A Typology of Numeral Systems in South Asian Languages

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By

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ABBREVIATIONS

AA	Austro-Asiatic
AB	Atom Base
ABL	Ablative
ADJ	Adjective
ANDA	Andamanese
AO	Arithmetic Operation
APPROX	Approximative
AUX	Auxiliary
BA	Base Atom
CL	Classifier
CM	Common
CM	Conjunctive Marker
CN	Complex Numeral
COLL	Collective
CPrt	Connective Particle
CX	Complex
DEM	Demonstrative
DIST	Distributive
Drav. /D	Dravidian
DRED	Double Reduplication
FEM/F	Feminine
GA	Great Andamanese
GEN	Genitive
+, - H	Human
H	Hundred
HL	High Low
HMN	Higher Multiplicative Numerals
IA	Indo-Aryan
LH	Low High
LI	Language Isolate
LOC	Locative
Ms/M	Masculine
MUL	Multiplicative
N	Noun
NICO/N	Nicobarese
NP	Noun Phrase

NUM	Numeral
ORD	Ordinal
P (Chapter 3)	Parameter
P	Person
PL	Plural
POSP	Postposition
POSS	Possessive
PREP	Preposition
PST	Past
RED	Reduplication
SA	South Asian
SAND	South Asian Numerals Database
SG	Singular
SUPP	Suppletive
SX	Simplex
T	Tens
TB	Tibeto-Burman
TK	Tai-Kadai
TR	Transcribed
U	Unit
WO	Word Order

CHAPTER ONE

LINGUISTIC ENCODING OF NUMERAL SYSTEMS: AN OVERVIEW

Abstract: The human capacity to understand, process and execute numerical ideas, the mode of functioning of the human counting system and the way they are linguistically encoded have made for a very dynamic field of investigation and analysis, with these systems having been studied cross-linguistically from synchronic, diachronic and evolutionary perspectives as reflected through the linguistic, cognitive and anthropological literature available on numeral systems, as reviewed in this chapter. We begin with a brief overview of the development of linguistic numeral systems that has been conceived of in research literature, followed by an illustration of some of the key terms that are employed in this book and in the research literature for the description of numeral systems, via a description of English. We also identify the key strategies used in the construction of numeral systems and present a broad overview of the syntactic behavior of numerals. Finally, we go over the list of the languages dealt with in this book, an outline of its goal, as well as an overview of the methodology employed in the book.

Keywords: Numeral Systems, Cardinals, Ordinals, Atoms, Bases, Syntagms, Crowns, Switch, Aggregation, Over Counting.

Numeracy, or the ability to count, calculate, and compute, is a fundamental human cognitive skill which is central to performing tasks which form the basis of several of our daily tasks. From performing basic calculations while making a purchase at the grocery store and managing our monthly budgets, to solving complex mathematical problems, numeracy forms the basis of all things that operate on the basis of the arithmetic value that we term a “number”. These numbers are arranged into a written system for their effective expression, which varies widely depending upon a number of factors, including linguistic ones.

Numeral systems have been a source of great interest to linguists over much of the history of the discipline itself. Hence, over the centuries, the nature and source of the human numerical ability and their linguistic encoding as numerals have been a major area of intellectual inquiry. Starting from the work of Hurford (1975), the questions such theoretical and empirical explorations have examined range from evolutionary to the cognitive and the purely linguistic. These approaches connect the existence of numerals in human languages to issues of comparison of humans with other non-human species in evolutionary terms on one hand, and on the other hand to the cognitive operations necessary for counting systems to develop. Further, the cross linguistic study of numeral systems in the world's languages reveals both a systematicity and variation in their construction that indicates a deep and complex relationship not only between humans' numerical and linguistic abilities, but also the role of contact and culture in the advancement of counting.

