Expectation and Interference in Constructing Long-distance Dependencies

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Processing dependencies in sentences

- *It was **the barber** that __ **saw** the lawyer in the parking lot.*

  |_____| (Subject cleft)

- *It was **the barber** that the lawyer **saw** __ in the parking lot.*

  |_____| (Object cleft)

Two aspects of **memory** on reading sentences

Long-term memory:

using lexical knowledge such as ***saw*** (X[+animate], Y)

Working memory:

storing and retrieving words you've read

1. Working Memory: Interference in retrieval

- *It was **the barber** that __ **saw** **the lawyer** in the parking lot.*

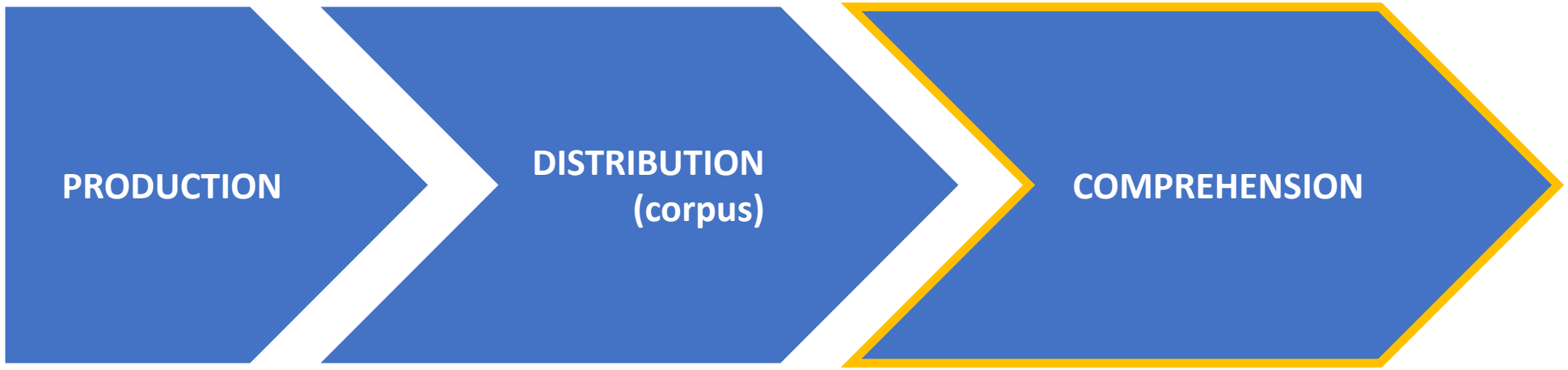
|_____| (Subject cleft)

- *It was **the barber** that **the lawyer** **saw** __ in the parking lot.*

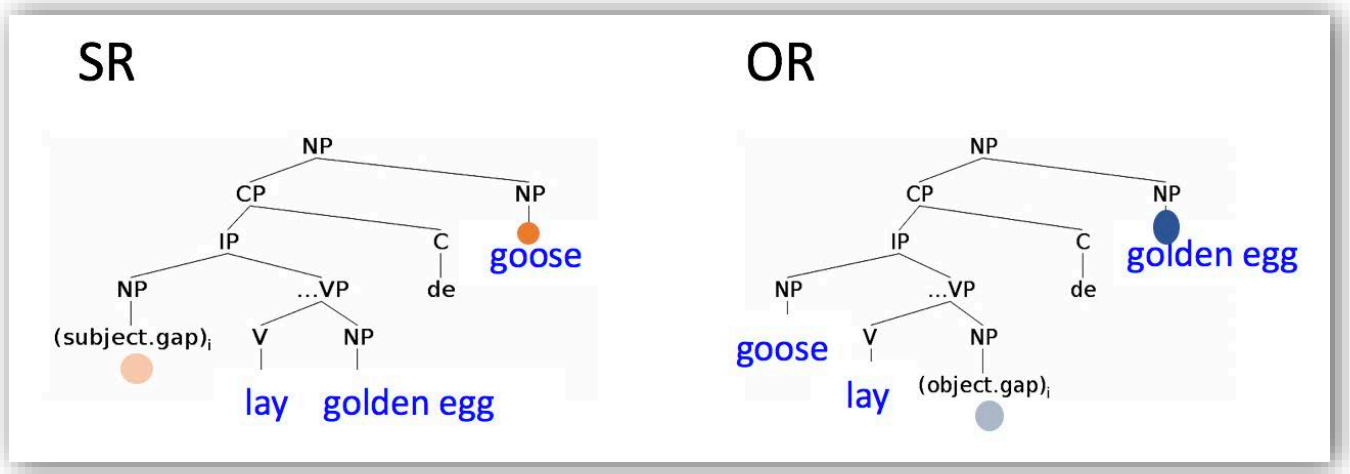
|_____| (Object cleft)

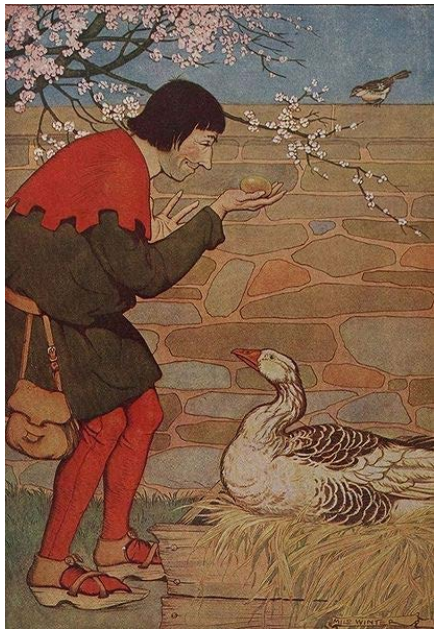
2. Long-term memory:

- You **expect** to read the **most likely** way a sentence can unfold based on linguistic experiences (Hale, 2001; Levy, 2008).
- Production-Distribution-Comprehension Model (MacDonald 2013)



Chinese relative clauses: Gap-Filler dependency





下 金蛋 的 鵝

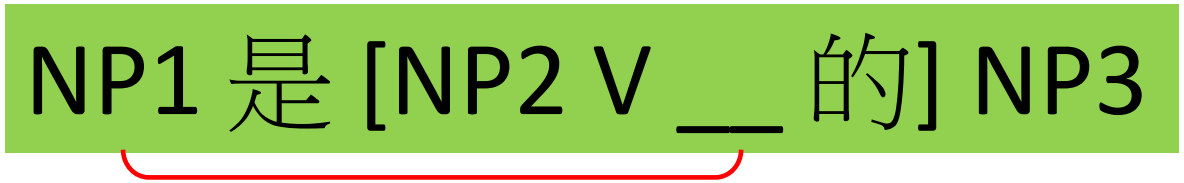
(e) lay golden egg DE goose

The Goose That Laid the Golden Eggs (*Aesop's Fables*)

What about **Filler-Gap** dependencies in Chinese?

