Significance of Structure in Cognition: A Study on Bangla Counting System

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ARTICLE INFO

Article history:
Received 14/02/2017
Received (revised form) 14/11/2017
Accepted 20/11/2017

Keywords:
numerals;
p-value;
f-value;
quantifier phrase
coordination
embodiment

ABSTRACT

Cognitive processing of complex expression is relative to the way information is structurally encoded. Under this assumption, this paper seeks to investigate how information relevant to the counting process is structurally encoded in Bangla numerals. It is noted already in literature (Hurford, 1987) that the construction of numerals as the collection-representing expressions have certain similarities with the construction of non-numeral expressions: Basic universal patterns in the scaffolding of numerals in larger constructions and the formation of complex numerals can be explained in terms of natural parallels and analogies with non-numeral constructions. This remains instrumental in asserting the fact that syntacto-semantic peculiarities associated with Bangla numeral construction can be captured with the help of a theoretical framework primarily developed in syntax.

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1. Introduction

Cognitive processing of complex expression is relative to the way information is structurally encoded. Under this assumption, this paper seeks to investigate how information relevant to the counting process is structurally encoded in Bangla numerals. It is noted already in literature (Hurford, 1987) that the construction of numerals as the collection-representing expressions have certain similarities with the construction of non-numeral expressions: Basic universal patterns in the scaffolding of numerals in larger constructions and the formation of complex numerals can be explained in terms of natural parallels and analogies with non-numeral constructions. This remains instrumental in asserting the fact that syntacto-semantic peculiarities associated with Bangla numeral construction can be captured with the help of a theoretical framework primarily developed in syntax.

2 Research Objectives

To address the research concern mentioned in Section 1, this paper will focus on those structures which are relevant for the interpretation of the numerals. By this, we do exclude those constructions which involve numerals as the modifier of nominal. Consider the following expressions:

1. *tin	hajar nOy So bottriS*
   three thousand nine hundred thirty two
   Three thousand nine hundred and thirty two

2. *tettriS-Ti am*
   thirty three Cla mango
   Thirty three mangoes

As per our discussion, then, this paper is concerned about the construction type of (1). Construction type of (2) will be kept aside for some other occasion. The construction type that we intend to deal with differs from the latter one in various respects. For example, construction mentioned in (2) is constitutive of a head (e.g. *am*) and a modifier (e.g. *tettriS*). As per the grammatical convention of Bangla, it might seem to one, that modifiers are always preceding the head. On the basis of this understanding, if one tries to pass the judgment that *bottriS* in (1) is head and whatever precedes it – e.g. here in this case *tin hajar nOy So* – would be categorized as modifier. But this is certainly not the case. In a construction like (1), it is often not easy to answer which one has the status of the head. Thus, the immediate task for this paper is to explain the following underneath.

i. To find the processes involved in the cognition of Bangla counting system;
ii. To determine the head status in Bangla numeric expressions; and,

\footnote{Though the phrase like (2) is treated to have a functional head (e.g. *tettriS-Ti*) rather than lexical, here the lexical head is put to the front in a more traditional way to make the distinction between (1) and (2).}
iii. To seek for an X-bar scaffolding that would possibly account for the underlying structure of Bangla numerals.

Probable solutions of these would be attempted in the following sections.

3. Discussion

The questions addressed in section 2 could be given some solutions, though subject to further modifications, with the execution of the difference between lexical and functional heads along with the body-part model responsible for cognition of numerals across the languages over the world. Heine (1997:19) mentioned “numeral systems across languages are motivated” and this motivation is claimed to be genetic, though no longer accessible to native speakers as well as historical linguists. According to him, there lies a notion of “base number” in numeral systems, seen cross-linguistically, which has kind of embodied conceptual basis. Heine (1997:19) mentioned some concepts that are prevalent in counting system of Mamvu, a central African Nilo-Saharan language are following.

a) Concrete items: ‘hand’, ‘foot’ and ‘person’
b) Actions: ‘seize’ and ‘spare’
c) Location: ‘above’

