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Numerals in Juruna

ABSTRACT: We present a reanalysis of Juruna numerals and present new data related to previous work (Fargetti 2007), which is compared to data from previous written records of the language. We briefly discuss current knowledge of the numeral systems of Brazilian indigenous languages, the factors that have led to their great differentiation, and the known possibilities for expansion.
KEYWORDS: Numeral systems; Juruna; Brazilian indigenous languages.

RESUMO: Apresentamos uma reanálise dos numerais da língua juruna, trazendo dados novos em relação ao trabalho anterior (Fargetti 2007), também comparados a dados de registros escritos anteriores da língua. Discutimos brevemente o conhecimento atual sobre sistemas numéricos de línguas indígenas brasileiras, os fatores que levariam a sua grande diferenciação, e as possibilidades conhecidas de expansões.
PALAVRAS-CHAVE: Sistemas numéricos; Juruna; Línguas indígenas brasileiras.

1. Introduction[3]

Numeral systems can have wide variation in languages, according to their base in mathematical terms and according to their realization in linguistic terms. Thus systems can be found with one single word as a typical numeral, and others with numerals exceeding the trillions. Numerals can be typical adverbs, or can function as prefixes or quantifier suffixes. This variety does not lead us to think of primitive systems versus evolved systems, but of systems of greater or lesser development according to the needs of each culture. For example, a people of India might need words for very large numerals to account for a remote time period, and an Amazonian people might have only the distinction 'one versus many' in their lexicon of numerals (although they are able to quantify in different ways).

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What leads to this great variation? Can a numeral system be reduced or expanded? In examining these issues we focus on the numerals of the Juruna language of the Juruna family, Tupi stock, spoken by the Juruna people (who refer to themselves as Yudjá). The Juruna currently live in the Xingu Indigenous Park, Mato Grosso State, Brazil, and have a population of approximately four-hundred.

2. Brazilian numeral systems – a comparison

Green (1997) studies indigenous numeral terms in Brazil, demonstrating the existence of systems based on one (as in Kampa, Kulina, Tenharim, Nadëb, Sanuma, Pirahã[4]), two (as in Xavante, Arara, Bororo, Kayapó, among others), three (as in Atroari), five (as in Munduruku), and ten (as in Pa'ikwené), as well as, apparently, systems where twenty predominates (as in Karajá, Kadiwéu, Makushi, Tikuna, Paresi, and others). She presents a linguistic description of numerical terms in forty-seven indigenous languages of Brazil. Her analysis is therefore not exhaustive, but explains the main differences between the numeral system bases: one, two, three, five, ten, and twenty.

Green (op. cit.) states that mathematical systems of base one or two indicate relational and global thinking, while the others indicate analytical and synthetic reasoning. Regardless, each system is logical in itself and meets the needs of the people who developed it and use it. Green also shows that numeral terms vary widely, depending in particular on the element to which they relate. As an example she cites the Canela language, where there are no specific numerical terms, but only general terms like "only" "a couple", "some", and "many". In contrast, she refers to the Kadiwéu language as having terms for numerals from 1 to 99. In addition, the language has ten forms for number 1, which agree with the substantive in gender and indicate the substantive's position, whether referential or directional (vertical, horizontal, sitting, leaving, or arriving). In the Palikur (or Pa'ikwené) language studied by Green,[5] the number system is very elaborate and complex, as also pointed out by Passes (2006).

We consider it important to stress two points from Green (1997). First, she talks about the general trend of using numerical terms borrowed from Portuguese for the numbers from 5 on, the Portuguese terms being more concise, accurate, and fixed. Another interesting point is that even if a language can express large quantities such as fifty or a hundred or more, there is a tendency to use a term expressing "many" for any number above 5 or 10. This is related to the material culture of the speakers, who do not need to use accurate terms for large quantities.

[4] Everett (2005), however, states that the Pirahã language has neither numerals nor the grammatical category of number, and concludes that the culture has no quantification mechanisms.

[5] According to Green, data on numerals in other languages were collected in personal conversations with researchers familiar with the languages in question.

Green points out that numerals may exercise the functions of adjectives, adverbs, nouns, and/or verbs in these languages. She also notes that all ways of counting and calculating are logical, and that no number system is 'better' or 'worse' than another – just different. Her study presents various numeral systems that are based on different types of reasoning, but it discusses only forty-seven Brazilian indigenous languages, thus lacking data from about one hundred and thirty languages that are still spoken. Therefore, despite attempting a large scope, Green's study is not an exhaustive one. Furthermore, questions remain about the systems presented, as seen in the controversy over the Pirahã. It may also be questioned whether the author's systems approach, which settles on single bases for particular numerical systems, is appropriate, as the systems can vary for a given numeral.[6] There are other studies of numerals in indigenous languages, of course, such as that of Medeiros and Miranda (2009) on the Krenak system, but there is obviously a lack of broadly based studies in Brazil. This problem is observed more generally in previous typological studies such as that of Hurford (2010), who presents a generative treatment of numeral systems, noting that: "We concentrate here on the more plausibly universal properties of numeral systems and ignore idiosyncratic, language-specific features" (op. cit., p. 247). His analysis has a syntactic-semantic basis and ignores different systems, an approach which presents problems for a typology. However, recent efforts have been made to document and understand the different systems found in languages across the world, such as the research of Eugene Chan (http://lingweb.eva.mpg.de/numeral/), performed under the supervision of Bernard Comrie.

