Crosslinguistic similarities and differences in babbling: Phylogenetic implications

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Introduction

Three main objectives are set out in this project entitled "Comparison between processes in language acquisition by children and language evolution: from the first syllables to the lexical spurt". First is understanding of relationships between children's early production patterns and characteristics of the production system affecting those patterns. The second is understanding of the role of perceptual input from the ambient language in early vocal patterns proposal of new hypotheses concerning similarities and differences between the processes involved in language acquisition and language evolution. A cross-linguistic perspective is adopted to allow for systematic comparison of babbling, first words and the lexical spurt in children acquiring typologically different languages: Dutch, Romanian, Turkish, Tunisian Arabic and French.

Cross-linguistic Similarities

Crucial importance for understanding speech development is assigned to the babbling period. This argument comes from longitudinal investigations of the transition from babble to speech showing continuity between phonetic features of an infant's pre-linguistic vocalizations and early speech forms (Oller *et al*. 1976, 1980; Stark, 1980; Stoel-Gammon & Cooper, 1984; Vihman, Ferguson & Elbert, 1986).

The pre-linguistic vocalizations of children display common trends across languages. Strong similarities in sound types (i.e. segments), sound combinations and utterance type preferences across different communities have been frequently documented, suggesting a universal basis for babbling. Consonants most frequently reported are stops, and to a lesser extent, nasals and glides (Locke, 1983; Robb & Bleibe, 1994; Rough, Landberg & Lundberg, 1989; Stoel-Gammon, 1985; Vihman *et al*., 1985). During the babbling period, children tend also to produce many coronal and labial consonants (Locke, 1983) and few dorsals (Stoel-Gammon, 1985). Vowels from the lower left quadrant of the vowel space (i.e. mid and low front and central vowels) are most often observed (Bickly, 1983; Buhr, 1980; Kent & Bauer, 1985; Lieberman, 1980; MacNeilage & Davis, 1990; Stoel-Gammon & Harrington, 1990). Children tend to favor open (CV) as opposed to closed (CVC) syllable types (Kent & Bauer, 1985; Locke, 1983; Oller & Eilers, 1982; Stoel-Gammon, 1985; Vihman, 1992).

In a typical utterance, consonants and vowels never appear in isolation but are produced serially. This phenomenon of serial ordering is one of the most distinctive properties of speech production. MacNeilage and Davis (1993, 2000) have developed a biomechanical model termed the "Frame-Content Theory" to characterize the serial organization of vocalizations in babbling (Davis & MacNeilage, 1995), first words (Davis, MacNeilage, & Matyear 2002), and languages (MacNeilage, Davis, Kinney, &

Matyear, 2000). In this perspective, intrasyllabic consonant-vowel alternations, which form the basis for syllables in spoken language, are proposed as being based in earliest acquisition on rhythmic close-open mandibular oscillations accompanied by phonation. These rhythmic mandibular oscillations (the "frame") comprise the "unit" within which speech-like behaviors first emerge in pre-linguistic babbling. In the course of development, as children gain control over the independent coordination of articulators within sequences, segmental elements ("content") are gradually differentiated to become separate entities in production and perception. In babbling and first words, "frame dominance", without independent control of other active articulators, produces predictions for patterns within spoken syllables. Three preferred within- syllable co-occurrence patterns emerge from this hypothesis. These co-occurrences are for coronal (tongue tip closure) consonants to occur with front vowels (e.g. "di"), dorsal (tongue back closure) consonants to occur with back vowels (e. g. "ku"), and labial (lip closure) consonants to occur with central vowels (e.g. "ba"). In each of these, the tongue does not move independently of the jaw within the syllable, but stays in the same position for the open portion (vowel) portion of the syllable as the jaw opens as it was for the consonant closure portion.

Recent studies have tested for these predicted co-occurrence patterns within syllables in the babbling and early speech period in English and a variety of other languages. In studies of 6 children during babbling (Davis & MacNeilage, 1995) and 10 children in first words (Davis, MacNeilage & Matyear, 2002) in an English language environment, all three predicted co-occurrences were found at above chance levels using chi square analysis. These predicted intrasyllabic co-occurrences have also been found in an analysis of 5 French children, 5 Swedish children and 5 Japanese children from the Stanford Child Language Database (Davis & MacNeilage, 2000), in 1 Brazilian-Portuguese learning child (Teixiera & Davis, 2002), in 7 children acquiring Quichua (Gildersleeve-Neuman & Davis, 1998) and in 7 Korean children (Lee, 2003).