With regards to the evolutionary and cognitive questions, a dominant hypothesis that has developed in the last few decades is that the numerical ability is an innate cognitive ability of both human and non-human species. Spelke (2003) has argued that both human and non-human animals are hard-wired with a set of cognitive abilities that enable them to build mental representations of (spatial) relationships, persons, objects and numerosity. Chomsky (1998) suggests that the numerical abilities of humans flow from a domain specific intelligence that may be termed as a 'number faculty', in analogy with the language faculty, echoing Hurford's remark that "numerals lie in the intersection of the human language faculty and number faculty" (Hurford 1987: 3).

Dehaene (1997) elaborates on the Innateness Hypothesis to argue that nature equips many species including humans at birth with a biologically determined ability to carry out basic elementary arithmetic operations and that this ability is evolutionarily selected. While the ability to do simple numerical operations in other animals is extremely limited, the fact that humans also have an ability for language and symbolic notation has enabled humans to develop these rudimentary abilities to yield the extremely abstract mental constructions that characterize human mathematics.

The book is a valuable resource for researchers, linguists as well as students interested in exploring and studying the typology of numeral systems in South Asian languages. It provides a detailed account of the structures and parameters of South Asian numeral systems as highlighted by the analysis of each language family that the languages are categorized into, and is an endeavor to contribute to the ongoing discussion of the universals of numeral systems through evidence as found during the original, empirical research which forms the basis of this publication.

Throughout the course of this book, we shall review the general considerations of the linguistics of numeral systems, which include a review of the existing literature on the study and structuration of these systems, followed by an examination of the standard parameters to describe patterns in languages with respect to the conceptualization of numeral systems which may serve as distinguishing criteria. The scope of the numeral expressions covered is wide, including ordinals, multiplicatives, fractions, as well as quantifying expressions such as collectives, distributives and frequentatives, as well as the relatively rarer types of systems encountered in the course of the study. Finally, the book then goes further by discussing the sociolinguistic factors involved in the borrowing of numeral systems.

An attempt to achieve the goal specified above has been done via extensive fieldwork on the numeral and other quantifying systems of 77 South Asian languages belonging to six language families – Dravidian, Tibeto-Burman, Austro-Asiatic, Indo-Aryan, Tai-Kadai and Great Andamanese. The primary objective of this typological exercise is to develop a framework by which the core morphological and syntactic properties of numeral systems may be formally described, so that inferences can be made about the role of the membership of language families, sprachbunds, and language contact and cultural convergence in influencing the nature and form of numeral systems.

Before we start delving into this domain, we need to first turn our attention to the development of linguistic numeral systems as has been conceived in research literature; doing so will help provide us with a comprehensive understanding of the field.

The Linguistics of Numeral Systems: General Considerations

In reviewing numeral systems, Hammarstrom (2010: 936) shall be followed for the working meaning of numerals, which is as follows: "spoken, normed expressions that are used to denote the exact number of objects for an open class of objects in an open class of situations with the whole speech community in question."

Numerals are interesting as a linguistic category: from one perspective, they are lexical components, yet from the other, they are also grammatical in that they may include a generative framework to infer higher values, and they collaborate with grammatical frameworks of quantification. Numeral frameworks are especially critical for their significant cross linguistic variation, so much so that languages may go from having no exact numeral terms at all to having frameworks whose cut-off points are essentially boundless. As Andersen (2005: 26) formulates it, numerals are in this manner a “liminal” linguistic category dependent upon social elaboration.

Numeral systems vary across human languages and may be of different sizes. The chronicled record of human tallying frameworks shows the advancements of numeral systems vividly. This progress can be seen in fact, as Spencer (1976: 42) notes, “there exist some South American tribes which still count by hands, i.e., using base 5”. Other ancient systems used base 12, chiefly in relation to measurements. The American Indian and Mayan tribes used a base 20 number, whereas the ancient Babylonians used a number system based on 60 (a system that still survives in the system used to measuring time and angles). Gokhale (1966) shows that the antiquity of numerals goes back to the Rigvedic period where certain numerals like 3, 8, 100 are mentioned, although the first full archaeological evidence of numerical systems occurs in the Asokan and Nanaghat inscriptions. In these inscriptions, separate signs for the units tens, hundreds and thousands are used.

