Klamath and Finnish as examples of languages that allow coda clusters but not onset clusters, and Sedang and Mokilese as examples of languages that allow onset clusters but not coda clusters. This points to complex onset vs. coda structures being governed by separate, non-stringently-related markedness constraints; the markedness constraints *COMPLEXONSET and *COMPLEXCODA fulfill this requirement. To capture Trevor's pattern, *COMPLEXCODA must be demoted more quickly than *COMPLEXONSET, so that coda clusters are realized accurately even as onset clusters continued to be repaired.

(5) Complex codas are acquired before complex onsets

/plænt/	*COMPLEXONSET	FAITHFULNESS	*COMPLEXCODA
plænt	*!		*
→ pænt		*	*
plæt	*!	*	
pæt		**!	

If only positional faithfulness constraints were at play in determining accuracy, this pattern would be unexpected. On the hypothesis that onsets are universally privileged positions and therefore are better licensers of marked structures (e.g., Beckman 1998), onset clusters should be acquired before coda clusters. The fact that this alternative pattern is not observed in either Trevor's productions or in the broader typology indicates that clusters in the two syllable positions are governed by distinct markedness constraints, and not by positional faithfulness.

3.2. Modeling the onset epenthesis preference

The second component of Trevor's pattern – i.e., the stronger preference for epenthesis in onset than in coda – provides evidence not only for the privilege of onset consonants, but also for the importance of the input in defining this privileged position. The basic reasoning is as follows. Epenthesis, unlike deletion, allows for preservation of both segments in a target cluster. The preference for epenthesis in onset cannot be attributed to a ranking of general MAX-C above *COMPLEXONSET because while both input segments are preserved, they are not realized as a cluster in the output. Furthermore, the preference for epenthesis cannot be attributed to an output-based positional MAX-C constraint like that defined in (6) – *cf.* Beckman (1998).

(6) MAX-C/ONSET$_{output}$: Assign a violation mark to any input consonant that lacks a correspondent in <u>output</u> onset position.

As (7a) shows, given a form with a target onset cluster, accurate realization of the cluster, deletion of M1, deletion of M2, and epenthesis all satisfy the output-based positional MAX-C constraint equally; in each case all of the surface consonants are realized in onset position. At the same time, with target coda clusters, this constraint actually prefers repair to accurate realization (7b) because repairs lead to fewer consonants being realized in the non-privileged coda context. Adding a vowel – i.e., epenthesis – moves one of the consonants in the target coda cluster into onset position, while deleting a segment removes it from the output entirely. The repair types in coda are not further distinguished.

(7) a. Target onset cluster candidates are not distinguished

/pleɪ/	MAX-C/ONSET$_{output}$
pleɪ	
peɪ	
leɪ	
pə.leɪ	

b. Repair is preferred for coda cluster candidates, but repair types are not distinguished

/hɛlp/	MAX-C/ONSET$_{output}$
hɛlp	**
hɛp	*
hɛl	*
hɛ.ləp	*

The output-based positional faithfulness constraint shows incorrect favouring relations in two respects. It wrongly predicts that repair will be more strongly preferred in coda than in onset, offsetting the *COMPLEXONSET >> FAITHFULNESS >> *COMPLEXCODA ranking discussed in the previous section, and it fails to capture the increased preference for epenthesis in target onset clusters.

Input-based positional faithfulness constraints, on the other hand, make the correct predictions. The constraint defined in (8) prefers epenthesis to deletion for target onset clusters (9a), and expresses no preference with respect to target coda clusters (9b).

(8) MAX-C/ONSET$_{input}$: Assign a violation mark to any consonant in <u>input</u> onset position that lacks an output correspondent.