There is also evidence that these common infant preferences, found in babbling and first words, are present in languages. This is true for syllable types (the open syllable is considered as the only universal syllable type in languages) and for consonants (stops and nasals are frequent in languages) (Maddieson, 1984). It has also been found for intrasyllabic CV co-occurrences patterns. MacNeilage *et al*. (2000) analyzed dictionary data for the three predicted CV co-occurrence in ten languages: English, Estonian, French, German, Hebrew, Japanese, New Zealand Maori, Ecuadorian Quichua, Spanish and Swahili using chi square analysis. Observed frequencies exceeded expected frequencies for labial-central pairs in 7 languages, for coronal-front pairs in 7 languages, and for dorsal-back pairs in 8 languages. Mean values across the ten languages were labial-central, 1.10, coronal-front 1.18; and dorsal-back, 1.27. Japanese was the only language that did not show an overall average above 1.0 for the three categories combined. Rousset (2004) examined 14 languages from the ULSID database (Maddieson, 1984): Afar, Finnish, French, Kannada, Kanouri, Kwakw'ala, Navaho, Ngizm, Nyah Kur, Quechua, Sora, Swedish, Wa,Yup'ik, and !Xoo. In CV forms, very few exceptions to the predicted CV co-occurrences were found: The labial-central trend was not found in Navaho, Thai, and !Xoo, and the coronal front co-occurrence was not found in Kwakw'ala. All other predicted associations showed above chance values (i.e. 38/42 above chance values). The very strong persistence of these patterns in languages as well as their presence at the onset of speech-like vocalizations in infants indicates that they reflect fundamental properties of the speech production system. As such, they do not merely represent an aspect of the acquisition process disappearing with maturity of the vocal apparatus. Both the common patterns and the language specific variants observed should have significant implications for understanding of the phylogeny of speech. It is possible, for example, that patterns common to all or most languages were present in the first spoken language, as they represent fundamental properties of operation of the production system. In contrast, language specific patterns are perhaps more likely to have emerged later as individual languages diversified to increase the size of their respective message sets.

Some counterexamples to these CV co-occurrence trends have been reported in studies of infants (Boysson-Bardies, 1993; Oller & Steffans, 1993; Tyler & Langsdale, 1996; Vihman, 1992). However most of these may be the result of methodological differences from studies that have found the predicted three co-occurrence patterns. A labial central association in initial syllables was shown by Boysson-Bardies (1993) for French, Swedish and Yoruba infants but not for English: the English-speaking children in her study preferred the labial front association. However, Boysson-Bardies analyzed the first and second syllables of utterances separately resulting in relatively small databases. Oller and Steffans (1993) evaluated their results against the expected frequencies of consonants, and did not include expected frequencies of vowels, complicating comparison of results. The three co-occurrence patterns were observable in Tyler and Langsdale's (1996) data if the small numbers of observations in the three age groups studied were pooled. An alveolar-front association was not found in 3 English-speaking and 2 Swedish-speaking subjects by Vihman (1992). However, she counted /æ/ as a central vowel, also complicating the interpretation of her results relative to the predicted CV co-occurrences.

Ambient Language Effects

It is generally acknowledged that input from the ambient language plays a role in children's very early perception as early as 8-10 months (Werker & Lalonde, 1988). It has also been proposed that input from the ambient language may also influence the shaping of children's production preferences at some point in the late babbling and first word periods. This potential for ambient language influence has been examined for utterance and syllable structures (Boysson-Bardies, 1993; Kopkalli-Yavuz & Topbaç, 2000), vowel and consonant repertoires (Boysson-Bardies, Hall, Sagart & Durand, 1989; 1992) and distribution as well as CV co-occurrence preferences (e.g. Lee, 2003).

In an early study, Boysson-Bardies, Sagart & Durand (1984) presented naïve adults with sequences of early babbling of French, Arabic & Cantonese children. Participants were asked to identify the babbling of French infants. Listeners were correct in judging 70% of tokens, suggesting that babbling in the pre-linguistic period may show language specific intonation characteristics. Boysson-Bardies, Hallé, Sagart & Durand (1989) also compared vocal sounds of French, English, Cantonese and Algerian infants. They proposed that that the acoustic vowel distribution was significantly different for the 4 language groups. Boysson-Bardies, Hallé, Sagart & Durand (1992) showed the same tendency within the infant's consonant repertoires. Their consonant data indicated significant differences in the distribution of place and manner of consonant articulation across the languages analyzed. French infants produced more labials than Japanese or Swedish infants. Boysson-Bardies (1993) also examined syllable types. She compared Yoruba babbling to French, English, and Swedish babbling. She interpreted her findings as showing that French, English and Swedish children produce between 65% and 75% of CVCV disyllables, whereas Yoruba children produced 62% VCV word types. She attributed this difference to the particular structure of Yoruba, where most words begin with a vowel.