Spencer (1976: 42) suggests that in subsequent stages of development, the need for extensive counting led to the counting system becoming systematized through the concept of a base, which is the number of distinct digits required by a system of numeric notation. Given that, as Wiese (2003: 58) points out, humans can use the recursive standard to develop an infinite system of complex numbers, languages have created numeral frameworks to communicate higher mathematical qualities, far more complex than the basic lexical portrayals (Detges 2003: 50–51). In such intricate numeral frameworks, atomic numerals are utilized as constituents of morphosyntactic blends. For instance, numeral 16 is a blend of 10 and 6 in English. The base and atom merge with the help of arithmetic operations to produce complex numeral systems.

Weise (2003) outlines a transformative situation for the advancement of numerals. As he points out, numbers are adaptable instruments that can be utilized to distinguish an entire scope of properties, of which, cardinality is only one. For example, besides cardinality as in "*six* transports", the number "six" can be used to identify positions or rank, as in "the sixth transport" and in naming items, i.e., "the #6 transport". In other words, the number concept is based on a numerical sequence whose elements are "not confined to quantitative contexts, but can indicate cardinal/quantitative as well as ordinal and even nominal properties of empirical objects (e.g., 'five buses': cardinal; 'the fifth bus': ordinal; 'the #5 bus': nominal), and it can involve recursion and, via recursion, discrete infinity." Weise argues that the manner in which a particularly unified number idea could advance in humans is through "*verbal sequences"* that are utilized as mathematical devices, that is, successions of words whose components are related with empirical objects in number tasks. Specifically, he shows that a particular sort of number words, to be specific, the counting sequences of natural languages, can be portrayed as a focal occurrence of verbal mathematical or numerical tools.

Many preliterate cultures standardized and formalized their number systems, but usually only if they had a special need for higher numbers. There is agreement that early numeral systems were small, that the numerosities 1, 2, and 3 are cognitively given and thereafter they are based on body parts and the tally mark counting system. Oneness, twoness, and threeness apparently are essential perceptual characteristics that our cerebrum can recognize and measure without counting. It very well may be guessed that when pre-historic people started to talk, they may have had the option to name just the numbers one, two, and three, in comparison to explicit discernments. To name them was not any more troublesome than naming some other sensory attributes (Dehaene 1997: 92).

Hurford (1999) broadly divides the numeral system into two types, "primitive systems" and "developed systems". The languages with restricted numerals and with no numerals at all, fall under "primitive systems". The words in the primitive system have not lost their non-numerical meaning, i.e., "one hand" could also mean numeral 5. Similarly, numerals above 5 could include "another hand" and numeral 10 could also mean either "full body", or "both hands", or "a man" etc. In these systems, most forms are mono-morphemic, and lower numerals mostly use addition. Most of such primitive systems, use base 2, 3, 4 and 5 to form numerals and cardinal sets are usually restricted until 20. In "developed systems", the system is based either on a decimal or vigesimal base, and a full set of cardinals at least up to 100 or more is generated, where 1–9 are atoms, 11–19 are teens which use addition, and the remaining running numerals use both multiplication and addition. Tens are multiplicatives and there are single words for 100, 1000, and sometimes for 20. In the formation of their complex numerals, however, both of the systems use the same recursion and packing strategy.

It is generally held that in the development of numeral systems, cardinals seem to be the more basic series across languages, and that amongst them, the lower numbers are more independent. In general, the recursive principle is overwhelmingly the underlying rule, based on which a numeral system continues to build and further proceed to infinity. Complex numerals are built on atomic components of the numeral system, such that their formation usually involves the structure, NUM → NUM+NUM. Higher numerals are typically the derivatives of either lower or the most basic series of cardinals. Furthermore, cross-linguistically, numerals show the property of linguistic discontinuity. These have been observed around the following points:

Around 3, preceding which lexical numerals show different abnormalities. For instance, gender agreement, suppletive ordinals, an unusual case system. Mentally or psychologically, three is about the constraint of subitization.

After 10, all things considered, the primary linguistically (syntactically) complex numerals ordinarily show up, utilizing addition.

