The effect of representational complexity on working memory processes

Chi-Dat (Daniel) Lam and Ming Xiang

How working memory stores linguistic representations

- Working memory (WM) is capacity-limited.

- Complex structures are assumed to increase WM cost.
  Gibson (1998), Grodner and Gibson (2005)

- Higher representational complexity can sometimes reduce WM cost.
  Hofmeister (2011), Hofmeister and Vasishth (2014)

- The current study shows that storing more complex NP **reduces maintenance cost**, possibly by **increasing distinctiveness**.

Complex NPs are encoded slower but retrieved faster

It was {a communist / an alleged communist / an alleged Venezuelan communist} who the members of the club banned …

- **Slower RT** for more complex NP at the **matrix noun**.
- **Faster RT** for more complex NP at the **subcategorizing verb**.

Hofmeister (2011)

Complex NPs are encoded slower but retrieved faster

- Increased salience.

- Increased distinctiveness.

- Features reinforcing each other's retrieval.

Key questions

- Do these observations generalize to **other complex structures**?

   e.g those judges and lawyers vs. those lawyers

- Does storing complex representations benefit or hinder **WM maintenance**?

Experiment 1 and 2: Procedure

- **Self-paced reading experiment** through Prolific.

- N = 94 for experiment 1 and N = 75 for experiment 2.

- Both have **2 x 2 design**: RC type x NP complexity.

- 36 experimental items and 36 fillers.

- All sentences followed by a comprehension question.
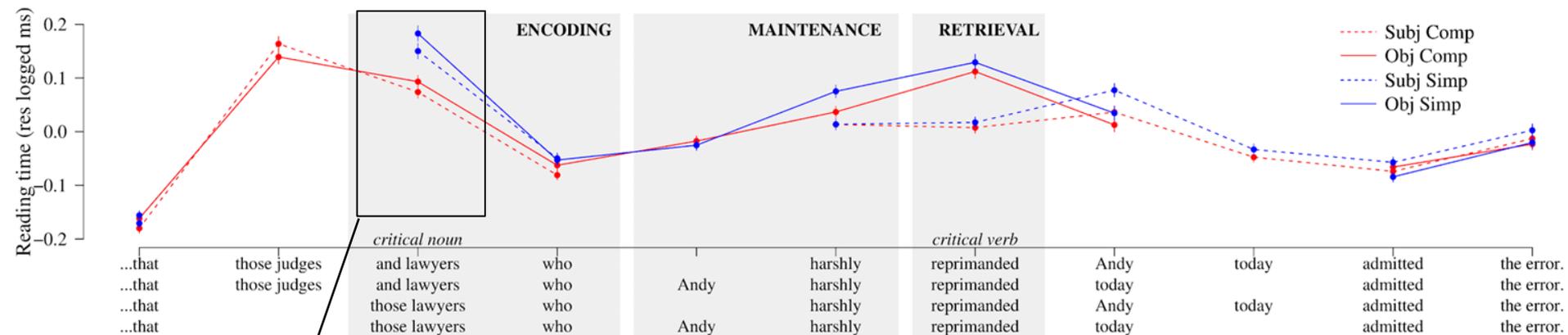
Experiment 1: Relative Clauses