FILLER ------- ***shi*** **N V [GAP]** ***de*** **N**

Standard Chinese **Cleft Construction**: 是 … 的



NP1 is the NP3 [that NP2 V __]

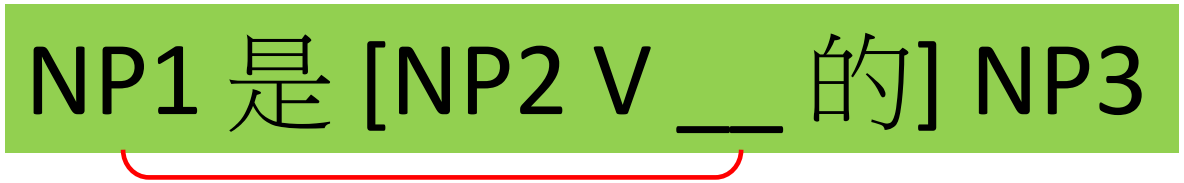
Research Questions:

How are **filler-gap dependencies** processed in Standard Chinese?

- How does one's experience with verb subcategorization affect processing? **[long-term memory]**
- How are fillers retrieved? **[working memory]**
  - How is animacy information on fillers used?
  - Do verbs and nouns function differently as fillers?

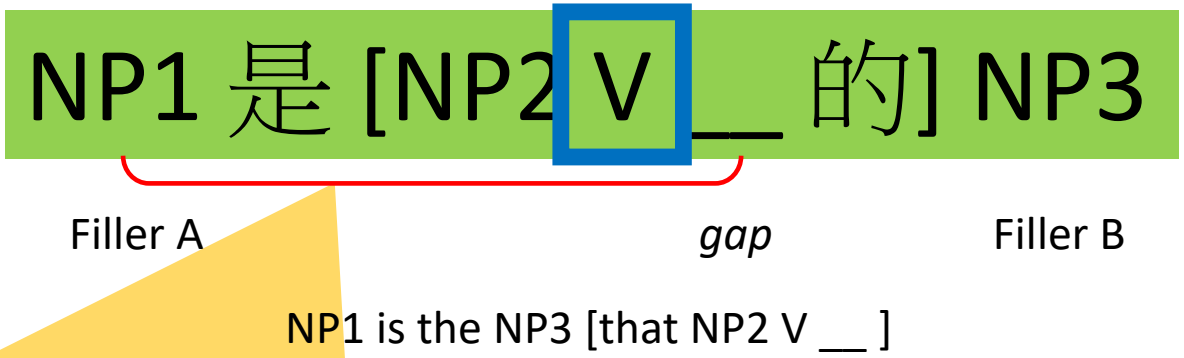
Design of the test sentences

Standard Chinese **Cleft Construction**: 是 … 的



NP1 is the NP3 [that NP2 V __]

Standard Chinese Cleft Construction: 是 … 的



Control/raising Verbs with multiple complement structures:

許諾，允諾，承諾，提議，想要；批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待

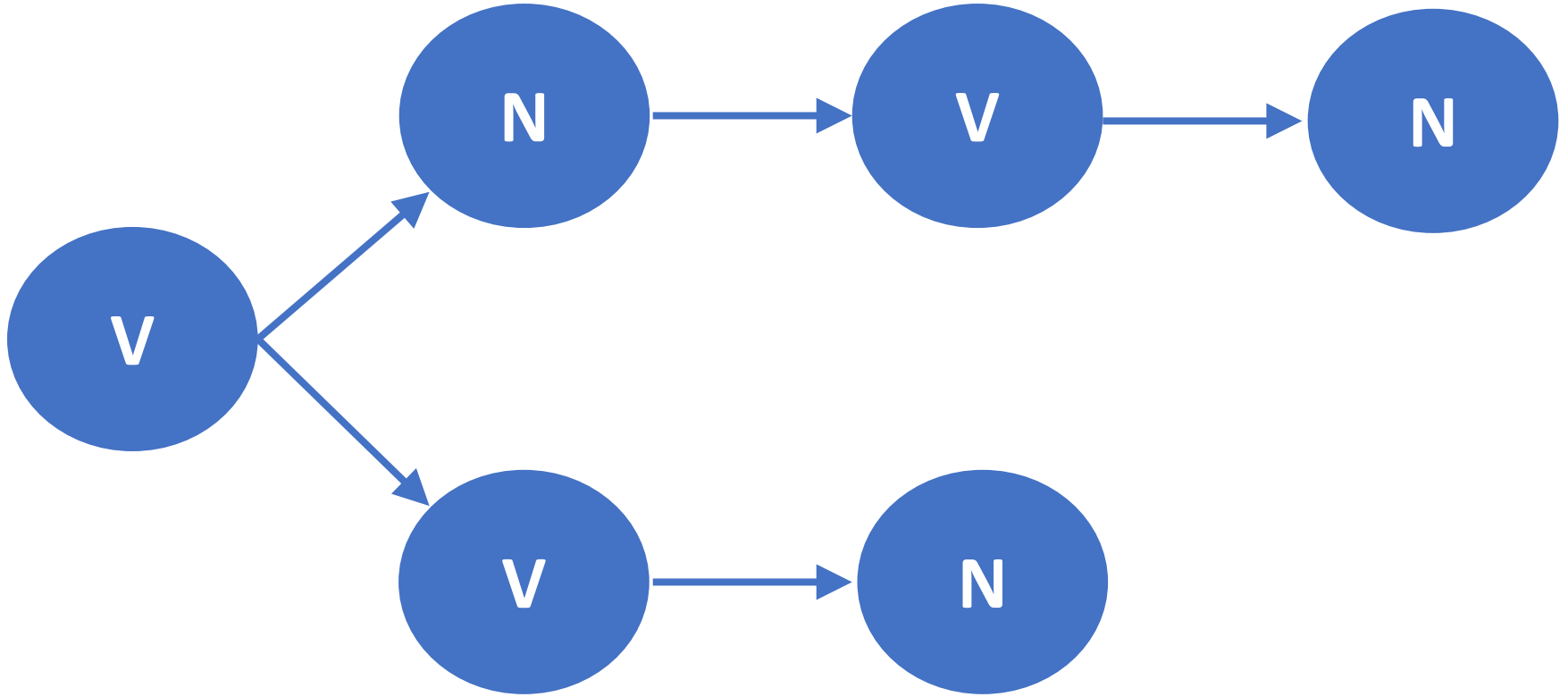
Verb NP/PRO Verb …

答應（諳諳）邀請朋友 ‘promise Anan to invite friends’

要求（壹壹）邀請朋友 ‘ask Yiyi to invite friends’