According to Everett (2005), linguistic determinism is not (as Whorf would have it) responsible for the occurrence of different types of number systems. Everett states that the Pirahã, a Brazilian indigenous language of the Mura family, does not have numerals or the grammatical category of number. In the absence of these, quantification, like other aspect of the language, is determined by cultural values to refer only to the constraints of immediate experience (Everett refers to this as the "Immediacy of Experience Principle"). Thus, it is the culture of a people that is responsible for shaping their grammar and cognition, and not vice versa. In later work with other authors (Frank et al. 2008), Everett analyzes data from experiments on quantities with fourteen Pirahã, and the results obtained refute Whorf's hypothesis that language determines thought. These authors prove that the Pirahã have no words for numerals (only "little", "little more", and "very"), and yet the speakers of the language can quantify and understand processes of adding or subtracting elements. Surely Pirahã presents an extreme example of restrictions. But it may be assumed that if the Pirahã people (whose culture is living and subject to change) feel the need, they can develop a numeral system, regardless of whether or not it is similar to other systems.

[6] Lean (1992), in his monumental study of five hundred and fifty numerical language systems of Papua New Guinea, when faced with this question, classified the system settings, possible bases, and cycles/standards (adopting the proposal of Salzmann (1950, cited in Lean 1990)). Thus, a cycle system (2.5, 20) could have numerals 1, 2, 3, 4, 5, 5 + 1 + 5 2, 5 3 ... + (2x5), (2x5) +1 (2x5) +2 ... 20, 20 + 1, 20 + 2, ... (20x2) ....; other systems could be (5, 10, 20), (5, 20), (4, 20) ... In this context, how would the Brazilian indigenous languages systems be classified? What would their cycles/standards be?

3. Juruna numerals

According to the classification of Rodrigues (1986), the Juruna language belongs to the Tupi stock and the Juruna family, along with Xipaya (with only one fluent speaker) and Manitsauá (now extinct). Juruna was considered endangered due to the drastic reduction of its population in the 1960s, when the group had less than fifty people. We can't rule out its loss today, although its total extinction is not to be expected; the Juruna population is currently around four-hundred people, all of whom speak the language, and the language has already been the subject of documentation and study. Initial studies were performed by Fargetti (2007, 1992), who continues to research the language and is currently working on a bilingual dictionary project with the participation of other researchers. A survey of linguistic studies on Juruna can be found in Fargetti (2010).

According to Fargetti (2007), the Juruna language[7] has words and expressions for numbers up to twenty, and for larger quantities uses the word *itxïbï* [i'tʃɨ̈bɨ́] ("many"). In everyday life, however, people use words from Portuguese to denote numbers higher than 5, for the purposes of making accounts and mentioning the time. We now present the description of the Juruna numerical system as presented in this first study, though later in this paper we discuss new information which brings into question some of these earlier results.

The numbers up 20 in Juruna (Fargetti 2007), when counting, are referred to by pointing to the fingers and toes in the following order: the first finger used in the count is the little finger of the right hand ("one"), then the ring finger, the middle finger, the forefinger, and the thumb.[8] Next is the left hand thumb ("six"), the forefinger, the middle finger, the ring finger, and the little finger. The same order is followed, in continuation, with the feet ("eleven" is the little toe of the right foot, and "sixteen" is the left toe).

The usual order in the noun phrase is numeral–noun, but the order noun–numeral is also possible. A pronoun may be inserted between the two elements, which proves that they are independent forms. The numerals behave as adjuncts and may therefore be removed from the sentence without causing syntactic change. Because of this behavior, they are considered adverbs.[9]

(1)	[u'na	tʃa'bíú	wara'ʃĩ	wɜ̃]
	una	*txabïu*	*waraxi*	*wã*
	1SG	three	watermelon	to buy
	'I bought three watermelons'			

[7] Juruna is a tonal language, with a high tone and a low tone. In the phonetic transcriptions we indicate high tones with a diacritical acute accent, but do not mark low tones. The orthographic notation of the data does not mark tones. Intensity stress is not contrastive and occurs in accordance with alternating tones, according to the following algorithm: the first syllable is stressed with a high tone, from left to right. If all tones are equal, the stress is on the last syllable. Not being contrastive, intensity stress is not marked in the orthography, but only in the phonetic transcription. (cf. Fargetti 2007).