<u>Complex (SRC and ORC):</u>

It seems that those judges and lawyers who {Andy harshly reprimanded / harshly reprimanded Andy} today admitted the error.
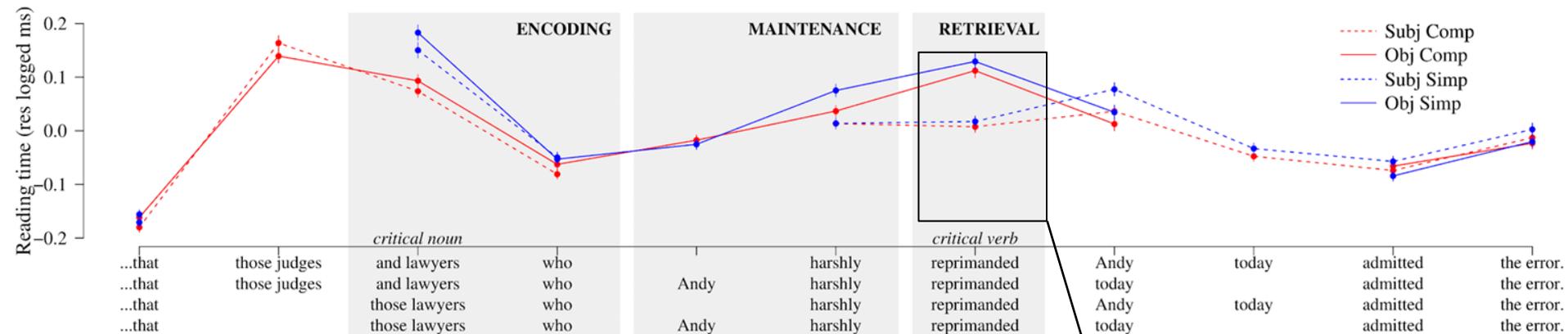
<u>Simple (SRC and ORC):</u>

It seems that those lawyers who {Andy harshly reprimanded / harshly reprimanded Andy} today admitted the error.

Experiment 1: Encoding
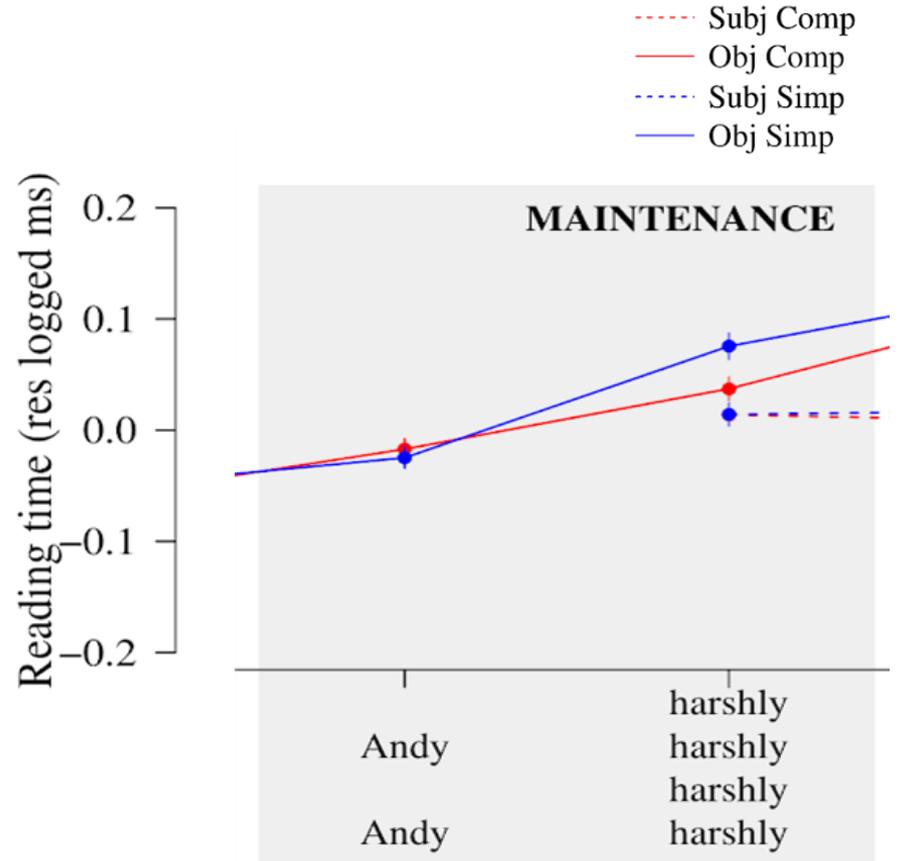

Faster encoding for complex NPs

Experiment 1: Retrieval

No effect of complexity at retrieval

Experiment 1: Maintenance

- *harshly*: Faster RTs for complex-NP conditions only in ORCs.

