Appendix A. Alignment axioms

Babatsouli et al. (2014) and Faes et al. (2016) propose subtracting a point for each additional produced segment. This procedure results in a PMLU score of 3 for Joan’s production. Beers et al. (2019) report that adding this subtraction rule did not significantly alter PMLU scores in their study because such additions occurred infrequently. Ingram’s exclusion rule leads to a further abstraction in the PMLU measure in that excluding extra sounds ties the measure of the child’s word closer to the target. Phrasal prosody and articulatory constraints can lead to the production of additional sounds in children’s words and such processes vary crosslinguistically (Demuth, 2014: 19). In keeping with a generalized measure, PMLU is best understood as an abstract measure of that portion of children’s words that align with the target.

Deciding which sounds to exclude from children’s words requires determining how the child’s segments align with segments in the target. One way to constrain this is to align the child’s consonants with targeted consonants and align the child’s syllable peaks with targeted syllable peaks. This rule prohibits the alignment of produced vowels with targeted consonants unless they are syllabic.

We take this requirement to be an axiom of segment alignment. It comes into play when there are mismatches between the number of consonants and vowels in the child and target words. Consider the two possible alignments for the Japanese child Takeru’s production of *osiete* ‘tell me’ (Ota, 2003) shown in (1). The first alignment applies a sequential approach that aligns segments in the child’s word with segments in the same position in the target word. The sequential alignment in (1a) matches the initial vowel in the target with the initial consonant in the child’s word, and so on. It leaves the final vowel of the child’s production unmatched. In contrast, the axiom prohibiting alignments between produced consonants and targeted vowels leaves the produced initial consonant unmatched, and aligns the first produced vowel with the first targeted vowel. It matches the [t] in the child’s word with the /s/ in the target then skips over the /i/ in the target to match the /e/ in the target with the [e] in the child’s word. It matches the final [t] in the child’s word with the /t/ in the target, skipping over the third [t] in the child’s word. The second alignment matches the final targeted vowel with the final produced vowel.

(1) Possible alignments for Takeru’s (1;11.02; Ota, 2003) production of *osiete* ‘tell me’

a. Sequential b. Axiom 1

Target o s i e t e Target o s i e t e

| | | | | | | | | | |

Child t o t e t t e Child t o t e t t e

Imposing an axiom for aligning segments requires skipping over segments in the child or target words that do not align. This axiom forces us to alter Ingram’s treatment of syllabic consonants. Ingram (2002: 716) analyzed syllabic consonants as single consonants rather than a combination of consonant and syllable. He aligned the [o] in a child’s production [bado] with the final syllabic consonant [l] in targeted *bottle*. His analysis violates the axiom that prohibits aligning child vowels with target consonants. Our decision to count syllable peaks rather than vowels led to analyzing syllabic consonants as consonants on the segmental level and syllables on the prosodic level. We analyze the child’s production [bado] as having two consonants and two syllables with a PMLU of 5 in comparison to a PMLU of 8 for the target word. The child’s production lacks the final consonant of the target word and has the incorrect medial consonant [d]. Counting syllable peaks rather than vowels makes the analysis of syllabic consonants consistent with that of other consonants.

A second axiom is necessary to prohibit crossing lines in the matches between the produced and target segments. The child SR, for example, produced *all gone* as a reduplicated syllable [ˈdada] (Stoel-Gammon & Dunn, 1985). Aligning SR’s first syllable [ˈda] with the targeted first syllable *all* results in a mismatch between the targeted and produced vowel-consonant sequences (2). Aligning syllable peaks leaves the initial /d/ in SR’s word unlinked. The alignment cannot link the initial /d/ in SR’s word with the /l/ in the target without crossing the link between the syllable peaks. This alignment gives SR’s word a PMLU score of 3 for its two syllables and one consonant. Axiom 2 prohibits crossing lines and supports the alignment shown in (2).

(2) SR’s production of *all gone* (Stoel-Gammon & Dunn, 1985)

Target a ll g o n e

| | |

SR ˈd a d a

Taelman et al. (2005) discuss a similar case in which Dutch children produce the target word *wesp* ‘wasp’ as [weps] (c.f., Bónová et al., 2005). Taelman et al. instituted a rule similar to ours to prohibit counting sounds in children’s words that do not follow the targeted sequence.

We further propose a third axiom to maximize the number of segments in the child’s word aligned with segments in the target. Consider the two alignments in (3) for Ines’ production of Portuguese *copo* ‘glass’ (Correia et al., 2010). Ines’ production reverses the targeted syllable order, resulting in a mismatch between the produced and targeted consonants. The alignment in (3a) maximizes the number of segments linked to segments in the target, while the alignment in (3b) maximizes the number of features shared between Ines’ produced and targeted consonants. Axiom 3 gives greater weight to the number of segments in children’s words linked to segments in the target rather than first aligning segments with shared features. The transcription for Ines shows syllable stress, which provides further evidence for the alignment in (3a). We list our proposed alignment axioms in (4).

(3) Alignments for Ines’ production of Portuguese word *copo* ‘glass’

a. Target c o p o b. Target c o p o

| | | | | |

Ines ˈp ɔ k u Ines ˈp ɔ k u

(4) Axioms for aligning segments in child and target words

Axiom 1. Align the child’s produced syllable peaks with syllable peaks in the target, and align the produced consonants with consonants in the target.

Corollary 1. Analyze syllabic consonants as syllables at the prosodic level and as

consonants at the segmental level.

Corollary 2. Analyze diphthongs as single syllables.

Corollary 3. Analyze postvocalic glides as part of a diphthong.

Axiom 2. Do not cross the links between the segments in the child’s production and the target word.

Axiom 3. Maximize the number of segments in the child’s production that link to segments in the target word.

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