

# Reactivation Effects Interact With Expectation Strength

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## INTRODUCTION

- ▶ Vasishth and Lewis (2006) have proposed that reactivation of upcoming VPs by adjuncts, and/or reactivation of arguments by intervening adjuncts might account for anti-locality effects: facilitation at the verb with increasing distance.
- ▶ An alternative explanation for anti-locality effects is that the expectation of upcoming verbs is sharpened as distance increases (Levy, 2008).
- ▶ In recent work, Husain et al. (2014) have shown that expectation strength matters: when the exact lexical item is predicted (strong expectation), anti-locality effects are seen; when only a VP is predicted (weak expectation), locality effects emerge.
- ▶ Research question: Does strength of expectation modulate reactivation effects?

## TASK AND PARTICIPANTS

- ▶ Participants read experimental sentences using the centered self-paced reading (SPR) paradigm.
- ▶ 82 Hindi native speakers from Jawaharlal Nehru University, New Delhi, India participated in the experiment.

## EXPERIMENT I

- ▶ Experiment 1 manipulated the activation of an NP subject, and the critical finite VP. Under the reactivation account (Vasishth and Lewis, 2006), reactivating a phrase leads to faster access of that phrase at the retrieval site.

**NP-subject** [NP participle-verb] ... **matrix-verb** ...

- ▶ The reactivation factors were crossed with a context factor (prediction context vs no-prediction context) that makes the critical matrix-verb and the NP-subject either completely predictable or not.

### Design

- ▶ 24 experimental items
  - ▶ 2 (VP-reactivation) x 2 (NP-reactivation) x 2 (Context)
- |     |     |               |
|-----|-----|---------------|
| No  | No  | Prediction    |
| Yes | Yes | No Prediction |