Different Expectations based on the Verbs

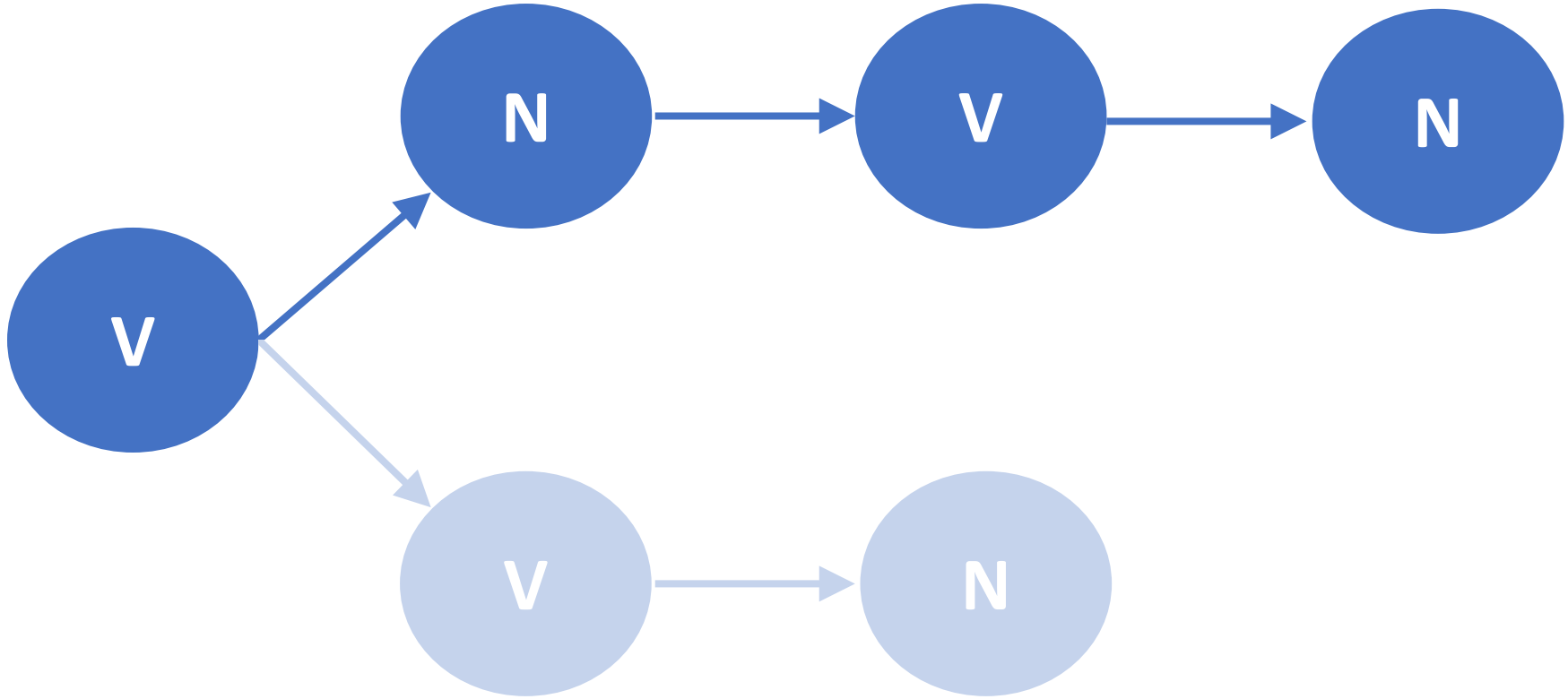
許諾，允諾，承諾，提議，想要 批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待，期待



