

Computation of Agreement is Not Predictive Regardless of Word Order

Caroline Andrews & Brian Dillon
University of Massachusetts Amherst

Motivating Question:

What are the conditions under which the parser can make use of phi-features during online processing, and what are the ways in which it does so? Are phi-features predicted and if so when?

Prediction Processes are Available to the Parser at Multiple Linguistic Levels

- *Lexical/Semantic Prediction* - Modulation of the N400 based on predictability of a word in context (Federmeier & Kutas, 1999; DeLong, Urbach & Kutas, 2005)
- *Syntactic Prediction* - Gaps are prioritized over lexical material following a Wh- Filler (Stowe, 1986; Frazier & Clifton, 1989)

Why Target Phi-feature Prediction?

Phi-features (person, number, & gender) are used in abstract grammatical dependencies, e.g. subject verb agreement in (1)

- (1) a. The key_{SG} is_{SG} ...
b. The key_{PL} are_{PL}...

→ If prediction occurs at all linguistic levels then it would be expected for phi-features as well

Mixed Evidence for Phi-Feature Prediction

No phi-feature prediction (Nevins et al., 2007)

No modulation of P600 for violating both [NUMBER+GENDER] over [NUMBER] or [GENDER] violations in Hindi agreement

Phi-feature prediction (Wicha et al., 2003/2004)

- (2) Caperucita Roja llevaba la comida para su abuela en **una**_{FEM}/**un**_{MASC} **canasta**_{FEM}/**corona**_{FEM} muy bonita.
*Red Riding Hood carried the food for her grandmother in a*_{FEM}/_{MASC} *basket*_{FEM}/*crow*_{FEM} very pretty.
- N400 for incongruent gender on the target determiner indicating prediction of the gender feature
→ Wicha et al. predict phi-features *via* lexical prediction

Does phi-feature prediction require lexical prediction?

A Test: **Subject-verb agreement** and **both** each enforce a grammatical requirement for a number feature, but:

- **Agreement** is an **abstract morphological dependency**
- **Both** forms a **lexical/semantic dependency** with the phrase realizing the number feature

Alternate Hypotheses and Predictions

Hypothesis 1: Both abstract morphological and lexical dependencies can generate predictions for phi-features.

Predictions:

- Agreement and *Both*: Slow down at the NP_{SG} and facilitation at coordination

Hypothesis 2: Phi-feature prediction requires lexical prediction. Instead, agreement is evaluated once the parser has encountered the verb and the subject.

Predictions:

- *Both*: Facilitation at the second conjunct when the prediction for [+PL] is confirmed
- Agreement: No prediction. Slow down at the NP_{SG} which is incongruent with the needs of agreement

(3) **Stimuli:** $\left\{ \begin{array}{l} \text{Are} \\ \text{Would} \end{array} \right\} \left\{ \begin{array}{l} \text{both} \\ \emptyset \end{array} \right\} \text{the/ on-call doctor/ and the fireman/ driv(e/ing)/ to the scene/ of the accident?}$