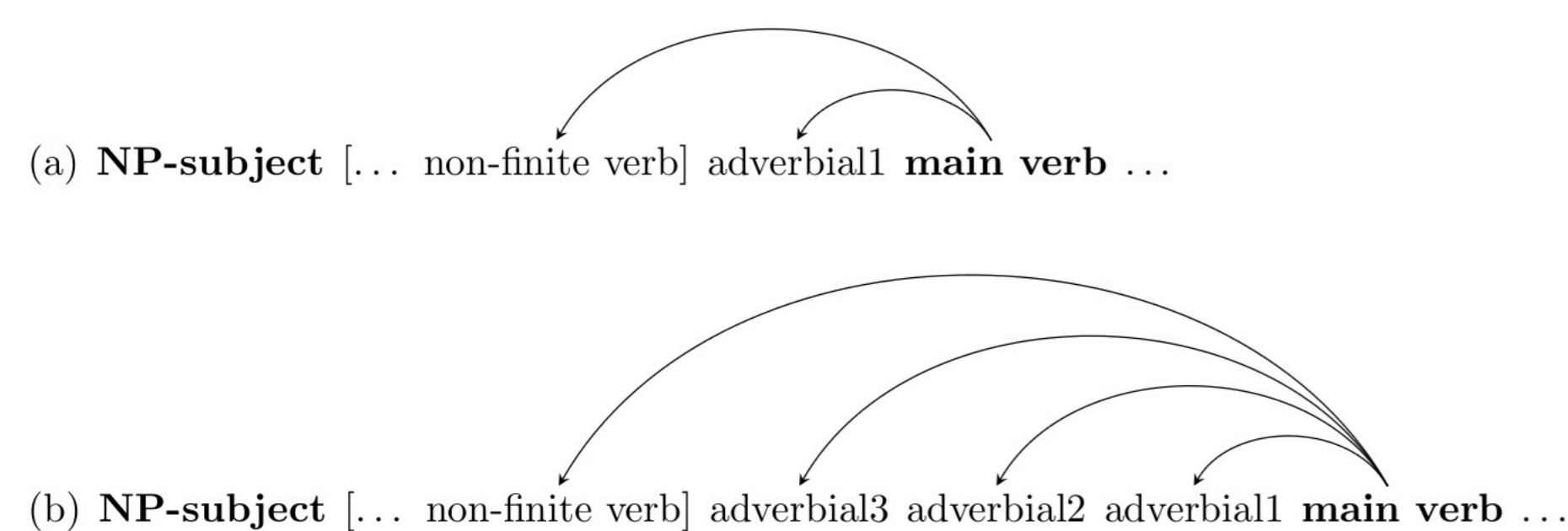


Figure 1: (a) No VP-reactivation condition: Only one adverbial modifies the main verb. (b) VP-reactivation condition: Three adverbials modify the main verb.

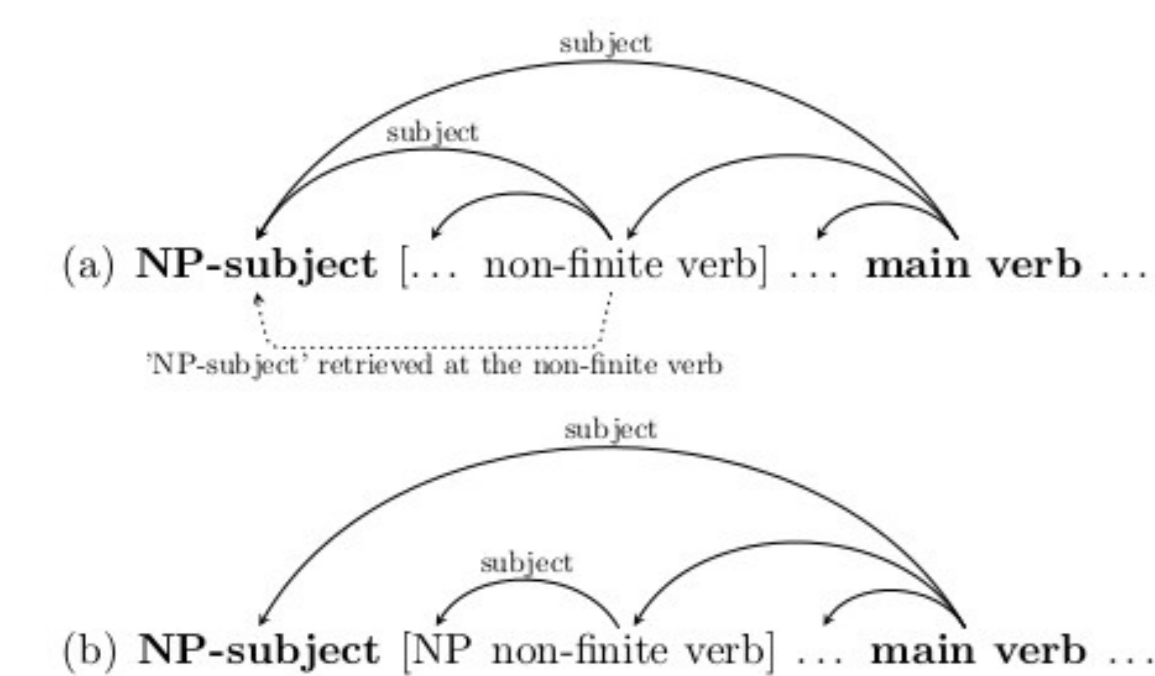


Figure 2: (a) NP-reactivation condition: NP-subject acts as the subject of both non-finite verb and the main verb. (b) No NP-reactivation condition: NP-subject is only the subject of the main verb.

### Analysis and Results

- ▶ Linear mixed-effects models were used to analyse the reading time data, logistic mixed-effects models were used to analyse question-answering data.
- ▶ The reading time data was log transformed before fitting the model.