As human hand has five fingers it might be conceived of to become the silent base in counting systems of many languages like Mamvu. But the base number may vary from language to language. It could be ten with the fact – human hands have ten fingers, in the conceptual level; it may be twenty as a person in its entirety has twenty fingers with the addition of feet to hands. Heine (1997:21) propounds that “the body-part model is in fact ubiquitous”. This model has influences, though in an opaque way, on many languages like English which has a decimal counting system as its base. Moreover, Heine (1997:32) talks of the distinction between semantic transparency and pattern transparency. Our concern is not about the first kind of transparency where the genetic motivation is fully reconstructed as language such as Mamvu has the forms like reli ‘one’ and reli qode reli ‘six’ that can be construed as ‘the hand seizes one’ where eli and qode stand for ‘the hand’ and ‘seizes’ respectively. On the contrary here we will deal with pattern transparency where the etymology of linguistic forms of numerals is not easy to discover. Bangla is an instance of this sort because the etymology of Ek, dui, tin, Egaro, kuRi etcetera is still not unfolded. Thus, under this circumstance our concentration should resort to the latter one, i.e., pattern transparency that states that languages having their base numbers like 5, 10 or 20 are suggestive of the body-part model.† Now, our primary task is to discover the base number prevailing in

† It could be found that more than body based concept, counting terms from Ek ‘one’ to dOS ‘ten’ in Bangla preserve their familiarity with both nature and culture while encountering the following heuristics.

Eke chOndro for comparing the number Ek ‘one’ with the number of the moon.
due pokkho for denoting that the number of fortnights is similar with the number dui ‘two’.
tine netro for making it clear that number of eyes of God matches with the magnitude of tin ‘three’.
chare bed for matching the number char ‘four’ with the number of Vedas.
paMc ce pOncoban for placing a similarity between paMc ‘five’ and number of arrows mentioned in myth.
Bangla counting system. In Bangla number names are interpreted with a reference to a positional decimal system consisting of (i) ten numbers ranging from 0 to 9, and (ii) a scale marked with position for each power of 10 as stated in (3).

3. koTi nijut lokkho ojut hajar SOtok dOSok ekok

\[
\begin{array}{cccccccc}
10^7 & 10^6 & 10^5 & 10^4 & 10^3 & 10^2 & 10^1 & 10^0 \\
\end{array}
\]

With the use of this positional decimal system, one can interpret (4), (5) and (6) in the following way:

4. 67 = 10^1(6) + 10^0(7)
5. 20 = 10^1(2)
6. 2 = 10^0(2)

As per this analysis, then, the meaning construal of sixty seven consists of a place value (henceforth, p-value) and a face value (henceforth, f-value). The domain of any place value is the positional decimal system, whereas the domain of face value is a set having ten numbers ranging from 0 to 9. With this understanding then any string of numbers can be represented according to the following scheme:

7. \(\sum p_i\text{-value} (f_i\text{-value}) = 10^i(N)\), where \(i \in \{0, 1, 2, \ldots, \alpha\}\) & \(N = \{0, 1, 2, \ldots, 9\}\)

The traditional main-stream representation of (4) (i.e. \(67 = 10^1\times 6 + 10^0\times 7\)) is replaced with a much efficient functional definition of (7) where p-value is behaving much like a function for which the domain of argument or the f-value is the set of \(\{0, 1, 2, \ldots 9\}\) and the domain of p-value is the positional domain system as per our discussion.

Thus, it’s been clear from this above analysis that Bangla uses decimal system in counting numerals. Our emphasis would be that the place value depicted above is of some interest while dealing with following linguistic data.