Around 20, at the point when the first main multiplicative manifestations are utilized which regularly corresponds with a switch in the manner in which addition is communicated (for example, in English, teens switch to – ty).

Less frequently, there may exist a point in the higher multiplicative numerals (say, at 1000 or 1000), where a different set of ordering rules may start to become involved (for example, in German additives, the order of the two elements switches from a LOW–HIGH to a HIGH–LOW order; after 100, for example, 101 is hunderteins (100+1)).

Rutkowski (2003), following neuropsychologist N. Cowan (2001), posits that the morphosyntactic properties of the numerals 1–4 is different from the higher numerals. The basic idea behind this statement is that in short–term memory, more than four entities cannot be stored. This might also be the reason why some languages do not have numerals above this threshold.

A major feature in the development of advanced numeral systems is the role of linguistic borrowing. Although numerals (specially 1, 2, 3) are among the most conserved lexical items in a language (Dale 1977: 63), (Buck 949: 936) and are most resistant to change — (Menninger 1969: 100) “they change scarcely at all with the passage of time”— it is also true that the construction of higher and complex numeral systems is frequently accomplished by borrowing (Beskrovny 1976). It has also been observed in several instances that languages can borrow number structures, if not the actual numeral words themselves.

The conditions under which languages build or even surrender their local numeral framework for borrowed ones is not totally clear. However, it has been contended that it is possible for the (at least two) frameworks to exist together next to each other for a period, as seen in Harui (Comrie 1999). Replacement of one numeral system by a borrowed one correlates with several factors like lower frequency of use, the predominance of standard and prestige languages used in trade and education, which as Comrie (1999: 87) proposes, pushes out minority/indigenous numeral frameworks. For example, the manner in which Japanese and Thai numerals were supplanted by Chinese ones (Comrie 2005) and the fact that all numerals above “two” (or incidentally “three”) in most Berber languages have been replaced by Arabic ones (Kossmann 2013: 306–311; Souag, 2007).

Once borrowing takes place, Greenberg (1978: 289) proposes, Universal 54 is likely to hold:

Greenberg's Universal 54 (1978: 289)

> If an atomic numeral expression is borrowed from one language into another, all higher atomic expressions are borrowed.

Greenberg also predicts that, internally and cross-linguistically: higher numerals tend towards more prominent consistency and less variety. All the Indo-European dialects (Indo-European example) structure 100s and 1000s in a similar way (atom*100, atom*1000) contrasted with the teen’s part of the number line, which presents the more prominent variety in syntagm development.

The linguistic study of numeral systems and quantifying expressions: Basic concepts and terminology

In the linguistic study of numeral systems, the focus is on spoken, rather than written, numerals, as the actual morphology and syntactic behavior of the numerals vary significantly from the Arabic notation that is now almost uniformly employed.

Core terminology in the linguistic study of numeral systems

Cardinal numerals are of two types: simplex and complex. Simplex numerals are mostly mono-morphemic or monosyllabic in nature, and complex numerals are composed of two or three numeral expressions. In complex numerals, components are combined together by arithmetic operations. Complex numerals can be of the following types:

Additives: If the relation between the components of the complex or compound numerals is addition, then this type of numeral is called *additive*. “Augend” and “addend” are the two components of such numerals. For example, in the numeral expression 10+3 = 13, the augend is 10, and the addend is 3.

Subtractives: If the relation between the components of the complex or compound numerals is subtraction, then this type of numeral is called *subtractive*. “Subtrahend” and “minuend” are the two components of such numerals. For example, in the numeral expression 10–1 = 9, the subtrahend is 10, and the minuend is 1.

Multiplicatives: If the relation between the components of the complex or compound numerals is multiplication, then this type of numeral is called *multiplicative*. “Multiplier” and “multiplicand” are the two components of such numerals. For example, in the numeral expression 10*2 = 20, the multiplicand is 10 and the multiplier is 2.

Multiplicative–cum–Additives: If the relation between the components of the complex numeral is both multiplication and addition, with multiplication preceding the addition, then this type of numeral is called *multiplicative–cum–additive*. For example, in the numeral expression (10*2) + 5 = 25, multiplication (which is a base) precedes addition (which is an atom).