Experiment: Eyetracking

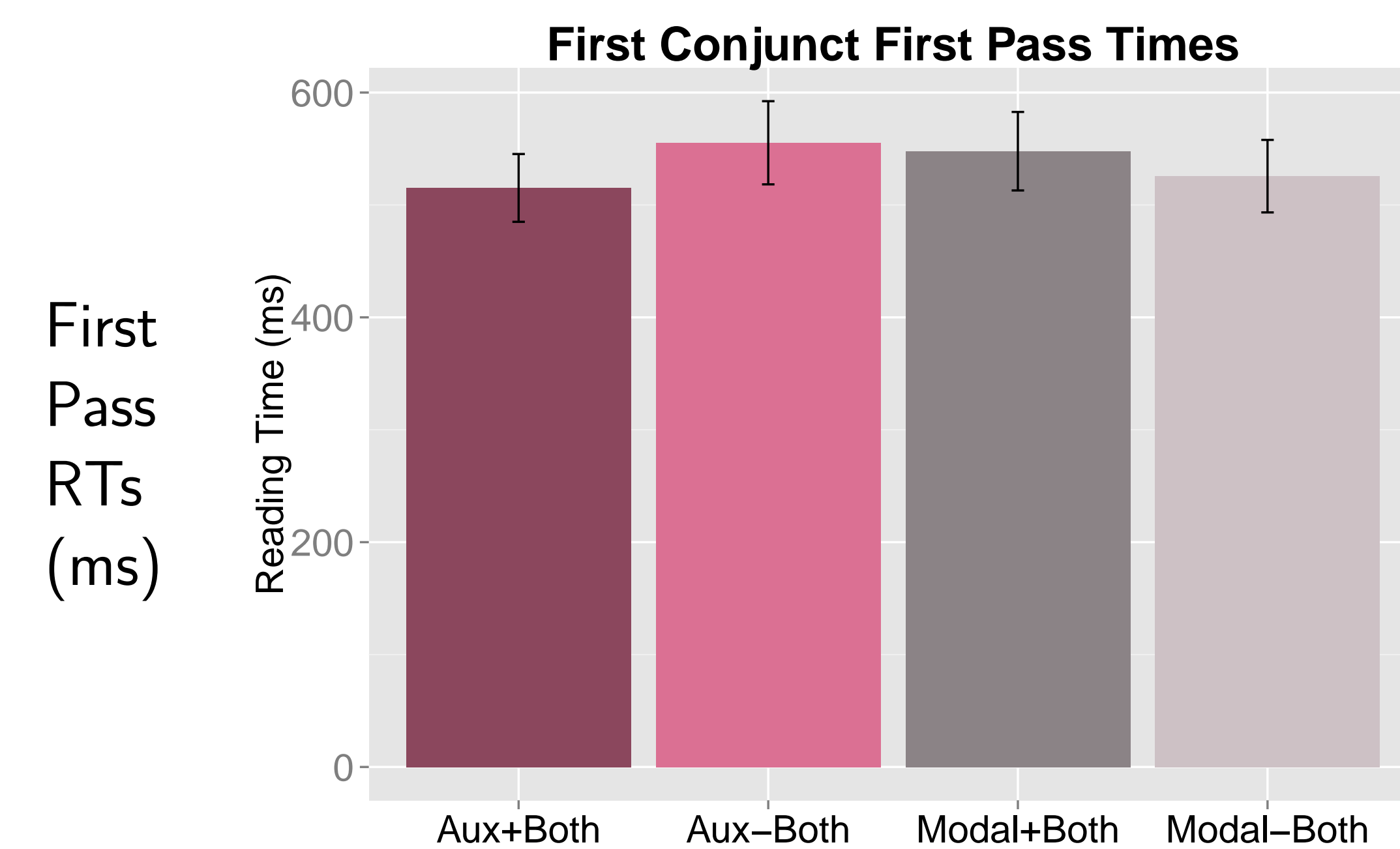
Method

- **Materials**
30 stimuli of the form in (3)
- **Participants**
32 UMass undergraduates participated for credit