答應 諳諳 邀請 朋友
提醒 壹壹 邀請 朋友

答應 邀請 朋友
提醒 邀請 朋友

許諾，允諾，承諾，提議，想要 批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待，期待

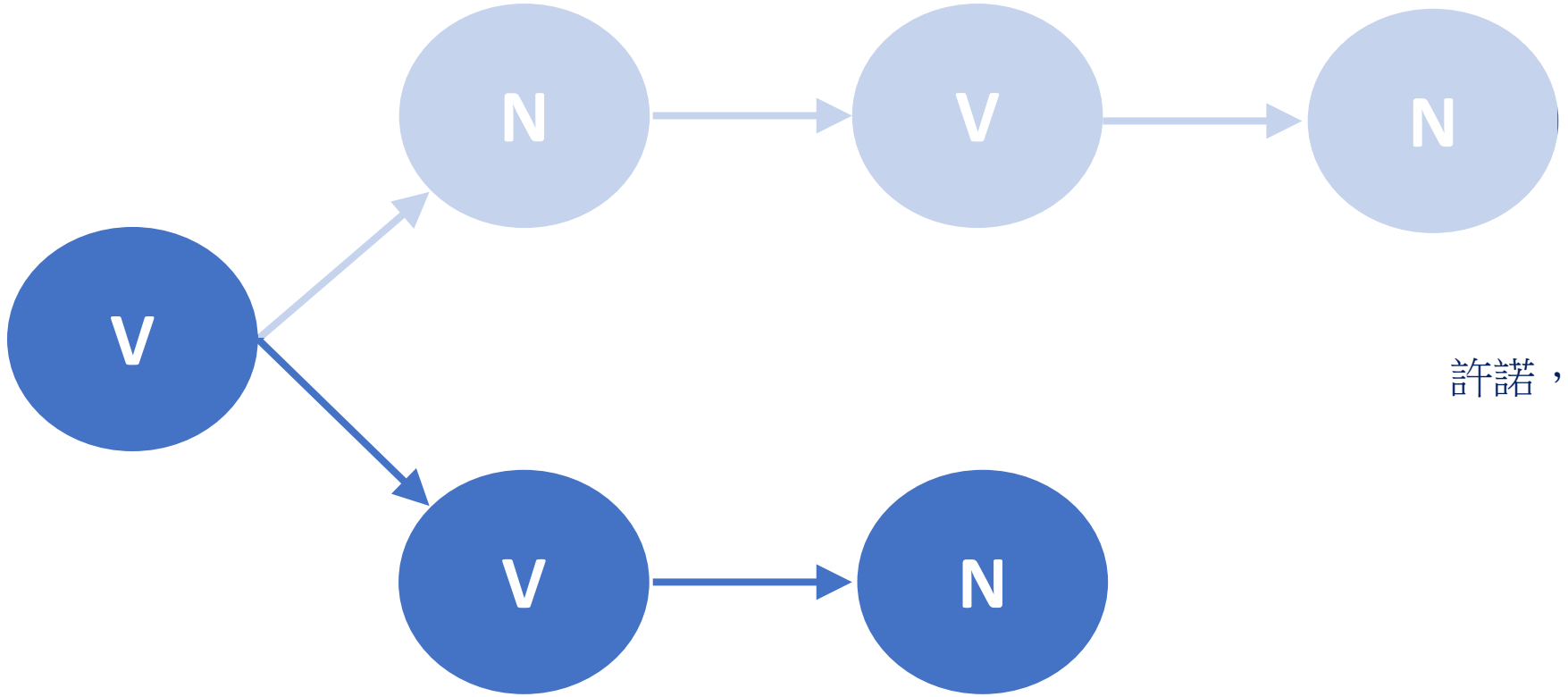


答應 諳諳 邀請 朋友
提醒 壹壹 邀請 朋友

N-prone: 答應

答應 邀請 朋友
提醒 邀請 朋友

批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待，期待



答應 諳諳 邀請 朋友
提醒 壹壹 邀請 朋友

N-prone: 答應

許諾，允諾，承諾，提議，想要

答應 邀請 朋友
提醒 邀請 朋友

V-prone: 要求

Verbs with multiple argument structures

- N-Prone Verbs: V + NP + VP

答應，許諾，允諾，承諾，
提議，希望，同意，想要；

- V-Prone Verbs: V + PRO + VP

批准，禁止，准許，請求，
要求，央求，懇求，吩咐，
提醒，命令，交待，期待

Determined by –
Corpus searches
Sentence completion tasks

- Corpus: Sinica corpus (Chen et al. 1996)
  - N-prone verb: 50% + animate N: 答應 'promise', 提議 'suggest', 想要 'want'
  - V-prone verb: 50% + V: 命令 'command', 提醒 'remind', 央求 'beg'
- Sentence Completion:
  - 瑪麗答應 Mary promise _____
  - 瑪麗是李四答應 Mary is Lisi promise _____ (percentage of RC completion, headed or headless?)

Standard Chinese Cleft Construction: 是 … 的

Control/raising Verbs with multiple complement structures:

許諾，允諾，承諾，提議，想要；批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待

Verb NP/PRO Verb …

答應（諳諳）邀請朋友 ‘promise Anan to invite friends’

要求（壹壹）邀請朋友 ‘ask Yiyi to invite friends’

Standard Chinese Cleft Construction: 是 … 的

NP1 is the NP3 [that NP2 V __]

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	邀請 invite		的 DE	那個 that	女孩。 girl

EXP1

- Self-paced reading; 42 participants, undergraduate students in Chongqing, China
- Two conditions for each verb:

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	(*GAP) ●	邀請 invite	●	的 DE	那個 that	女孩。 girl
b)Ina	歷史 history	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	選修 choose	●	的 DE	那門 that	專業。 major

- Animate: ambiguous; potential two gaps for the filler NP1: after V1 and after V2; V2 is correct
- Inanimate: unambiguous; only gap after V2 is possible

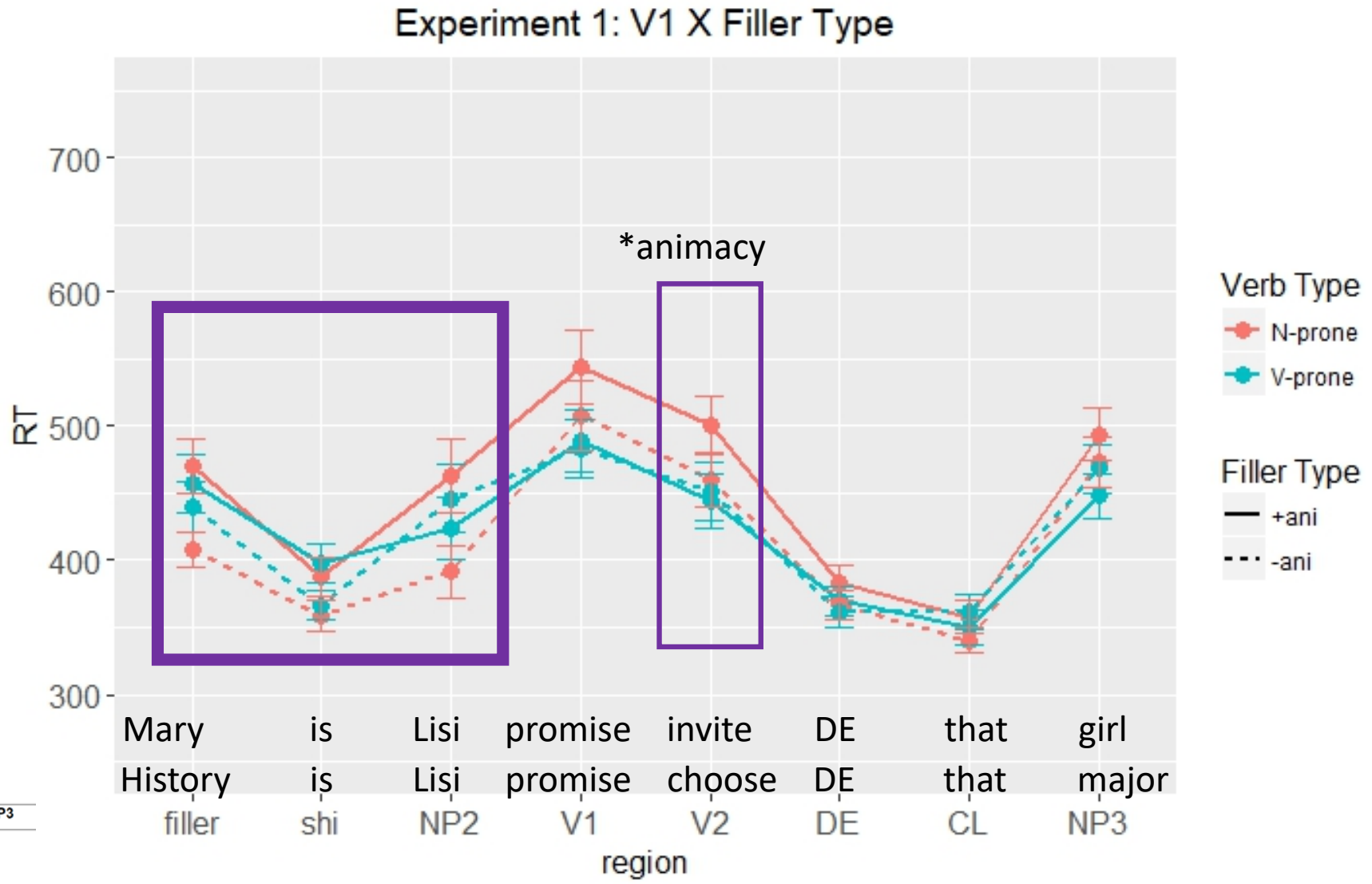
Predictions

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	(*GAP) ●	邀請 invite	●	的 DE	那個 that	女孩。 girl
b)Ina	歷史 history	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	選修 choose	●	的 DE	那門 that	專業。 major

- **Animacy effect:** only an animate NP1 would induce a reanalysis effect on V2
- **Expectation-based effect:** N-prone verbs would show greater animacy effect on V2 than V-prone verbs

RESULTS

- **Animacy effect:** only an animate NP1 would induce a reanalysis effect on V2



	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 slower than -ani (*p*<.05)	n.s.	+ani > -ani (*t*=-1.795)	n.s.
V1 * filler	n.s	n.s.	n.s.	n.s.

