ICON - 2008

6th International Conference on Natural Language Processing

Details Of The Selected Paper

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Topic	**Machine Translation**
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Problems of Transfer Grammar:
The Hindi Postpositional Correlatives in Bangla

Abstract

A system of machine translation under the framework of transfer-based grammar for Indian languages needs a set of rules for mapping the several *syntactic* as well as the *semantic* facts of a source language on to the target language representations. Among these critical syntactico-semantic facts, this paper tries to approximate rules for Hindi postposition transfer to Bangla. The rules describe the way of transferring. This work empirically deals with the Bangla correspondences of Hindi postpositions. This paper also explores some *useful* conditions or properties of the grammatical elements playing roles in the sentential environment of both languages.

Keywords: Transfer Grammar (TG), Postpositions (PSP), Inflections, Modern Hindi (MH), Modern Bangla (MB)

1 Introduction

The main task of this paper is to approximate certain *utilitarian* laws based upon the *facts* and (con)*fusions* in some empirical issues of creating a Transfer Grammar for machine translation. In particular we are working on developing a transfer based machine translation system between Hindi (3rd highest spoken language in the world) and Bangla (7th highest spoken language in the world). [1] These are related languages from the same family and have convincing similarities. While there is a broad similarity in the structure of the sentences in these two languages, which makes the process of translation easy, there are many subtle differences in the structure, which must be addressed. In this paper we present our study of the correspondence of the Hindi postpositions (PSP) to their 'most' appropriate grammatical correspondences in Bangla. This is an important component in building up rules of Transfer Grammar (TRG) for these languages.

If the method of comparative *reconstruction* in Philology is to be believed, then one may draw a link that Modern Hindi (MH) and Modern Bangla (MB) both *originate* from Old Indo-Aryan (OIA). Therefore, MH and MB both have been recommended to New Indo-Aryan (NIA) language group by the philologists, though there may be different judgments contradicting each other on the evolution of MH and MB. Despite the similarity in syntactic pattern, i.e., SOV structure and the *reality* of interrelation between these two languages as the members of Indo-Aryan language family, the grammaticality of these two languages are quite different, for example, these two have considerable structural differences such as in the construction of Noun Phrase (NP) or in Verb Phrase (VP) or other else. This paper elaborates such a difference where MH PSP system results dissimilar grammatical units in MB.

2 Problems

MB has two possibilities to express the parallel senses of MH PSPs. MB words may take inflexions (as in 1 (i)) or they hold PSPs as different lexical entities (as in 1 (ii)) parallel to the MH PSPs, or both can be employed. The case, when a PSP of MH

[1] The highest spoken language is Chinese, 2nd highest is English and French in on the 10th Position. See the link: http://www.aneki.com/languages.html

cannot be translated straightway as a different lexical entity like PSP in MB and it just make a change in the form of an inflexion of a modified item, is very complex in nature. For example, we may see the way how MH PSP [-me.n] is transferred into MB inflexions and PSP [-se] sometimes goes to take a PSP as a different lexical entity like [-diYe] or [-dbArA] in MB.

1. (i)
MH: **ja.ngala** me.n eka purAnA mandira thA
'jungle' 'in' 'one' 'ancient' 'temple' 'was'
MB: **ja~Ngale** ekaTA purona mandira Chila
'jungle (-in)' 'one -the' 'ancient' 'temple' 'was'
=> "There was an ancient temple in the jungle"
(ii)
MH: **kalama se** likhanA
'pen' 'with' 'writing'
MB: **kalama diYe** lekhA
'pen' 'with' 'writing'
=> "Writing with pen"
(iii)
MH: **raama se** sitA achchii hain
'raama' 'than' 'sitA' good is
MB: **raamera cheye** sitA bhAlo
'raama-genitive' 'than' 'SitA' good
=> "Ram is better than Sita."

Sometimes a single form of a PSP of MH is operated for communicating various meanings. For example, we have many variations of PSP [-se] according to the practical usage of MH. (We denote variations by superscripts, discussed in section 5.1.4.) /-se/ produces senses as English preposition 'by', 'with', 'since', 'to', etc.

This is the puzzle we discuss in this paper and try to solve for the best possible rules for Hindi-to-Bangla transfer grammar. For the above cases, if we translate the senses of 'se' in their corresponding target translations, the follow-on Bangla cases vary not only in forms but in senses but in morpho-semantic parameters. These are however very crucial things which may influence the quality of translation.

