



Question

- ▶ What is the nature of forgetting in the head-final language Hindi?
- ▶ This study:
 - Hindi native speakers are not susceptible to verb forgetting effects in center-embedded structures
 - Hindi patterns with other head-final languages
 - Consistent with the predictions of the language adaptability hypothesis [1]
 - However, comprehension data points to the possibility of shallow parsing.

Verb Forgetting in Center-embedded Structures

- ▶ Working-memory constraints are known to induce ‘forgetting’ effects in center embedded constructions in English [2].
- ▶ Forgetting the prediction of the upcoming VP is argued to underlie the illusion of grammaticality observed in sentences with a missing verb phrase:
(1) *The patient who the nurse who the clinic had hired met Jack.
- ▶ The verb forgetting effect has not been observed in head-final languages such as German and Dutch [1, 3], but see [4].
- ▶ This asymmetry in processing in head-final languages has been attributed to the parser’s adaptability to certain language characteristics such as head directionality.
- ▶ The parser encounters a large proportion of head-final structures and, therefore, becomes very efficient in predicting and maintaining the upcoming verbal heads.

Motivation

- ▶ Prediction processes are fallible in Hindi. [5, 6]
 - Ungrammatical sentences with center embedded relative clauses [6]
 - Word order manipulation within RC - Canonical (2a) & Non-canonical (2b)
 - Speakers are unable to sustain the prediction of the matrix verb that was to be integrated with the head noun in the face of the locally coherent parse available in the Non-canonical order (2b)
 - Indexed by faster reading times at the matrix verb for non-canonical order
- (2) a. NP_{Masc} [Rel-pro_{Erg} ... NP_{Fem} RC-V_{Fem}] NP_{Dat} Verb_{Fem} Aux_{Fem}
b. NP_{Masc} [Rel-pro_{Erg} ... RC-V_{Fem} NP_{Fem}] NP_{Dat} Verb_{Fem} Aux_{Fem}
- ▶ In light of these results, both the ‘forgetting hypothesis’ and the ‘adaptation hypothesis’ need to be tested further cross-linguistically.

EXPERIMENT

- ▶ Doubly center embedded structures of the type previously employed by [1]
- ▶ Experimental manipulation:
a. **Grammatical: All verbs present** b. **Ungrammatical: Missing V2**
- (3) a. NP₁_i [Relpro_j NP2.object_j [Relpro_j NP3 NP4.object V3] V2] V1 ...
b. NP₁_i [Relpro_j NP2.object_j [Relpro_j NP3 NP4.object V3] ∅] V1 ...

Item, Fillers, Methods

- (4) Experimental Item (‘/’ indicates region breaks. **Critical region=V1** bolded)
a. vah dhobi/ jo/ us doctor ko/ jo/ mariiz se/ paise/ le rahaa tha/ dekh raha tha/ **gussa kar**
That washerman who that doctor Acc who patient from money take -ing was see -ing was anger do
raha tha...
-ing was
‘That washerman was angry who was seeing the doctor who was taking the money from the patient.’
b. vah dhobi/ jo/ us doctor ko/ jo/ mariiz se/ paise/ le rahaa tha/ ∅ / **gussa kar raha tha...**
That washerman who that doctor Acc who patient from money take -ing was anger do -ing was
- (5) Spillover region (‘/’ indicates region breaks. **Post-critical region 1** bolded)
... **magar**/ baad me/ uskaa/ gussaa/ kam ho gaya.
but later Loc his anger reduce happen went
‘...but later on his anger died down.’