EXP2: self-paced reading

- Self-paced reading; 21 participants, graduate students from IU (Bloomington, IN, USA)
- Fixed Complicated animate NP1
  - 欣怡*Xinyi*， 逸凡*Yifan*， 俊賢*Junxian*， 子豪*Zihao* etc.
  - EXP2: 張三 *Zhangsan*， 李四 *Lisi*， 小華 *Xiaohua*， 小明 *Xiaoming*
- Add +vp filler: 開車， 打牌， 植樹 etc.

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	小華 Xiaohua	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	邀請 invite	●	的 DE	那個 that	女孩。 girl
b)Inanimate	歷史 history	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	選修 choose	●	的 DE	那門 that	專業。 major
c) vp	開車 Drive	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	學習 learn	●	的 DE	那件 that	事情。 thing

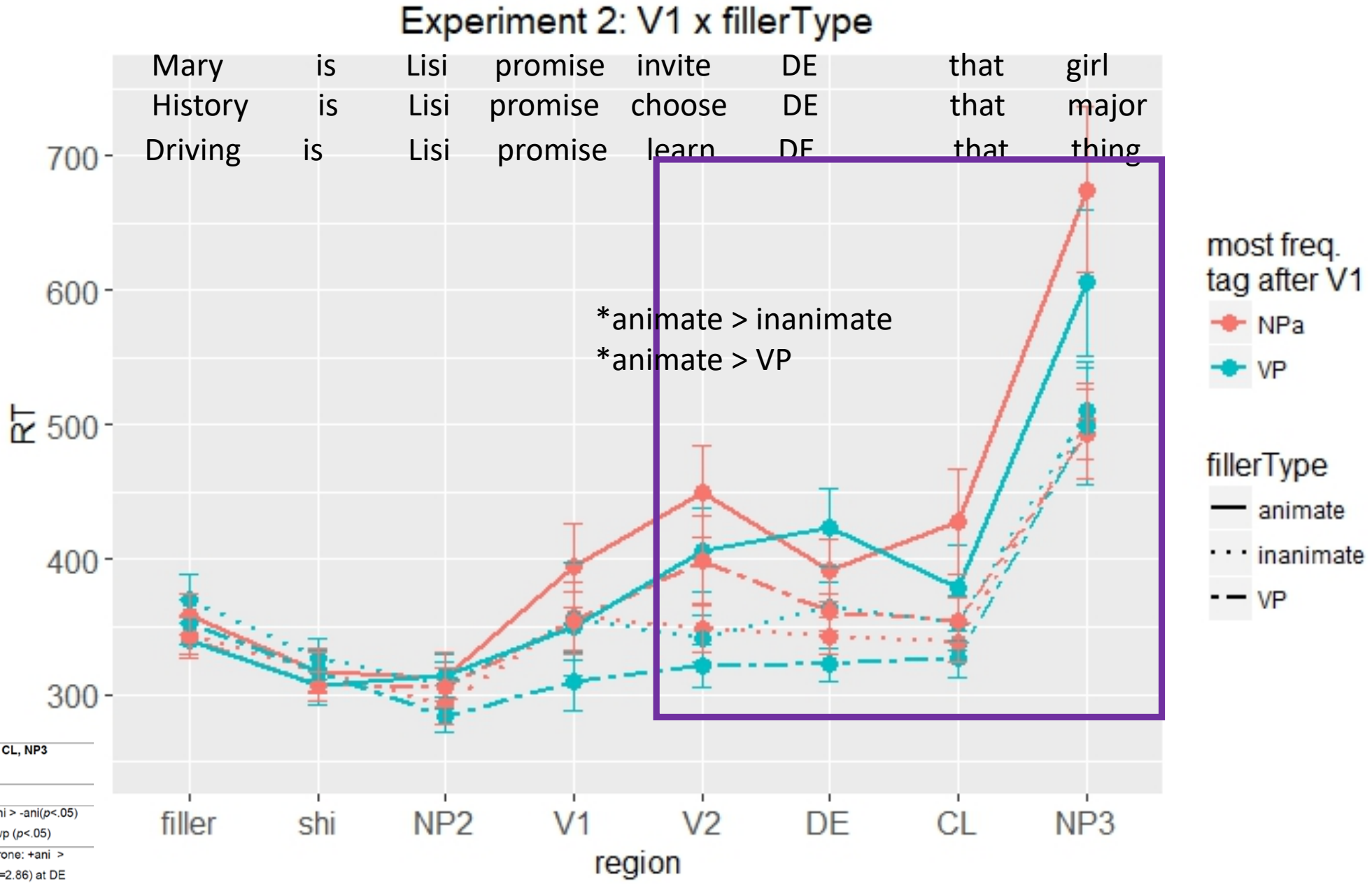
Predictions

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	邀請 invite	●	的 DE	那個 that	女孩。 girl
b)Inanimate	歷史 history	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	選修 choose	●	的 DE	那門 that	專業。 major
c) vp	開車 Drive	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	學習 learn	●	的 DE	那件 that	事情。 thing

