The contribution of functional load on children’s phonological development  
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Children’s phonology is replete with regular, predictable phenomena that nevertheless differ from adults (Pater & Barlow 2004; Inkelas & Rose 2007). Discrepancies between adult and late-childhood speech cannot be solely attributed to environmental input, so immature motor development is often cited (McAllister Byun 2011). Normally-developing children quickly acquire the motor skills and segmental planning necessary to avoid these “errors”, a tendency illustrated by the fact that the field of child phonology focuses on the early years of 1;6-4;0 (Hazan 2017). But phonological development continues well into late-childhood. For example, the negative correlation of age and segment duration/variability in children is reported for English (Lee et al. 1999) and French (Ménard et al. 2007). We present here contradictory data from South Bolivian Quechua (SBQ) that shows children producing shorter vowel durations than adults and attribute this to the role of functional load (FL). Interest in FL as an explanatory device for phoneme merger and inventories has recently resurfaced (Hockett 1955; Surendran & Levow 2004; Wedel et al. 2013), but few studies have examined it in the context of children’s segmental acquisition (but see Stokes & Surendran 2005; Van Severen et al. 2013). By the age of 5;0, children are cognizant of contrasts in their language and employ production strategies (e.g. increased duration) based on their own, unique phonological neighborhood densities (Charles-Luce & Luce 1990; Storkel 2002; Storkel & Hoover 2011). FL is an important metric to examine since children’s relatively smaller lexicons may lead them to make different generalizations regarding the relative importance of certain phonological contrasts. We test this hypothesis in a study of [+continuant] segments in SBQ, a Quechua II language (Torero 1964) that is underrepresented in studies of child phonology.

The system: SBQ is a highly-agglutinative language, with a series of verbal and nominal suffixes. It also has a three vowel /a, i, u/ system, with corresponding mid-vowels [e, o] derived in uvular contexts (Gallagher 2016). The following consonants were chosen for analysis as they exhibit longer durations and permit comparison between adults and children: /n, m, s, f/.

Data: Data consisted of oral recordings of virtually monolingual child and adult SBQ speakers from rural Chuquisaca, Bolivia (Kalt 2009, Kalt to appear). N = 7 (F = 5) children aged 5;0-6;0 completed a picture selection and description task and N = 2 adults (F = 1) narrated a story based on a six frame comic strip. All participants responded to questions about stimuli posed by an adult native or fluent heritage speaker interlocutor. This resulted in naturalistic yet contextually-consistent data across speakers. A native speaker transcribed and morphologically segmented the narratives, which were then aligned in Praat (Boersma & Weenink 2016). Acoustical measurements were automatically extracted for a total of N = 1,212 tokens of child speech and N = 832 adult.

Results: Adult and child segment duration differed significantly: a series of linear models fit separately to consonant and vowel duration showed that child consonant duration was longer than adult ($β=0.0158$, $t=2.262$, $p=.024$) but child vowel duration was shorter ($β=-.0069$, $t=-2.538$, $p=.01$) (Figure 1). Crucially, neither vowel nor consonant length is core to SBQ’s phonological contrast system; long vowels occur only in derived environments. Given the disparity between phone type in

![Figure 1: Adult vs Child Vowel Duration](image-url)
the children’s speech – longer consonants but shorter vowels – the exclusive roles of speech rate or underdeveloped motor skills were ruled out as the sole explanation.

FL was determined utilizing a 25,457-word SBQ lexicon composed of separate entries for root words and suffixes (Heggarty 2006). After excluding homonyms (14.42% of lexicon), FL for vowels and /n, m, s, tf–ʃ/ in pseudo-child and adult lexicons was calculated by dividing the number of unique lexemes by the number without (Table 1). We make the following assumptions: SBQ-speaking children productively employ verbal morphology (see Kalt 2015 and Courtney & Saville-Troike 2002) and that children aged 5;0–6;0 have smaller lexicons than adults, averaging 5,000 head words for English (Anglin 1993).

Table 1: SBQ Functional load across roots and suffixes

<table>
<thead>
<tr>
<th></th>
<th>SUFFIX ONLY</th>
<th>SUFFIX + 5,000 ROOTS [CHILD LEXICON]</th>
<th>SUFFIX + ALL ROOTS [ADULT LEXICON]</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOWEL</td>
<td>1.26</td>
<td>1.11</td>
<td>1.28</td>
</tr>
<tr>
<td>FRIC+NASAL</td>
<td>1.26</td>
<td>1.08</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Consequently, the adult lexicon constituted all suffixes and roots and the child lexicon contained all suffixes plus a random selection of 5,000 roots (FL calculated as average over 100 iterations). We use these results to offer an explanation for why SBQ children reduce vowel duration, and not consonant. With a smaller lexicon, but fully formed morphological system, the children may attribute a lower FL to the vowels than adults do. This may be due to the makeup of SBQ-speaking children’s lexicons where suffixes carry more weight relative to roots.