

# THE ACQUISITION OF PLOSIVES AND IMPLOSIVES BY A FULFULDE-SPEAKING CHILD AGED<sup>1</sup> FROM 5 TO 10;29 MONTHS

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## ABSTRACT

This paper reports an analysis of the acquisition of plosives and implosives by a Fulfulde monolingual child aged from 5 months to 10 months and 29 days. Analyses revealed that before 11 months the child was making use of complex consonant-like implosives and prenasal plosives. We provided new aerodynamic analyses of adult's implosive /b/. These aerodynamic data revealed that in Fulfulde this phoneme exhibits both voiced and voiceless allophones.

**Keywords:** acquisition of plosives and implosives, Fulfulde

## 1. INTRODUCTION

Research on child phonological acquisition focuses on several aspects of the emergence of speech production in children: prosody [7], segments [2], syllables [6].

In this paper we describe and discuss, from longitudinal data, the acquisition of plosive and implosive consonants, prenasalized and nasal consonants by M, a male monolingual child exposed to Fulfulde. We focus on these types of consonants because they are produced with a complete obstruction made with the primary articulators (lips or tongue). The age of acquisition of the various plosives and implosives attested in the input language is observed. The timing of acquisition of these consonants is compared to the scale of consonants' complexity [8]. We hypothesize that elaborated consonants such as implosives and prenasalized are acquired late. Implosives acquired in babbling are compared to adult production in Fulfulde.

## 2. METHODS

### 2.1. Subjects and procedures

This paper is based on two types of data.

#### 2.1.1. Child data

M's spontaneous productions were collected during 7 months in Mali. M was recorded during

half an hour twice a month from the age of 5 months to 10 months 29 days in his family (in the village of Nokara). M was recorded interacting with his mother during "normal" daily life activities. M is growing up in a Fulfulde monolingual family and village.

#### 2.1.2. The adult data

The adult data on implosives are from I., a 28 years old male native speaker of Fulfulde from Nokara. A list of words containing implosives was recorded. Each word was recorded 3 times using an EVA2<sup>®</sup> portable workstation. This portable workstation provides simultaneously synchronized intra-oral pressure (Ps) measured in hPa and an audio waveform of speech. The audio recording sampling was at 44100KHz.

### 2.2. Recordings and transcriptions

Audiovisual recordings were made with a Tascam RD100 and a Sony Handycam. The audio signal was sampled at 44100 KHz. Multilevel speech annotations and transcriptions were made using *Praat* (version 5.1.20) with the video footages. Detailed acoustic analyses and reliability checking were done by the authors.

Although all researchers are not unanimous about the validity of using the IPA to transcribe young children's productions (e.g. [4]) in this paper, a detailed transcription of the infant's productions was done by means of the IPA symbols (the 2005 revised version). Fine phonetic details were transcribed using cues from the audio-signal wave form and sonagram (sound spectrum). One hundred and fifteen babbling sequences were analyzed.

## 3. FULFULDE: CONSONANTS' SYSTEM

Fulfulde (Niger-Congo, Atlantic) is spoken across the Sahel from Senegal in the West to Sudan in the East. The language has many dialects. This paper focuses on the dialect spoken in the Douentza area (Mali). There are 5 short /i u e o a/ and 5 long vowels /i: u: e: o: a:/, and 27 consonants in

Fulfulde. 8 oral plosives /p b t d c ʒ k g ʔ/ prenasalized /mb nd nɲ ŋg/ and 4 nasals /m n ɲ ŋ/, 3 implosives /b d f/, 3 fricatives /f s h/, 1 lateral /l/, 1 trill /r/ and the approximants /j w/. [3]

#### 4. RESULTS

##### 4.1. The acquisition of plosives and implosives

In table 1 we report the age at which the different consonant-like were acquired by M. The acquisition of each consonant-like is validated when it occurs at least in two different recording sessions. There is an interval of two weeks between two recording sessions. It is the age at the second session which is taken as the age of acquisition.