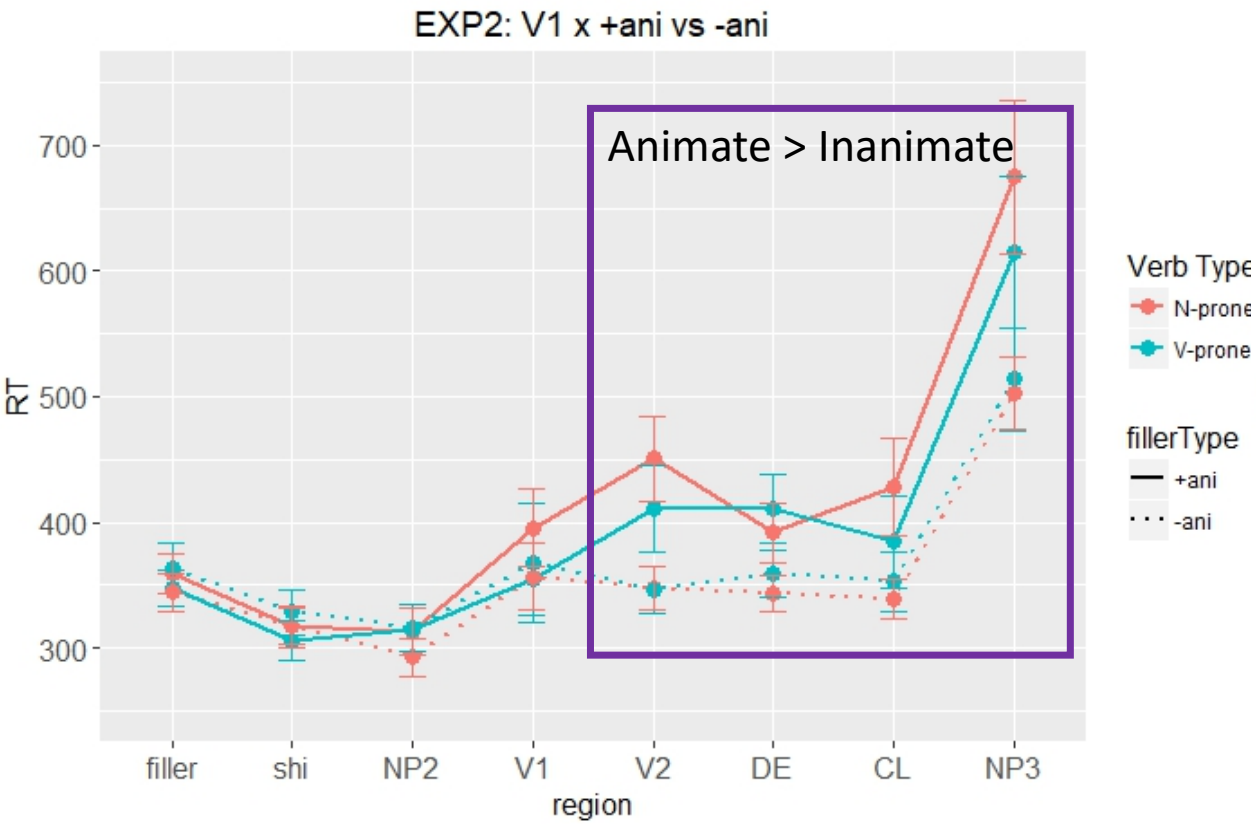
- **Comparing a & b:**
  - **Animacy effect:** only an animate NP1 would induce a reanalysis effect on V2
  - **Expectation-based effect:** N-prone verbs would show greater reanalysis effect on V2 than V-prone verbs
- **Comparing b & c:**
  - **POS effect:** only a verb would induce a reanalysis effect on V2
  - **Expectation-based effect:** V-prone verbs would show greater reanalysis effect on V2 than V-prone verbs
- **Comparing a & c:**
  - **Ns and Vs differ as fillers.**

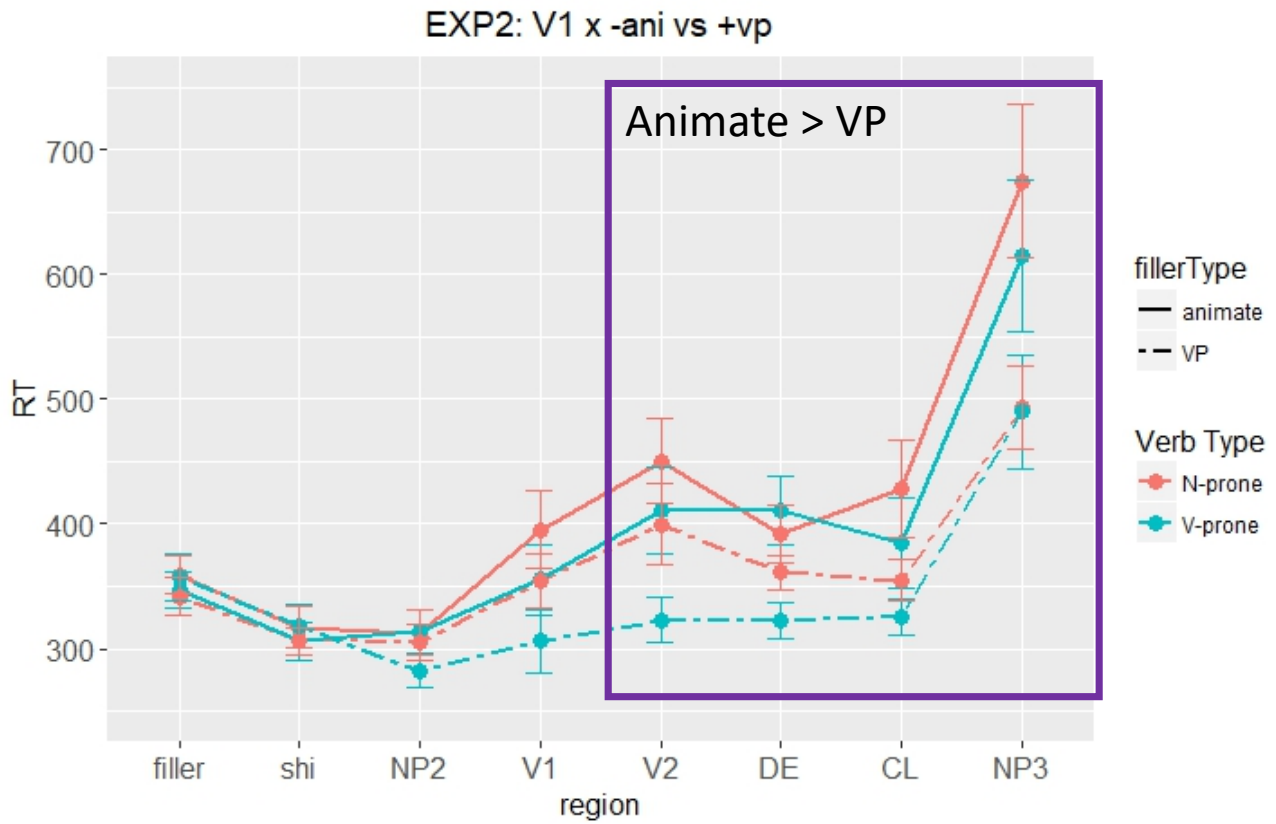
Results

Animacy effect:
only an animate NP1 would induce a reanalysis effect on V2



	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(p<.05) & +vp (p<.05)
V1*filler	n.s	n.s.	n.s.	V-prone: +ani > vp(t=2.86) at DE


EXP2: V1 x +ani vs -ani
Animate > Inanimate
RT
700
600
500
400
300
filler
shi
NP2
V1
V2
DE
CL
NP3
region
Verb Type
N-prone
V-prone
fillerType
+ani
-ani


EXP2: V1 x -ani vs +vp
Animate > VP
RT
700
600
500
400
300
filler
shi
NP2
V1
V2
DE
CL
NP3
region
fillerType
animate
VP
Verb Type
N-prone
V-prone