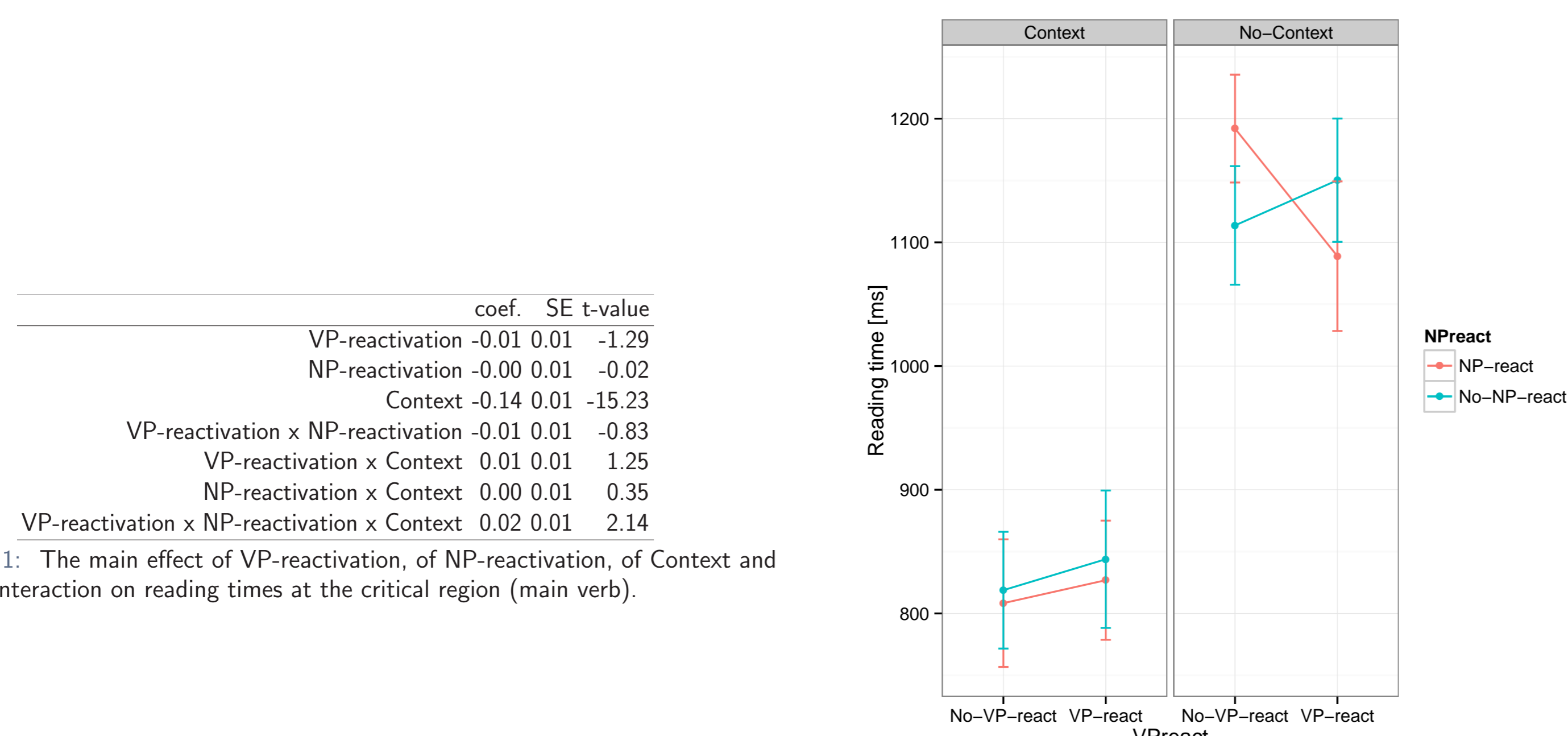


Figure 3: Reading times in ms at the critical region (matrix verb). The VP-reactivation x NP-reactivation x Context interaction ( $t=2.14$ ) is driven by the No-Context condition. Nested contrast shows that RT in NP-reactivation, No VP-reactivation, No-Context > NP-reactivation, VP-reactivation, No-Context.