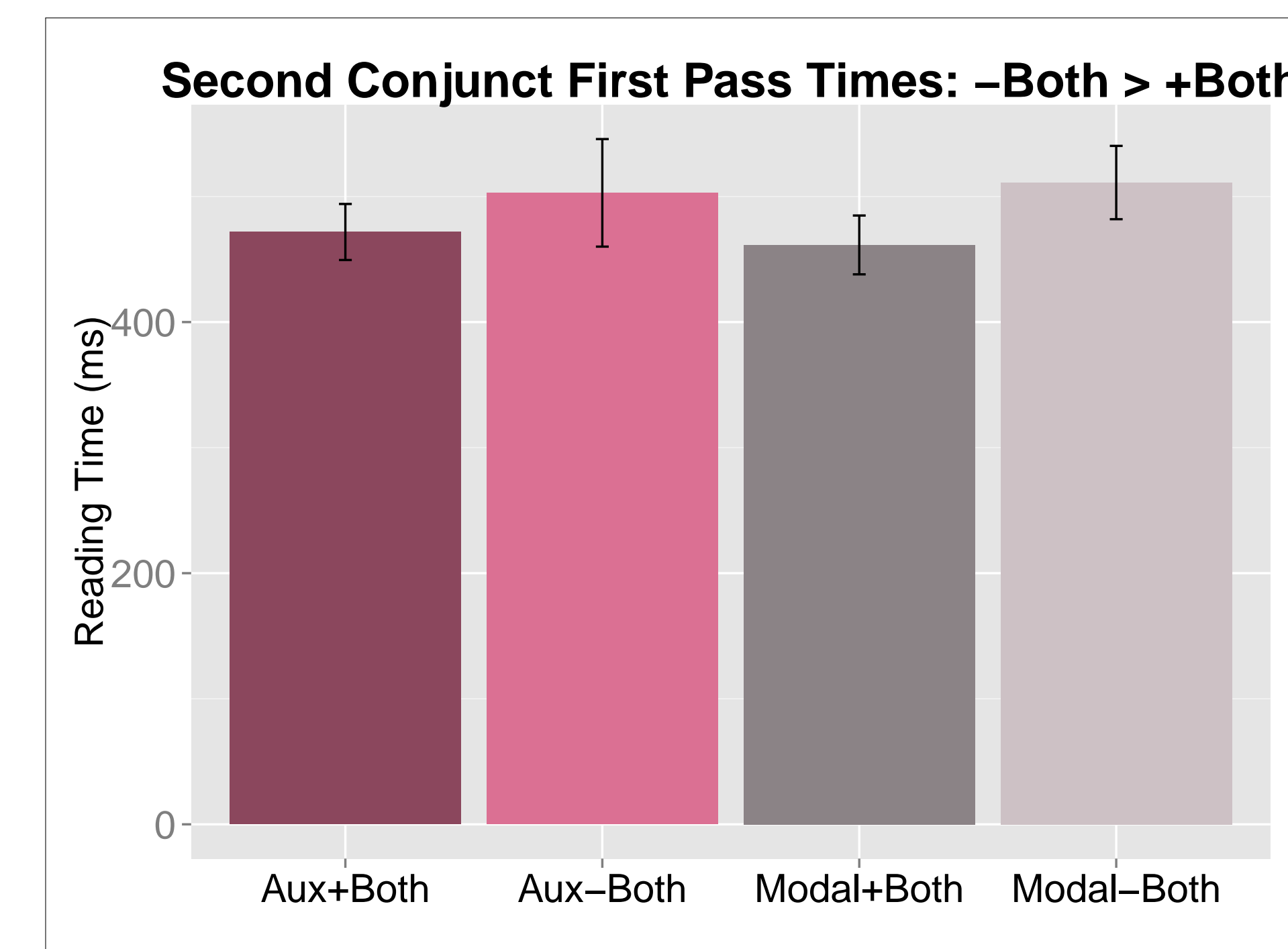
Significant Effects

Region	Effect	$\hat{\beta}$	se
First Conjunct (TT)	AuxiliaryType × Both	-135.83	66.15
Second Conjunct (FP)	Both	-39.656	18.92

