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Nouns and Verbs Behave Differently as Fillers: Expectation and Interference in Constructing Long-Distance Dependencies

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1. Background: Expectation-based model & Memory interference

In reading sentences, given that there is an infinite number of ways that a sentence can continue, parsers constantly deal with **uncertainty** and adjusts **expectations** about the upcoming words. **Nominal cues** such as gender, number and animacy also interfere with the retrieval of a dependency.

How are ambiguous complement structures processed?

1) **Expectation-based theories**: readers are more likely to expect complement structures with higher frequencies (Hale, 2001; Levy, 2008; MacDonald, 1994);
2) **Memory interference**: Nouns and nominal cues can interfere with retrieval of the left edge of a dependency (Gordon, Hendrick & Levine, 2002; Lewis & Vasishth 2005)

Research Questions:

What is the role of expectation in the comprehension of Chinese sentences with ambiguous complement structures?

How verbal and nominal fillers are retrieved in the process of building a dependency?

2. Research Design

Uncertainty: 20 Verbs followed by VP or NP in Mandarin Chinese:

1）玛丽 答应[NP(李四)][VP去 邀请 约翰] 。
Mary promise Lisi go invite John
'Mary promised (Lisi) to invite John.

Frequencies of complements: Corpus + Completion Tasks

Animacy of fillers in relative clauses:

- **animate** 李四 'Lisi'**; inanimate** 历史 'history'; **VP** 开车 'to drive'

Corpus: Sinica Corpus (Chen, Huang, Chang & Hsu, 1996)

Completion Task: 40 native Mandarin speakers completed gated sentences with given fragments.
a) 李四答应 ____ 'Lisi promised …'; b) 李四是玛丽答应 ___ 'Lisi is who Mary promised …'

Verb-type	Examples	
V-prone	答应 'agree', 承诺 'promise', 禁止 'forbid', 提议 'suggest', 想要 'want'	+VP > 50%
N-prone	批准'approve', 央求'beg', 提醒'remind', 命令 'command' ,期待 'expect'	+ NP(+ani) > 50%

Self-paced reading: the sentences were presented using a **relative clause:**

Filler shi [[NP2 V1 V2] DE CL NP3]

1) 李四$_2$ 是 玛丽$_1$答应 [PRO/e$_1$ 邀请 e$_2$]的 那个男孩。 **[+ani]**
Lisi is Mary promise invite DE CL boy
'Lisi is the boy who Mary promised *e$_1$ to invite e$_2$.'

2) 历史$_2$ 是 玛丽$_1$答应 [PRO/e$_1$ 选修 e$_2$]的 那个 科目。 **[-ani]**
History is Mary promise choose DE CL subject
'History is the subject that Mary promised *e$_1$ to study e$_2$.'

3) 开车$_2$ 是 玛丽$_1$答应 [PRO /e$_1$ 学习 e$_2$]的 那件事情。 **[+vp]**
Drive is Mary promise study DE CL thing
'To drive is the thing that Mary promised *e$_1$ to study e$_2$.'

