

HUMAN SENTENCE PROCESSING

Relative clause attachment ambiguity in Hindi sentences

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Abstract

Syntactic or structural ambiguity in Hindi can be attributed to the occurrence of multiple parse trees for a single sentence. It can either be due to an ambiguous lexical entry where the word has more than one part of speech category, or due to the attachment of a prepositional phrase tree. Relative clause attachment ambiguity is the second type of syntactic ambiguity.

This paper analyses the interpretations by native speakers of Hindi of the test sentences which are syntactically ambiguous sentences through a DMDX experiment and a questionnaire. The DMDX experiment also analyses the reading time of each subject for each test sentence, while the questionnaire only gives the preferred interpretation by the subjects. The subjects for both the questionnaire and DMDX experiment were different since it would inhibit the smooth testing of the subjects.

Objective

The aim of the experiment is to test how native speakers of Hindi interpret syntactically ambiguous sentences in Hindi when two equally appropriate interpretations are given. Here the syntactic ambiguity occurs due to the attachment of the relative clause in the sentence. The differences in attachment site of object relative clauses result in prosodic differences when the antecedent of the relative clause is part of a complex NP with the structure N1 of N2.

Relative clause attachment ambiguity arises due to the presence of two preceding nouns acting as potential hosts for the given relative clause. In this paper, we look into the relative clause attachment preferences of the subjects in the test sentences. These test sentences are independent of any context and thus the subjects choose the interpretation they prefer. These preferences are influenced by certain factors and through this experiment we lay the probabilistic factors that might influence the subjects' preferences.

Introduction on Hindi

Hindi is the most widely spoken language of India according to the number of

speakers. However, it is difficult to estimate how many Indians speak Hindi as their native or secondary language. It is important to note that India is a very diverse country in which many languages are spoken, and thus not all Indians speak Hindi. It is spoken widely in the north-central regions of India. Hindi derives its vocabulary from several major sources, including Sanskrit, Arabic, and Persian. The modern standard Hindi also owes structural transformations majorly in communication due to the influence of English. It is cited as the fourth most spoken first language in the world, as a linguistic variety.

DMDX

DMDX, a tool used in psychological and linguistic experiments, developed by Jonathan and Ken Forster at the University of Arizona, is the primary tool used in the experiment. It is a windows based program designed primarily for language processing experiments. It relies on rtf files in which parts of the stimuli, design and procedure of an experiment are defined in a complicated syntax. It uses the features of Pentium class CPUs and the library routines provided in DirectX to provide accurate timing and synchronization of audio and visual output. It is reliable, flexible, millisecond accurate and can be downloaded for free.

EXPERIMENT

The experiments aims to analyze relative clause attachment ambiguity in Hindi sentences for which we conduct one DMDX experiment and a survey, of such sentences which are syntactically ambiguous owing to the attachment of the relative clause in the main clause. This experiment and survey has been done on native Hindi speakers of East Bihar where a slightly varied form of Hindi is spoken.

The subjects are first presented with a structurally ambiguous sentence as described in previous sections. In the following screens two equally accurate interpretations of the test sentence are displayed and the subject is asked to select the one they think is accurate. Reading times are also recorded for every sentence and interpretation.

The setup consists of ten test sentences interspersed with fifteen filler sentences to prevent biasing. The experiment was performed on ten

subjects. The age range of the subjects is 15-60. All the subjects are from Bihar. They are proficient in Hindi and it is also their first language, however in this region of Bihar a slight variation of Hindi is spoken which is one of the influencing factors.

The survey is done by 16 subjects. The age range of the subjects is 21-50. The subjects are proficient in Hindi and it is their first language. Unlike the subjects of the DMDX experiment, they do not speak the Hindi spoken in the East Bihar region to avoid any such influence of the dialects of Hindi.