3 Methodology

Primarily this work is duly framed by the inductive method. Inductive method approaches the way of climbing from the specific observations to generalizations or generic formulations. As the methodological concern we observe some raw corpus or somewhere some parallel corpus of MH and MB to examine the conditional transfer of MH-PSP. Observing the corpus we try to find out pattern from the cited examples of each PSP variation and thus we proceed to formulate the general rules depending on those patterns.

4 Hindi Postpositions

The Hindi postpositions are like prepositions in English and they are free in form as separate lexical items. Normally they are mostly to be seen after a noun occurs in a sentence. Along with a postposition a noun is always counted as indirect or oblique case in Hindi grammar. These postpositions also take part in è-role in a sentence. Though it is true that we are expecting to resolve the translation problem for MH to MB, it is rather to say that the PSP for only Nouns we are discussing here. And this must be remembered that as a natural language is a very complex system it deserves more explicit scrutiny for detail study which of course is attempted in this paper, but there are the lacunas proving difference between examples cited from selected corpus and living standard colloquial for both MH and MB.

This is very essential to cull some of those variations which show the complexity of usage of PSP in MH. So that though this paper tries to build some generic laws on PSP transfer in two certain languages, but it of course counts those examples which may have not helped to prove the laws at ease. For the above examples, if it is tried to trans-

fer the senses of /-se/ in the matching target translation, what options for /-se/ the resulting sentences would capture for a correct sense of the source sentence and how? Especially when it seems to be at the same positions, i.e., after a noun, in two sentences with a same phrase structure, i.e. NN + PSP, is very complex to transfer the actual sense of the particular case, though we can make different Transformational Trees for these two sentences. In Table A where we have two variations of 'ko', eight different scopes to see how 'se' works, and two variations of each'me.n' and 'para'.

To solve these puzzles we must know about all the possibilities in target language. In most cases of MB we see the noun takes inflexions, inflectional suffix or endings, and inflectional words and postpositions.

4.1 Bangla Inflexions and Postpositions

The two categories like *pratyaYa* (affixation) and *bibhakti* (inflexion) in Bangla grammar are close to each other in the sense of attaching something to the words. But these two are different in functions. First is necessary for word formation and second is to identify different *kAraka*. After attaching *bibhakti* there is no scope of adjoining another particle to the word.

There is a skinny dissimilarity between two types of *bibhakti* in Bangla grammar. Suniti Kumar Chatterji (1939/ 1988) noted this difference and categorized *bibhakti* into two subclasses; a. Inflexion Proper b. Post Positional Words.

Proper Inflexion:

[Nominative = /-0/, /-e/ (/-Ye/, /-Ya/), /-te/ (/-ete/); Accusative/ Dative = /-e/ (/-Ye/, /-Ya/), /-ke/, /-re/ (/-ere/); Instrumental/ Locative = /-e/ (/-Ye/, /-Ya/), /-te/ (/-ete/); Genitive = /-r/, /-era/]

Post-Positional Words:

[Instrumental = /-diYA/ (/-diYe/, /-de/), /-dbArA/, /-kartRRika/, /-kariYA/ (/-ka're/); Dative = /-tare/ (<antarae, Antare), /-janya/ (/-janye/), /-lAgiYA/ (/-lege/), /-kAraNa/ (/-kAraNe/), /-hetu/ (-hetute); apAdAna = /-haite/ (> ha'te), /-thAkiYA/ (>/-theke/), /-kAchh theke/, /-nikaTA haite/; Locative = /-kAchhe/, /-nikaTe/, /-madhye/]

It has been examined that the MB PSPs perform the same 'functions' as the inflectional markers or '*bibhakti*' designate relations between nouns and verbs. But MB PSPs are free in forms where as inflectional markers in MB are not. (Bagchi, 2007) There is another problem when we try to identify a different *kAraka* by same bibhakti marker. Now is time to evaluate the process of transfer from MH to MB.

