

# CROSS-LINGUISTIC INFLUENCES ON INFANT BABBLING

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## 1. INTRODUCTION

Access to phonetic structure through language input is critical for what it provides to language development. It is well known that infants' speech perception is progressively tuned to native language phonemes with increasing linguistic experience. The impact of linguistic experience is observed at a particularly early age for the perception of native language vowels (Kuhl et al., 1992). In contrast, little is known about the impact of linguistic experience on early vowel production. Most studies of vowel development have been concerned with English-learning infants: Kent and Murray (1982) observed a developmental increase in the range of first formant (F1) frequencies in vowels produced during the first year of life; Rvachew, Slawinski, Williams, & Green (1996) reported a small decrease in mean second formant (F2) frequencies and a steady increase in the standard deviation of F2 during the second year of life. Although some developmental changes in vowel production are undoubtedly due to anatomical and physiological changes in the vocal tract during this period, linguistic experience may also play a role. In a study of 10-month-old infants from English, French, Cantonese, and Algerian speaking families, de Boysson-Bardies et al., (1989) reported cross-linguistic effects on F1 and F2 frequencies. However, this study described only a single age group and a replication has never been published.

### 1.1. Purpose

The purpose of this study was to systematically examine (i) developmental changes in F1 and F2 frequencies in vowels produced by infants 10 through 18 months of age, and (ii) cross-linguistic differences in F1 and F2 in vowels produced by English- and French-learning infants during this period.

### 1.2. Hypotheses

It was hypothesized that there would be an initial overlap in the vowels produced by English and French infants, but that their respective vowel spaces would diverge linearly with age. Specifically, it was predicted that (i) mean F1 and standard deviation of F1 would remain stable with age for both groups; (ii) mean F2 would increase with age for English infants and decrease with age for French infants, and (iii) standard deviation of F2 would increase with age for both language groups.

## 2. METHOD

### 2.1. Participants and Design

Forty-three infants from Montreal, Canada, ranging in age from 10 to 18 months participated in this cross-sectional study - 23 from monolingual French- and 20 from monolingual English speaking families. All infants were born at full term, were reported to be healthy at the time of testing, and had no known hearing difficulties.

### 2.2. Babble Sample Recordings

The babble samples were recorded during a play session between mother and infant, which either took place in a sound proof booth in the laboratory, or in their homes. Mothers were instructed to interact with their child in the usual manner. The samples were obtained using a Sony portable DAT recorder and a Sennheiser microphone affixed to the infant's shirt at the shoulder. Each recording session continued until the infant produced 60 utterances, or until 30 minutes had lapsed, whichever came first.

### 2.3. Acoustic Analyses

Speech utterances were digitized at 22050Hz using Time Frequency Response software (AVAAZ) and PC hardware. Isolated vowels and vowels contained within canonical syllables (Oller, 1986) were selected if vowel or syllable duration was less than 500 ms and phonation and resonance were normal. Formant analysis on 1430 vowels was performed by an individual trained in speech acoustics, blind to the age and language background of the infant. F1 and F2 were measured at the middle of the steady state portion by LPC autocorrelation analysis with a window size of 256 points, 50% overlap, 98% preemphasis, Hanning window and model order of 12. Model order was increased or decreased for some vowels to obtain reliable measurements. Formant locations were confirmed with narrowband short-time FFT spectrograms (512 points).

### 2.4. Reliability Coding

Intraclass correlations between independently identified formant frequencies for 248 vowels were  $r = .918$  and  $r = .928$  ( $p = .01$  level) for F1 and F2 respectively.

## 3. RESULTS

### 3.1. Measures

The mean (M) and standard deviation (SD) of the formant values were calculated for each infant's vowel space, yielding four measures per sample:  $M_{F1}$ ,  $M_{F2}$ ,  $SD_{F1}$ ,  $SD_{F2}$ .

