



Question: What is the nature of prediction in head-final languages?

- This study:
 - Prediction is fallible: prediction of a head/structure in the main clause is forgotten in sentences with a center-embedded relative clause in the language Hindi.
 - Local coherence effect [1].
 - Current results are not explicable by expectation-based accounts [2, 3].

Prediction: what we know

- Speakers of head final languages are assumed to be good at making predictions about the upcoming material based on the input received so far [4].
- Inclusion of pre-verbal elements facilitates processing at the predicted clause-final verb [5].

(1) vo laRkaa jisne us kaagaz.ko (mez.ke piichhe gire.hue) **dekhaa** bahut jigyaasu thaa
that boy who that paper_{Acc} table_{Gen} behind fallen saw very inquisitive was
'The boy who saw the paper (fallen behind the table) was very inquisitive.'

- Explanation: expectation based accounts [2, 3]

The FORGETTING hypothesis

The prediction of the main clause verb by the head noun is forgotten in the presence of a locally coherent parse.

EXPERIMENT: Local Parse type × post-RC Clause Type

- Ungrammatical* sentences with center-embedded relative clauses (RC) where the post RC material cannot be integrated with the head noun across all conditions.
- Local Parse type: **-Locally coherent**, **+Locally coherent**
 - In the +Locally coherent conditions, post RC material can be integrated with RC internal object noun in a locally coherent parse.
 - This manipulation utilizes Canonical(=SOV) word order in RC for -Locally coherent and Non-canonical(=SVO) word order for +Locally coherent (based on [6]).
- post-RC Clause Type: Copula, Transitive.
 - Copula: agreement morphology does not match the head noun
 - Transitive: the transitive verb can not be integrated thematically with the head noun & agreement morphology does not match the head noun

(2) a. NP_{Masc} [Rel-pro_{Erg} ... NP_{Fem} RC-V_{Fem}] **Adjective_{Fem} Copula_{Fem}** **-Locally coherent**, Copula
 b. NP_{Masc} [Rel-pro_{Erg} ... RC-V_{Fem} NP_{Fem}] **Adjective_{Fem} Copula_{Fem}** **+Locally coherent**, Copula
 c. NP_{Masc} [Rel-pro_{Erg} ... NP_{Fem} RC-V_{Fem}] NP_{Dat} **Verb_{Fem} Aux_{Fem}** **-Locally coherent**, Transitive
 d. NP_{Masc} [Rel-pro_{Erg} ... RC-V_{Fem} NP_{Fem}] NP_{Dat} **Verb_{Fem} Aux_{Fem}** **+Locally coherent**, Transitive

- Main effect of Local Parse type:** Reading Times at the post RC verb for +Locally Coherent < -Locally Coherent if the prediction of the main clause verb is forgotten and the RC internal NP_{Fem} is integrated with the post-RC material in a locally coherent parse
- A significant interaction: the effect of Local Parse type on RTs may differ across the two structures
- An expectation-based account [2, 3] predicts no difference in RTs between the conditions at the post RC verb.
 - Since the critical verb-forms in the experimental items are *ungrammatical*, their probability of occurrence given prior words ought to be close to zero across all conditions.

Methods

- Centered self-paced reading + Acceptability rating
- 24 latin-squared items, 56 fillers
- N=52 native speakers of Hindi at the Indian Institute of Technology, Delhi
- Pre-registered on AsPredicted.com