- ORCs have two competing referents while SRCs have one.
- Extracted NP complexity helps maintain distinctiveness.

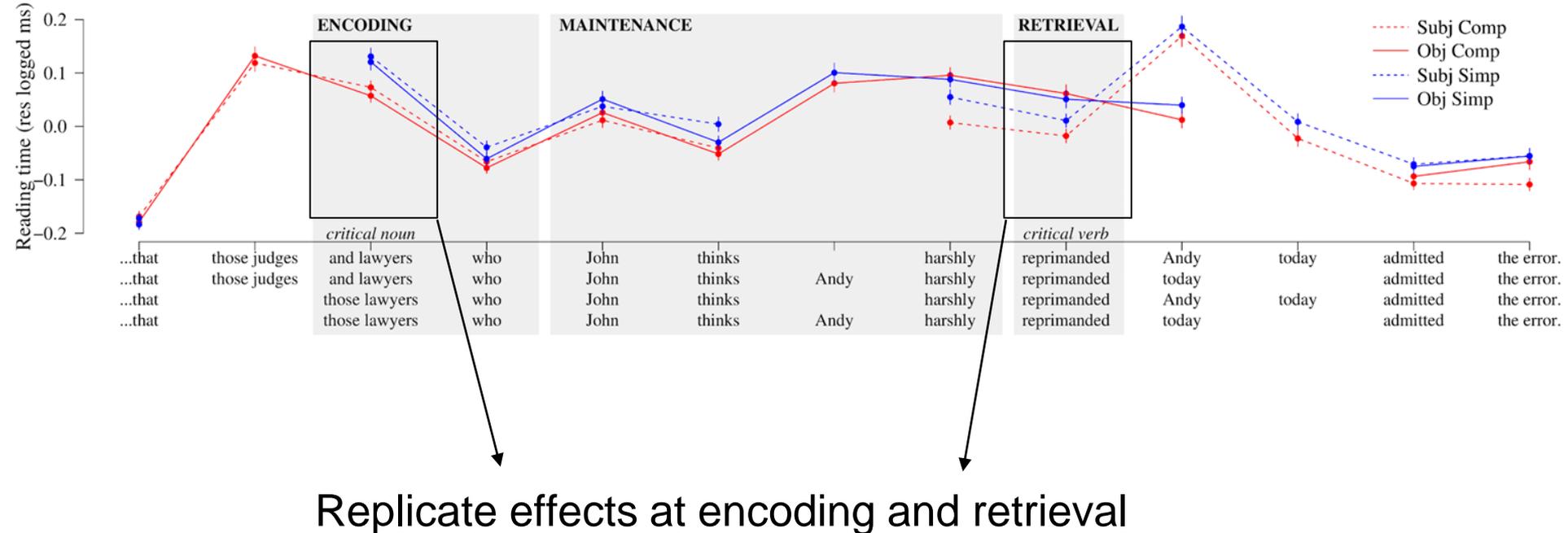# Experiment 2: Relative Clauses with Extra Embedding