[8] In several studies, however, it is said that for languages with such systems the count starts with the left hand fingers.

[9] See examples 1 to 4 in Fargetti (2007: 125), with phonetic transcriptions added after orthographic ones.

(2) [tʃa'bɨú na wara'ʃĩ wɜ̃]
txabïu *na* *waraxi* *wã*
three 1SG watermelon to buy
'I bought three watermelons'

(3) [dua'dʒúsɪ a'líi i'ju]
duadjuse *alii* *iyu*
four children to sleep
'The four children slept'

(4) [a'lí́i dua'dʒúsɪ i'ju]
alii *duadjuse* *iyu*
children four to sleep
'The four children slept'

In the data on numerals obtained by Fargetti,[10] we observe two types of system for the number 5: type I – compounds indicating how many fingers are carried from the right to the left hand or foot, and type II – compounds indicating the names of the fingers, without indicating whether they refer to the left hand or left foot. Variation is possible, because the data were obtained from three informants (a teenager and two adult males). Informants could not explain the differences, nor give contexts for their occurrence, saying that the two systems are acceptable. We present the numerals, with the segmentation of expressions, in glosses (as in Fargetti 2007: 125-131) and in orthographic writing, preceded by phonetic transcription:

1 [me'mé]
meme
'alone'
'one'

[me'méhinaku]
meme-hinaku
alone-ADV
'one'

2 ['jáuda]
yauda
'two'

3 [tʃa'bɨú]
txabïu
'three'

4 [duwa'dʒúsɪ]
duwadjuse
'four'

[10] The collection of data by Fargetti is similar in part to that done by Jackeline Rodrigues Mendes, who was the ISA advisor for the teaching of mathematics. Fargetti added to, enlarged, segmented, and translated the data, collecting data orally with informants in 2000.

5 [se'wá] [11]
se-wa
1PL-finger/hand
'five (our-inclusive hand)'

[se'wá ara'híhɨ́]
se-wa ara-hïhï
1PL-finger round-big[12]
'finger (our-inclusive big and rounded finger (thumb))'

6	[se'wá	pauna	'bé	me'méhinaku	'kára]
	se-wa	*pauna*	*be*	*memehinaku*	*kara*
	1PL-hand	side	DAT	one	to pass

'one (finger) passes to our hand of the other side'

[se'wá	ara'híhɨ		pau'na]
se-wa	*a-rahïhï*		*pauna*
1PL-finger	rounded-big		side

'our thumb of the other side'

7 [se'wá	pauna	'bé	'jáuda	'kára]
se-wa	*pauna*	*be*	*yauda*	*kara*
1PL-hand	side	DAT	two	to pass

'two (fingers) pass to our hand of the other side'

[se'wá	ara'híhɨ		detʃĩã́]
se-wa	*a-rahïhï*		*detxiã*
1PL-finger	rounded-big		near

'near the thumb (index finger)'

8 [se'wá	pauna	'bé	tʃa'bíú	'kára]
se-wa	*pauna*	*be*	*txabïu*	*kara*
1PL-hand	side	DAT	three	to pass

'three (fingers) pass to the hand of the other side'

[se'wá	ʃï'pá]
se-wa	*xipa*
1PL-finger	middle

'our middle finger'

9	[se'wá	pauna	'bé	duwa'dʒúsɪ	'kára]
	se-wa	*pauna*	*be*	*duwadjuse*	*kara*
	1PL-hand	side	DAT	four	to pass

'four (fingers) pass to the hand of the other side'

[11] All constructions with body parts have a citation form with the person marker of first person plural and inclusive (which includes the interlocutor). Thus the marker means "our, of all us, including you".

[12] **-*wa*** means both "finger" and "hand". The distinctiveness is given by context.

[se'wá 'ʃĩʃĩ detʃĩ'ã́]
se-wa *xĩxĩ* *detxiã*
1PL-finger small near
'near our small finger (ring finger)'

10 [se'wá 'né]
se-wa *ne*
1PL-hand equal
'equal to our hand'

[se'wá 'ʃĩʃĩ]
se-wa *xĩxĩà*
1PL-finger small
'our small finger (little finger)'

11 [sebida'há 'bé me'méhinaku 'kára]
se-bïdaha *be* *memehinaku* *kara*
1PL-foot DAT one to pass
'one (toe) passes to our foot'

[semaɾa'ʃã́ 'ʃĩʃĩ]
se-maraxã *xĩxĩ*
1PL-toe small
'our little toe'

12 [sebida'há 'bé 'jáuda 'kára]
se-bïdaha *be* *yauda* *kara*
1PL-foot DAT two to pass
'two (toes) pass to our foot'