The DMDX rtf file

```
<azk><fd 100><t 90000><id "keyboard"><dbc 0><dwc  
000255000><cr><rcot><nfb><d 0><n 70><vm desktop><fbp 0>  
0 "Press spacebar to start";  
0 "Read each Hindi sentence presented now in Roman script ";  
0 "Two inferences based on the sentences will be displayed";  
0 "PRESS RIGHT SHIFT key for correct interpretation",  
<ln 2> "PRESS LEFT SHIFT key for incorrect interpretation";  
0 "Try to respond as quickly as possible",  
<ln 2>"but not so quickly that you make errors";  
0 "Press the SPACEBAR to begin the demo ";  
  
0 "1. Kal ek aisa din tha jab sab galat ho raha tha", <line 2 > "PRESS SPACEBAR  
when Ready";  
+101 * "(a) Kal jo bhi ho raha tha sab galat ho raha tha";  
+201 * "(b) Kal ka din galat tha";  
  
0 "2. Shivam ek ladki se mila jiske sath mai school jaati thi", <line 2 > "PRESS  
SPACEBAR when Ready";  
+601 * "(a) Shivam ek ladki se mila, mai Shivam ke sath school jati thi";  
+701 * "(b) Shivam jis ladki se mila mai uss ladki ke sath school jati thi";  
  
0 "3. Kisine uss abhinetri ki beti ko goli maar di jisse award mila tha", <line 2 >  
"PRESS SPACEBAR when Ready";  
+102* "(a) Kisine uss abhinetri ki beti jisse award mila tha usse goli maar di";  
+202* "(b) Kisine uss abhinetri jisse award mila tha uski beti ko goli maar di";
```

0 “4. Uss ladke ne bottle tod di jiske pita ek doctor hai”, <line 2 > “PRESS SPACEBAR when Ready”;

+602 * “(a) Uss ladke ne bottle tod di, uske pita ek doctor hai”;

+702 * “(b) Uss ladke ke pita ne bottle tod di, uske pita ek doctor hai”;

0 “5. Kya tum mujhe wo slide bhej sakti ho Whatsapp pe jiske bare me sir baat kar rahe the”, <line 2 > “PRESS SPACEBAR when Ready”;

+103 * “(a) Kya tum mujhe wo slide bhej sakti ho jiske bare me sir Whatsapp pe baat kar rahe the”;

+203 * “(b) Wo slide jiske bare me sir baaat kar rahe the, kya tum mujhe wo Whatsapp pe bhej sakti ho”;

0 “6. Laptop ek computer hai jisse lekar ghuma jaa sakta hai”, <line 2 > “PRESS SPACEBAR when Ready”;

+603 * “(a) Laptop ek computer hai, laptop ko lekar ghuma jaa sakta hai”;

+703 * “(b) Laptop ek computer hai, computer ko lekar ghuma jaa sakta hai”;

0 “7. Woh murti waha ghar me hai jo bhukamp me gir kar aadhi toot gayi”, <line 2 > “PRESS SPACEBAR when Ready”;

+104* “(a) Woh murti jo bhukamp me gir kar aadhi toot gayi thi waha ghar me hai”;

+204 * “(b) Woh murti waha ghar me hai, jo ghar bhukamp me gir kar aadha toot gya tha”;

0 “8. Meri cycle jo mere pas 10 saal se adhik samay se hai garage me rkhi hui hai”, <line 2 > “PRESS SPACEBAR when Ready”;

+604 *“(a) Meri cycle garage me rakhi hui hai, garage 10 saal se adhik samay se mere pas hai”;

+704* “(b) Meri cycle garage me rakhi hui hai, cycle 10 saal se adhik samay se mere pas hai”;

0 “9. Doctor uss patient ke bhai se mili jisse cancer tha”, <line 2 > “PRESS SPACEBAR when Ready”;

+105 * “(a) Doctor uss patient jisse cancer tha uske bhai se mili”;

+205 * “(b) Doctor uss patient ke bhai jisse cancer tha se mili”;

0 “10. Woh kutta pagal ho gaya hai jiska maalik London me rehta hai”, <line 2 > “PRESS SPACEBAR when Ready”;