<u>Complex (SRC and ORC):</u>

It seems that those judges and lawyers who *John thinks* {Andy harshly reprimanded / harshly reprimanded Andy} today admitted the error.
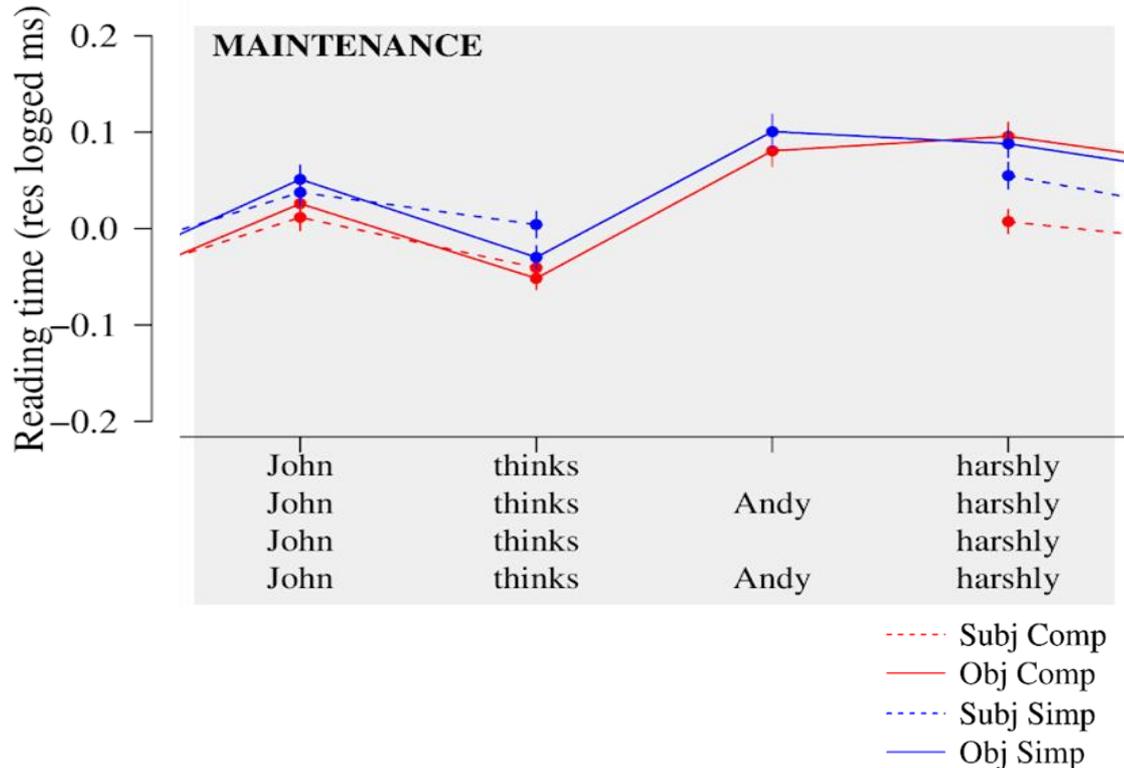
<u>Simple (SRC and ORC):</u>

It seems that those lawyers who *John thinks* {Andy harshly reprimanded / harshly reprimanded Andy} today admitted the error.

Experiment 2: Encoding and retrieval

Replicate effects at encoding and retrieval

Experiment 2: Maintenance

- *thinks*: Faster RTs for complex-NP conditions.

- *harshly*: Faster RTs for complex-NP conditions only in SRCs.

Experiment 2: Relative Clauses with Extra Embedding

Subject, Complex: It seems that those judges and lawyers who John
thinks **harshly** reprimanded Andy today admitted the error.

↓   ↓

2 referents   2 referents

Object, Complex: It seems that those judges and lawyers who John
thinks Andy **harshly** reprimanded   today admitted the error.

↓   ↓

2 referents   3 referents

Conclusion

- <u>Encoding and retrieval regions:</u> differ from Hofmeister (2011)

- <u>Maintenance region:</u> complexity helps only when there are **two competing referents**.
- Complexity helps to maintain distinctiveness between representations.
- Too many competing representations overwrites this benefit.

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Bibliography

Gibson, E. (1998). Linguistic complexity: Locality of syntactic dependencies. *Cognition*, *68*(1), 1-76.