Levitt & Utman (1992) compared reduplication and variegation in babbling in French and American English-learning infants. They found that French infants showed significantly more reduplicated utterances during the babbling period (four or more syllables in length) than their American-English learning infant cohort. This type of result suggests an early effect of the ambient language related to the length of the prosodic word during the pre-linguistic babbling period.

The babbling studies just reviewed indicate common effects in production patterns as well as some indication of early appearance of output patterns related to input from the ambient language. These individual differences found in infants in diverse languages are indicative of early learning and reproduction of precise ambient language regularities. To understand the interaction of patterns based on production system propensities common to all infants versus the role of early learning from unique environmental regularities in the ambient phonology, it is important to examine diverse languages that produce targets for learning outside the common characteristics suggested as being present in many infants across languages. Many studies to date have examined small numbers of infants and employed diverse methodologies for analysis. In the work to be summarized here, we have collected and imposed a uniform analysis profile on large corpora for five diverse languages, in a continuing attempt to understand common trends as well as the timing and characteristics of appearance of language specific influences. The following predictions will be tested related to the common characteristics proposed as being universal across languages:

1. There will be a significantly higher proportion of stops, nasals and glides than other consonants;
2. There will be a significantly higher proportion of coronal and labial than dorsal consonants;
3. There will be a higher proportion of mid and low front and central vowels than other types of vowels;
4. There will be a significant tendency for patterns of co-occurrence between consonants and following vowels within an utterance:
    - central vowels in the environment of labial consonants
    - front vowels in the environment of coronal consonants
    - back vowels in the environment of dorsal consonants

Method

Participants

Twenty children (10 girls and 10 boys; 4 children per language) developing normally according to community standards and reports from parents and physicians regarding developmental milestones were observed in their normal daily environments. These children were being reared as monolingual speakers of Turkish, French, Romanian, Dutch and Tunisian Arabic.

Data Collection

Four types of data were collected. First, one hour of *spontaneous vocalization* data was audio and video recorded every two weeks from 8 through 25 months in the children's homes. Parents were told to follow their normal types of activities with their child. Second, minimally 1,000 *dictionary* entries from the ambient language employed by the parents of each child participant were analyzed for comparison with the child data for that language. *Parental reports* were administered using adaptations of the <u>MacArthur Development Inventories</u> (Fenson *et al*., 1993) respectively elaborated by Zink and Lejaegere for Dutch and by Kern for French participants. Mothers filled out the questionnaire once in a month. For the remaining languages, no adaptation of this inventory is available. In those languages, the spontaneous data will be employed to elaborate the same instrument. An object manipulation *categorization task* was administered every two months. This task was conceived to evaluate the children's spontaneous non-verbal categorization abilities. Several toys, which were consistent across the language groups, served as stimuli. Each task involved a contrast of objects from two different categories (animal, means of locomotion, furniture).

Data Analysis

Data analyzed for this report were the *spontaneous vocalization samples* collected in each language. We analyzed available vocalization samples for 13 children (at least 2 participants per language) during the babbling period. Table 1 summarizes descriptive data, for the 13 participants considered here.

This period ranged from the onset of data collection (when children were between 7;15 months and 9;15 months) until the production of their first words (around 12;15 months). 122 hours of spontaneous data were phonetically transcribed using the International Phonetic Alphabet. Broad phonetic transcriptions were used, supplemented by some diacritics (mainly for palatalized, pharyngealized, nasalized sounds and duration of sounds). All singleton consonants and singleton vowels as well as syllable-like vocalizations were transcribed and analysed. Tokens considered as single utterance strings were bounded by 1 second of silence, noise or adult speech. Transcribed data were entered into Logical International Phonetic Programs (LIPP) for analysis of patterns.

A variety of characteristics were analyzed. Utterance structures were described in terms of number of syllables. Utterances were grouped into monosyllabic utterances (one syllable), disyllables (two syllables) and multi-syllables (more than two syllables in one utterance). Consonants were grouped according to 1) place of articulation: *labial* (bilabial, labiodental, labio-palatal and labio-velar), *coronal* (dental, alveolar, postalveolar and palatal), *dorsal* (velar and uvular) and *guttural* (pharyngeal and glottal) and 2) manner of articulation as oral stops, fricatives, liquids, nasals, glides and "other" (i.e. trills, taps and affricates). Glides were considered as consonants as they share the consonantal property of accompanying the mouth-closing phase of babbling. Vowels were grouped according to 1) height: *high* (high and lowered-high), *mid* (higher-mid, mid and lower-mid) and *low* (raised-low and low) 2) *front/back*: front, central and back. An "other" category included all non-transcribable segments (UC, UV, US).