Participants: 42 (EXP1) and 21 (EXP2) native speakers of Mandarin Chinese

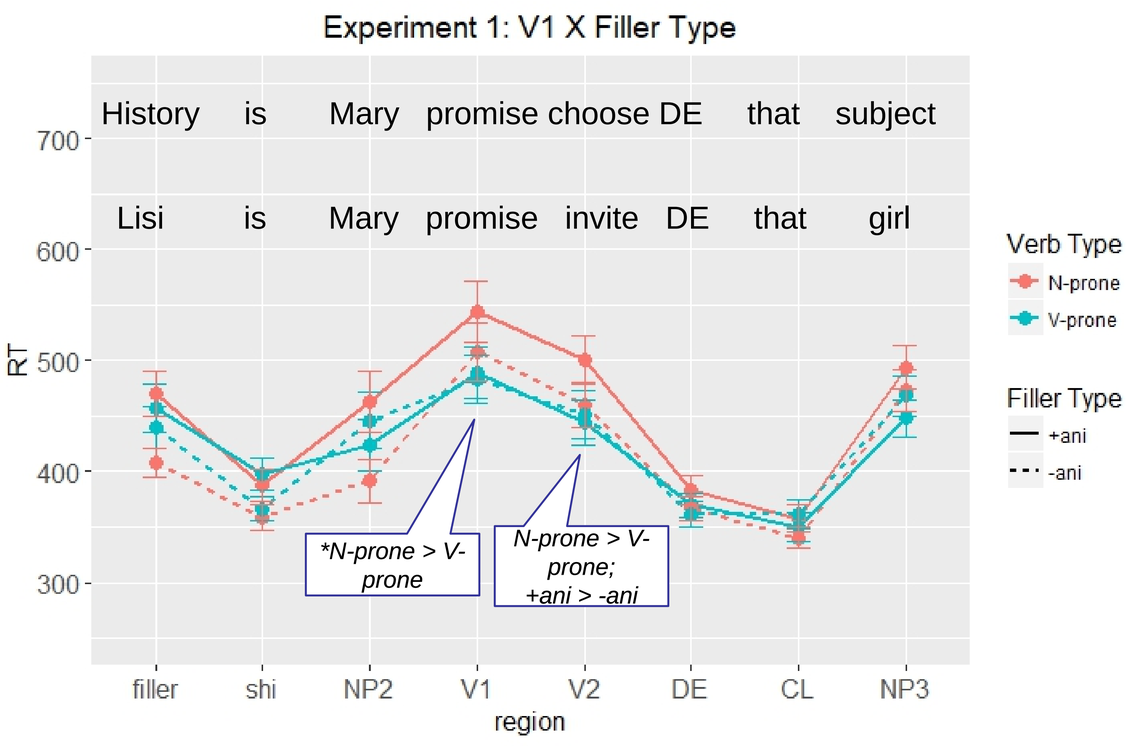
Items: Relative clauses with 20 target verbs as V1:

- EXP1: Filler type (1) + (2);
- EXP2: Filler type (1) + (2) + (3); +ani filler names simplified; improved follow-up Q;

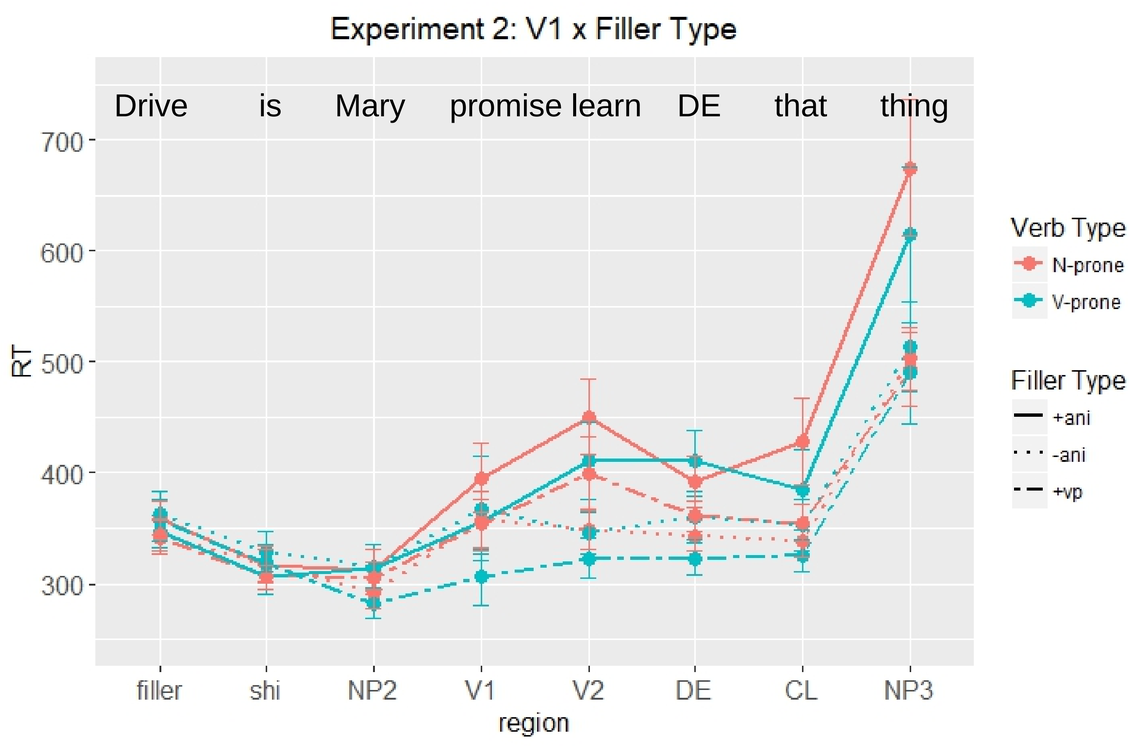
Predictions:

Region	Expectation-based	Memory-interference
V1	+ani: N-prone > V-prone; +vp: V-prone > N-prone	+ani > -ani
V2	N-prone: +ani > -ani & +vp; V-prone: +vp > +ani & -ani	+ani > -ani

3. Results



	filler, *shi*, NP2	V1	V2	DE, CL, NP3
Verb Type	n.s.	N-prone > V-prone (*t*=-1.758)	*N-prone > V-prone (*t*=-1.96)	n.s.
Filler Type	* +ani > -ani (*p*<.05)	n.s.	+ani > -ani (*t*=-1.795)	n.s.
V1 * filler	n.s	n.s.	n.s.	n.s.



	filler, *shi*, NP2	V1	V2	DE, CL, NP3
Verb Type	n.s.	n.s.	n.s.	n.s.
Filler Type	n.s.	n.s.	*+ani > -ani(*t*=-3.11); +ani > +vp(*t*=-2.54)	*+ani > -ani & +vp (*p*<.05)
V1*filler	n.s	n.s.	n.s.	V-prone: +ani > +vp(*t*=2.86) at DE

4. Discussion & Conclusion

Discussion: Discrepancies between EXP1 & EXP2

- Different reading strategies: RT in first 5 regions vs. last 3 regions
  - ***Ratio:*** average speed per character in first 5 regions / of last 3 regions
  - EXP1**:** M=1.02; EXP2: M=0.76 (**t*=6.65);
- **Frequencies** from corpus only significant in EXP1
  - Alternative methods & designs: Eye-tracking
  - Can frequencies from corpus predict expectations in online comprehension?
- **Animacy**: strong predictor in both experiments, lending support for cue-based, memory interference in comprehension.

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Conclusion:

- Nominals and verbs/verbal nouns induce different garden-path effects;
- Animacy of nominals interferes with the retrieval of nominals in long-distance filler-gap construction; support memory interference of nominals;
- Expectations based on frequencies: more evidence needed for effects.

Reference: Chen, Keh-jiann, Chu-Ren Huang, Li-ping Chang, and Hui-Li Hsu. 1996. Sinica Corpus: methodology for balanced corpora. In *Proceeding of the 11th Pacific Asia on Language, Information and Computation*, edited by B.-S. Park and J.B., 167-176. Seoul:Kyung Hee University; Gordon, P. C., Hendrick, R., & Levine, W. H. (2002). Memory-load interference in syntactic processing. *Psychological Science*, *13*(5), 425-430; Hale, J. T. (2001). A probabilistic Earley parser as a psycholinguistic model. In *Proceedings of the 2nd Meeting of the North American Chapter of the Association for Computational Linguistics* (pp. 159–166). Pittsburgh, PA: Association for Computational Linguistics; Levy, R. (2008). Expectation-based syntactic comprehension. *Cognition* 106 (3):1126-1177; Lewis, R. L. & Vasishth, S. (2005), An Activation-Based Model of Sentence Processing as Skilled Memory Retrieval. Cognitive Science, 29: 375–419; MacDonald, M.C. (1994). Probabilistic constraints and syntactic ambiguity resolution. *Language and Cognitive Process, 9*(2), 157-201.