Semantics of Modified Numerals in Bangla

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***Abstract*—These instructions give you guidelines for preparing papers for the Modified numerals in natural language semantics are defined as denoting cardinal numbers that are modified by a quantifier or degree modifiers (+ adposition) and quantifies over the variable sets of the number. In Bangla (a.k.a. Bengali), there are a range of modified numeral expressions that occur as a quantificational phrase. A numeral phrase in Bangla can be simultaneously modified by two modifiers that further define the cardinality of the numerals. They also occur embedded under the scope of negation, as well as can occur both proceeding to and postpositionally with the numerals. In contrast to languages such as English, French and Hindi which have overt comparative particles (e.g. than, que, /se/ etc.), Bangla has an optional comparative postposition occurring with the numeral before the degree adjective. This paper presents an overview of the semantic distribution of the modified numerals in Bangla. Furthermore, I examine the occurrences of these composite modified numeral phrases in different types of syntactic constructions in Bangla. Along with this, I put forward an account of the scope interaction of these modified numerals with negation and provide a formal analysis of the modified numerals as scalar expressions in Bangla.**

***Index Terms*—Formal semantics, language & linguistics, linguistic theory, modified numerals in Bangla.**

I. Introduction

Highlight Modified numerals in natural languages are defined as a composite phrase denoting cardinal numbers that are modified by a quantifier or degree modifiers (+ adposition) and yield plurality. Modified numerals denote plurality with or without specifying the exact cardinality of the numerals. The examples of a few of these modified numerals are given below:

1. There are *at most 10* students in the class.
2. I have *fewer than 10* pens.
3. Ram has *at least 10* friends.
4. Mary read *exactly 10* books.

The structure of modified numerals can also be observed on postpositional languages, where the quantifiers or degree modifiers follows the numeral. (e.g. Bangla, Hindi etc.) In several languages, there is a comparative adposition that occurs in between the numeral and degree modifiers, such as, *than*, /se/ (in Hindi), /que/ or /de/ (in French) etc. However, in Bangla (a.k.a. Bengali, language spoken in West Bengal, Assam, Tripura and Bangladesh), a null comparative postposition is present that implicitly denote the comparative quantity which is signaled by the numeral and adjectival degree modifiers in a modified numeral phrase. The following sections will present an overview of the various modified numerals in Bangla. In addition to that, the syntactic structure of these modified numerals will be provided along with an in-depth semantic analysis to show the different kinds of plurality that is expressed by the modified numerals in Bangla.

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II. Semantics of Modified Numerals

The issue of various aspects of the semantics of modified numerals, quantification and compositionality in natural language has been a debated topic of inquiry in the contemporary semantics (May, 1977 [1]; Partee, 1995 [2]; Heim &Kratzer, 1998 [3]; Matthewson, 2001 [4]; Herburger, 2016 [5] etc.). According to Szabolcsi (2010) [6] modified numerals include counting words (e.g. *exactly n* NP), comparative quantifiers (e.g. *more than n* NP) and non-comparative/superlative quantifiers (e.g. *at most n* NP). [p. 175]

III. Review of Literature

Several studies have shown the quantificational distribution of the modified numerals in natural languages. Hackl (2001) [7]; Krifka (2007) [8] and Takahashi (2006) [9] have analysed comparative quantifiers, Nouwen (2010) [10] has examined negative comparative quantifiers, Solt (2007) [11] posits an semantic account of differential quantifiers, Geurts & Nouwen (2007) [12]; Umbach (2006) [13] and Krifka (2007) [8] have inquired into degree quantifiers, Corver & Zwarts (2006) [12] put forward an analysis of locative quantifiers, and Nouwen (2010) [10] has theorized about directional quantifiers. Mayr (2013) [14] has analyzed the domain of implicatures that are encoded by modified n2umerals in natural language. Dasgupta (1988) [15] has proposed an analysis of /kɔek/ and claimed that it cannot be extraposed out of an agent subject NP but can be extraposed out of an object NP or an unaccusative subject NP. He claims this phenomenon as "QP postposing". Bagchi (2014) [16] has proposed the analysis of 'scalar' quantification of / ɔnek/ (many) in Bangla and gives an account of where it occurs also as a "quantifier adjective".