5 Selection of Senses

We may choose appropriate sense of a postposition based upon some conditions and properties of the lexical environment in respect to their both syntactic and semantic relations. Each and every sense of these items goes to different rules which are constructed grammatically. Keeping the format for rules proposed by Husain, Misra Sharma, Reddy (2007) in mind we hereon modify for the best result of transferring PSP within Indian languages. These rules cover at most the high frequent Hindi PSPs and their basic variations through the transference into the Bangla.
Various results in the target language for given MH PSP are decided on the basis of rules syntagmatically framed with its natural grammar. The format of the rules contains at least six attributes. Following Husain, Misra Sharma, Reddy (Ibid) the attributes are:

a) Source Language postposition
b) Modifier category
c) Constraints on the modifier item
d) Modified category
e) Constraints on the modified item
f) Target language out put

If we have P for Source Language postposition; m_1 for Modifier (lexical) category;

α, β and γ are supposed to be as three constraints of m_1 and have been composed with 'and' operator (represented as &&); m_2 for Modified (lexical) category, but m_2 has no significant constraint which takes parts in translation; and T for Target language out put, we can formulate an underlying rule. Despite the model done by Husain, Misra Sharma, Reddy (Ibid), where the process of providing constraints is to choose 'some set of lexical items found in a synset of a hypernym obtained from WordNet', we provide constraints (α, β and γ) depending on three levels of information about modifier and modified category. For example, α for type of lexical category, β for description of the semantic field, such noun 'time' 'place' or describing pragmatic property of the modifier and γ for extra information like where θ – Role is to be mentioned. And for the modified category only β may be provided. That is why we use -:_:- to indicate the three level constraints on the lexical category in our format of rules. A replica of the format here we are discussing is given below;

 # P, m_1, -: (α, β, γ) :- , m_2, -: (β) :-, T

This is to say that the constraints are not fixed constantly in a given sentence. May be there is no scope to identify semantic field of the lexical item or no scope to define the θ – Role. If so then the redundant space in linier representation should be blank.

5.1 Transferring Postpositions

The main issues now should be discussed here. The mostly possible cases that describe the variations of Hindi postpositions and their correspondences in Bangla can be interpreted with examples. Interpretations are drawn both from syntactic and semantic parameters. But the problem is that all the variations of the Hindi postpositions cannot be describable syntactically. And those which are not describable syntactically seek semantic as well as pragmatic explanations from source and target language. Therefore, in the following sub-sections we in first step consolidate the fact of transfer, secondly we give examples and then map both a syntactic and semantic rule and lastly we discuss.

5.1.1 Noun without PSP or Inflexion

In MH and equally in MB there are so many scopes where nouns are used normally without any postpositions or inflexions. This is either a case of singular nominative or a case of singular accusative. To make the above case clear we may site examples. Considering the following constructions;
(iv) X is Y
(v) X gave a book to Z
(vi) X makes P happy
We see the proper nouns (in nominative); X, Y, P, or the objects like 'book' are 0-ending. Similarly in MH or MB, there are the nouns without inflexion or PSP. Therefore, this is very easy to say that nouns without PSP in MH can be mapped equally in MB, i.e. /-0/ à /-0/. A simple rule can satisfy above case.

0, n, -: (NNP/NN) :- , v, (_), ZZ

This is a simple case of TRG. MH nouns with /-0/ PSP possibly appear to be always Zero ending nouns in MB. So the rule is monolithic whether it has been observed from the syntactic or the semantic point of view.

5.1.2 Postposition /ne/

Hindi nominative form sometimes can be identified by the postposition /-ne/. As in MB the uses of other than /-0/ inflexion for singular form of nominative are very low in frequency, we observe the cases of Hindi PSP /-ne/ is dropped at the syntactic level of Bangla same as at English.
(vii)
MH: shyAma ne raama ko bola
'Shyam' 'PSP_ne' 'Ram' 'to' 'said'
MB: shyAma raam ke bollo
'Shyam' 'PSP_Φ' 'Ram' 'to' 'said'
=> "Shyam said to Ram"

A very simple rule can be formed syntactically;

ne, n, -: (NNP/NN) :-, v, -, ZZ.

But if we try to proceed more than the syntactic description, the underlying form of the transfer can be produced as;

ne, n, -: (NNP && NN, <+/-object/ agent>) :-, v, -, ZZ.