[semaɾa'ʃã 'ʃĩàʃĩ detʃĩ'ã́]
se-maraxã *xĩxĩ* *detxiã*
1PL-toe small near
'near our little toe (ring toe)'

13 [sebida'há 'bé tʃa'béíú káɾa]
se-bïdaha *be* *txabï* *kara*
1PL-foot DAT three to pass
'three (toe) pass to our foot'

[semaɾa'ʃã́ ʃĩ'pá]
se-maraxã *xipa*
1PL-toe middle
'our middle toe'

14 [sebida'há 'bé duwa'dʒúsɪ 'káɾa]
se-bïdaha *be* *duwadjuse* *kara*
1PL-foot DAT four to pass
'four (fingers) pass to our foot'

[semaɾa'ʃã́ ʃĩ'pá deʧĩ'ã́]
se-maraxã *xipa* *detxiã*
1PL-toe middle near
'near our middle toe (ring toe)'

15 [sebɨda'há 'bé se'wá 'né 'káɾa]
se-bïdaha *be* *se-wa* *ne* *kara*
1PL-foot DAT 1PL-hand equal to pass
'one hand passes to our foot'

[sebɨda'há 'né]
se-bïdaha *ne*
1PL-foot equal
'equal to our foot'

16 [sebɨda'há 'bé se'wá pauna 'né 'káɾa]
se-bïdaha *be* *se-wa* *pauna* *ne* *kara*
1PL-foot DAT 1PL-finger side equal to pass
'(one) our finger passes to our foot'

[sebɨda'há pauna 'bé me'méhinaku 'káɾa]
se-bïdaha *pauna* *be* *memehinaku* *kara*
1PL-foot side DAT one to pass
'one (finger) passes to our foot of the other side'

[sebɨda'há pauna 'né 'káɾa]
se-bïdaha *pauna* *ne* *kara*
1PL-foot side equal to pass
'pass to the foot of the other side'

17 [sebɨda'há 'bé se'wá pauna 'né 'jáuda 'káɾa]
se-bïdaha *be* *se-wa* *pauna* *ne* *yauda* *kara*
1PL-foot DAT 1PL-hand side equal two to pass
'two fingers of the other side pass to our foot'

[sebɨda'há pauna 'bé jáuda 'káɾa]
se-bïdaha *pauna* *be* *yauda* *kara*
1PL-foot side DAT two to pass
'two (fingers) pass to the foot of the other side'

[semaɾa'ʃã́ aɾa'híhɨ́ deʧĩ'ã́]
se-maraxã *a-rahïhï* *detxiã*
1PL-toe rounded-big near
'near our big toe (long toe)'

18 [sebɨda'há 'bé se'wá pauna 'né tʃa'bɨ́ú 'káɾa]
se-bïdaha *be* *se-wa* *pauna* *ne* *txabïu* *kara*
1PL-foot DAT 1p-finger side equal three to pass
'three fingers of the other side pass to our foot'

[sebɨda'há pauna 'bé tʃa'bɨú 'kára]
se-bïdaha pauna be txabïu kara
1PL-foot side DAT three to pass
'three (fingers) pass to our foot of the other side'

[semaɾa'ʃã́ ʃĩ'pá]
se-maraxã xipa
1PL-toe middle
'our middle toe'

19 [sebɨda'há 'bé se'wá pauna 'né duwa'dʒúsɪ kára]
se-bïdaha be se-wa pauna ne duwadjuse kara
1PL-foot DAT 1PL-finger side equal four to pass
'four fingers pass from the other side to our foot'

[sebɨda'há pauna 'bé duwa'dʒúsɪ 'kára]
se-bïdaha pauna be duwadjuse kara
1PL-foot side DAT four to pass
'four (fingers) pass to our foot of the other side'

[semaɾa'ʃã́ 'ʃĩʃĩ detʃĩ'ã́]
se-maraxã xĩxĩ detxiã
1PL-toe small near
'near our little toe (ring toe)'

20 [sebɨda'há dʒu se'wá 'másehu]
se-bïdaha dju se-wa masehu
1PL-foot with 1PL-finger to finish
'with our feet, our fingers finish'

[sebɨda'há se'wá ɻã'húéɲã'hã́ ne]
se-bïdaha se-wa lãhue-yãhã ne
1PL-foot 1PL-finger to join-NMLZ equal
'equal to what joins ours hands and feet'

[sebɨda'há a'húmé]
se-bïdaha ahume
1PL-foot to join
'our feet joined'

In the above data, the occurrence of numerals 1 to 5 corresponds almost exactly to data collected by Louro (1979) at the end of the 1970s (see below). This author, however, has 5 as *seuapaũnane*, which must mean "hand/finger equal the other side" and which seems to indicate a misunderstanding. But unlike the data found in Louro and the other authors mentioned below, the Juruna of Xingu, in 2000, also had numerals 6 to 20. The pattern of using name of finger/toe was presented for number 5, which suggests that this numeral has a recent use and is in variation. This is also true of the numerals from 6 to 20.