Geurts and Nouwen (2007) [12] propose that superlative modifiers are inherently different from comparative modifiers when they modify numerals. Nouwen (2010) [10] puts forward the claim that there are two classes of modified numerals (C*lass A* and *Class B*) and provides a semantic analysis of modified numerals in English. According to Nouwen (2010) [10], Class A modified numerals readily express relations to definite amounts. The following sentence is therefore acceptable:

5. A hexagon has *fewer than 11* sides.

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Class B modified numerals, on the other hand, are incapable of expressing relations to definite amounts. This is illustrated in example (6):

6. #A hexagon has *at most/maximally/up to 10* sides.

The cardinal numbers in natural language can be modified by adjectives and degree quantifiers (Barwise and Cooper, 1981 [17]; Doetjes, 1997 [18]). Numeral modifiers modify the exact cardinality of the natural numbers and encode a set of scalar range for the number. The modified numerals differ from the proportional quantifiers. Although, the proportional quantifiers denote a set of numeral variables, however, they encode the relation between two cardinal numbers or one cardinal number and a measurement value, for example, more than half of 10, 8 out of 10 and one thirds etc (Corver & Zwarts, 2006 [19]).

In Hindi, the numerals are modified by /se/, for example /dɔs se jyada/ 'more than 10', /dɔs se kuch kɔm/ ' a little less than 10' etc. Similarly, in Bangla, the numerals can be modified by adjective quantity words, comparative quantifiers and degree quantifiers. Additionally, these modified numerals can also be modified further by adjective quantity words, quantifiers, partitives and negation. Some of the examples of modified numeral phrases in Bangla include (from examples 7-13):

7. /dɔš er kɔm/(less than 10)
8. /dɔš er ɔnek kɔm/ (fewer than 10)
9. /dɔš er ɔnek beši/ (a lot more than 10)
10. /dɔš er beši nɔe/ (not more than 10)
11. /ɔnt̪ot̪o dɔš/ (at least 10) /
12. /dɔš er beši nɔe/ (not more than 10)
13. /dɔš er kɔm nɔe/ (not less than 10)

The modified numeral construction in Bangla include cardinal numbers that are modified by degree modifiers (/kɔm/,/ beši/), quantifiers (/kic^{h}u/, /ektu/, /ɔlpo/), adjective quantity words (/ɔnek/) etc.

These modified numerals occur in different sentence structures and encode comparative quantificational sets of entities/objects. The cardinality of the numeral is denoted by comparative quantification and definite NPs. However, the plural readings of these modified numerals needs to be defined in relation to the complex cardinality that is implicitly encoded by these composite phrases.

IV. Modified Numerals in Bangla

Bangla numeral modifiers occur both proceding to and postpositionally with the numerals. In contrast to languages such as English, French and Hindi, which have overt comparative particles (e.g. *than, que/de, /*se/), Bangla has an optional comparative postposition occurring with the numeral before the degree adjective. Further, Modified numeral phrases in Bangla can be observed in the examples (14-16):

14. Ram porikhae **ašir opor(e)** nɔmbor peyəche
    Ram porikha -e aši -r opor -e nɔmbor peyəche
    Ram exam -loc. 80 -gen. over -loc. number got.pres.3rd
    "Ram got over 80 marks on the exam."
15. Rimar **dɔšer kɔm** bonḍ^{h}u ac^{h}e
    Rima -r dɔš -er kɔm bonḍ^{h}u ache
    Rima -gen. ten -gen. less friend be.pres.
    "Rima has fewer than ten friends."

16. ekta t̪rikoner **ɔnt̪ot̪o t̪inte** bahu t̪^{h}ake
    ek -ta t̪rikon -er ɔnt̪ot̪o t̪in -te bahu t̪^{h}ake
    one -cls. triangle -gen. at least three -cls. hands be.gen.
    "A triangle has at least three hands."

Moreover, a numeral in Bangla can be simultaneously modified by two modifiers that further define the cardinality of the numerals. This phenomenon can be illustrated by followings:

17.kichu loker **ɔnt̪ot̪o ḍutor beši** gaṛi ache
    kichu lok -er ɔnt̪ot̪o ḍu -to –r beši gaṛi ache
    some people–gen.atleast two-cls.–gen.morecar be.pres.hab.
    'Some people have more than at least two cars.'

18. ei boite **dɔšer ɔnek kɔm** paṭa ache
    ei boi -te dɔš –er. ɔnek kɔm paṭa ache
    this book -loc. ten –gen. much less page be.pres.
    'This book has less than 10 pages.'

Therefore, we can observe that numeral phrases in Bangla can be simultaneously modified by two adjectival quantity modifiers and they encode various scalar range for the cardinality of the N phrase.