(9) a. Epenthesis is preferred to deletion for onset cluster repairs

/pleɪ/	MAX-C/ONSET$_{input}$
pleɪ	
peɪ	*
leɪ	*
pə.leɪ	

b. Target coda cluster repairs are not distinguished

/hɛlp/	MAX-C/ONSET$_{input}$
hɛlp	
hɛp	
hɛl	
hɛ.ləp	

Accorded an appropriate weight, MAX-C/ONSET$_{input}$ will correctly favour a higher rate of epenthesis in target onset clusters, and will do so without subverting the effects of the general markedness constraints *COMPLEXCODA and *COMPLEXONSET.

3.3. Modeling deletion preferences

The third component of Trevor's pattern is his general preference for retention of the less sonorous (M1) segment in a cluster, and the enhancement of this preference with target onset clusters. The analysis here requires reference to both the sonority of output segments, and, arguably, the position of these segments in the input.

As a starting point, we can take the situation in coda – a roughly 75%-25% split for retention of M1 vs. M2 – as the default, and attribute the stronger preference for M1 retention in onset to some additional constraint. The simplest account here associates the enhanced M1 preservation effect in onset with a privilege accorded to segments in input word-initial position, as captured with the constraint defined in (10).[2]

(10) MAX-C/INITIAL$_{input}$: Assign a violation mark to any consonant in <u>input</u> word-initial position that lacks an output correspondent.

[2] MAX-C/INITIAL$_{input}$ is arguably a version of ANCHOR-L (McCarthy & Prince 1995) demanding that the initial segment of an input grammatical word have a correspondent at the left edge of the output PWd. Crucially, in both cases the initial segment of the input is referenced; referring to output positions alone is insufficient.

This constraint gives a particular protection to the first segment in a target onset cluster (11a), while remaining agnostic about deletion preferences in coda clusters. An output-based positional faithfulness constraint cannot make the relevant distinctions. Only one segment can occupy word-initial position at a time, and so any segment realized in surface word-initial position will equally satisfy output-based MAX-C/INITIAL$_{output}$ (11b). In other words, output-based positional faithfulness cannot distinguish between the candidates [peɪ] and [leɪ], because in each case there is exactly one consonant and it occupies the privileged word-initial position in the output.

(11) a. M1 retention is preferred in onset

/pleɪ/	MAX-C/INITIAL$_{input}$
peɪ	
leɪ	*

b. M1 vs. M2 retention is not distinguished

/pleɪ/	MAX-C/INITIAL$_{output}$
peɪ	
leɪ	

An alternative account attributes the enhanced pattern of M1 preservation in onset to a general preference for realization of less sonorous singleton onsets. This type of analysis has a long tradition in child phonology literature (e.g., Barlow 1997, Fikkert 1994, Goad & Rose 2004, Gnanadesikan 2004, Ohala 1999, Pater & Barlow 2003), and the general approach is consistent with deletion patterns seen in Trevor's data when a full range of onset sonority profiles are considered. As Figure 5 shows, while deletion of M2 is strongly preferred for rising sonority onset clusters like those analyzed in §2.3, this preference is reversed for falling sonority onset clusters. Target words like *spoon* are preferentially repaired as [bun], not [sun], allowing the onset position to be occupied by the less sonorous stop, rather than the more sonorous fricative.

Figure 5 – M1 deletion (dark grey) vs. M2 deletion (light grey) in onset clusters

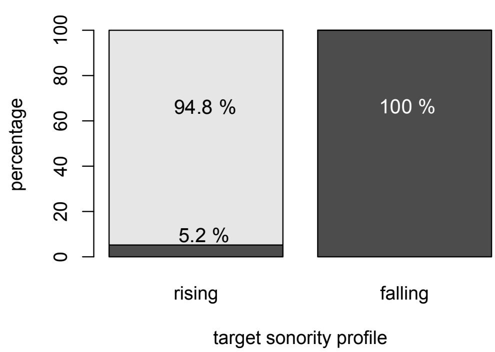
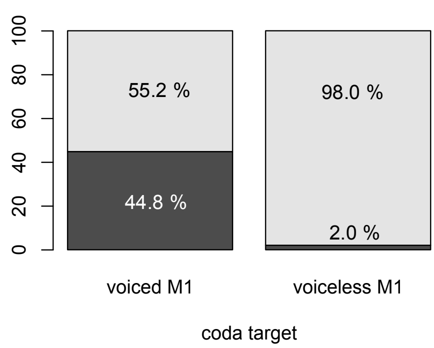


Figure 6 – M1 deletion (dark grey) vs. M2 deletion (light grey) in coda clusters



Rather than the constraint MAX-C/INITIAL$_{output}$, a sonority-based account would rely on the stringently-related constraints in (12).