8. e-te dOS-er bhalo ho-b-e
   Dem-Loc ten-Gen good be-Fut-3p
   It is for the greater good of men

9. SO-e SO-e lok aS-ch-\(\phi\)-e

\(ch\)Oye \(r\)ita for denoting the number \(ch\)Oy ‘six’ standing for the number of seasons.
\(Sate\ Somudro\) for placing the magnitude of \(Sat\ ‘seven’\) being similar to number of oceans.
\(a\)Te \(OS\)tobo\(Su\) for relating number \(a\)‘eight’ with eight deities.
\(n\)Oye \(n\)obogroho for relating the number \(n\)Oy ‘nine’ to the number of planets.
\(dOSe\ dik\) for finding similarity between the number \(dO\ ‘ten’\) and the number of directions.
But neither such heuristics can be found for \(E\)garo ‘eleven’, \(b\)aro ‘twelve’, \(t\)Ero ‘thirteen’ and so forth nor they are composition of the basic heuristics described above.
People are coming in lots

10. *tiriS-e tiriS-e lok as-ch-ɸ-e


The fact seems intriguing during the discussion that the place values are licensed to occur in (8) to (11). Moreover, the place values are not denoting the exact magnitudes of them while these sentences are getting interpreted. Rather they are utilized to designate some notion of “group”. When the sentence (8) is uttered it does not mean the betterment of only ten people. Instead, it means betterment of a bunch of fellow. In a same manner, (9) is not telling us the coming of exact one or two hundred people; it refers to a vast group of folks. Likewise, (10) is denoting a crowd of people gathered in a procession. (11) is also not auguring the scarcity of something only among lakhs; it might denote the laxity of that among cores. (12) and (13) are not grammatical in Bangla as numbers other than place values like ‘tiriS’ and ‘SaT’ can’t be used to denote any notion of group in the way p-values can refer to.

Now, our attention at this point should incline toward determining the head status of numerical expressions in Bangla. As stated in section 2, the head modifier distinction is not overt in case of dealing with these types of expressions. Let’s divide these expressions into two classes. One is simplex numerals (i.e. p-values and multiples of those values such as dOS, EkSo, kuRi, tiriS, paMcSo etc.). Latter is the class that consumes all kinds of complex numerals such as Egaro, ektriS, SatSoTTi, EkSo ek, duhajar paMc, tin hajar nOySo bottriS etc. Now, a general question might be on the stage as to whether the head status of first type differs from the second class or not. Our proposal is it differs, but the two classes share a common thing regarding the nature of their headedness. Let’s take multiples of p-values at the first place. The underlying form of them might be represented like the following.

14. *tiriS ‘thirty’ = tin-Ti dOS ‘three times ten’
15. *Sottor ‘seventy’ = Sat-Ti dOS ‘seven times ten’
16. *duSo ‘two hundred’ = du-Ti (Ek)So ‘two times hundred’
17. *tin hajar ‘three thousand’ = tin-Ti hajar ‘three times thousand’
This type of numerals, then, is conceived to have Num-Cla (e.g. tin-Ti, Sat-Ti, du-Ti) form as their internal structure. As Bhattacharya (1999) suggested, Q can be construed of as head of the entire phrase as the scope of Q is taken to quantify the nouns following them. Here, the Num-Cla cluster is quantifying the p-values (dOS, EkSo, hajar) that follow them. Thus, the structure of these numerals could be like the below.

18.

Q

\[
\text{QP} \quad \text{spec} \quad \text{Q'}
\]

\[
\text{tin-Ti} \quad \text{NP} \quad \text{dOS}
\]

The governing head (Num-Cla here) takes the p-value \((dOS = 10^1)\) as its compliment. Only \(dOS\) can be schematized as \(ek-Ti \ dOS\). Numbers between \(Ek\) ‘one’ to \(nOy\) ‘nine’ might be extended to form such as \(ek-Ti \ ekOk\ (=10^0)\) for \(Ek\), \(du-Ti \ ekOk\ for \(dui\) etc. Thus, what we can conclude here is that simplex numerals have a functional item Q as their head element that takes p-values as sister compliment.

Now, let’s get into the issue of complex numerals in Bangla. This type of constructions is often formed following the process of compounding – traditionally, known as samāsa and further subcategorized as samāhāradvandva (collective co-ordinative). Johannesen (1998:84) speaks of instances of empty conjunctions in many languages in the world. As per him, many languages like Cayuga, a Northern Iroquoian language of Ontario, have empty conjunctions specific to certain categories, but not for others.‡ Keeping analogy with his observation, it could be hypothesized that Bangla has this type of coordination while dealing with complex classes of numerals such as \(tin \ hajar \ nOySo \ tiriS\ ‘three thousand nine hundred thirty’, \(Ekso \ dOS\ ‘one hundred ten’, bottriS ‘thirty two’ etc. §

These expressions can be dealt with in following way.