+605 * “(a) Woh kutte ka maalik London me rehta hai, maalik pagal ho gaya hai”;

+705 * “(b) Woh kutte ka maalik London me rehta hai, kutta pagal ho gaya hai”;

0 “11. Kya tum wo kitaab laa sakti ho library me jo mai padh rahi thi”, <line 2 >
“PRESS SPACEBAR when Ready”;

+106 * “(a) Kya tum wo kitaab library me laa sakti ho jo mai padh rahi thi”;

+206 * “(b) Kya tum wo kitaab laa sakti ho jo mai library me padh rahi thi”;

0 “12. Woh chhoti ladki jiski gudiya kho gayi thi woh bahot dukhi hai”, <line 2 >
“PRESS SPACEBAR when Ready”;

+606 * “(a) Woh chhoti ladki ki gudiya kho gayi thi, woh chhoti ladki bahot dukhi hai”;

+706 * “(b) Woh chhoti ladki ki gudiya kho gayi thi, uski gudiya bahot dukhi hai”;

0 “13. Vyshnavi ek bachche ko nahla rahi thi jo jhula jhul raha tha”, <line 2 >
“PRESS SPACEBAR when Ready”;

+107* “(a) Vyshnavi ek bachche ko nahla rahi thi, bachcha jhula jhul rha tha”;

+207 * “(b) Vyshnavi ek bachche ko nahla rahi thi, Vyshnavi jhula jhul rahi thi”;

0 “14. Shikari ne ek bade se chimpanzee ko jungle me dekha daurte huye”, <line 2 >
“PRESS SPACEBAR when Ready”;

+607* “(a.) Shikari ne khud daurte huye ek bade se chimpanzee ko jungle me dekha”;

+707 * “(b.) Shikari ne ek bade se chimpanzee ko daurte huye dekha jungle me”;

0 “15. Anushka uss kaale kapde wali ladki ke sath aayi thi jo mujhse address puch rahi thi”, <line 2 > “PRESS SPACEBAR when Ready”;

+108 * “(a.) Anushka uss kaale kapde wali ladki ke sath aayi thi, Anushka mujhse address puch rahi thi”;

+208 * “(b.) Anushka uss kaale kapde wali ladki ke sath aayi thi, wo ladki mujhse address puch rahi thi”;

0 “16. Photographer ne Shubham ko phone kiya jo ki kafi gusse me tha”, <line 2 >
“PRESS SPACEBAR when Ready”;

+608* “(a.) Photographer ne Shubham ko phone kiya, photographer kafi gusse me tha”;

+708 * “(b.) Photographer ne Shubham ko phone kiya, Shubham kafi gusse me tha”;

0 “17. EFL University jaha meri behen padhti hai woh Hyderabad me hai”, <line 2 >

“PRESS SPACEBAR when Ready”;

+109 * “(a) EFL University Hyderabad me hai, meri behen Hyderabad me padhti hai”;

+209 * “(b) EFL University Hyderabad me hai, meri behen EFL University me padhti hai”;

0 “18. Uss laal suitcase me mere kapde the jisse maine fek diya”, <line 2 > “PRESS SPACEBAR when Ready”;

+609 * “(a) Uss laal suitcase me mere kapde the, maine suitcase fek diya”;

+709 * “(b) Uss laal suitcase me mere kapde the, maine kapde fek diye”;

0 “19. Lane 26 me woh chai ki dukan abhi bhi hai jaha mai Prachi se mili thi”, <line 2 > “PRESS SPACEBAR when Ready”;

+110 * “(a) Lane 26 me woh chai ki dukan abhi bhi hai, chai ki dukan pe mai Prachi se mili thi”;

+210 * “(b) Lane 26 me woh chai ki dukan abhi bhi hai, lane 26 me mai Prachi se mili thi”;

0 “20. Airplane me baithe log chiriyo ko dekhte rahe upar jaate huye”, <line 2> “PRESS SPACEBAR when Ready”;

+610 * “(a) Airplane me baithe log chiriyo ko upar jaate huye dekhte rahe”;