(12) *SON/ONSET: Assign a violation mark to any sonorant consonant in singleton onset position.
*SONFRIC/ONSET: Assign a violation mark to any sonorant or fricative consonant in singleton onset position.

These constraints can effectively model the general preference for retention of the less sonorous onset segment, including in the case of falling-sonority onset clusters. MAX-C/INITIAL$_{input}$ cannot capture the full pattern quite as straightforwardly, but is able to do so if the /s/ is syllabified as an appendix or coda to a preceding empty-headed syllable (*cf.* Goad & Rose 2004) and initial position in (10) is reinterpreted as initial in the first full input syllable.

While the sonority approach can provide insight into the onset deletion preferences, capturing the fact that deletion of the more sonorous segment is preferred even in coda proves more challenging. Baertsch (2002) argues that the basic structure of a CVC syllable is M1-Peak-M2, so that while less sonorous consonants are preferred as singleton onsets, more sonorous consonants are preferred as singleton codas. This is not supported by Trevor's data. While he does show a strong preference for retention of less sonorous consonants in onset, he also shows a strong preference for retention of less sonorous consonants in coda. Regardless of whether the sonority or initial-position privilege approach is adopted for onset position, then, a further constraint is required to capture the coda effect. General *SONORANTCONSONANT can serve this purpose, but only if the constraints in (12) are defined with respect to onset, and not M1 position in general (*cf.* Baertsch 2002).

A comparison of coda clusters with voiced vs. voiceless M1 consonants shows that the effect of *SONORANTCONSONANT is relatively weak. The relevant data here come from liquid + stop coda clusters (*hurt* vs. *bird*) and nasal + obstruent coda clusters (*don't* vs. *hand*). As Figure 6 shows, for coda clusters where M1 is voiceless (e.g., *don't*), M1 is preserved in 98% of tokens, revealing the full effect of *SONORANTCONSONANT. In contrast, in cases where M1 is voiced (e.g., *hand*) it is preserved in only 55.2% of tokens. This difference in deletion rates between voiceless and voiced M1 coda segments is significant ($\chi^2(1) = 46.4602$, $p < .001$), suggesting that a markedness constraint like *VOICEDOBSTRUENT contributes to the choice of deletion target in coda clusters. Onset stop + liquid clusters with voiceless vs. voiced M1 segments (e.g., *play* vs. *blue*) show no such effect. In onset M1 is always preserved, regardless of voicing. *VOICEDOBSTRUENT cannot overcome the pressures preferring retention of the input word-initial consonant.

None of the constraints discussed in this section can replace input-based MAX-C/ONSET$_{input}$ in capturing the enhanced onset epenthesis preference. The reason for this is simple. Epenthesizing a vowel in either onset or coda has the effect of creating a new singleton onset segment. This means that epenthesis into onset clusters actually adds violations of the sonority constraints (13a). Likewise, MAX-C/INITIAL$_{input}$ cannot replace MAX-C/ONSET$_{input}$ because it expresses no preference for epenthesis over M2 deletion (13b).