19. \(tin \ hajar \ nOySo \ tiriS\ ‘three thousand nine hundred thirty’ = tin-Ti hajar ebON nOy-Ti \ (Ek)So \ ebON \ tin-Ti \ dOS\ ‘three times thousand and nine times hundred and three times ten’ = three \(10^3\) and nine \(10^2\) and three \(10^1\).

‡ Cayuga executes the use of empty conjunctions while coordinating verbs and clauses only. In case of nouns it uses \(hni\).

§ Even empty conjunctions are not very uncommon in Bangla while having the following in hand.

1. \(din \ ebON \ rat > \text{din-rat} \ ‘day and night’\)
2. \(chOndro \ ebON \ Surjo \ ebON \ groho \ ebON \ tara > \text{chOndro-Surjo-groho-tara} \ ‘moon, sun, planet, and star’\)
20. *ekso dOS* ‘one hundred ten’ = *ek-Ti (Ek)So ebON ek-Ti dOS* ‘one time hundred and one time ten’ = one $10^2$ and one $10^1$.

21. *bottriS* ‘thirty two’ = *dui ebON tin-Ti dOS* ‘two and three times ten’ = two $10^0$ and three $10^1$.

The constructions in (19), (20) and (21) consist of a functional category *ebON* ‘and’ that serves to the interpretation of *collections* and contributes to the “interpretations of its complements”. Here, modifying elements are the conjuncts that are implying about the nature of these *collections* (e.g. collection of numbers). Thus, the phrases above are considered to be conjunction phrases (CoP in short) with QPs as conjuncts. (19) can be sketched like below.

![Graphical representation of CoP]

The same format would take care of the structures like (20) and (21) respectively. It’s somehow clear that *complex numerals* are headed by the functional element Co that takes QPs as arguments. This functional Co, though empty, makes the fact explicit that these expressions are all about collections of simplex forms with Q head.

Bangla numeral system makes use of decimal format as its base number which is, in turn, suggestive of body-part model of numeral cognition seen pervasively across the languages over the world. On this ground Bangla counting system could be branched into two subclasses such as simplex form of

**As per Johannessen (1998:109) Bangla should follow the C-H-S order for being an SOV language. He partially followed the LCA and antisymmetry thesis of Kayne (1994) that states only two orders, S-H-C and C-H-S seem acceptable in UG. Kayne (1994:36) further puts stress on the universality of S-H-C order across the languages. On this point Johannessen (1998:109) differs from Kayne saying that if S-H-C order is the only one licensed in UG then what one would do with the issues like parallel directionality between heads, verbs, adpositions, conjunctions and their complements. Johannessen (1998:110) advanced here to simply add a directionality parameter to the model of UG. But, Kayne (1994:47) showed in chapter 5 that no directionality parameter is needed. In case of postpositions the complement position moves into the specifier position of that adpositional phrase. In OV construction the O must move leftward past the V into higher specifier position and IP must pass under a leftward movement into [spec, C$^0$] position where IP preceeds the C$^0$ [Kayne (1994:48)]. Thus, here in case of Bangla the S-H-C order is maintained in structuring CoP.**
numerals and complex forms made of those simplex ones. Further, it’s been postulated in this paper that both these forms have functional heads in common rather than lexical ones. But, the two types differ in one feature. Simplex forms have functional Q as their head quantifying over the place values whilst, the complex type is headed by the functional conjunctions making them a CoP.

4. Conclusion

Bangla numeral system makes use of decimal format as its base number which is, in turn, suggestive of body-part model of numeral cognition seen pervasively across the languages over the world. On this ground Bangla counting system could be branched into two subclasses such as simplex form of numerals and complex forms made of those simplex ones. Further, it’s been postulated in this paper that both these forms have functional heads in common rather than lexical ones. But, the two types differ in one feature. Simplex forms have functional Q as their head quantifying over the place values whilst, the complex type is headed by the functional conjunctions making them a CoP.

Bibliography