V. Modified Numerals and Plurality in Bangla

Scha (2003) [20] has described a unified treatment of plurality in natural language that accounts for the variety of plural readings. According to Scha, "A quantification which ranges over the extensions of a noun is called *distributive*." [ibid] Winter and Scha (2015) [21] examine the problem concerns in the interpretations of plurality in natural languages by mainly concentrating on English plurals. They put forward two central approaching of analysis of plurals, i.e. as modifiers of predicates and as plural determiners. They argue that in many instances the plural NP quantifies over single entities or collections of entities. They claim that the sentence *John shuffled the decks* encode both the collective and distributive readings. Moreover, many languages show internal variations in the properties of numerals. Zweig (2005) [22] has proposed extensive empirical cross linguistic analysis focusing on the interaction between numerals and adjectival phrases.

Balusu (2005) [23] has put forward semantic account of the distributive readings of the reduplicated numerals in Telugu. Along similar lines, the modified numerals also encode various range of plurality in Bangla, such as:

[Collective Plurality]

19. ei boi -te dɔš -ta -r kɔm pat a ache
    this book -LOC. ten -CLS. –GEN. less page be.PRES.
    "This book has less than 10 pages."

20. ami bajar t heke thik kuri -ta lebu kinechi
    I market -ABL exactly twenty -CLS. Lemon buy.PERF.1st

"I bought exactly 20 lemons from market."

[Distributive Plurality]

21. Ram kauke dɔš -er opor –e nɔmbor d ayə ni
Ram anyone ten -GENover-LOC.marks
give.PERF.NEG .3rd
"Ram has not given anyone more than 10."

The above examples express the various plural readings that is encoded by the various modified numerals in Bangla. An account of the syntactic structure of the modified numeral in Bangla is also provided in the Section VI.

VI. Syntactic Analysis of Modified Numerals in Bangla

The syntactic structure of these modified numerals in Bangla includes a composite phrase that has a null comparative postpostion. The structure of the modified numerals in Bangla can be analysed as follows (Kayne, 2005, 2007 [24], [25]; & Bittner and Hale, 1996 [26]; Cinque, 2014 [27]): 22. /dɔš er beši/ (more than 10).

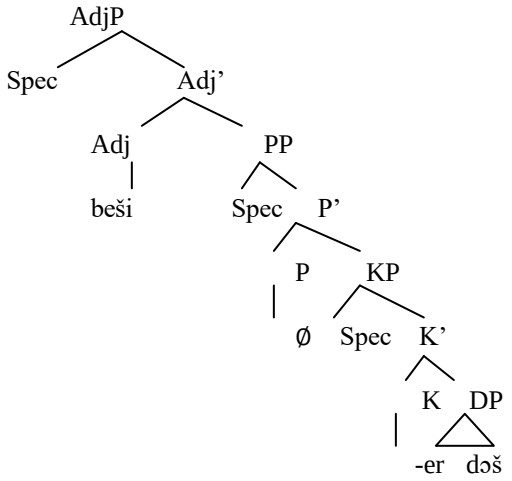

Fig. 1. (a) the repeated (22.) phrase structure after Merge.

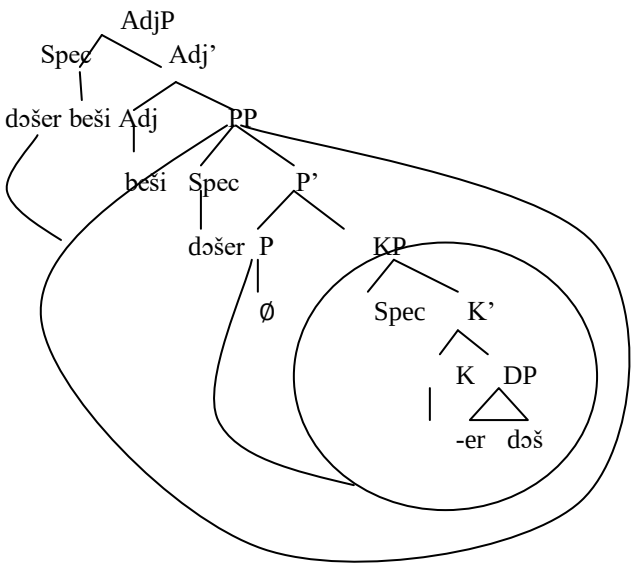

Fig. 1. (b) the syntactic derivation after Move.