(13) a. Epenthesis is dispreferred

/pleɪ/	*SON/ONSET
peɪ	
leɪ	*
pə.leɪ	*

b. Epenthesis is not favoured

/pleɪ/	MAX-C/INITIAL$_{input}$
peɪ	
leɪ	*
pə.leɪ	

3.4. Comparing models

To further demonstrate the importance of input-based positional faithfulness constraints in capturing these data, I modeled Trevor's basic pattern using the UCLA MaxEnt Grammar Tool.[3] Three models were compared. The first model – the basic model – used only the markedness constraints *COMPLEXONSET, *COMPLEXCODA, and *SONORANTCONSONANT, and the non-positional faithfulness constraints MAX-C and DEP-V. The second model – the output-based model – added the traditionally-defined positional faithfulness constraints MAX-C/ONSET$_{output}$ and MAX-C/INITIAL$_{output}$. The third model – the input-based model – replaced these with the alternative input-based positional faithfulness constraints MAX-C/ONSET$_{input}$ and MAX-C/INITIAL$_{input}$. The results are given in (14). All models were trained on the overall patterns seen in Trevor's data, as represented in the first column below.

(14)

		Trevor	basic model	output-based model	input-based model
/hænd/	→ [hænd]	**.65**	.65	.65	**.65**
	→ [hæn]	**.09**	.03	.03	**.09**
	→ [hæd]	**.25**	.30	.30	**.25**
	→ [hæn.də]	**.01**	.03	.03	**.01**
/blu/	→ [blu]	**.15**	.15	.15	**.15**
	→ [lu]	**.00**	.06	.06	**.00**
	→ [bu]	**.77**	.72	.72	**.77**
	→ [bə.lu]	**.08**	.06	.06	**.08**

[3] Available at: www.linguistics.ucla.edu/people/hayes/MaxentGrammarTool. Default parameter values were maintained for all constraints: $\mu = 0.0$ and $\sigma^2 = 10000$. For discussion, see Wilson (2006).

The three models are all able to capture the basic pattern of coda clusters being realized accurately at a higher rate than onset clusters; this is unsurprising, given that the models all include the independent constraints *COMPLEXONSET and *COMPLEXCODA discussed in §3.1. When it comes to repair preferences, however, neither the basic model nor the output-based model adequately distinguishes between coda and onset clusters. As seen in Trevor's data, both models predict that most repairs will involve deletion of the more sonorous M2 consonant – a pattern made possible through inclusion of the constraint *SONORANTCONSONANT. However, in both onset and coda positions the remaining repairs are equally divided between deletion of M1 and epenthesis. As a result, epenthesis is over-represented as a repair in coda, and M1 deletion is over-represented as a repair in onset. The cause is simple: The output-based model accords zero weight to the constraints MAX-C/ONSET$_{output}$ and MAX-C/INITIAL$_{output}$ because they are unable to make relevant distinctions among the candidates.

The results for the input-based model, on the other hand, closely match Trevor's data. Epenthesis is preferred to a greater degree with target onset clusters than with target coda clusters, and deletion of M1 is categorically excluded in onset. Both of the input-based positional faithfulness constraints receive considerable weight in this system, allowing it to model distinctions in repair preferences across the two positions. Replacing MAX-C/INITIAL$_{input}$ with *SON/ONSET achieves the same result, but only if MAX-C/ONSET$_{input}$ is retained.

4. The nature of the input

This paper has argued that reference to input positions is crucial in modeling the repair preferences seen in child phonology. Throughout, the input has been represented as relatively rich, including contrasts and positions that are not necessarily accurately realized in the child's productions. In a sense, then, the input here is identical to the target adult output form – including at least some information, such as syllabification, that is arguably predictable based on the target grammar.

The hypothesis that the adult's surface form is the child's input form has a long history in both constraint-based theories and earlier work (e.g., Smith 1973, Hayes 2004, Pater 1997). While it is not obvious that the child's UR is always identical to the adult's surface form (or to the adult's UR), proper operation of error-driven learning algorithms discussed in the literature (e.g., Boersma & Hayes 2001, Tesar & Smolensky 2000) demands that faithfulness constraints operate between the "true" input and output. In other words, while the child's input for a given word may not be identical to the adult's, it is nonetheless an input in every relevant sense and the faithfulness constraints at issue must be the same IO-Faithfulness constraints as exist in the adult grammar.