+710 * “(b) Airplane me baithe log khud upar jaate huye chiriyo ko dekhte rahe”;

0 “21. Mai kamre ko aise rang se rangana chahti hu jo aakarshak ho”, <line 2> “PRESS SPACEBAR when Ready”;

+111 * “(a) Mai kamre ko aakarshak rang se rangana chahti hu”;

+211 * “(b) Mai kamre ko aise rang se rangana chahti hu jisse kamra aakarshak ho”;

0 “22. Maine abhi apne dost ke bhai ko dekha jo Switzerland me rehta hai”, <line 2> “PRESS SPACEBAR when Ready”;

+611 * “(a) Maine abhi apne dost ke bhai ko dekha, mere dost ka bhai Switzerland me rehta hai”;

+711 * “(b) Maine abhi apne dost ke bhai ko dekha, mera dost Switzerland me rehta hai”;

0 “23. Mai apni ek padosi ke liye gift kharid rahi hun jisne meri samaaan uthane me madad ki”, <line 2> “PRESS SPACEBAR when Ready”;

+112 * “(a) Mai apni uss padosi ke liye gift kharid rahi hun, jisne meri samaan uthane

me madad ki”;
+212 * “(b) Mai apni ek padosi ke liye gift kharid rahi hun, meri padosi ne meri saman uthane me madad ki”;

0”24. Mera pura parivaar uss mahine me ghumne jaa raha hai jab meri internship shuru hogi”, <line 2> “PRESS SPACEBAR when Ready”;

+612 * “(a) Mera pura parivaar uss mahine me ghumne jaa raha jis mahine me meri internship shuru hogi”;

+712 * “(b) Mera pura parivaar ussi mahine me ghumne jaega jab meri internship shuru hogi”;

0”25. Bhari baarish ne mere bagiche ke kafi paudho ko barbad kar diya jo iss saal ke liye asamanya tha”, <line 2> “PRESS SPACEBAR when Ready”;

+113 * “(a) Bhari baarish ne mere bagiche ke kafi paudho ko barbad kar diya, paudho ka barbad hona iss saal ke liye asamanya tha”;

+213 * “(b) Bhari baarish ne mere bagiche ke kafi paudho ko barbad kar diya, bhari baarish hona iss saal ke liye asamanya tha”;

0 “That’s the end of the experiment, Thank you”, <line 1> “Press ESC key to save the data”;

Results and analysis

The results of the test sentences in the DMDX experiment :

Question number in the code	Avg. RT taken for +ve assumption (in ms)	Avg. RT taken for –ve assumption (in ms)
4	4972.29	-6758.36
6	4250.36	-5963.58
8	3122.26	-5355.36
10	2855	-3125.33
12	3664.221	-3166.203
14	2570.22	-2808.302

16	2002	-2502.36
18	3086.25	-6855.23
20	2864.205	-4678.5
22	2664.205	-5687.5

The Questionnaire

Choose the correct interpretation

Kya tum mujhe wo slide bhej sakti ho whatsapp pe jiske bare me sir baat kar rahe the?

☐ Kya tum mujhe whatsapp pe wo slide bhej sakti ho jiske bare me sir baat kar rahe the?

☐ Kya tum mujhe wo slide bhej sakti ho jiske bare me sir whatsapp pe baat kar rhe the?

Kisine uss actress ki beti ko goli mar di jisse award mila tha.

☐ Kisine uss actress jisse award mila tha uski beti ko goli mar di.

☐ Kisine uss actress ki beti jisse award mila tha usse goli mar di.

Woh murti waha ghar me hai jo earthquake me gir kar aadhi toot gyi.

☐ Woh murti jo earthquake me gir kar aadhi toot gyi thi waha ghar me hai.

☐ Woh murti waha uss ghar me hai jo earthquake me gir kar aadha toot gya

☐ Other: _____

Doctor uss patient ke bhai se mili jisse cancer tha.

☐ Doctor uss patient jisse cancer tha uske bhai se mili.