In addition, intrasyllabic consonant-vowel (CV) co-occurrence patterns were analysed. For this analysis, consonants were grouped into 3 categories according to the place of articulation: labial, coronal and dorsal. Vowels were grouped into front, central and back dimensions.

Table1.
Participant Descriptions.

Language	Number of participants	Number of sessions analyzed
French	4	37
Romanian	2	19
Tunisian	3	26
Turkish	2	19
Dutch	2	21
Total	13	122

Results
Utterance structures

Table 2 displays frequency of occurrence for segments, syllables and utterance types. Overall number of segments analysed totalled 84.737 for the 13 participants. In all languages, number of vowels exceeded consonants. Overall, vowels accounted for 55% and consonants for 45% of all segments. Number of utterances for all languages was 31.686 ranging from 1.599 to 11.738. The total number of syllables was 21.326, ranging from 1.664 to 7.162. Overall, across all languages, monosyllables accounted for 42% of utterances and polysyllables (disyllables plus multi-syllables) accounted for 58%. This trend occurred in 4 out of 5 languages. Only Romanian children produced more monosyllables than polysyllables. Moreover, overall there were more monosyllables (at least two times more) than disyllables with the exception of Turkish. Turkish children produced fewer monosyllables than disyllables (ratio of 0.6).

Table 2.
Frequency of Occurrence of Segments, Syllables, and Utterance Types.

	Type		Total	Utterances	Total sylls	Monosylls	Disylls	Multisylls
French	C	11054	25208	11738	7162	1968	920	4274
	V	14108						
	"Other"	46						
Tunisian	C	10566	23746	7358	4421	2035	568	1818
	V	13177						

	"Other"	3						
Romanian	C	6461	14962	6446	4645	2780	880	985
	V	8500						
	"Other"	1						
Turkish	C	3817	7875	1599	1664	490	719	455
	V	3974						
	"Other"	84						
Dutch	C	6117	12946	4548	3434	1651	483	1300
	V	6819						
	"Other"	10						
	total		84737	31686	21326	8924	3570	8832

Consonants

Overall, 38.015 consonants were analysed. Number of consonants ranged from 3.817 to 11.054 across languages.

Some overall similarities were apparent as well as some striking differences across languages relative to manner of articulation. Figure 1 displays percentage-of-occurrence figures for manner of articulation for all consonants in the entire corpus. Overall, oral stops were the most represented. 4 languages out of 5 exhibited this trend: oral stops represented 51% in French, 52% in Romanian, 50% in Dutch and 60% in Turkish. Only Tunisian produced less than 50% of stops (38%). This difference can be related to the frequent use of fricatives, especially the glottal fricative [ɦ] by Tunisian children. In Tunisian, the glottal fricative [ɦ] represented the largest category type of consonants with a frequency of 38.7% (Percentages (>5%) and totals of consonants in each language are given in Table 1 in the Appendix A).

Glottal fricatives not taken into account, nasals were the second most represented manner of articulation, with 13.69 percent overall occurrences. French children produced twice the average frequency of nasals whereas Dutch and Tunisian children produced half the average number of nasals.

Glides occur less than nasals with an overall 9.5 percent occurrence.

Finally, articulatory fricatives, liquids and "other" had the lowest frequency of occurrence across languages. The high ranking for glottal fricatives is accounted for Tunisian as depicted above as well as for Dutch by glottal fricative [h] representing respectively 21% of occurrences.

Figure 1: Percentage of Occurrence for Consonant Manner of Articulation.