Fillers:

- ▶ Simple declarative sentences
- ▶ Embedded RCs
- ▶ Correlatives
- ▶ Clausal complements
- ▶ Right-extraposed RCs
- ▶ Sentential coordination
- ▶ Declarative sentences with complex NPs

Methods:

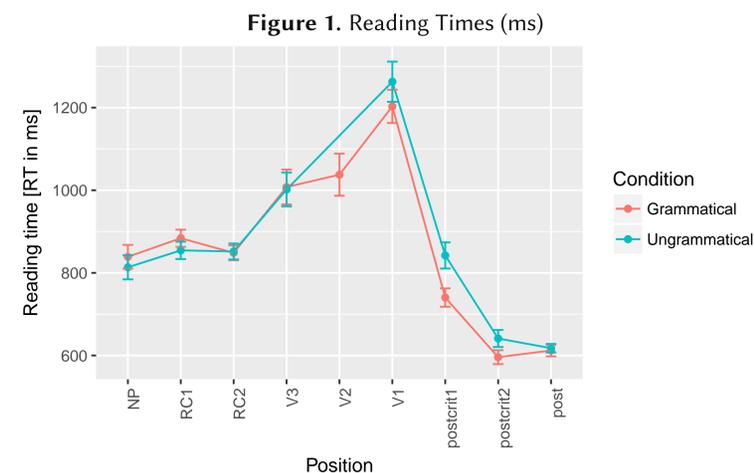
- ▶ Centered self-paced reading
- ▶ Y/N comprehension questions on 66% of trials
- ▶ 24 latin-squared items, 48 fillers
- ▶ N=48 native speakers of Hindi at IIT, Delhi

HYPOTHESES and PREDICTIONS

- Forgetting Hypothesis [2]: **Grammatical** >_{RT} **Ungrammatical**
 - ▶ Reading times at V1 (and possibly at the post-critical region due to spillover) in (a) should be slower than (b), owing to the fact that V2 has presumably been forgotten at NP4 in (b).
- Adaptation Hypothesis [1]: **Grammatical** <_{RT} **Ungrammatical**
 - ▶ opposite pattern – reading times at V1 in (b) should be slower than (a) because of not encountering the required number of verbal heads in (b).

RESULTS: Reading Times

- ▶ Log RTs were analyzed using linear mixed-effects models.
- ▶ Significant difference at the post-critical region (t=2.4): **Grammatical** <_{RT} **Ungrammatical**.



Results: Comprehension Accuracy

- ▶ Comparing participant responses across items and fillers:
 - Experimental items: only 33% of the total participants exceed 70% in their comprehension accuracy for the items.
 - Filler sentences: 100% of the participants exceed 70% comprehension accuracy in the fillers.
- ▶ Average comprehension accuracy for experimental items is not high

	Grammatical	Ungrammatical
Comprehension Accuracy (%)	71	68
- ▶ Non significant difference between Grammatical and Ungrammatical conditions (z=-1.6).
 - Comprehension accuracy in German [1]. Grammatical = 65%, Ungrammatical = 71.5%.
 - Comprehension accuracy for questions about NP2 in French [7]. Grammatical = 68%, Ungrammatical = 49%.

Discussion:

- ▶ The reading time data (Fig.1) is compatible with two underlying states:
 - the parser is making correct structural integrations
 - the parser is using a surface cue (e.g., counting the number of Relpros since these clearly mark clause boundaries) to track the upcoming heads.
- ▶ The comprehension data for this experiment makes (ii) seem more likely.

CONCLUSION

- ▶ RT results: Hindi native speakers are not susceptible to verb forgetting effects in doubly center-embedded structures.
- ▶ This result patterns with other head-final languages.
- ▶ This result is consistent with the predictions of the language adaptability hypothesis [1].
- ▶ However, the low comprehension accuracy suggests a shallow parsing strategy where the required structural integrations may not be taking place in spite of the successful tracking of the number of verbal heads.
 - The low comprehension accuracy in [1] also points to this.
- ▶ Given that in Hindi prediction errors are frequent [5] and predictions can be forgotten [6], the role of robust prediction and its maintenance as an explanation for the lack of forgetting effects in head-final languages needs to be further probed.

Acknowledgments

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References

- [1] Vasishth et al., 2010. [2] Gibson & Thomas, 1999. [3] Frank et al., 2016. [4] Häussler & Bader, 2015. [5] Apurva & Husain, 2018. [6] Bhatia & Husain, 2018. [7] Gimenes et al., 2009.