The representation <object/ agent> means NNP or NN whichever takes PSP 'ne' is possibly followed by an object 'or' by an agent. Here one thing is striking: though generally /-ne/ is a PSP and this is counted as a different lexical unit, but whenever /-ne/ is attached with Pronoun like /tum/, /myAYa/, /kis-/, as exemplified in below; has become as a morphological part as well as a bound morpheme of the Pronouns, like;

(viii)

(a) myAYa↓[ne] khAYA "I ate "

(b) tuma↓[ne] dikhAYA "You showed"

(c) kisa↓[ne] kAhA "Who said"

We can just keep /0/ for every /ne/.

5.1.3 Variations of /ko/

PSP /ko/ has several expressions in Hindi. For example, we have observed four variants of /ko/ at random scrutiny from the corpus. We designate these variations as ko^1, ko^2, ko^3 and ko^4.

A. *Hindi ko^1 is normally used as accusative or dative, that has to be mapped with /-ke/ in Bangla. This variety is mostly frequent in Hindi.*

(ix)
MH: rabi ne shyAmala ko eka kitAba diYA
'Ravi' 'PSP_ne' 'Shyam' 'to' 'a' 'book' 'gave'

MB: rabi shyAmalake ekaTA bai dila
'Ravi' 'PSP_Φ' 'Shyam(to)' 'a' 'book' 'gave'

=> "Ravi gave a book to Ram"

ko^1, n, -: (NNP/NN_animate_ind obj) :-, v, -:(_):-, -ke

B. *ko^2 is genitive in form with corresponding [-era/-ra] ending in Bangla, as in the following sentence produce sense in English;*

(x) Ravi is feeling hungry

ko^2, n, -: (NNP/NN_??) :-, v, -:(_):-, -genitive

C. *ko^3 is as locative form in Hindi and can be mapped with –e ending in Bangla. This is less-frequent than / ko^1/ and / ko^1/. For example;*

(xi) X will go to home on Sunday.

ko^3, n, -: (NST) :-, v, -:(_):-, -e

D. */-ko^4/ is used with verb is commonly caused for an infinite factor of that verb. For example;* rabi ne shyAma ko jAne ko bolA => "X told Y <u>to go</u>" (we don't have any scope to capture this transfer by rule in this paper as we concentrate here only on to the noun transfer.)

5.1.4 Plural meaning of /-se/

We count more than ten variations of PSP /-se/ as this is problematized in section 2. The number may be increased if more corpuses are scrutinized. We of course do not discuss about all except mostly frequent variations. Now if we try to map these variations of [-se] with the parallel sense items in MB, we get as follows;

$-se^1$	diYe (with/ by)
$-se^2$	-ke diYe/ -dera diYe (with/ by)
$-se^3$	theke (from)
$-se^4$	dhare (since)
$-se^5$	-ke (to)
$-se^6$	-cheYe (than)
$-se^7$	-te (with/ by)
$-se^8$	-0 (Φ)
$-se^9$	-bhAbe (in…)
$-se^{10}$	-ra sa~Nge (with)

Examples;

$-se^1$
(xii) <u>kalama se</u> likhnA AchchhA hE

=> “It is good to write with a pen”

The rule is: # se[1], n, -: (instrumental) :-, v, -: (_) :-, diYe/dbArA. But there is a problem in developing a system, that is, how would one know the category of instrumental noun. We can make a list of that type of word (instrument). There is also a problem we face, i.e. many cases of instrumental form depend on the nouns which are not instrument, though they are acting as instrument, such as /dimAga se socho/ => “think with brain”. /demAga/ => “brain” is not an instrument in Hindi, but it acts as an instrument. Then what is to be done? Observing the facts where /se/ is used with the nouns, we should take a risk to hypothesize a law on it.

se[1], n, -: (NN_ind obj_inanimate) :-, v, -: (non causative) :-, diYe

-se[2]
(xiii) adAlata ne DakTaro se sharmA kA svAsthyaya parIkshaNa karAne kA nirdesha diyA thA
=> “The Court ordered the check-up of Sharma’s health by the doctors”

se[2], n, -: (NNP_singular) :-, v, -: (causative) :-, -ke(Acc) diYe

-se[3]
(xiv) ghara se
=> “from home”

This variation of [-se] is very frequent in use. But this is very critical to manifest a law in terms of its syntactic structure. So we have to count the role of noun and verb and propose a theme-based law on it.

se[3], n, -: (place/position) :- v, -: (_):-, theke

-se[4]
(xv) sahasra varShoM se
=> “since thousand years”

This is also very difficult to extract an exclusive law from the syntactic structure of MH where /se/ is equal to /-dhare/ in MB. We can try to make list of such time words which have a length, such as, varSh (year), samaya (time), sAla (year), kAla (time), dina (day), mAhinA (month), ghanTA (hour), miniTa (minute), etc.