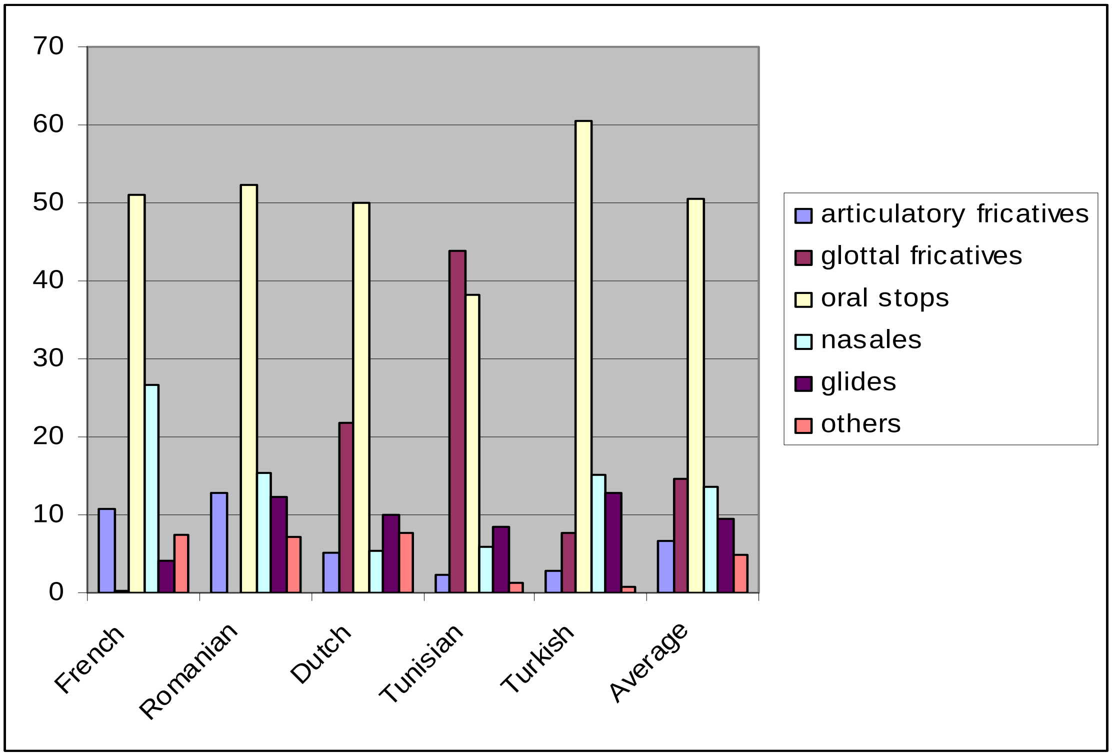
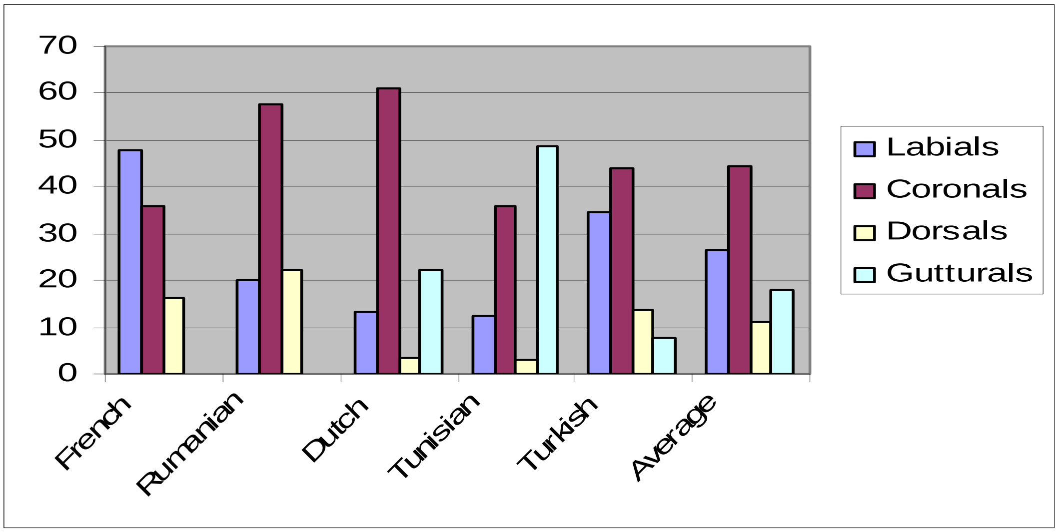


Figure 2 displays percentage-of-occurrence figures for place of articulation for all consonants in the entire corpus. Overall, coronal consonants are the most prominent category with 44.4% of occurrences. However in French, there are more labials than coronals. Labials were produced with a frequency of 34.36%, alveolars with a frequency of 26.07% and velars with 5.73%. Among labials, the nasal [m] was frequently produced by these children. In Tunisian, there were more gutturals than coronals, with a high frequency of the glottal fricative [ɦ]. The second most frequent category was labials and, overall, there are more dorsals than gutturals. In Tunisian and Dutch the trend is reversed: more gutturals than dorsals occur. These diverse patterns may be motivated by the role of the ambient language.

Figure 2: Consonant place of articulation: percentage of occurrence for each language.