- ▶ A significant three-way interaction ( $t=2.14$ ): NP- and VP-reactivation jointly lead to a facilitation at the matrix verb in the no-prediction context condition only; in the prediction condition, no facilitation is seen at the matrix verb.
- ▶ This experiment points to a model of processing where memory activation and expectation are not mutually exclusive factors but closely interact.

## EXPERIMENT II

- ▶ In Experiment 2 the activation of the critical participle verb was manipulated by placing an adjunct that either modified (i.e., reactivated) the participle verb (Attach-NFV) or the matrix verb (Attach-MV):

[NP adjunct ... **participle-verb**] ... matrix-verb ...

- ▶ Like in Expt 1, this two-level attachment factor was crossed with Distance/VP-reactivation factor and a context factor giving us a 2x2x2 design.

### Design

- ▶ 24 experimental items
  - ▶ 2 (Distance) x 2 (Attachment) x 2 (Context)
- |       |           |               |
|-------|-----------|---------------|
| Short | AttachMV  | Prediction    |
| Long  | AttachNFV | No Prediction |

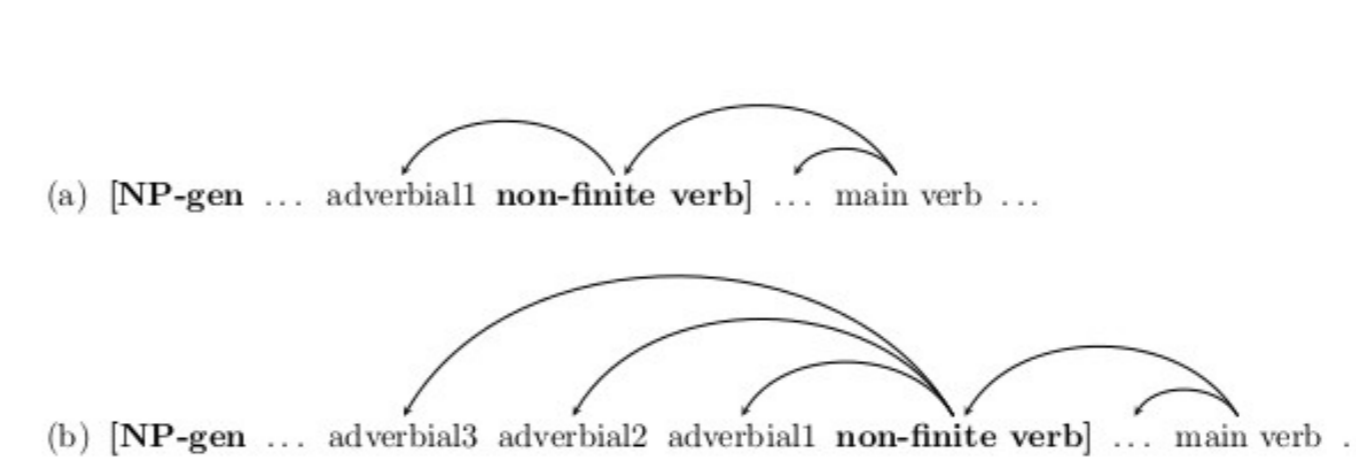


Figure 4: (a) Short: Only one adverbial modifies the critical non-finite verb. (b) Long: Three adverbials modify the critical non-finite verb. NP-gen signifies an NP phrase headed by a noun with a genitive post-position.