Table 1: Model coefficients for RTs, Effect Significant at $|t| > 2$

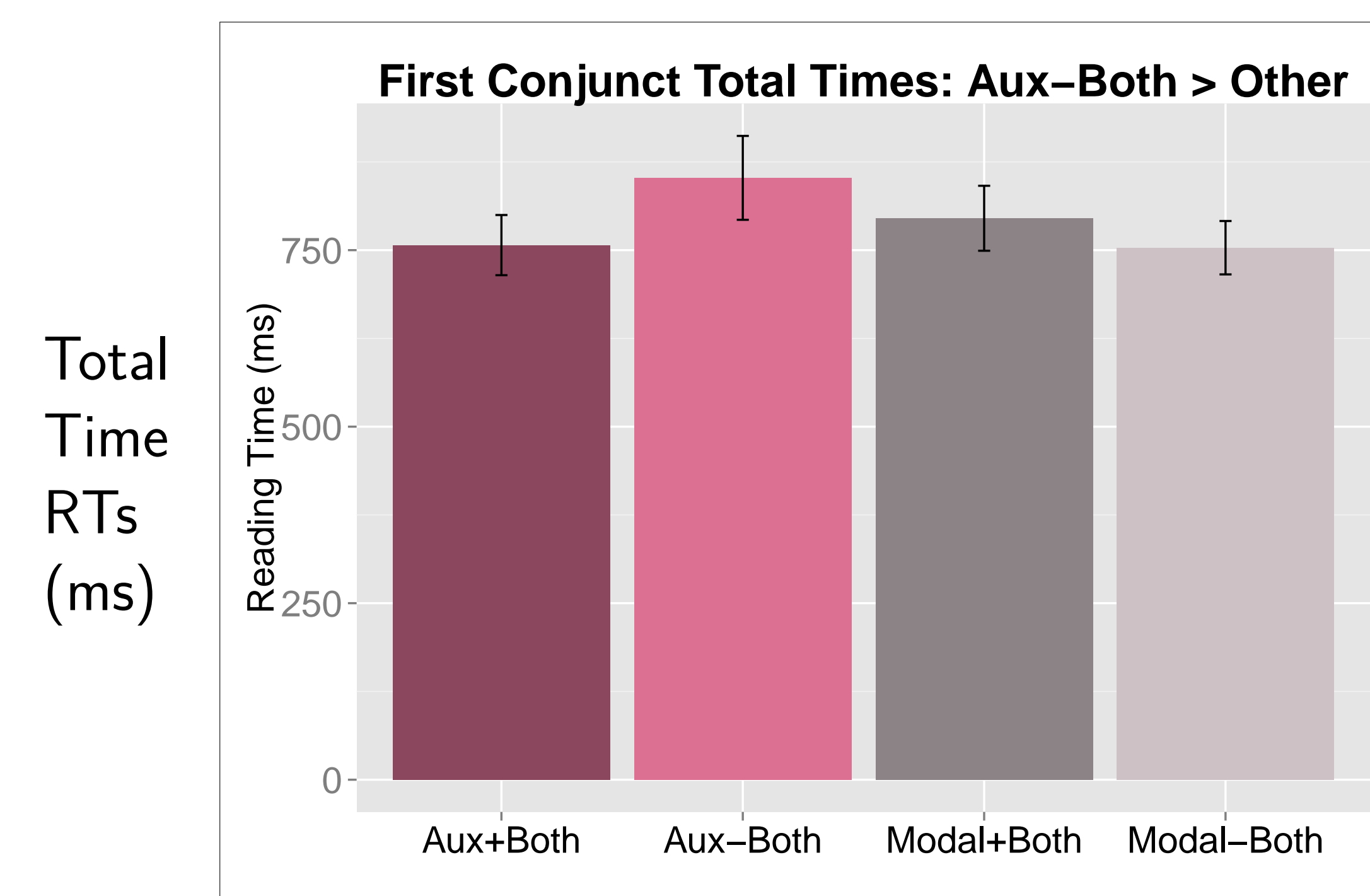


First Pass RTs (ms)