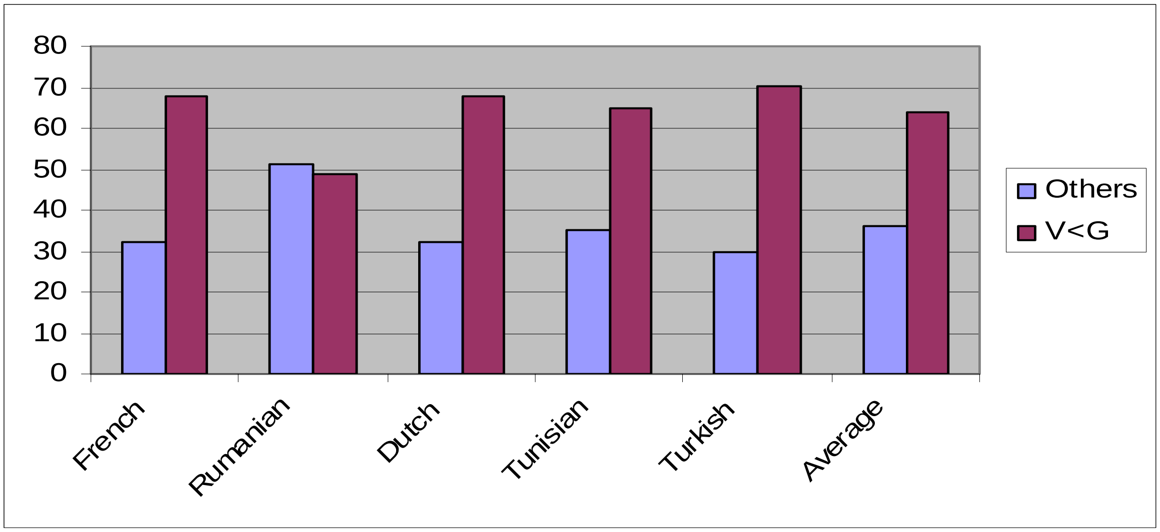


Vowel Characteristics

Overall, 46,578 vowels, including those occurring less than 5% were transcribed for all 5 languages. Number of vowels ranged from 3,974 to 14,108. For all languages, 2 or 3 vowels accounted for 50% of types. Only the low front vowel [a] occurred with a frequency of >5% in all 5 languages (See Appendix B for percentages and totals of vowels occurring >5%).

Vowels in the lower left quadrant of the vowel space were separated and compared with other vowel types (Figure 3). Overall, mid front, low front, mid central and low central vowels are the most represented categories. Combining the five languages together, the lower left quadrant category yielded 65% of all vowels. In French, the low central vowel [a] and lower-mid front vowel [œ] represented approximately 60%. In Tunisian, the two most represented vowels are [æ] and [e]. The Dutch children exhibited a high percentage of both central vowels [ə] and [a]. Finally, in Turkish, the vowels were the most diversified with one category occurring with more than 30%: the schwa and 4 other vowels with more than 5%: [ɐ], [æ], [a], [ɯ]. Note however a different trend in Romanian, due to an important use of the high central vowel [ɨ]. The Romanian children produced as many of the high central vowel [ɨ] as the low central vowel [a].

Figure 3: Percentages of vowels from the lower left quadrant versus other vowels in each language.



Group and language trends for vowels were apparent for vowel height and front-back dimensions. Figure 4 displays the distribution of vowels by front-back dimensions for each language and overall. Only two languages, French and Tunisian followed the overall trend of more front than central vowels. Back vowels are the least represented category in all 5 languages.

Figure 4: Vowel front back: percentage of occurrence for each language.