**Table 1:** Age of acquisition of the different plosive and implosive consonant-like.

Age	Consonant-like (IPA transcription)	Place	Manner
6;11	m	Bilabial	Nasal
7;22	b	Bilabial	Voiced Plosive Voiceless Plosive
	d	Alveodental	
	t	Velar	
	k		
8;06	p	Bilabial	Voiceless Plosive Voiced Plosive
	g	Velar	
	ŋ	Glottal	
	ʔ		
8;20	mb	Bilabial	Prenasalized Plosive
9;04	j	Palatal	Voiced Plosive
10;15	ŋg	Velar	Prenasalized Plosive
10;29	ɓ	Bilabial	Voiced Implosive
	ɗ	Alveodental	

In line with previous studies on children phonological acquisition, we found that the first consonant-like to be acquired were predominantly plosives. The first to be acquired were [b d t k]. However, we noted that the first consonant gesture to be acquired in M's reduplicated babbling sequences before 7 months was mainly the bilabial nasal [m]. At the beginning of his 8<sup>th</sup> month, M had the following oral plosive consonant-like:

p	t	k	ʔ
b	d	g	

The two other oral consonant-like plosive missing in M's productions were the palatals [j] and [c]. The former was acquired at 9;04 but the latter was not acquired before 11 months. M started adding new complex consonant-like from the end of the 8<sup>th</sup> month to the end of the 10<sup>th</sup> month. Within this timeframe the prenasalized [mb]

were acquired at 8;20 months, [ŋg] at 10;15 months and the implosives [ɓ] and [ɗ] at 10;29 months.

From 8 months to the end of the 10<sup>th</sup> month, there remained very few reduplicated babbling.

The path of acquisition followed by M is first, plosives (simple) followed by the prenasalized and finally the implosives which are considered to be elaborated sounds.

##### 4.2. The distribution of plosives and implosives

Concerning these consonant-like gestures' distribution within babbling sequences produced by M, we didn't find any preference patterns in the distribution of plosive *vs* implosive productions. However, 5 patterns were observed as listed below:

1. Consonant-like appearing in M's babbling at the onset, middle and final positions of utterance. [ʔ] [p] and [m] appeared in all positions: onset of utterance (e.g. [ʔa:ʌ:hɔ̃:aʒ:h] (9;04), [paʊə] (10;15), [mamamə] (6;11)), in the middle of utterance (e.g. [h̥ʊʊəʒʔɛʌjɛʌh] (9;04), [pæ mbapəpəh] (10;29), [mmɛmmɛæ:] (6;11)) and utterance final position (e.g. [hjeʒaʔ] (10;29) [əəp<sup>h</sup>] (8;20), [z:məfiəm] (6;25)).
2. Consonant-like appearing only in utterance onset position: [d] and [ŋg] appeared only at the onset of utterances (e.g. [de] (7;22), and [ŋgæ] (10;15)).
3. Consonant-like which didn't appear in utterance middle position: [k] and [ŋ] appeared at utterance onset (e.g. [kəʔɪʔ] (7;22) [ŋʔgəh] (8;06)). Unlike [k], [ŋ] appeared in final position (e.g. [ptaɓɓwæ ɓabaŋ] (10;29)).
4. Consonant-like which didn't appear in utterance final position: [ɗ ɓ j t b] and [mb] appeared both as onset of utterances (e.g. [dáh] (10;29), [ɓah] (10;29), [jaɦa] (9;04), [tɛ] (7;22), [bɜ:] (8;06), [mbɛmɓɛ] (8;20)); in the middle of utterances (e.g. [paɗæ] (10;29), [ptaɓɓwæ ɓabaŋ] (10;29), [hjeʒaʔ] (10;29), [tæ:nífi] (8;06) [ʔəbœʊvœvəh] (8;20), [ɛlampəwampwambamʔ] (10;29) but there are no instances in which these consonant-like appeared in utterance final position.
5. Consonant-like which didn't appear in utterance onset: [g] appeared in utterance middle position (e.g. [ɛjæʒaʔagægægwaɛh] (8;20)), in final position (e.g. [baŋ] (10;29)) but not in utterance onset.