☐ Doctor uss patient ke bhai jisse cancer tha usse mili

☐ Other: _____

Kya tum wo kitaab laa sakti ho library me jo mai padh rahi thi?

- ☐ Kya tum wo kitaab library me laa sakti ho jo mai padh rhi thi?
- ☐ Kya tum wo kitaab laa sakti ho jo mai library me padh rahi thi?
- ☐ Other: _____

Uss shikari ne ek bade se chimpanzee ko jungle me dekha daurte huye.

- ☐ Uss shikari ne jungle me ek bade se chimpanzee jo ki daur rha tha ko dekha.
- ☐ Uss shikari ne khud daurte huye ek bade se chimpanzee ko jungle me dekha
- ☐ Other: _____

Woh ladki uss black dress wali ladki ke sath aayi thi jo mujhse address puch rhi thi.

- ☐ Woh ladki jo mujhse address puch rhi thi uss black dress wali ladki ke sath aayi thi.
- ☐ Woh ladki uss black dress wali ladki jo mujhse address puch rhi thi ke sath aayi thi.
- ☐ Other: _____

Uss red suitcase me mere kapde the jisse maine fek diya

- ☐ Uss red suitcase jisse maine fek diya me mere kapde the
- ☐ Uss red suitcase me mere wo kapde the jisse maine fek diya
- ☐ Other: _____



☐ Other: _____

Uss red suitcase me mere kapde the jisse maine fek diya

☐ Uss red suitcase jisse maine fek diya me mere kapde the

☐ Uss red suitcase me mere wo kapde the jisse maine fek diya

☐ Other: _____

Airplane me baithe log chiriyo ko dekhte rahe upar jate huye.

☐ Airplane me baithe log chiriyo ko upar jate huye dekhte rahe.

☐ Airplane me baithe log khud upar jate huye chiriyo ko dekhte rahe

☐ Other: _____

Maine abhi apne dost ke bhai ko dekha jo Switzerland me rehta hai.

☐ Maine abhi apne dost jo Switzerland me rehta hai uske bhai ko dekha.

☐ Maine abhi apne dost ke bhai jo Switzerland me rehta hai ko dekha.

☐ Other: _____

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Results and analysis

The results of the test sentences in the questionnaire:

Test sentence	Percentage of the option chosen	The sentence chosen
1	93.8	1. Kya tum mujhe whatsapp pe wo slide bhej sakti ho jiske bare me sir baat kar rahe the
2	73.3	1. Kisine uss actress jisse award mila tha uski beti ko goli mar di
3	81.3	1. Woh murti jo earthquake me toot kar aadhi gir gayi thi uss ghar me hai
4	62.6	2. Doctor uss patient ke bhai jisse cancer tha se mili
5	50-50	1 and 2

6	80	1. Uss shikari ne jungle me ek bade se chimpanzee jo ki daur raha tha ko dekha
7	64.3	2. Woh ladki uss black dress wali ladki jo mujhse address puch rahi thi ke sath aayi thi
8	57.1	1. Uss red suitcase jisse maine fek diya me mere kapde the
9	53.8	2. Airplane me baithe log khud upar jate huye chiriyo ko dekhte rahe
10	71.4	1. Maine abhi apne dost ke bhai jo Switzerland me rehta hai ko dekha

Discussion

In this paper, we analyzed the relative clause attachment ambiguity in sentences in Hindi. The results found in the DMDX experiment shows influence of the dialect spoken in this region of Bihar. However the subjects are proficient in standard Hindi. The results have correct and incorrect interpretations of the test sentences. The questionnaire shows the preference of subjects who are not otherwise influenced by any other dialect predominantly spoken in their region.

Conclusion

As a native speaker myself, I could find a pattern in the preferences of the subjects of the DMDX experiment. Also, the survey provided a ground for comparison and analyzing similarities in the responses of the subjects of both the experiment and survey. Through this paper, we see a pattern but not a solid proof to the preferences of the subjects, irrespective of their reading time as it varies, of syntactically ambiguous sentences.