Predictions

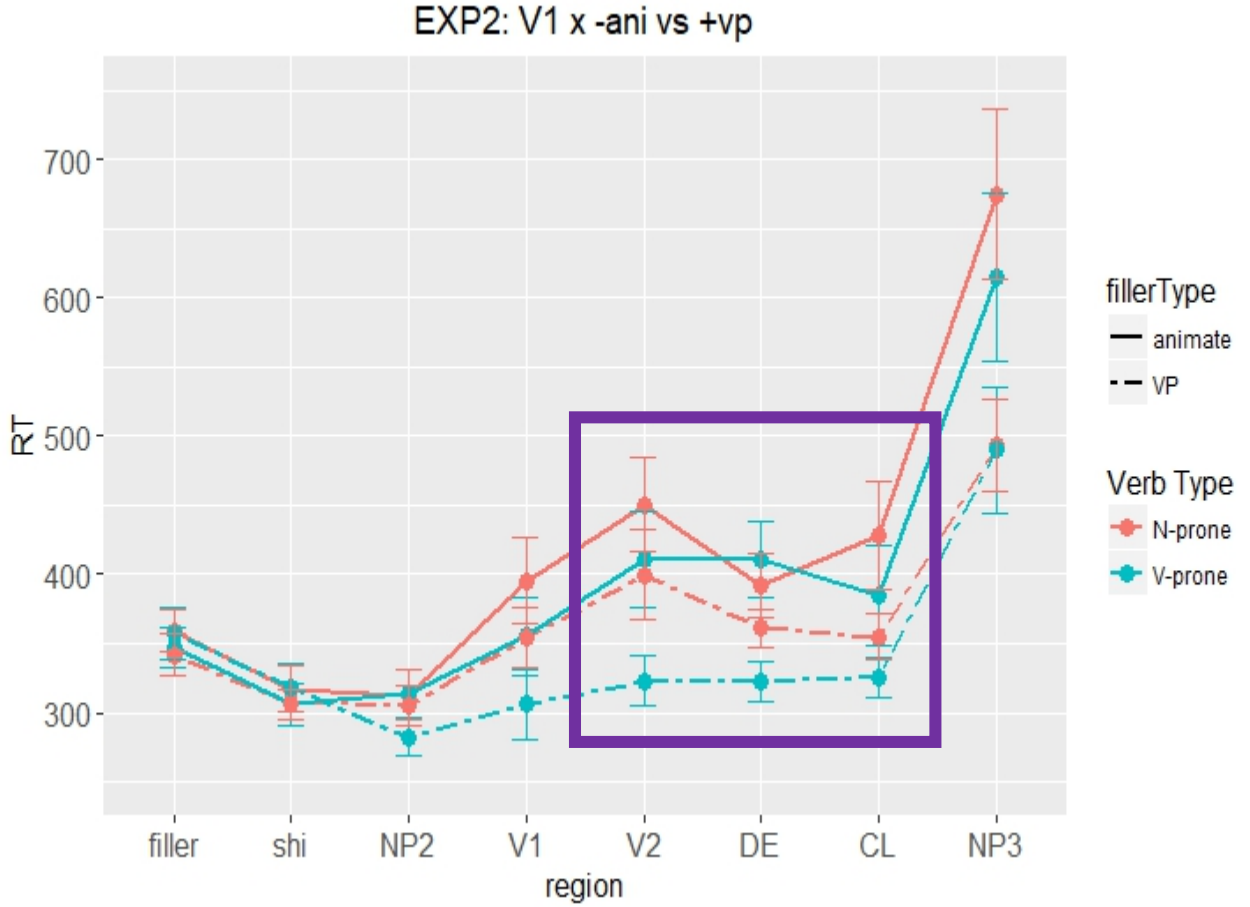
	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	邀請 invite	●	的 DE	那個 that	女孩。 girl
b)Inanimate	歷史 history	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	選修 choose	●	的 DE	那門 that	專業。 major
c) vp	開車 Drive	是 is	李四 Lisi	答應 promise 要求 request	● (*GAP)	學習 learn	●	的 DE	那件 that	事情。 thing

- **Comparing a & b:**
  - ★**Animacy effect:** only an animate NP1 would induce a reanalysis effect on V2
    - **Expectation-based effect:** N-prone verbs would show greater reanalysis effect on V2 than V-prone verbs
- **Comparing b & c:**
  - **POS effect:** only a verb would induce a reanalysis effect on V2
  - **Expectation-based effect:** V-prone verbs would show greater reanalysis effect on V2 than V-prone verbs
- **Comparing a & c:**
  - ★**Ns and Vs differ as fillers.**

Summary

	Experiment 1	Experiment 2
Expectation-based effect	**-**	**-**
Animacy effect	**+**	**+**
N/V differ as fillers		**+**

	Experiment 1	Experiment 2
Expectation-based effect	-	-
Animacy effect	+	+
N/V differ as fillers		+



Conclusion

- Animate effect was observed as a global effect spanning across several regions after V1. Only animate nouns, not inanimate nouns or verbal nouns, are used as the complement of V1.
- Nominals and verbal fillers are processed differently. Verbal fillers are more like inanimate nouns than animate nouns—even for V-prone verbs.
- Expectation-based effect (i.e. differences between N-prone and V-prone verbs) was not observed. The V-prone and N-prone tendencies may need to be stronger.

Thank you.

LaCL 語言與認知實驗室
LANGUAGE AND COGNITION LABORATORY

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Processing dependencies in sentences

- *It was the barber that __ saw the lawyer in the parking lot.*
- *It was the barber that __ saw Bill in the parking lot.*
- *It was John that __saw the lawyer in the parking lot.*
- *It was John that __saw Bill in the parking lot.*

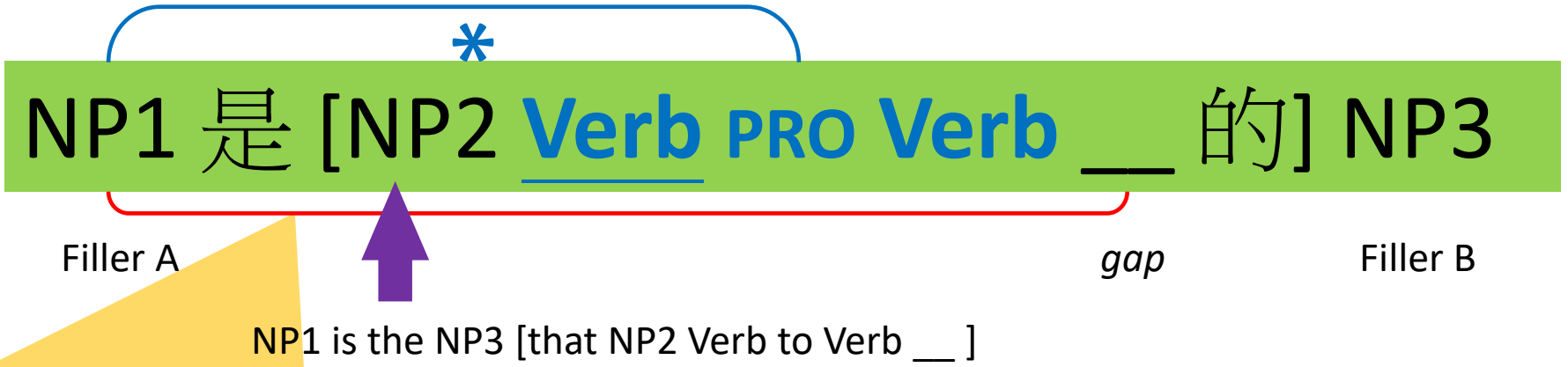
(Subject cleft)