In M's productions, implosives like most of the plosives appeared at the onset and middle positions within babbling sequences.

**4.3. Aerodynamic analysis of the adult's bilabial implosive [ɓ]**

We decided to do aerodynamic analysis of the adult's bilabial implosive /ɓ/ for two reasons: First we found voiced and voiceless bilabial implosives in M's productions (e.g. [pɯɛɓɤh] and [tɛɓɤ] observed at 10;29) and second there is no detailed phonetic study of the implosives in M's Fulfulde variety (The Hayrankoore). We noted [1] did a phonetic analysis of the implosive /d/ in a Fulfulde variety spoken in Liptako (Burkina Faso) which is geographically close to M's variety.

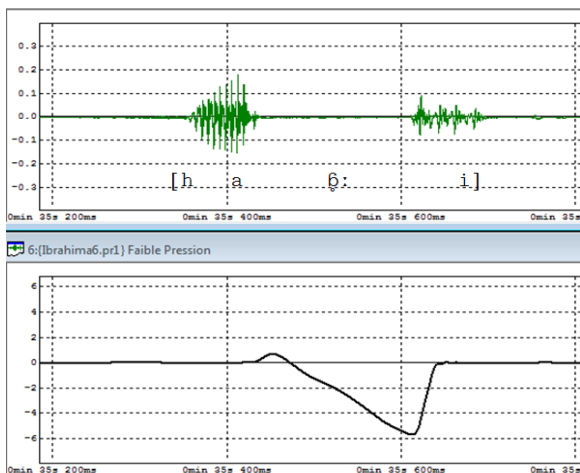
We compared a word in which there is a voiceless geminate bilabial implosive [haɓɓi] 'has tied' with a word in which there is a geminate bilabial plosive [lobbo] 'a beautiful person' and a third word in which there is a voiced bilabial implosive [laɓi] 'knife'. Let's note that geminate bilabial implosives contrast with non-geminate bilabial implosives.

Figure 1 shows that there is no voicing during the voiceless geminated implosive [ɓ:]. Ps is negative during most of the consonant, suggesting a lowering of the larynx with a closed glottis.

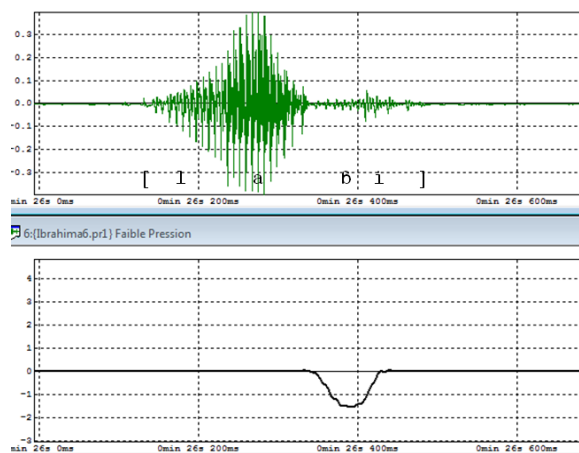
Figure 2, shows that the voicing increases gradually during the voiced bilabial implosive [ɓ]. Ps is negative during most of the consonant, suggesting a lowering of the larynx.

Figure 3, shows that the voicing's amplitude diminishes slowly at the end of the voiced geminated bilabial consonant [b:]. Ps is positive and quite stable during most of the consonant.

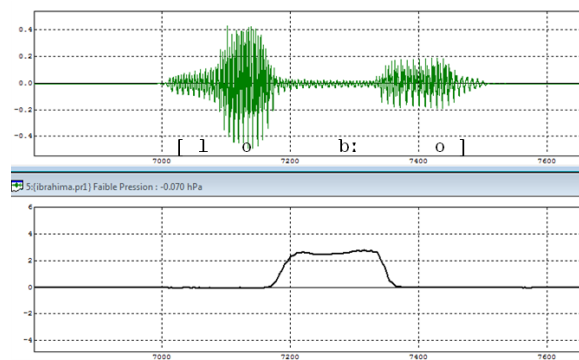
**Figure 1:** Audio waveform and intraoral pressure, Ps, (measured in hPa) for the word [haɓɓi] 'has tied'.