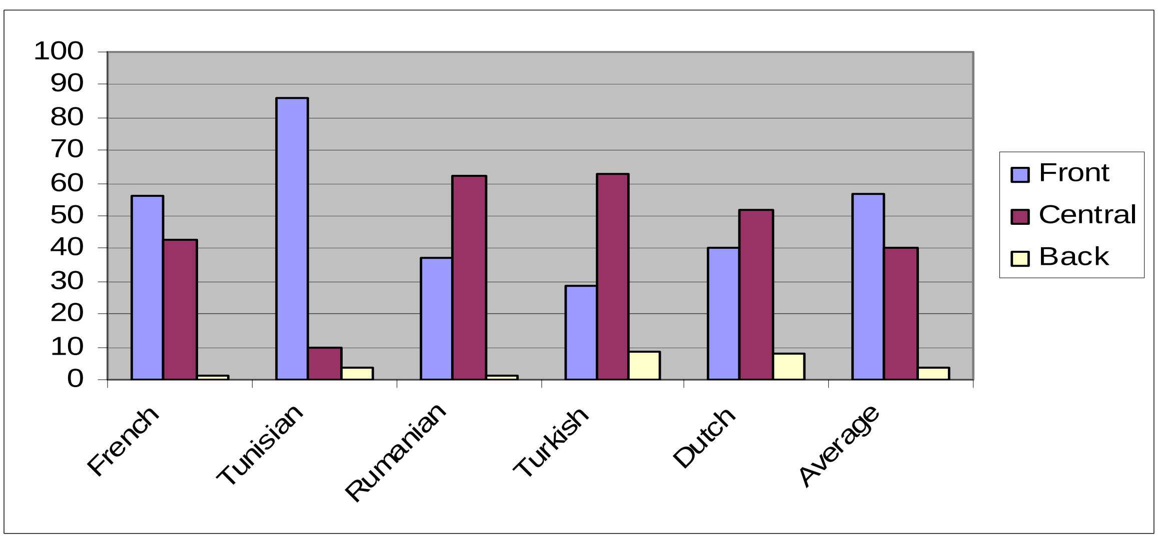
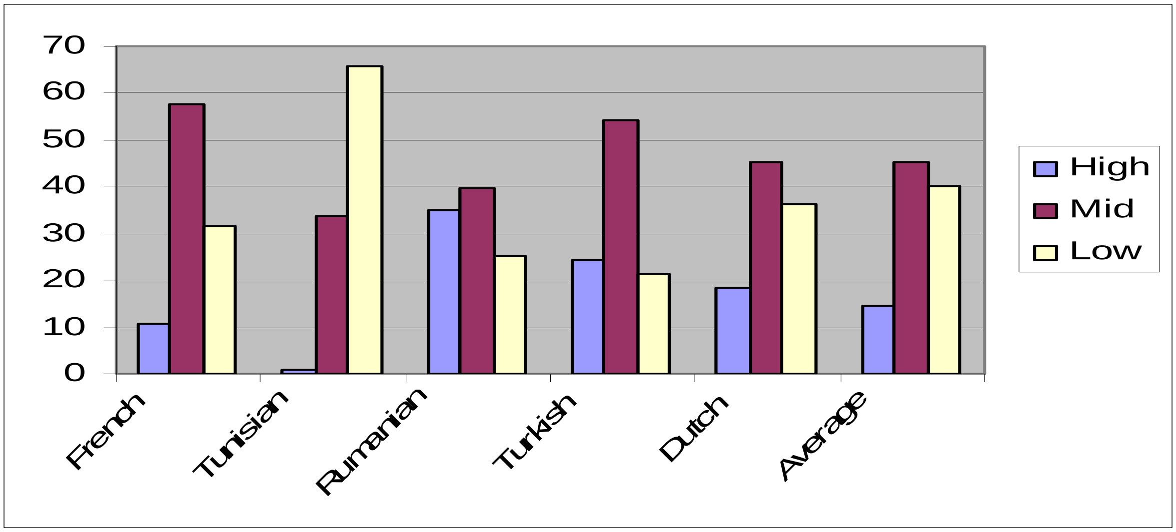


Figure 5 displays the percentage of vowels according to their height in the 5 languages. Overall, mid vowels are the highest in frequency. This trend is present in 4 of 5 languages. Only Tunisian children preferred low to mid vowels. Tunisian children produced more than 60% low vowels and the front raised low vowel [æ] represented 53% of occurrences.

Figure 5: Vowel height: percentage of occurrence for each language.



CV Co-occurrences

The predicted trends tested in this analysis were: labial consonants with central vowels, coronal consonants with front vowels, and dorsal consonants with back vowels. Concerning coronal vowel co-occurrences, all infant groups showed the preferred association between coronal consonants and front vowels. The median observed to expected ratio was 1.08. The labial consonants and central vowels association was found in 4 of 5 languages. The median preference level was 1.15. However, an association between labial consonants and back vowels was also found in 4 of 5 languages. It was stronger overall than the labial-central association. The expected association between dorsals and back vowels was found in 3 of 5 languages. The median preference level was only slightly above chance (1.01).

When considering the 13 individual infants, there was an extremely strong tendency to prefer the three predicted CV co-occurrence patterns over the non-predicted ones. While 28 of 37 of the 3 predicted instances were above chance, only 26 of 72 non-predicted cells were above chance. (5 cells had chance values and 3 cells contained no observations.) The overall distribution of above and below chance values of predicted and non-predicted cells was highly significant (Chi square, df = 1: 15.3 p > .001).

Table 5.
Ratio of Observed to Expected Occurrences of Labial, Coronal and Dorsal Consonants with Front, Central and Back Vowels. (Above-chance values are in boldface.)