Data from the numeral 6 onwards present type I compounds, which indicate the number of fingers that carry to the left hand or foot, and type II compounds, which indicate the names of the fingers. Thus for 6 we have type I: "pass a finger (our hand) to the other side", and type II: "our thumb on the other side". The same variation occurs up to the numeral 10. For 11, reference is made to the feet or to the name of each finger or toe, noting that for "finger" we have a formal correspondence with "hand" (*sewa*), but for "toe" (*semaraxã*) the form is different than for "foot" (*sebïdaha*).

With regard to 16, the name of the corresponding toe (big toe) does not occur, but rather the expression "passes to the foot of the other side". In the case of 20, there also was no finger name for the corresponding foot, but rather the expression "our feet joined". However, 17, 18, and 19 are the names of the fingers.

It can be noted that for the fingers serving as the reference system in which the numbers are used, the names are as follows: little finger (*se-wa xĩxĩ*), and thumb (*se-wa a-rahïhi*). Other names are composed from them: ring finger = "near the little finger" (*se-wa xĩxĩ detxiã*), index finger = "next to the thumb" (*se-wa arahïhĩ detxiã*). The same process occurs with the toes. Note that only the numeral 14 is presented as composed of the middle finger: *se-maraxã xipa detxiã* ("next to our middle toe"); this appears to be an exception. It could be hypothesized that it was thus designated so as not to be confused with 17, but this hypothesis falls apart when we note that 12 and 19 have the same form in the finger name system: *se-maraxã xĩxĩ detxiã* ("next to our little finger"). This point therefore requires further investigation.

At the time of this study we had information that this system, with its variations, was in use by the Juruna and was regarded as traditional. However, diachronic study and work with other speakers of the language brought forth other data and questions, as seen in the next sections.

4. Juruna numerals in past records

There are written records of Juruna numerals made by travelers, ethnologists, frontiersmen, and linguists, although none of these individuals made a scientific study of the language. Their data make use diverse forms of notation, often adapted to the writing systems of their native languages. The records under consideration are just word lists, coming mostly from brief contact with the language and the people. Two of these records were made in the late nineteenth century; one was made in the early twentieth century, and the other three in the 1960s and 1970s. In all of them, with one exception, words are found that refer only up to the number 5, which shows that in earlier times the Juruna did not deal with larger numbers.

Steinen (1942: 417) obtained his data in 1894, and they differ from those gathered two years later by Coudreau (1977). Steinen does not mention who his informants were, and his list of numerical words is quite small: 1 – *duáyo* ; 2 – *naná* ; 3 – *naná(m)ba* ; 4 – *duayózo* ; 5 – "*uma vez uaũ (?), outra vez ts'uvó* (?)".[13] The datum for 1 is not found in any other author, past or contemporary, and so may be a misconception, a misunderstanding, or a dialectal

[13] The notation adopted by the authors is maintained here, including the two question marks.

variation. Compared to 4 (see below), Steinem's 1 could be a spelling of [duwa'dʒú], which literally would be "along with his own finger" (du-wa-dju – "reflective – finger - along with"). This would conform with the somatic principle in the formation of numerals. What is observed today as 2 means "other", and this form was also found in the early twentieth century by Nimuendaju. As for Steinem's 3 (found only by this author), we can think of it as a translation of "yet another" or "other more". Regarding his word for 4, we may imagine that it is something close to what we have today, [duwa'dʒúsɪ], which actually refers to the numeral 4, and we may think of its translation as "along with his own fingers". As for 5, the form *uatũ* could be the spelling of [u'wá] "my hand/my finger". Today the form for this numeral is *sewa* (literally, "our hand / our finger"). It is therefore probable that somatic reference numerals were observed in these data. However, the word *ts'uvó* spells out sounds that do not exist in the language's phonetic/phonological system, and could hardly have existed: ts', v, ó. In this case there could have been a misunderstanding, or perhaps the data could have been provided by someone other than a native speaker. It therefore seems that the numeral 5 was not yet fully in use.

Two years later, in 1896, Coudreau (1977: 145) presents a slightly longer list of words and sentences in the language. Like Steinen, he does not mention his informants, leading us to think that his data were collected in a non-systematic way, probably with the participation of several people. He presents only the following numbers: 1 – *mimén*; 2 – *quinanom*; 3 – *tiubu* . This author does not mention the numerals 4 and 5. Probably his informants did not use them, or he would have found them. His data is totally different from that of Steinen, which may correspond to a different variety of the language. Note that the numeral 1 should be a notation of what is now [me'mé:], with the translation "alone". For 2 is found the form [kɨ'nánú], now heard among the elderly, and we think it may have come from [kɨ na'ná anu] , literally "this is another" ("this - other - verbal aspect"). The form for 3 corresponds to what is now [ttʃa'bɪ́ú], whose origin is unknown.