The reason for this is straightforward. Error-driven learning algorithms adjust the ranking (or weighting) of constraints in response to mismatches between the input and the output selected as optimal by the learner's current grammar. Increasing the permissiveness of the grammar requires that the values of IO-Faithfulness constraints increase sufficiently to overcome conflicting Markedness constraints. In order for this to eventually lead to an adult-like grammar, these IO-Faithfulness constraints must be the same IO-Faithfulness constraints as ensure appropriate restrictiveness in the target. If they are not – i.e., if some other Faithfulness relationship is at play in the child's grammar – the final grammar learned will, under most conditions, be overly restrictive.

There are further reasons to think that the faithfulness relationship operative in the child's grammar is specifically not one based on Output-Output correspondence. First, the requisite type of faithfulness here is quite different than the type of Output-Output faithfulness discussed by Benua (1997). The form to which the child is being faithful is not a morphologically-related word, but rather a form with the same meaning produced by someone else in the environment. Second, children show paradigm uniformity effects of the type that OO-Faithfulness would lead us to expect, but these effects are distinct from those discussed in this paper and emerge later in development as the child becomes aware of the morphological relationships between words that she is producing herself (for discussion, see Hayes 2004, Tessier 2007, Jesney & Tessier 2011). Finally, to ensure restrictiveness of the adult grammar, true OO-Faithfulness constraints must be biased toward a high ranking throughout the acquisition process (McCarthy 1998). Thus, if faithfulness within the child's system were consistently assessed over the Output-Output dimension, children would not be expected to produce *any* errors during acquisition – a prediction that is clearly not supported.

This all raises the question of whether inputs also serve as the basis for defining privileged positions in adult grammars. The claim here is that they do. The most common argument against defining positions on the input comes from the fact that many of the positions in question are predictable based on the ranking of other constraints in the language. Which segments are in onset, for instance, is a consequence of the language-specific ranking of constraints like *COMPLEXONSET and NOCODA. Stressed syllables – another locus of privilege – are likewise generally predictable based on the ranking of other constraints. This said, the claim that factors such as syllabification and stress must be predictable based on the constraint ranking of the language does not preclude redundant storage of this information as part of the input. In fact, the principle of Lexicon Optimization (Prince & Smolensky 1993/2004) predicts that such predictable information should be part of the adult's UR.

Relatedly, certain types of positional faithfulness constraints in common usage are already effectively defined against the input. Root faithfulness constraints, for instance, accord particular privilege to elements associated with roots – a category that is defined in the lexicon and that, by consistency of exponence (McCarthy & Prince 1993), cannot be freely altered in the input-output mapping. The same is true of noun faithfulness (Smith 2001). Such constraints are not typically thought of as being input-based, but in practice their positions, like those of the constraints discussed in this paper, are crucially defined on the input.

Finally, positional faithfulness constraints that are not defined against the input – i.e., traditionally-defined output-based positional faithfulness constraints – are typologically problematic in ways that are sometimes not recognized. In particular, such constraints can subvert the rankings of constraints determining prosodification, yielding a variety of opaque and pathological patterns (see *esp*. Beckman 1998 fn. 37, Jesney 2011, Wilson 2003). With positions defined on the input, positional faithfulness constraints do not overgenerate in this way.

5. Conclusion

This paper has argued that reference to input positions is crucial in providing an adequate analysis of repair patterns in child language data. Trevor consistently shows higher rates of epenthesis in target onset clusters than in target coda clusters, a fact that cannot be described or analyzed without reference to input position. He also shows an unexpectedly strong preference for retention of target word-initial consonants in cases where deletion applies. Reference to input positions by faithfulness constraints co-exists with markedness constraints' reference to output positions, and is crucial in allowing a full treatment of the repair patterns. Further study will provide more insight into the consequences of input-based positional faithfulness constraints for learning and for typology.

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