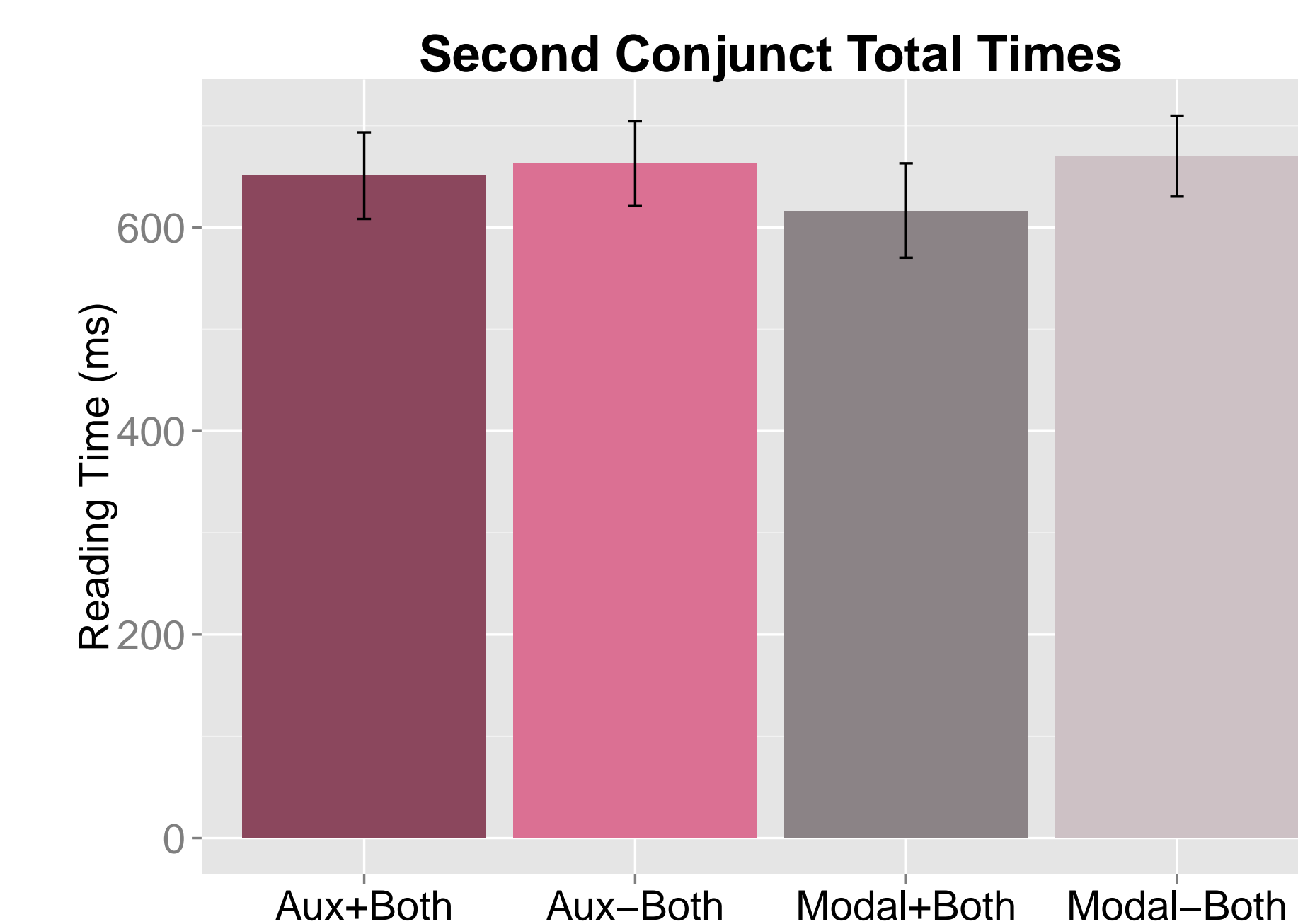


...and the fireman/...

$\left\{ \begin{array}{l} \text{Are} \\ \text{Would} \end{array} \right\} \left\{ \begin{array}{l} \text{both} \\ \emptyset \end{array} \right\} \text{the/... ...on-call doctor/...}$



Total Time RTs (ms)



First Conjunct:

- Penalty for *both* relative to the modal
- Large penalty for AUX-BOTH condition
- Significant Interaction is a trend in First Pass and Go Past

Second Conjunct:

- Early facilitation for *both*
- Lack of facilitation for in the AUX-BOTH condition

Cloze Task Follow Up

Motivation: Eyetracking results confound ability to predict and preference to predict NP_{PL} or coordination

40 participants from Mechanical Turk

Table 2: Cloze Continuations of Aux+(both)+NP adapted from (3)

Continuation	Auxiliary +Both	Auxiliary -Both	Modal +Both	Modal -Both
Coordination	93.2%	72.3%	97.2%	0.0
Predicate	0.0 %	2.9%	0.0	100%
Plural	6.8%	17.7%	2.8%	0.0
Other	0.0%	6.9%	0.0	0.0

Table 3: Cloze Continuations for Would both...

Coordination	Partitive	Plural	Other
18.6%	54.4%	23.6 %	3.3%

Results

- *Both*: Predicts an NP_{PL} or coordination
- Agreement: Diminished predictability for coordination

Summary of Results

Consistent with Hypothesis 2, only lexical/semantic dependencies show clear evidence of prediction. No evidence for prediction of number features in agreement.

- *Both* predicts of NP_{PL} then coordination
- (Potential) Lack of Prediction from a number marked Auxiliary
 - Certainly for no prediction of coordination and possibly no prediction for NP_{PL}
 - Slow down at NP_{SG} has two possible explanations:
 - Non-Prediction: Inability to resolve to a grammatical parse
 - Prediction: Denial of the prediction for an NP_{PL}

Conclusions

- No evidence for phi-feature prediction independent of lexical/semantic prediction
- Lexical/semantic dependency headed by *both* does predict

References

- [1] Federmeier & Kutas. (1999). *Cognitive Brain Research*; [2] DeLong, Urbach, Kutas. (2005). *Nature Neuroscience*; [3] Stowe. (1986). *Language and Cognitive Processes*; [4] Frazier & Clifton. (1989). *Language and Cognitive Processes*; [5] Nevins, Dillon, Malhotra, & Phillips. (2007). *Brain Research*; [6] Wicha, Moreno, & Kutas.(2003). *Cortex*; [7] Wicha, Moreno & Kutas (2004). *JoN*

Acknowledgements

Many thanks to Lyn Frazier, Adrian Staub, Shayne Sloggett, Amanda Rysling, Anthony Yacovone, Amanda Doucette and the UMass Psycholing Workshop

Contact: ceandrews@linguist.umass.edu