A little later, in 1916 and 1917, Nimuendaju (1932: 586) presented a slightly larger vocabulary of Juruna. He was careful to point out the source of his data, marking with an asterisk the data provided by an Arara Indian who had grown up with the Juruna and spoke Portuguese with difficulty, and who preferred to express himself in Juruna. The numerals presented by the author were obtained either with this Arara Indian (examples marked with an asterisk) or from Juruna informants (no asterisk): 1 – *mį- mį , mę-iná * , me-me *;* 2 – *na-na , kįnanu * , kįnanú **; 3 – *doa dyu amačiwã, čabįhá *,. čabį **; 4 – *doa dyu **; 5 – *iwã *,* 6 – *dyu-se doa de **. Observing Nimuendaju's data for 1, there is vowel marking difference between the first and the last examples. For 2, he shows the two forms encountered by previous authors and analyzed above. For 3, together with the form found by Coudreau (last example), he presents a variation (second example). The first example of 3 may be thought of as [duwa'dʒúse detʃɪ'ã̂], "near his own fingers", i.e. "close to 4". The numeral 4 is also presented in reduced form, probably due to the pronunciation of the informant, and it must correspond to [duwa'dʒúsɪ]. The numeral 5 is presented as "his hand", differing from that found by Steinen, "my hand". The numeral 6 clearly appears to be a mistake, since it appears as the inverted form of 4, which makes no sense.

Nimuendaju's (1932) data from the Arara Indian called Pedro were obtained in 1917 in Santa Julia Iriri, Pará,[14] where the Juruna were located before their most recent migration. Other data were obtained in 1916 in Porto Alegre, the village of chief Mamá, located in the middle Xingu region below Pedra Seca and having at the time a population of 50. This different geographic location indicates the possibility of dialectal variation. It may be observed that in comparing Nimuendaju's data to that of Steinen, there are similarities in the case of 2 (*naná*), no resemblance in the case of 3, similarity in the case of 4, and an indication that the numeral 5 probably began to be used around the time when Nimuendaju was doing his research.

Regarding Coudreau (1977), the three numerals he presents are similar to those used by the Juruna today. It is possible that he had contact with a community that had only three numerals that time, or that for some reason did not tell him the expression for the numeral 4.

The data presented by Claudio Villas Boas (1989: 175) must have been obtained in the 1960s or 1970s with a Juruna residing in the Xingu Indigenous Park, which is where the Juruna now live. Unlike other authors, who had short contact with the Juruna, the Villas Boas brothers lived with them for several years, although it must pointed out that they were not linguists. Claudio Villas Boas did not indicate who his informants were for the small numerical vocabulary he recorded: 1 – *mêmê*; 2 – *quenãnum*; 3 – *tchabêu*. It may be concluded that his informants followed the system found by Coudreau, with the same numerals 1 to 3.

Collins (1962), a linguist who was with the Juruna of Xingu in 1962, got his data from the male informants Da'a and Sureri, ages 25 and 30, respectively. His data[15] corroborate those of Villas Boas and Coudreau: 1 – *mĩmĩ;* 2 - *kĩ'nanuʔ;* 3 – *čabĭuʔ.*

Louro (1979), also a linguist, presents data collected in 1978 and does not mention who his informants were. His data are as follows: 1 – *me'meinaku*; 2 – *i'auu̯'da*; 3 – *ča'biu̯*; 4 – *dua'džuse*; 5 – *seupaũnane*. We note the reference to five numerals, which coincides with Steinen and Nimuendaju. However, the form for 2 was first recorded in this publication, and it is the form that occurs today among the majority of Juruna speakers. The form for 5 is different from that which it is now common.

We also have data from the past century for the Xipaya language. Kurt Nimuendaju (1929) records only four numerals: 1 – *me-me hinaku*, 2 – *bi̯dá,* 3 – *mewaũ*, 4 – *dua dju ze.* This is exactly what is found nowadays, according to Carmen Lúcia Reis Rodrigues (p.c.): *memehinaku, bïda, mewaũ duadjuse*; the Xipaya also use *tïbï* ("many") for higher quantities. The Xipaya language has thus maintained the only four numerals found in the early 20th century. We have no information about the other language of this family, Manitsawá, which became extinct long ago.

Based on this brief historical-comparative review we can say that the older system of the Juruna language, as recorded by the authors mentioned above, varied between three and five numerals, having already presented in its early forms a tendency to somatic formation based on parts of body, specifically, the hand and fingers.