Grodner, D., & Gibson, E. (2005). Consequences of the serial nature of linguistic input for sentential complexity. *Cognitive science*, *29*(2), 261-290.
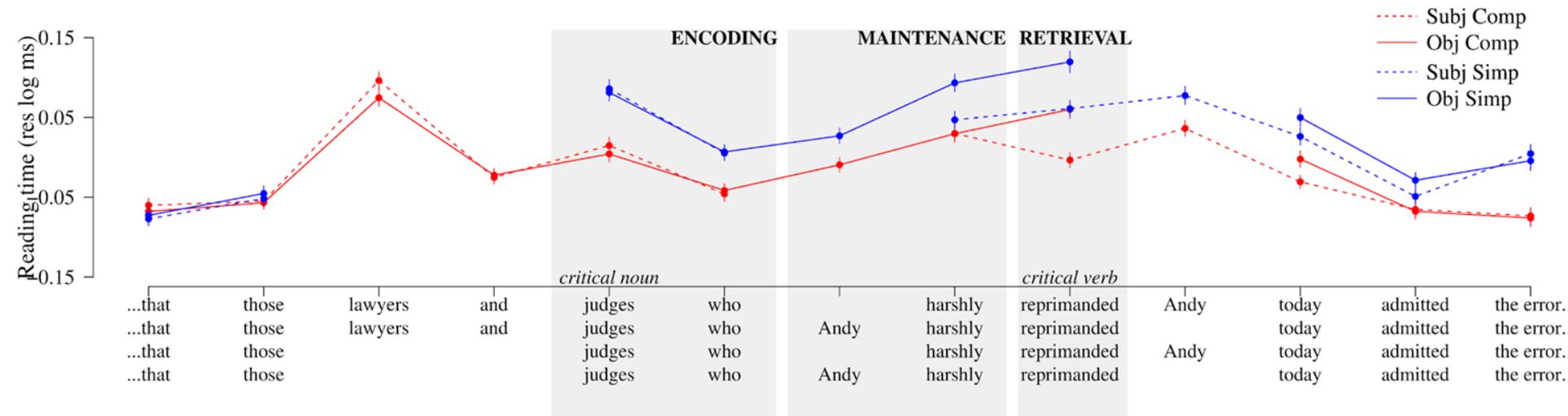
Hofmeister, P. (2011). Representational complexity and memory retrieval in language comprehension. *Language and cognitive processes*, *26*(3), 376-405.

Hofmeister, P., & Vasishth, S. (2014). Distinctiveness and encoding effects in online sentence comprehension. *Frontiers in psychology*, *5*, 1237.

Experiment 3: Relative clauses with modification
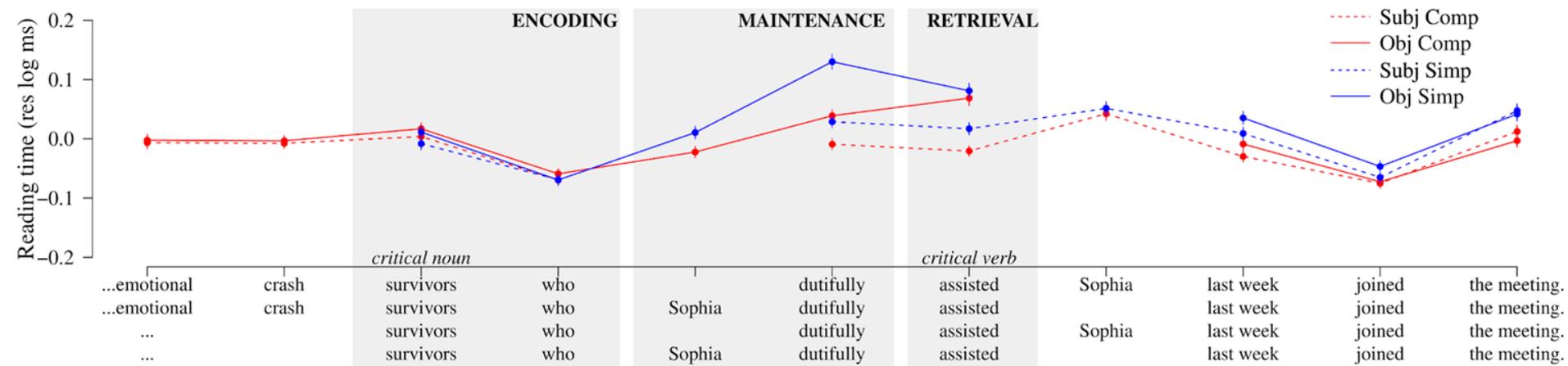
Experiment 4: Relative clauses with separate matrix NP

Complex NPs are encoded slower but retrieved faster

Faster retrieval

Slower encoding

Hofmeister (2011)