Additive–cum–Multiplicatives: If the relation between the components of the complex numeral is both addition and multiplication and addition take place before multiplication, then this type of numeral is called *additive–cum–multiplicative*. The basic word order that generally holds in this case is Atom–Base. For example, in the numeral expression 5 + (10*2) = 25, addition (which is an atom) precedes multiplication (which is a base).

The Multiplicative-cum-Additives and Additive-cum-Multiplicatives basically relate to the order of the elements in the complex numeral systems.

The terminology described below is used in the description of numeral systems, and this will be employed in the book in the following senses:

Atoms are mono-morphemic roots and are basic lexical expressions (Greenberg 1978: 270). As per Dehaene (1997) and Dehaene and Mehler (1992), atoms are profoundly steady lexical elements, and this high stability of atoms can be ascribed to recurrence of utilization impacts, where more modest numerals (one to ten and the teens) are used more than higher numerals. For example, in English, the numerals one to nine (1-9) are atoms.

Bases constitute turning points along the number line, where transitions can occur in syntactic and semantic rules. Irregularities in the derivation patterns used in a given language (should there be any) tend to cluster around the base form; and where there is a choice among competing forms for representing the same number, these also occur around the base (Seiler 1990: 199–200). For example, the English numeral system has a decimal base, and as a consequence, all the complex numerals are based on this system. Every crown takes a "–ty", a variant of ten, for the formation of complex numerals and crowns; consider example (1):

(1) English

Twen–*ty*	(2*10)
Twen–*ty* one	(2*10+1)
Thir–*ty*	(3*10)
Thir–*ty* five	(3*10+5)
For–*ty*	(4*10)
Fif–*ty*	(5*10)

Syntagms are the derivatives of atoms. The formation of the syntagm includes three segments: an atom, a base, and arithmetic expressions such as multiplication, subtraction, addition, exponentiation or division. For example, 'fif–teen' in English is numerically notated as 5+10; 5 here is the atom, 10 is the base and the arithmetic operation that has been used is addition.

Crowns are commonly framed by multiplication of a base and an atom (depending upon what the language's choice of base is). It could also be totally a new form, inside and out, bearing no association with the atom or base. Basically, the multiples 20, 30, 40, 50, 60, 70, 80, 90 and 100 are crowns.

Excluding atoms, bases and crowns from the set of cardinal system of a particular language, the numerals that remain in the set are called **running numerals**. Barring a handful of exceptions, every language forms its running numerals utilizing a common rule: "Atom+Base" or "Base+Atom". In a decimal system, 21–29, 31–39, 41–49, 51–59, 61–69, 71–79, 81–89, and 91–99 are the running numerals, and as example (2) for the English running numerals shows, they are consistently arranged in the order [Base + Atom]:

(2) English

25	twen–ty five	(2*10+5)	Base+Atom
36	thir–ty six	(3*10+6)	Base+Atom
42	for–ty two	(4*10+20)	Base+Atom
98	nine–ty eight	(9*10+8)	Base+Atom

There also exist languages that use a linking particle or a conjunctive marker between the base and the atom in the formation of running numerals.

Numerals higher than 99, are called **higher multiplicative numerals,** e.g., "hundred", "thousand", "million", etc. Hundreds and thousands are shaped consistently across the languages by combining applicable atoms and bases framed by the word for "hundred" or the word for "thousand" separately. Barring a few exceptions, the bases of "100" and "1000" are morphologically inconsequential and unrelated to any previous numerals. As Sidwell (1999: 253) describes, in Austro-Asiatic, the common roots for numerals "one" to "four", are well distributed, and this allows a classification of them in terms of AA etymology; however, exactly the opposite scenario holds for the higher numerals, where it is difficult to conclude what the roots in fact are.