So, we formulate a rule as;

se[4], n,-: (list of time word) :-, v, -, dhare

-se[5]
(xvi) la.DakA ne le.Daki se kAhA
=> “the boy said to the girl”

Examining the set of examples like the one above, we see that the PSP /-se/ can only be associated with the verbs like kAhA, bolA, puchhA, etc. which are similar in their semantic set up. Wherever we try to examine constructing sentences with the combination of /-se/ and the other verbs, we fail to make accepted sentences.

se[5], n, -: (NNP/NN_sing_ani_ind obj, acc) :-, v, -:(verb group like, kAhA “say”, bolA “tell”, prashna kiYA “ask”):-, -ke(acc)

-se[6]
(xvii) chha-sau se adhika
=> “more than six hundred”

se[6], n, -: (NNP/ object, comparison ?) :-, v, -:(-_):-, cheYe

This rule is not satisfied a good accuracy level because of the predicament of what is meant by the comparison.

-se[7]
(xviii) khushI se uchhala pa.DI
=> “jumped with joy”

 # se[7], n, -: (object??) :-, v, -:(_):-, -te

This is also like se[6] as there is no good reason to categorize the nouns in a category of object, which effects or fills mind or body (any kind of body, or container), but this is very difficult to categorize it.

-se[8]
(xix) chhoTe se
=> “Φ very little”

This is very straightway to represent the law of the above case of transfer. /-se/ with adjective in Hindi is always dropped at Bangla.

 # se[8], JJ, -, v, -, -0

-se[9]
(xx) apane dAyiTva kA THIka se nirvAha nahI.n kiyA
=> “did not do his/her own duty in a good way”

This is a very easy case too to represent the law

of the above case of transfer. /-se/ with adverb in Hindi is always being mapped with '-bhAbe' at Bangla.

 # se[9], RB, -, v, -, -bhAbe

-se[10]
(xxi) sIriyA kI sImA irAka se milatI hE
=> "the boundary of Syria merges with Iraq"

 # se[10], n, -: (NNP/NN_genitive (comp)) :-, v, -:(_):-, -genitive_ sa~Nge

5.1.5 kA, ki, ke→ -r

All the genitive forms in MH, i.e. /-kA/, /-ki/, /-ke/ are corresponding to MB genitive inflexion /-r/. for example as ''s' and 'of' in the following English construction;
(xxii)
X's mother
Or,
Father of Y
The form of transfer from Hindi to Bangla is drawn below;

kA/ ki/ ke, n, -: (_) :-, v, -: (_) :-, -r

There are some cases in MB are to be considered as "compound", which contains two nouns together, such as 'jaanakiinandana' that means 'jaanakir nandan' (son of Jaanaki). If we consider to break this compound as "byaasa-baakya" (analytic sentence), e.g., "baTagAcha = baTera gACha", the *bibhakti* of the first noun is [-era] as in "sambandha pada" in MB, the condition matches with a PSP "—kaa" with the effect of the gender and number government in Hindi. Therefore the case of Compounds in MB may have the possibilities to be correlated with MH /-kA/, /-ki/, /ke/.

5.1.6 Locative PSP

/-me.n[1]/ → /-e/ (=>in)
/-par[1]/ → /-e/ (=>on)
/-tak/ → /-paryanta/ (=>up to)

Locative items like /-me.n/, /-par/, /-tak/ in MH can be correlated straight with MB locative markers like /-e/, /-ete/, and /-paryanta/ or /-abadhi/ as these have been maintained in the chart above.