Sample Item

- (3) Experimental Item (‘/’ indicates region breaks. **Critical region** bolded)
- a. vah laRkaa/ jisne/ kal/ bahut dilchasp_{ii} se/ **kitaab/ paRhii thii/**
That boy_{Masc} who_{Erg} yesterday lots interest with book_{Fem} read_{Fem} had_{Fem}
moTii thii
fat_{Fem} was_{Fem}
- b. vah laRkaa/ jisne/ kal/ bahut dilchasp_{ii} se/ paRhii thii/ kitaab/
That boy_{Masc} who_{Erg} yesterday lots interest with read_{Fem} had_{Fem} book_{Fem}
moTii thii
fat_{Fem} was_{Fem}
- c. vah laRkaa/ jisne/ kal/ bahut dilchasp_{ii} se/ kitaab/ paRhii thii/
That boy_{Masc} who_{Erg} yesterday lots interest with book_{Fem} read_{Fem} had_{Fem}
mujhe/ **bechnii paRii**
I_{Dat} sell_{Fem} had-to_{Fem}
- d. vah laRkaa/ jisne/ kal/ bahut dilchasp_{ii} se/ paRhii thii/ kitaab/
That boy_{Masc} who_{Erg} yesterday lots interest with read_{Fem} had_{Fem} book_{Fem}
mujhe/ **bechnii paRii**
I_{Dat} sell_{Fem} had-to_{Fem}
- (4) Spillover region (‘/’ indicates region breaks. **Post-critical region** bolded)
- ... **aur/ vahi kitaab/ k_{aii} dostoM ne bhi/ khariidii**
And that book_{Fem} many friends Erg also bought_{Fem}

RESULTS: RTs

- Linear-mixed effects models were used for all statistical analyses.
- RTs at the critical region:
 - a significant main effect of Clause Type (t=-4.06): RTs for Transitive > Copula.
 - a significant interaction effect (t=-2.56) driven by the Transitive condition: RTs for +Locally coherent < -Locally coherent.
- RTs at the post-critical region:
 - a significant effect of Local Parse type (t=-4.32): RTs for +Locally coherent < -Locally coherent.