Language	**Vowels**	**Consonants**		
French		**Coronal**	**Labial**	**Dorsal**
	Front	**1.08**	0.80	1.13

	Central	1.05	**1.15**	0.65
	Back	0.72	1.23	**1.28**
Tunisian	**Front**	**1.04**	0.75	**1.21**
	Central	0.86	**1.80**	0.51
	Back	0.95	**1.40**	0.42
Romanian	**Front**	**1.09**	0.98	0.79
	Central	0.98	0.86	**1.17**
	Back	0.33	**3.97**	0.19
Turkish	**Front**	**1.18**	0.86	0.69
	Central	0.95	**1.13**	0.77
	Back	0.97	0.75	**2.09**
Dutch	**Front**	**1.05**	0.55	**1.33**
	Central	0.98	**1.24**	0.61
	Back	0.84	**1.99**	1.01

Conclusions

These preliminary results provide further evidence for a universal basis for vocal patterns in babbling. Overall, children produced more stops, nasals and glides than other types of sounds; they tended to use more coronals and labials than dorsals and gutturals. Vowel production data showed a strong preference for vowels belonging in the lower left part of the vowel space, a trend reported across many studies of this period. The expected coronal-front and labial-central CV co-occurrences were found in 9 out of possible 10 instances. In contrast, only 1 instance of the opposite CV co-occurrence pattern was observed. The finding of these already observed early patterns, proposed as being based on biomechanical inertia, in a number of additional language environments, increases the likelihood that they are universal infant patterns. The strength of this finding for infants increases the likelihood that they represent simple patterns emerging from use of the vocal mechanism logical to consider as underlying vocal patterns in the first words of earliest hominid speakers.

The third pattern the dorsal-back pattern has been widely reported. It was less consistently observed (3 out of 5 instances) in this data. In studies of babbling, the frequency of dorsals occurring with back vowels has often been extremely small. Studies of dictionary items of sets of 10 languages (MacNeilage *et al*., 2000) and 14 languages (Rousset, 2004) show that the dorsal-back pattern is typically present in adult languages. As this pattern, like the coronal-front and labial-central patterns, appears to result from biomechanical inertia, it remains possible that it is a universal infant pattern, and that it was present in the first words of hominids. Future work may reveal that the dorsal-back co-occurrence preference pattern develops only after the overall frequencies of dorsal consonants with back vowels in the infant's repertoire become higher.

Some differences have also been pointed out. In Tunisian, glottal fricatives were the most frequent manner of articulation. Two places of articulation trends did not fit the universal patterns: labial was the most frequent place in French followed by coronal; guttural was the most frequent place in Tunisian. For vowels, only Romanian children prefer to produce "other" vowels as opposed to the vowels belonging in the lower left quadrant of the vowel space. Finally, 4 non-expected intra-syllabic co-occurrences patterns were found: Labial-back co-occurrences were most frequent in French, Romanian and Dutch; front vowels and dorsal co-occurrences were frequently produced by Tunisian and Dutch children.

These data seem to indicate some emergent influence from the ambient language during babbling. The Tunisian phonemic inventory includes 14 different fricative sounds, whereas all the other languages include less than 10 fricatives. The Tunisian childrens phonetic inventory could also be related to the frequent use of gutturals, as Tunisian includes 5 guttural consonants. The other languages had zero - two.

The ongoing comparison of the cohort of infants considered here at later ages and comparisons with adult values in each ambient language should provide further evidence regarding the relationship between common trends, proposed as being based on characteristics of the human production system, and unique sound and sequence patterns related to early perceptual learning of ambient language regularities.

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Appendix A.
Percentages and Totals of Consonants in Each Language (>5%)

Consonants > 5%	French	%age	Tunisian	%age	Romanian	%age	Turkish	%age	Dutch	%age
	[m]	23,44	[ɦ]	38,7	[d]	25,37	[d]	22,54	[h]	21,84
	[d]	15,69	[t]	17,55	[x]	10,22	[b]	20,33	[d]	17,12
	[t]	10,38	[j]	6,98	[n]	9,47	[j]	10,5	[l]	7,5
	[b]	10,92	[d]	6,35	[j]	8,15	[m]	9,89	[t]	6,92
	[g]	5,73			[b]	7,44	[g]	9,68		
					[g]	7,02	[h]	7,6		
					[t]	6,92				
Total		7259		7272		4804		2664		3233

Appendix B.
Percentages and Totals of Vowels in Each Language (>5%).

Segments > 5%,	French		Tunisian		Romanian		Turkish		Dutch	
	[a]	30,11	[æ]	53,67	[ɨ]	25,76	[ə]	31,12	[ə]	27,91
	[Œ]	29,25	[e]	28,73	[a]	24,07	[ɐ]	11,07	[a]	22,19
	[ɛ]	7,44	[a]	8,20	[e]	14,69	[æ]	10,51	[ɛ]	9,89
	[ɔ]	7,25			[ɛ]	12,92	[a]	10,51	[i]	9,3
	[e]	6,04			[ə]	11,56	[ɯ]	6,84	[ɑ]	7,5
							[ɨ]	5,66	[I]	7,48
							[ɛ]	5,59	[æ]	6,29
total		11129		11848		8249		3185		6005