[14] Coudreau (1977 [1896]) and Steinen (1894) also obtained their data in Pará.

[15] In the first example the author presents an intonation contour that we prefer not to mark.

5. A reanalysis of Juruna numerals

At first, as mentioned earlier, it was believed (Fargetti 2007: 124-132) that the Juruna people used twenty numerals in their numeral system. The data were somewhat puzzling, however, because there were many variations for numbers from five onward. With a new collection of data in 2009, we realized that the Juruna used a system of base two, having, until a few years ago, only four numerals. Unlike Palikur, the Juruna do not use numbers to describe moods or social behavior, or as classifiers.

Lima (2014) performs a semantic analysis of counting in Juruna, and her hypothesis is that all nouns in the language are countable; that is, she shows that every noun can be modified by numerals, needing no "container construction" (a bowl, a cup, a package) – this is true even for those considered "mass" nouns (flour, water, meat). Lima presents several experiments, acknowledging, however, that she found conflicting data which would require sociolinguistic research to determine the influence of bilingualism (Juruna-Portuguese) on the results. We will not discuss in this latter type of analysis, because it is not within the scope of this paper.

At first, along with Green (1997), we thought of the Juruna language as having a system of base five or twenty. But in light of our new collection of data and our diachronic discussion, everything points to an older base two system which has recently been expanded. The data collected by us in July 2009 among with middle-aged men in the village of Tubatuba were analyzed. Different information was observed, such as the possibility of the formation of new terms in Juruna for the numbers 50, 60, and 70, used in the quantification of straw, for example, in the traditional construction of a roof of a house. This finding raised more questions: Are such terms usual? Do speakers have other contexts in which they can form new numerical terms? Is there a difference between the speech of young people and adults? What would these be?

One informant, a speaker of Juruna and Portuguese, was asked about the numerals. She knew by name the numbers up to 4, with the word *itxïbï*, meaning "many", and coming after this. Another interesting fact is that as she spoke she lifted a pair of fingers joined together, which, according to Green (1997), would be typical of the system of base two. According to this informant, until about twenty years ago (when she left the village to live in the city), the Juruna used the numbers *memehinaku* ("one"), *yauda* ("two"), *txabïu* ("three"), and *duwadjuse* ("four"), with *itxïbï* ("many") coming after this. She states that after *duwadjuse* there are no more numbers, and showed four fingers, always joined in pairs. She added that her parents and grandparents counted just like her. Thus it seems that the numbers from five were created recently as an extension of the process of pointing fingers two by two in order to count. We do not know if schools or the systems of other peoples may have influenced the Juruna counting system, as we have no evidence on this point.

We cited to this informant, in the most natural way possible, the names *se-wa xĩxĩ* and *se-wa xipa*, which are the little finger ("little finger") and middle finger ("middle finger"), respectively, but which may also represent, according to data collected by Fargetti (2007), the numbers 10 and 8, respectively. The informant recognized the terms as having only the first meaning, that is, as finger names only. As she had been living outside the community for many years, it is reasonable to suppose that Juruna within the speech community only recently began to make use of the latter meaning of those words, and derived this newer meaning from somatic/body reference.

After our questioning, the older informants told us an old story. According to these individuals, long ago there was a girl who could quickly copy any hammock or other craft design. In half an hour she learned what took someone else a whole day, and she could make an entire hammock very quickly. One day she copied the design of the hammock of her friend, who was secretly seeing a man. The copied hammock had the same design, but included a representation of the name and the person of the boy. This caused a fight between the two girls, and the girl in love went and told the shaman. He prohibited the girls from doing such a great variety of different designs, for at that time there were many drawings and people were very creative. When weaving, they used numbers to count the strings. How this counting was done was not clear, although it is clear that for all work of geometric content, such as weaving, a type of counting for separating lines of different colors is necessary in order to repeat or modify patterns, etc. Thus it may be concluded that although the Juruna had only four numerals, they did have counting processes that met their needs, and this shows that the type of linguistic number system does not limit mathematical thinking or geometric knowledge.

According to the teachers of the community, numbers in the indigenous language up to twenty are taught at the Juruna School. For twenty onward, everyone uses the Portuguese language. In fact, the way mathematics is taught in this community deserves study. Is the teaching of numbers up to twenty in Juruna a strategy for transitioning to "white" mathematics? It is a bridge to arrive at foreign knowledge? This is a matter for Juruna teachers to discuss.