Figure 1. RTs for the Copula condition

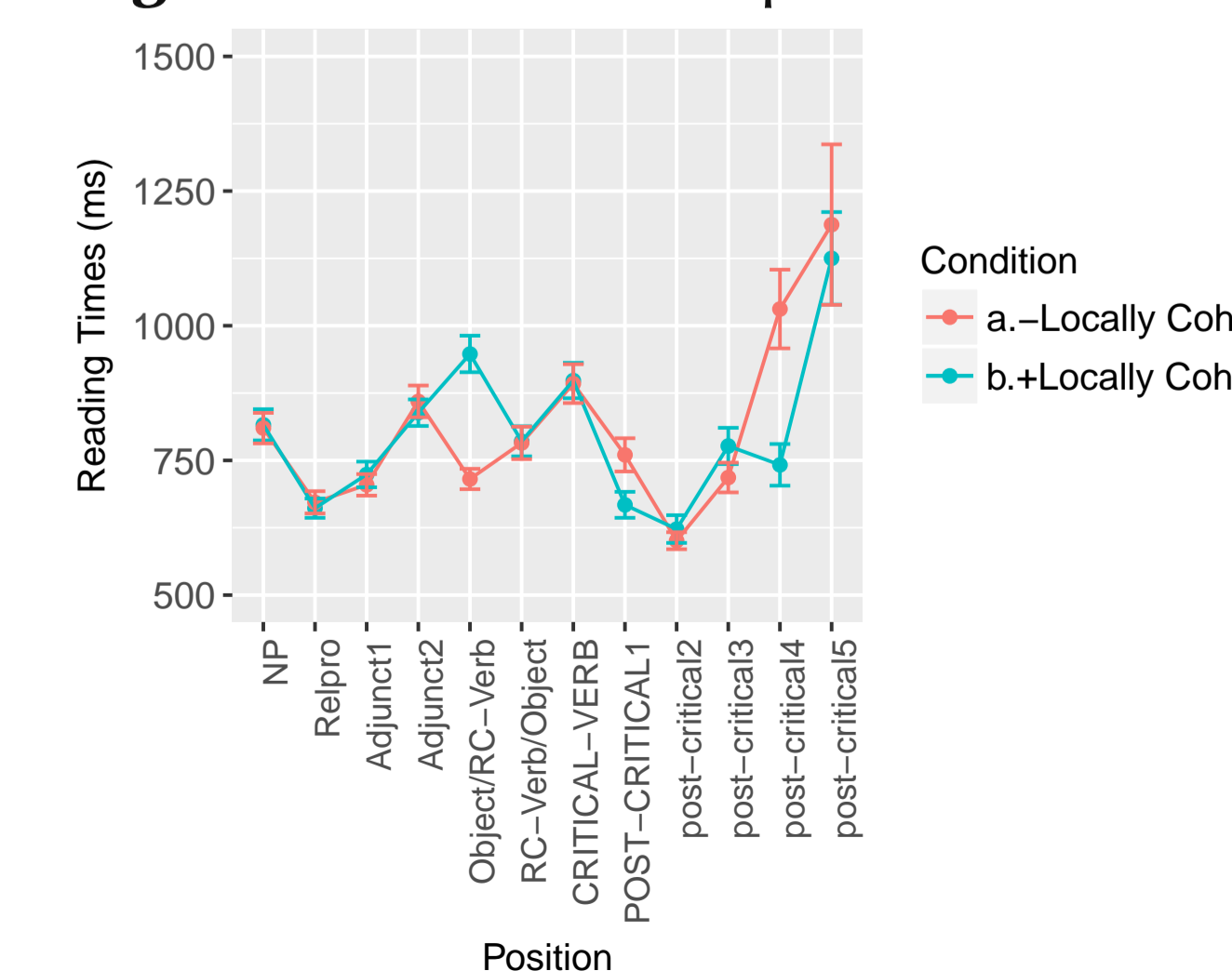
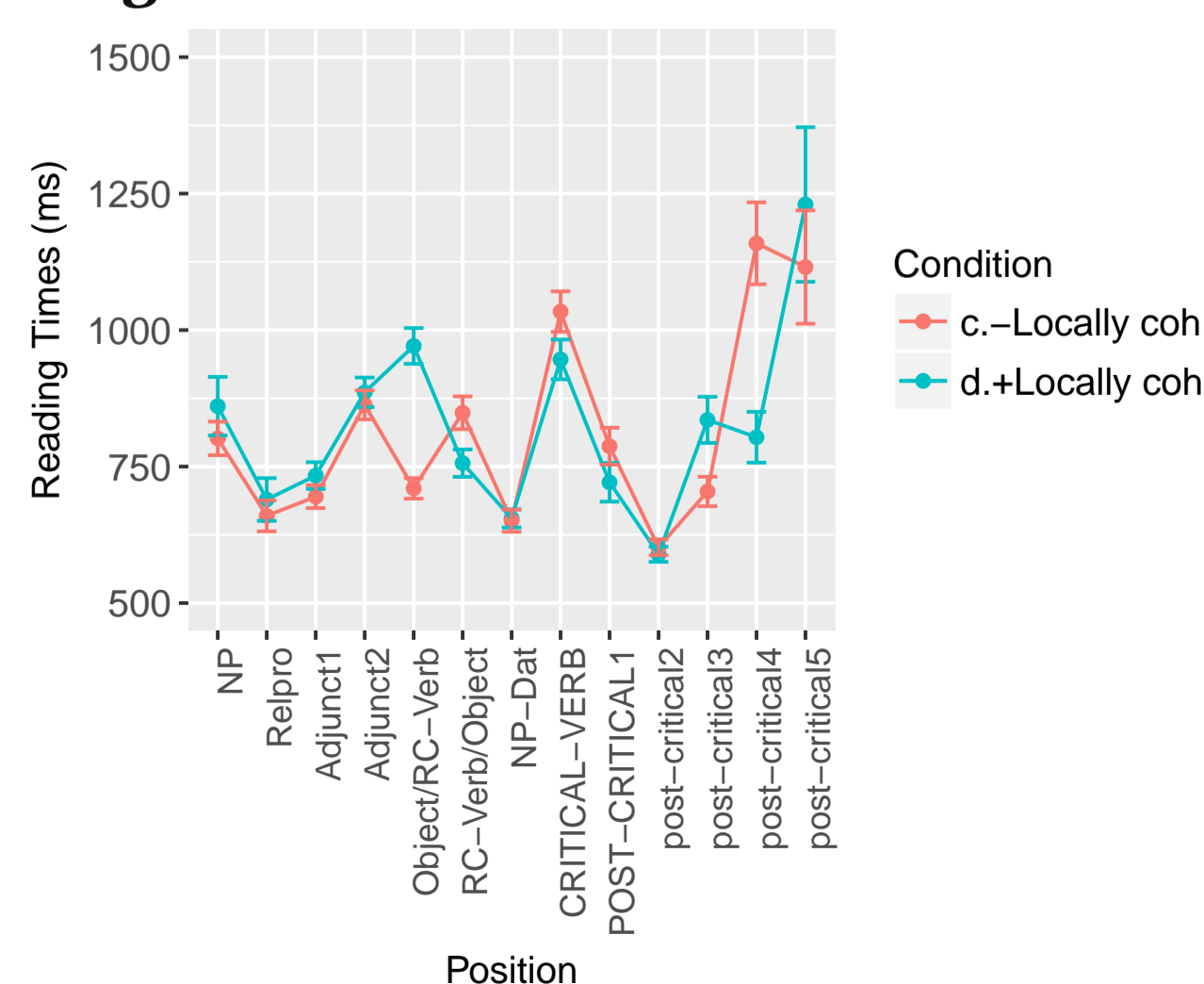