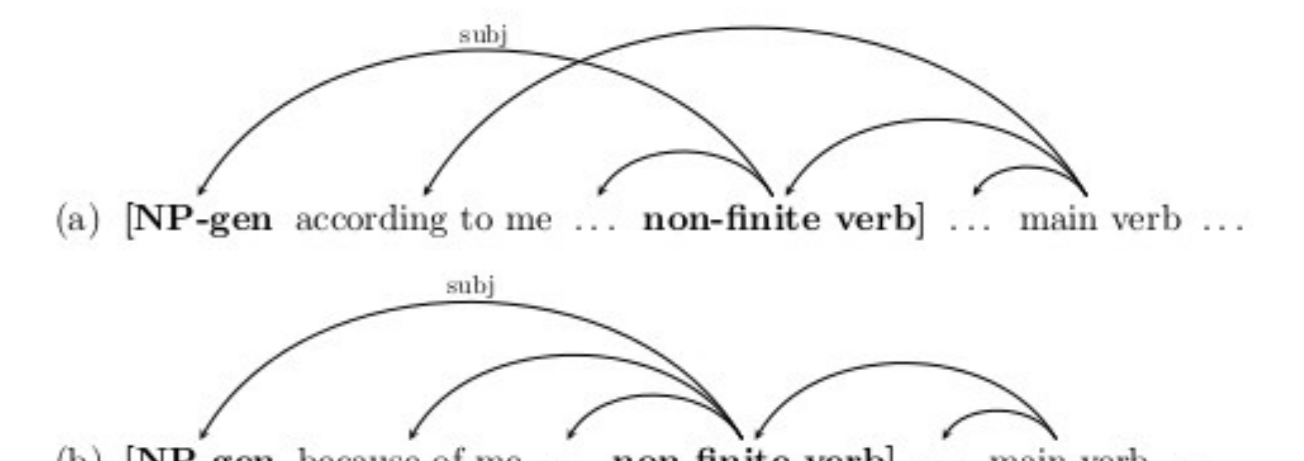


Figure 5: (a) AttachMV: The phrase 'according to me' inside the non-finite clause modifies the main verb. (b) AttachNFV: The phrase 'because of me' inside the non-finite clause modifies the non-finite verb. NP-gen signifies an NP phrase headed by a noun with a genitive post-position.

### Results

	coef.	SE	t-value
Distance	-0.01	0.01	-0.72
Attachment	0.00	0.01	0.62
Context	-0.10	0.01	-12.11
Distance x Attachment	0.00	0.01	0.01
Distance x Context	0.01	0.01	1.88
Attachment x Context	0.01	0.01	0.76
Distance x Attachment x Context	-0.02	0.01	-2.04

Table 2: The main effect of Distance, of Attachment, of Context and their interaction on reading times at the critical non-finite verb.