Scandiuzzi (2009), based on his experience with the Kuikuro people (Karib family), deals with issues that are extremely relevant for anyone interested in indigenous education. He talks about the importance of opening the mind to a whole new culture, different from one's own, before attempting any interference in it. He says that the educator must repudiate all indifference to the other people's culture, as well as all self-sufficient and ethnocentric viewpoints, attitudes very often taken by government agencies when approving teaching materials and educational projects in indigenous education. The author characterizes mathematics as a power relationship object between two culturally distinct peoples, and discusses what may result from this. He wonders if there can be contact between people from different cultures that does not result in indifference or disregard for the culture and otherness of the other, and asks how it might be possible to for people work together without the suspicions and prejudices brought about by power relations.

D'Ambrosio (2010) points out that the ethnosciences do have their importance, and that they have value and applications in the social context of the people that use them. However, the author makes a point of criticizing the teaching of traditional mathematics in Brazil and around the world. First, it is worth noting that he defines ethnomathematics as "a program that aims to explain the processes of generation, organization, and transmission of knowledge in diverse cultural systems, as well as the interactive forces acting within and among the three processes" (op. cit. p.7). Although we respect the work of this eminent researcher, we do not agree with this definition, as it is so broad that it does not adequately define its object. We do, however, agree with him that traditional knowledge should be respected, including in the schools.

In any case, the school is what very often legitimizes attitudes, decisions, and language policy (Fargetti 2011). The Juruna teachers, when asked about the origin of their numbers from 6 to 20, said that the older people knew them but that they had been forgotten by the younger generations; this could explain the fact that a middle-aged woman far from the community only knew the numbers up to 4. For the Juruna teachers, the school could help recover this knowledge, which was being forgotten.

One might think that this is a line of argument in favor of the idea that the present Juruna number system is a recent creation, because if the system up to 20 were actually used in the past, there would not be as much variation among the numerals as was seen above. The fact of that variation suggests that this creation, strongly based on somatic/body processes, would be recent to the point that there was no standardization. This is corroborated by the fact that all previous records do not indicate numerals above 5 until the year 2000.

The teaching of numerical sequences is also open to reevaluation. This may be disturbing with regard to educational practice, because one of the goals of the Political Pedagogical Project of the Juruna school is to "recognize quantity and count the numbers orally" in Juruna, and the another objective is to "count in the LI (Indigenous Language) and LP (Portuguese Language) the following numbers (1 to 10)," and "recognize the position of the number in the sequence". If the numbers from 5 onward may be "nominated" in several ways, how should they be taught? Have the Juruna reached a consensus on this?

6. Conclusion

Finally, we must consider the problem posed by the variety of different informants as it relates to the question of whether in the past the language had only numerals up to four, or in fact had up to twenty. In our own fieldwork, the oldest informant knew numbers only up to four, while the teachers said that knowledge from the past had been forgotten; these facts taken together would lead one to think that the older generation used a reduced system. This is denied by a middle-aged informant, a woman in living away from the community for many years, who states that there were only up to four numerals. Was there a reduction process, followed by a resumption of what was there before, or was there in fact just a process of expansion? According to Winter (1999), the trend observed in the languages of the world is in the direction of the expansion of numeral systems in accord with to the needs of speakers and contact with other systems and/or cultures, and never in the direction of their reduction. Therefore, one would assume that the Juruna language had only numerals up to 4 in the past, and that subsequently the counting process that joined two fingers was expanded by a somatic process using hands and feet. As we understand the observed variations, with different possibilities of naming, the creation process was recent (within less than twenty years) and does not have standardized forms. We conclude this from the fact that from the numeral 5 onward the community tends to use Portuguese terms.

What, then, is the numeral system of the Juruna? Although in the past it had only four numerals, today it has twenty numerals with no standardized forms, and there are indications of system expansion. One cannot know what these forms will be with future expansion, nor whether the process for numeral formation based on parts of the body will be followed. This type of process was not found in the Xipaya language, which still has only four numerals in its system and no other kind of expansion. According to Comrie (2013), the numeral system of the Kobon language of New Guinea makes use of body parts in addition to hands and feet, such as the shoulder, arm, elbow, and wrist. He states that base ten numeral systems are the predominant in the world, and that contact with people with such systems has influenced other different systems, which, in short, are more in danger of being lost than the languages in which they occur. Corroborating Comrie's observations, Owens (2001) mentions the case of influence on users of Papua New Guinea systems, who began to use Austronesian base 10 systems after the occurrence of ancient migrations. She claims that systems based on the fingers and toes ("digit tally systems") appeared previously to systems using other parts of the body ("body-part tally systems"). She cites the Fasu system of New Guinea, which uses the finger, palm, wrist, arm, forearm, shoulder, chest, neck, ear, face, eye, and nose, all apparently only on the left side, to represent up to eighteen numerals.

We thus conclude that the question of whether the Juruna numeral system is to be expanded further, maintained, or completely replaced, is an issue for the younger generation with its new cultural needs.

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Abreviations

1SG	first person, singular
1PL	first person, plural
ADV	adverb(ial)
DAT	dative
NMLZ	nominalization

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