The sense of locative by means of where noun is a 'place' or a space which can contain x. or x is *inside* that, e.g., "ja.ngala" (<forest), "desha" (<country), jaala (<net) etc.). In such case inflexion [-e], [-Ye] or [-Ya] in MB would be correlated with PSP "– me.n" in MH. And these MB inflexions correlated with MH /-par/ where the sense locative would be considered as means of 'things' or "objects" or something which can contain x or x *on* something. And where we mean to a limit or a destination we see the same inflexions or different words like 'abadhi' 'paryanta' etc in MB correlate with MH /-tak/.

me.n[1], n, -: (inanimate) :-, v, -:(_):-, -e
para[1], n, -: (inanimate) :-, v, -:(_):-, -e
taka, n, -, v, -, -paryanta

5.1.7 /-me.n[2]/ (genitive) → /-r/ (genitive)

Somewhere MH /-me.n/ is supposed to be used for the purpose of marking genitive case, e.g., MH: aadami me buddhi nehi hE. In that case MH /-me.n/ is genitive /-r/ in MB when the noun is in singular form and /-dera/ in MB when the noun is in plural form.

But, if we can have a look on the semantic field of the sentences where the case is supposed as genitive in time of transfer from MH to MB, this is also a case of Locative form. Though differently in MB it takes a 'genitive' marker, it is not so in MH.

Looking through the example, one can bring to a close that there are some nouns which are used as "location" though they are not so in their nature.

Thus;

me.n[2], n, -: (animate) :-, v, -:(_):-, -era

6 Evaluation

The TRG rules are tested on a set of 500 sentences extracted from corpus in the feature

domain. Therefore we observe result among the specific domain and the result is with accuracy report obtained without the specialized processing.

Table A shows the total distribution of various Hindi postpositions among the 14.86% postposition (total) of the total 1057147 words extracted at random from the corpus. *Chart 1* shows a graphical representation of the *Table A*. *Table B* is presented for showing the frequency of the variations of PSP /-ko/ among the total occurrence of /-ko/ and *Table C* is for the variations of /-se/.

Table A

		Total	% (Frequency)
Word		1057147	100.00
Postpositions			
	ne	5103	0.48
	ko	15062	1.42
	se	19261	1.82
	kA	15917	1.5
	kI	23346	2.2
	ke	34515	3.26
	me.n	31285	2.95
	para	10138	0.95
	tak	2511	0.23
Postpositions		**157138**	**14.86**

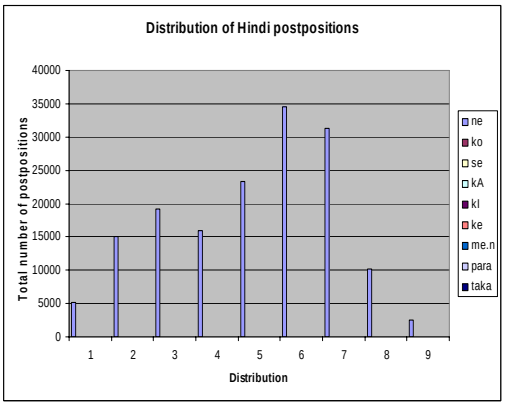

Chart 1

Table B

	Total Occurrence	Rank	% (Frequency)	% (Accuracy for Transfer Rule)
ko	105		100.00	
ko^1	85	1	80.95	65.06
ko^2	5	3	4.76	??
ko^3	4	4	3.8094	(?)
ko^4	11	2	10.47	x

Table C

	Total Occurrence	Rank	% (Frequency)	% (Accuracy for Transfer Rule
se	500			
se^1	74	3	14.8	73.33
se^2	1	9	0.2	??
se^3	243	1	48.6	68
se^4	19	5	3.8	90.50

se^5	16	6	3.2	50.7
se^6	0	10	0	0
se^7	97	2	19.4	??
se^8	15	7	3	82
se^9	5	8	1	43
se^{10}	30	4	6	??

7 Conclusion

Since the PROCESS is getting to be captured in the problems over the language specificity and in some cases of lacuna between the traditional model of grammar and the modern approach of machine translation, a "total", "explicit" as well as "unified" method for capturing RULES FOR TRANSFER should be established.

When some errors are detected in machine translation, there should be a mechanism of conveying the problems of both linguistic and its MACHINE implications, so that it can be acted upon quickly and successfully developed in future.

Colophon: Rita Khastagir, Lipika Sur

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Links:

http://www.itu.dk/people/pfw/hindi/

http://www.ethnologue.com/14/show_language.asp?code=BNG

http://www.aneki.com/languages.html