Language-specific Sources of Acoustic Stability in Phonological Development

Meg Cychosz

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Introduction to topic

Multilingualism is a global norm. For decades, researchers have demonstrated the cognitive and economic benefits of speaking multiple languages. Yet for many communities in Bolivia, bilingualism in Spanish and languages such as Quechua or Aymara precipitates debilitating social stigmatization. One of the overarching goals of this research program is to disseminate information to parents and teachers in Cochabamba, Bolivia and several surrounding communities such as Sucre and Tarabuco, concerning the trajectories of bilingual Quechua-Spanish language development in children. This information may eventually permit indigenous communities to make their own decisions about which languages to teach in school and speak in the home.

Given that most child Quechua learners acquire both Spanish and Quechua from a young age, the lack of understanding of simultaneous South Bolivian Quechua-Spanish acquisition prohibits parents and teachers from making informed decisions on language usage. Furthermore, though threatened by globalization and the influence of Spanish, Quechua is a thriving language, regularly transmitted to children and today spoken by approximately 10 million speakers in Bolivia, Peru, Colombia, Ecuador, and Argentina. These relatively large speech communities warrant representation in the linguistics and language development literature.

To impart information to parents and educators, we must first examine monolingual Quechua development. This is the focus of the project at hand. There is little to no developmental research on Quechua; however, from a cross-linguistic perspective, South Bolivian Quechua is highly informative. It is typologically unlike the languages upon which the majority of developmental research focuses (English, French, Spanish, Dutch) and the speech community and surrounding culture also differs greatly from those of Western Europe and North America. Consequently, Quechua and its speech communities have much to contribute to our understanding of universals and language-specific trends in child language acquisition and language socialization.

The project

Acoustic variability in speech is ubiquitous. This is largely chalked up to speech reduction and coarticulatory motor routines – at least for adults. Variability in children, however, is primarily studied in the context of physiological development: anatomical difference from adults (Denny & McGowan 2012) and underdeveloped motor planning routines (Nittrouer 1993). These elements of child articulation result in variable formant frequencies and f0, and segments of longer duration (Lee et al. 1999; Vorperian & Kent 2007) with adult-like levels only attained around 12;0. Phonetic mastery clearly poses a challenge throughout childhood, despite

the importance of acoustic competence for efficient adult communication (Aylett & Turk 2004). This project examines an additional source of child variability: phonological, specifically vocalic, structure of the language being learned.

Previous findings on acoustic variability have primarily come from lab speech: naturalistic child production data demonstrate no such age-related decrease in variability (McGowan et al. 2014). Additionally, previous conclusions on child acoustic variability were drawn solely from languages with relatively large vowel inventories (e.g. English, French). This impedes our understanding of phonological development, especially because vowel inventory size and intra-category dispersion may be negatively correlated in adults (Recasens & Espinosa 2006). Furthermore, since children tend to be more accurate at producing consonants that are most frequent in their ambient language (Edwards & Beckman 2008), development in systems with different vowel frequencies warrants investigation. If linguistic structure affects children's acoustic stability, we expect children to be equally, if not more, variable than adults when acquiring a language with few vocalic contrasts.

Methodology

To address this question, I measured acoustic variability in Chuquisaca Bolivian Quechua, a highly agglutinating three-vowel (/a, i, u/) language with non-contrastive mid vowels. Recordings for this study come from oral child (5;0-10;0) and adult corpora (Kalt 2009; Kalt to appear). *N*=21 (F=10) children in age groups 5;0-6;0, 7;0-8;0, and 9;0-10;0 completed a picture selection and description task. *N*=2 adults (F=1) narrated the Duck Story (Kalt et al. 2009). This resulted in naturalistic yet contextually-consistent narratives of 10-20 minutes. Participants responded to questions about the stimuli posed by an adult native or fluent heritage speaker of South Bolivian Quechua.

A native speaker transcribed and morphologically segmented the narratives, which were aligned in Praat (Boersma & Weenink 2017). Formants and vowel durations were automatically extracted with IFC Formant (Watanabe 2001) at three evenly-spaced time points (25-50-75). Given the high formant frequencies of child speech, automated extraction can be problematic. Approximately 10% of measurements were hand-verified in spectral slices to ensure reliability with the peak harmonic. Intra-category vowel variability was calculated as a function of Mahalanobis distance, a metric of normalization that can reflect oblong dispersions that are common in 2D acoustical space.

Preliminary Results

Mixed-effects linear regression models fit to predict the distance metrics demonstrated that dispersion only differed by morphological status – both adult and child speakers showed more variation in suffixes than roots (β= -0.3827, t= -2.174, p=.03). Age did not predict dispersion (p=.78) meaning that child Quechua speakers may tend to vary more (Figure 1), but their vowel variability does not reliably differ (Figures 2, 3). These findings suggest that variability may not stem entirely from children's articulatory limitations – inventory size may play a role in their attainment of acoustic stability. This

analysis affirms the need to supplement existing acoustic studies of child phonology with data from languages, such as Chuquisaca Bolivian Quechua, that remain underrepresented in the literature.

FIGURE 1. 5;0-6;0 child vowel dispersion

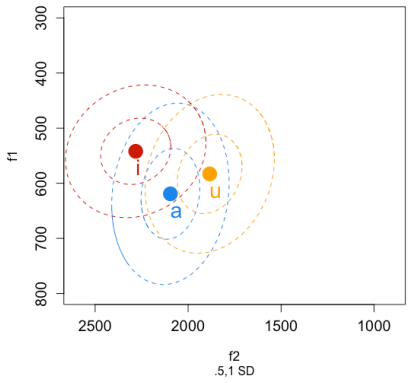


FIGURE 2. Adult vowel dispersion, male

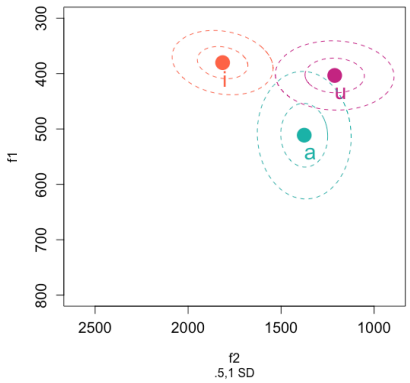
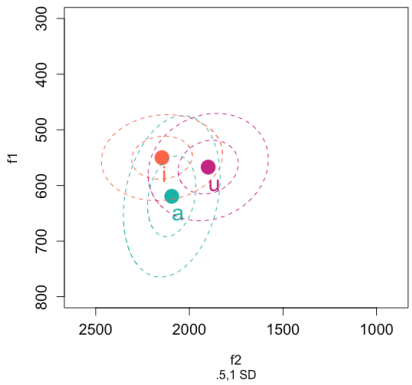


FIGURE 3. Adult vowel dispersion, female



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