### 3.2. Regression Analyses

Linear regression analyses were used to examine the main effect of age, the main effect of language group, and the interaction of age and language group for each of the four measures. Mean F1 values and regression lines for English and French infants are plotted in Fig. 1. For  $M_{F1}$ , there was a trend towards an age by language group interaction, indicating a decline with age for French [ $F(1,21) = 7.62, p = .01$ ] but not English infants [ $F(1,18) = 2.22, p = .15$ ]. An interaction was also observed for  $SD_{F1}$  indicating an age-related decrease in dispersion of first formant frequencies for French [ $F(1,21) = 4.97, p = .04$ ] but not English [ $F(1,18) = 2.35, p = .14$ ] infants.

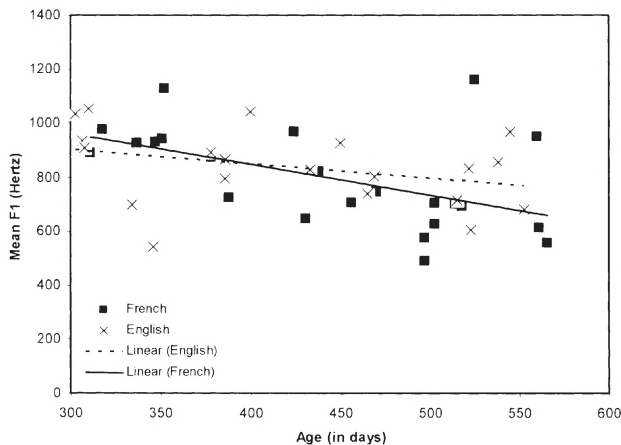


Fig. 1.  $M_{F1}$  by age and language group.

Mean F2 values and regression lines for English and French infants are plotted in Fig. 2.

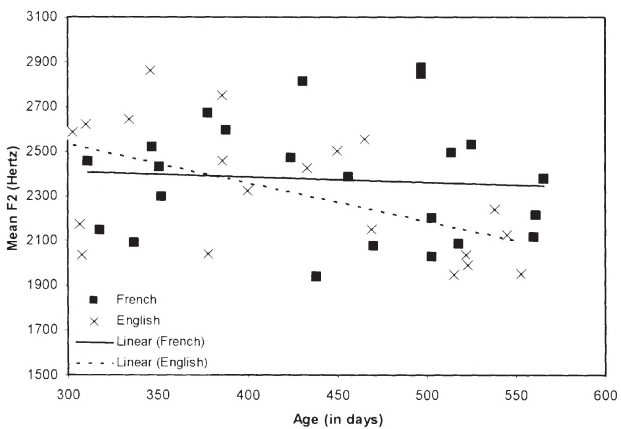


Fig. 2.  $M_{F2}$  by age and language group.

A significant interaction between age and language group was found and confirmed by the decline over age for English infants'  $M_{F2}$  [ $F(1,18) = 7.36, p = .01$ ], whereas French infants'

$M_{F2}$  remained stable across age [ $F(1,21) = .11, p = .74$ ]. An interaction was also observed for  $SD_{F2}$ , with increasing dispersion of F2 across age for English infants [ $F(1,18) = 5.57, p = .03$ ], but not for the French infants [ $F(1,21) = .17, p = .89$ ].

## 4. DISCUSSION

There is clear evidence for age by language group interactions. Mean F1 and standard deviation of F1 decreased with age for the French but not English infants. Mean F2 decreased and standard deviation of F2 increased with age for English-learning infants, but there was no change in either mean F2 or standard deviation of F2 for French-learning infants' vowels. These developmental changes are undoubtedly explained by a combination of anatomical, physiological, input, and intake factors. However, it is assumed that the anatomical and physiological constraints do not differ between language groups, and therefore these cross-linguistic differences must be explained by differences in the input provided to and received by the infants. Currently we are investigating differences in the input provided by French- and English-Canadian mothers to their infants, as well as their infant's ability to attend to and process cues for French and English vowels in their own speech.

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