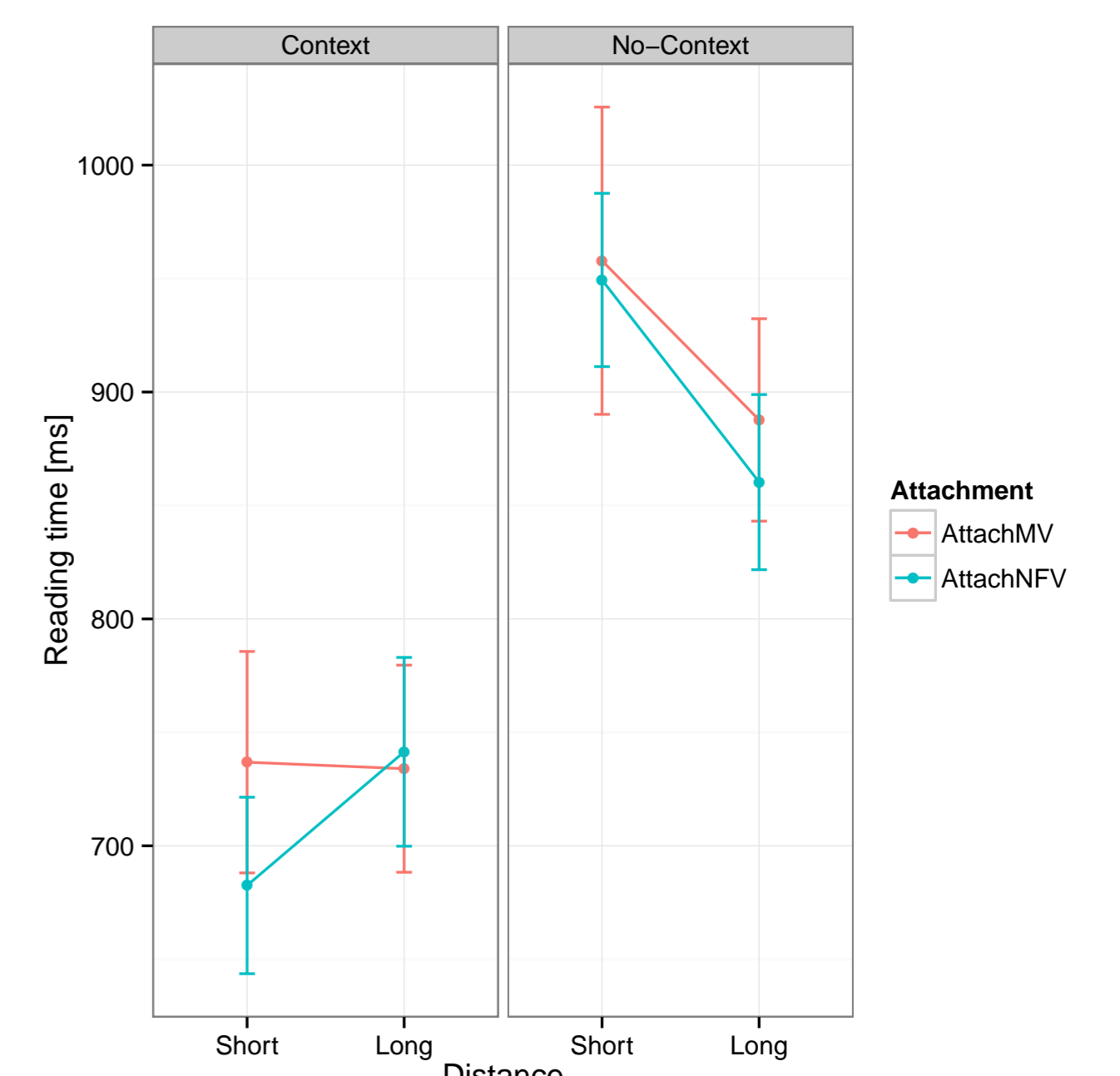


Figure 6: Reading times in ms at the critical region (non-finite verb). The Distance x Attachment x Context interaction ( $t=-2.04$ ) is driven by the No-Context condition. Nested contrast shows that RT in AttachNFV, Short, No-Context > AttachNFV, Long, No-Context. Note that the difference between the No-Context, AttachMV conditions is not significant.

- ▶ A significant three-way interaction ( $t=-2.04$ ): there is facilitation at the participle verb due to increased distance in the AttachNFV, no-prediction context condition; but no facilitation at the participle verb in the prediction context conditions. This replicates Expt 1's findings.

## CONCLUSIONS

- ▶ This is, to our knowledge, the first set of studies to show that expectation directly affects activation of predicted chunks.
- ▶ Both experiments show that facilitation due to reactivation can disappear when the reactivated phrase is strongly expected (i.e., its exact identity is predictable). In the above experiments, prediction context leads to strong expectation while no-prediction context leads to weak expectation.
- ▶ Reactivation effects as proposed in Vasishth and Lewis (2006) only emerge in weak expectation configurations.
- ▶ We propose that the effect of strong (respectively, weak) expectation should lead to relatively high (respectively, low) activation of the predicted phrase.
- ▶ The Levy (2008) expectation account and the Vasishth and Lewis (2006) reactivation account for antilocality effects are not two alternative accounts but are actually closely related.