In several languages, numerals up to the base are a particular grammatical category or part of speech, while the words for powers of the base are members of one of the other word classes. In English, these higher words are “hundred”, “thousand”, “million” and higher forces of “1,000” or of “1,000,000”. In East Asia, the higher units are “hundred”, “thousand”, “myriad” (10 force 4), and “power of myriad”, and they are “hundred”, “thousand”, “lakh”, “crore”, in India. The Mesoamerican framework used somewhat in Mayan dialects, was based on the power 20: *bak* “400 (20 force 2)”, *pik* “8000 (20 force 3)”, *kalab* “160000 (20 force 4)”, and so on.

Grammatically, higher numerals must be created afresh each time they are used so that the numeral derivation process is an instance of creativity not dissimilar to that of sentence construction. In general, cross-linguistically speaking, higher numerals exhibit more consistency in both parts and their ordering, than the lower numerals, tending to become increasingly noun-like. In some languages, the use of classifiers is restricted by the numeral involved. Greenberg states (1972: 6): “It is particularly common for classifiers not to occur with higher units of the numerical system and their multiples.” In some languages, as in many Alor-Pantar languages, bases for “hundred” and “thousand” cannot be used as numerals by themselves (Schapper and Klamer, 2014). That is, they should be compared with the accompanying multiplicand, so that “one hundred” means 100*1, “two hundred” means 100*2 and so on.

In general, as Ionin and Matushansky (2006) say, the higher cardinals generally follow the lower cardinals. But this is not true in South Asian languages, as both the orders do exist. Higher numerals in SA could be LOW–HIGH and HIGH–LOW. Follow example (3) and (4) to see both the orders of higher numerals in case of multiplication:

(3) Hindi (IA)

100	sɔ/ ek sɔ	(1–100)	LOW–HIGH
200	do sɔ	(2–100)	LOW–HIGH

(4) Lotha (TB)

100	mžʊɑ/ mžʊɑ ekʰɑ	(100–1)	HIGH–LOW
200	mžʊo eni	(100-2)	HIGH–LOW

Switch: As has been stated earlier, complex numerals are either in “atom+base” or “base+atom” order. But, within the complex numerals, the change in the order (of the element) could be observed at different levels. The “atom+base” changes to “base+atom” or vice-versa, either at crown or teen level. Cross-linguistically, this is a common phenomenon. Following Hurford (1975), this word formation transformation is referred to as "Switch". In both English "sixteen" [6 (LOW) + 10 (HIGH)] and "two hundred" [2 (LOW) * 100 (HIGH)], the order is LOW– HIGH. However, in Hungarian, while "eleven" follows a HIGH–LOW [10 (HIGH) +1(LOW)] order, "forty" [4 (LOW) * 10 (HIGH)] *switches* to a LOW–HIGH order. Greenberg (1978) has proposed the following universals about switching:

> Universal 26: "If in a language, in any sum the smaller addend precedes the larger, then the same order holds for all smaller numbers expressed by addition."
>
> Universal 27: "If in a language, in any sum the larger addend precedes the smaller, then the same order holds for all larger numbers expressed by addition."

In Italian, a switch takes place after 16, and in most of the languages, it takes place after a multiple of 10 (20, 100, etc.).

In the formation of the higher multiplicative numerals, there is a cross linguistic tendency to pack the highest valued constituent as near as possible to the root (top) of the tree (Hurford (1987), Von Mengden (2010: 92)). In other words, the numerical value of a serialized multiplicand generally exceeds the numerical value of its multiplier. This *packing strategy* ensures that of two immediate constituents of a complex numeral, the one containing the multiplier must be valued lower than the one containing the serialized multiplicand and the one containing the addend must be valued lower than the one containing the serialized augend (Hurford, 1975:67–80; 1987: 242–252).

Core terminology in the linguistic study of quantifying expressions

The classificatory and descriptive definitions described in the previous subsection mostly apply to one kind of quantifying expression in natural languages—the **cardinals—**but not to the other type of numerical expressions that are found in human languages, which are briefly explored here.

In general, **ordinals** – i.e., the numerical expressions that indicate the exact position where something occurs in a series (Sansui, 1995: 16) – are built on the cardinals. Although, as Stump (2014) notes, the lowest natural numbers are often suppletive. In English, the suppletive forms also appear