- *It was the barber that the lawyer saw __ in the parking lot.*
- *It was the barber that Bill saw __ in the parking lot.*
- *It was John that the lawyer saw __ in the parking lot.*
- *It was John that Bill saw __ in the parking lot.*

(Object cleft)

Gordon, Hendrick & Levine, 2002; Lewis & Vasishth 2005

Standard Chinese Cleft Construction: 是 … 的



Control/raising Verbs with multiple complement structures:

許諾，允諾，承諾，提議，想要；批准，禁止，要求，央求，懇求，吩咐，提醒，命令，交待

Verb NP/PRO Verb …

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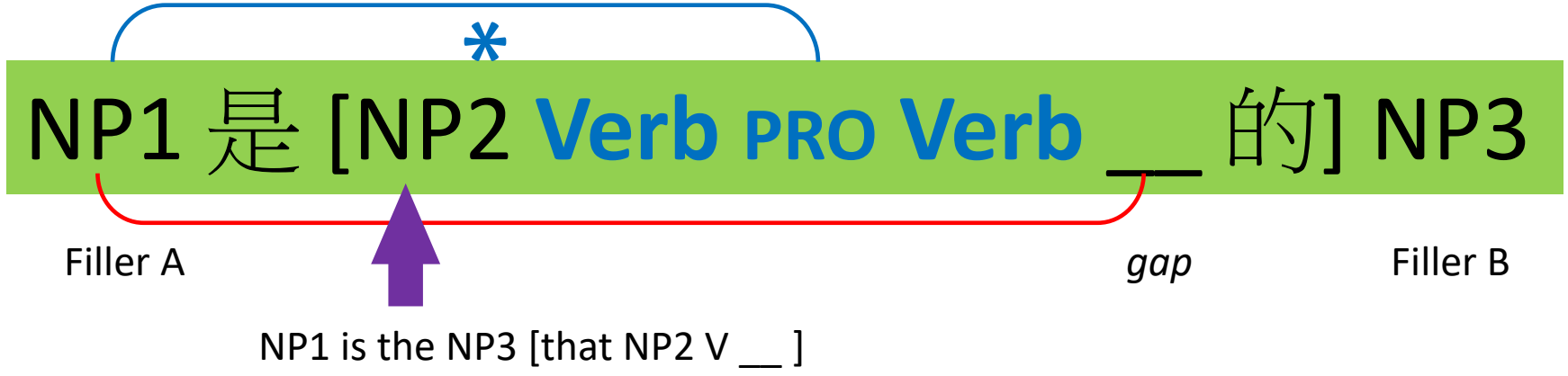

	NP1	SHI	NP2	V1	PRO	V2	GAP	DE	CL	NP3.
a)Animate	瑪麗 Mary	是 is	李四 Lisi	答應 promise 要求 request	(*GAP)	邀請 invite		的 DE	那個 that	女孩。 girl

Meta-analysis of exp1 and exp2

Different reading strategies?

- Time spent during the first 5 regions vs. in the last three regions

	NP1	SHI	NP2	V1	V2	DE	CL	NP3.
a)Ani	瑪麗 Mary	是 is	李四 Lisi	答應 promise	邀請 invite	的 DE	那個 that	女孩。 girl
b)Ina	歷史 history	是 is	李四 Lisi	答應 promise	選修 choose	的 DE	那門 that	專業。 major
c) vp	開車 Drive	是 is	李四 Lisi	答應 promise	學習 learn	的 DE	那件 that	事情。 thing

- Ratio: average speed per character of first 5 regions / that of last 3 regions

Lin (2014) different reading effects before and after relativizer in Chinese RCs

Ratios comparisons of exp1 & exp2

- EXP1 AVG: 1.02
- EXP2 AVG: 0.76
- Add STATS test b/w exp1 and exp2

- → Participants of EXP1 spent longer time in the first 5 regions than participants of EXP2

References

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Factors

- Frequencies of complements
- Animacy of the filler/NP1
  - Animate N: **瑪麗** 是 李四 答應 _1_ 邀請 _2_ 的 那個女孩。
  - Mary is Lisi promise invite DE that girl
  - '**Mary** is **the girl** that Lisi promised to **invite**.'
  - Inanimate N: **法語/French** 是 李四 答應 _1_ 學習/learn _2_ 的 那門語言 /that language。
  - Verbal N: **開車/Driving** 是 李四 答應 _1_ 練習/practice _2_ 的 那件事情 /that thing。

  - In terms of word formation, emphasize here that VP and NP are not morphologically distinguishable in Chinese.

Predictions

	Expectation-based	Cue-based
general	frequency/probability	nominal: animacy, gender etc.
NP1-NP2	NP1: +ani more difficult (complicated human names in EXP1)	no difference
V1	+ani: N-prone slower than V-prone (assignment cost) -ani: no difference	+ani: more difficult across conditions (NP interference)
V2	+ani: N-prone slower than V-prone (reanalysis) -ani: no difference	+ani: more difficult across conditions (NP interference)

Predictions

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V1	+ani: N-prone slower than V-prone (assignment cost) -ani: no difference +vp: V-prone slower than N-prone	+ani: more difficult across conditions (NP interference)
V2	+ani: N-prone slower than V-prone (reanalysis) -ani: no difference +vp: V-prone slower than N-prone (reanalysis)	+ani: more difficult across conditions (NP interference)

Discrepancies

	EXP1	EXP2
NP1-NP2	+ani slower than – ani for N-prone verb	No stat. sig. diff. across conditions
V1	N-prone slower than V-prone verb; -N-prone: +ani slower than -ani -V-prone: no difference	No stat. sig. diff. across conditions
V2	-N-prone: +ani slower than -ani **-V-prone: no difference**	+ani slower than -ani and vp fiilers across V1 types; +vp: N-prone slower than V-prone

comparing exp1 and exp2

- Item
- Participant
- comp question