Figure 2. RTs for the Transitive condition



RESULTS: Ratings

- A significant effect of Parse type (t=-5.4): +Locally coherent < -Locally coherent

| Table 1. Experimental items | Rating | Table 2. Filler sentences | Rating |
|----------------------------------|--------|-------------------------------|--------|
| a. -Locally coherent, Copula | 4.4 | Clearly grammatical fillers | 5.2 |
| b. +Locally coherent, Copula | 3.8 | Clearly ungrammatical fillers | 2.4 |
| c. -Locally coherent, Transitive | 4.2 | All fillers | 4.3 |
| d. +Locally coherent, Transitive | 3.8 | (1 to 7 scale, 7=highest) | |

CONCLUSION

| Table 3. Summary of results | Critical Region(RT) | Post-critical region(RT) | Ratings |
|-----------------------------|---------------------|--------------------------|-------------|
| Parse Type | Significant | Significant | Significant |
| Clause Type | Significant | | |
| Parse Type : Clause Type | Significant | | |

- RT results: Hindi speakers are unable to sustain the prediction of the matrix verb that was to be integrated with the head noun (NP_{Masc}), in the face of a locally coherent parse.
- This effect seems temporary since it does not translate to higher end-of-sentence acceptability ratings for +Locally coherent sentences.
- The results demonstrate fallibility in prediction processes in a head-final language using a relatively simple structure.
- Therefore, it is important to further investigate broad claims about the absence of forgetting effects caused by memory constraints in head-final languages [7].

Further issues

- Local coherence occurs with a non-canonical word order (SVO) in the RC:
 - Role of head-finality – the finite verb in the RC could be a strong cue for a clause boundary and the RC-final NP_{Fem} may be treated as being beyond this boundary allowing integration of NP_{Fem} with the upcoming string.
 - Role of revision within the RC – more time in RC, more decay of NP_{Masc}.
- Combining RTs for RC-Object & RC-verb: a significant effect of Local Parse type in a Post hoc t-test (t=5.6)

| Table 4. Means for combined RTs | Copula | Transitive |
|---------------------------------|--------|------------|
| -Locally coherent | a. 749 | c. 779 |
| +Locally coherent | b. 867 | d. 864 |

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References

- [1] Tabor, Galantucci & Richardson, 2004. [2] Hale, 2001. [3] Levy, 2008. [4] Levy & Keller, 2013. [5] Vasishth & Lewis, 2006. [6] Husain, Vasishth & Srinivasan, 2014. [7] Vasishth, Suckow, Lewis & Kern, 2011.