**Figure 2:** Audio waveform and intraoral pressure, Ps, (measured in hPa) for the word [laɓi] 'knife'.



**Figure 3:** Audio waveform and intraoral pressure, Ps, (measured in hPa) for the word [lob:o] 'a beautiful person'.



In our data on the adult's bilabial implosive /ɓ/, we found that this consonant can be voiceless in intervocalic position such as showed in Figure 1. We also found that in intervocalic positions the bilabial implosive consonant-like in M's productions can be voiced and voiceless.

**5. DISCUSSION**

Out of 13 plosives, 11 are attested (acquired) in M's productions at the age of 10;29. Two prenasalized are missing: [nd] and [ɲ]. Out of the 3 implosives attested in Fulfulde, 2 are already in M's productions [ɓ] and [ɗ], while the palatal implosive /ɟ/ is lacking in his productions. Moreover, we observed that among palatals the four categories of consonants (plosives, implosives, nasals and prenasalized) are acquired late. This confirmed the findings in [11] on the phonological systems' tendencies in world languages and on the acquisition of consonants' systems by young children. However, the alveodental [n] was not observed in M's babbling till the end of the 10<sup>th</sup> month.

[8] makes the hypothesis that consonant systems in the world's languages are organized according to a scale of complexity divided in three parts: basic, elaborated and complex. Elaborated articulations are those which are different from basic or simple manner of production in their initiation, phonation or articulation. These articulations include segment types such as ejectives, implosives, breathy or laryngalized vowels, prenasalized consonants and segments produced with secondary articulations (palatalized, labialized, velarized). A complex articulation is defined as an articulation combining two elaborated articulations (e.g. palatalized and aspirated, nasalized and glottalized...).

Following these statements, Fulfulde phonological system falls within the category of elaborated phonological systems as implosives and prenasalized are attested. We hypothesized that implosives and prenasalized which are elaborated consonants will be acquired late by the child. This hypothesis is based on Jakobson's predictions that the phonological oppositions which are rare in the world languages would be acquired the latest. In addition, [9] and [5] report that implosives are attested only in 10% of the world's languages. In M's babbling at 10;29 implosives account for more than 37% of the whole complete closures that he produced. Concerning the distribution from 7;22 to 10;29 there was no preference pattern in the distribution of plosives and implosives in the data.

Our findings partially confirm the hypothesis. Concerning the age of acquisition, plosives emerged before implosives in M's productions. The first prenasalized to be acquired was the bilabial [mb] at the age of 8;20; the velar prenasal [ŋg] and the two implosives [b̥] and [d̥] were acquired within the same month (10;15 for the prenasal and 10;29 for the implosives). We note that the bilabial implosive is more frequent than the alveodental one. According to [8] implosives are elaborated consonants. However, we didn't observe in M's babbling sequences from 5 months to about 11 any fricative sequence apart from [ʔvva vve] and [ssæ hæ]. In [8] simple fricatives are considered as basic segments i.e. without elaborated or complex articulations.

In this case study, complexity per se does not seem to be a good candidate to explain the early emergence of implosives and prenasalized in M's productions. [2] claims there is an early influence of the ambient language on the age of acquisition. [10] proposes that the part relative to articulatory

complexity, functional load and frequency in input are function to languages and stages in the path of language acquisition.

There is a need for further investigations on the concept of articulatory complexity and ambient language effect on the acquisition of complex sounds in Fulfulde (prenasalized and implosives). The same is true for other consonants of the language. Data from 2 other Fulfulde monolingual children (aged from 6 to 14 months) are available and analyses are underway.

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<sup>1</sup>Age marking convention is as follows: 10;29 for 10 months and 29 days.