In this structure KP denotes case phrase under which node the affixed case markers (for example, genitive case marker, ablative case marker etc.) are marked. The syntactic derivation occurs after Merge and with the application of Move. In this following Fig. 1.(b) we can observed the Quantifier raising of the modified numeral phrases in Bangla to the higher node of the syntactic tree.

Moreover, the syntactic structure of the modified numeral phrase where two adjectival quantity modifiers (e.g. **ɔnek kɔm /a little less/)** simultaneously modify a numeral phrase , the syantctic structure of the same will also be derived by Quantifier raising that is triggered by the scope relation between the adjectival quantity modifiers in the modified numeral phrase.

VII. Bangla Modified Numerals and Scope

Kennedy (1999, 2013) [28-29] has given an account of assignment of scopal semantics to numerals. The logical dimension of quantifiers is also discussed in Peters & Westerståhl, 2006 [30]. Kennedy (2013) [29] has proposed that numeral *two* could be formalized as the cardinal degree quantifier:

24. $\lambda P \in D\langle d,t\rangle . \max D = 2$
Where, $2 = \max\lambda n$ [you have n-many Ns]

Thus, a 'maximizing operator' (exh or max) binds the variable to the numeral argument position and denotes the cardinality of the numeral itself. Assigning Kennedy's degree maximization analysis to Bangla modified numeral we derive the following analysis for the followings:

25. klase dɔser ɔnek besi chatro esheche
klas –e dɔs -er ɔnek besi chatro esheche
class -loc. ten -gen. many more student come.pre.perf.
'More than 10 students have come to the class.'

26. klase dɔser besi chatro esheche
klas –e dɔs -er besi chatro esheche
class -loc. ten -gen. more student come.pre.perf.
'More than 10 students have come to the class.'

In the example (25), the modifier numeral expression denotes:

27. / dɔser ɔnek besi +N/
$\vDash \|X \text{ card}\| = X>30$
where $\lambda P \in D\langle d,t\rangle . \max D = 50$

Whereas, in the example (26), the modifier numeral expression denotes:

28. / dɔser besi+N/
$\vDash \|X1 \text{card}\| = X<30$
where $\lambda P \in D\langle d,t\rangle . \max D = 50,$

However, the alternative set of X1 has a wider range of Scalar value than X in the example (26):

29. ⟦X1 card⟧ ∈ {11,12,13,14...49}

According to Horn (1972) [31], the establishment of the scales is motivated by the induced unilateral entailment relationship between the quantity modifiers:

30. <some, many, most, all>

Therefore, the negation is inherent within the set of alternatives that are entailed by the modified numeral expressions. The scope relation between negation and the modified numerals can be observed. In some instances, the modified numerals occur embedded under the scope of negation and sometimes negation gets the narrow scope. This phenomenon is illustrated by the examples (31- 33):

[∃e > ¬]

31. boi ḍutor ḍam ekšor kɔm noe
boi ḍu -to -r ḍam ekšo -r kɔm noe
book two -cls. –gen. price hundred -gen less neg.
'These two books do not cost less than 100.'

[¬ > ∃e]

32. Sita ṭinter beši boi pɔreni
Sita ṭinte -r beši boi pɔre ni
Sita three -gen. more book read.perf. neg.
'Sita did not read more than three books.'

The semantic distribution of the adjectival modifiers that modify the numerals in Bangla:

[superlative + N]

33. ɔnek baṛiṭe onṭoṭo ḍuto boi thake
ɔnek baṛi - ṭe onṭoṭo ḍu -to boi thake
many house -loc. at least two -cls. book be.pres.hab.3rd
'At many houses, there are at least two books.'

[N + comparative]

34. ekta boite dəštar kɔm paṭa ache
ek -ta boi -te dəš -ta -r kɔm paṭa ache
one -cls. book -loc. ten -cls. –gen. less page be.pres.
'One book has less than 10 pages.'

These composite modified numeral phrases occur in different types of sentences in Bangla. (e.g. indicative, conditional, modal etc.)

VIII. Conclusion

This paper presents brief analysis of the semantic distribution of modified numerals in Bangla. Syntactically these modified numerals include a nullP denoting a comparative adposition (either overt or implicit). These modified numerals occur with negation and quantifiers and encode various scope readings. Moreover, this paper examines the modified numerals as scalar expressions that include a 'maximizing operator'. In conclusion, this paper highlights the issue of the semantic mapping of the modified numerals in Bangla.

Conflict of Interest

The author declares no conflict of interests.

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