Structural Expectations in Chinese Relative Clause Comprehension

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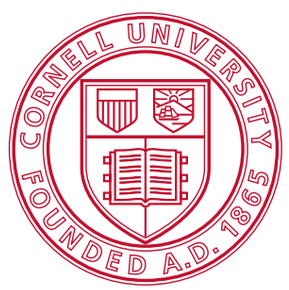
Cornell University



Outline

Introduction

Chinese RC

Modeling

Conclusion

Relative clause comprehension

Subject relative clause (SR)

The **senator**$_i$ [who **e**$_i$ attacked the reporter] admitted the error.

Object relative clause (OR)

The **senator**$_i$ [who the reporter attacked **e**$_i$] admitted the error.

Comprehension difficulty: SR << OR

Two major accounts

Memory-based

(Gibson 1998, 2000; Grodner & Gibson 2005)

Experience-based

(Mitchell et al 1995; Hale 2001; Lewis & Vasishth 2005; Levy 2008)

Memory-based approach

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Memory-based: SR << OR

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Memory-based: SR << OR

Experience-based approach

English Penn Treebank: 86% SR vs 13% OR (Hale 2001)

German NEGRA: 74% SR vs 26% OR (Skut et al. 1997)

Experience-based: SR << OR

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Hsiao & Gibson (2003)

SR: [**e**$_i$ yaoqing fuhao de] **guanyuan**$_i$ da-le jizhe

invite tycoon DE official hit reporter

'The official who invited the tycoon hit the reporter.'

OR: [fuhao yaoqing **e**$_i$ de] **guanyuan**$_i$ da-le jizhe

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- Subject-modifying SR (SR-S)
    - [**e**$_i$ yaoqing fuhao de] **guanyuan**$_i$ da-le jizhe
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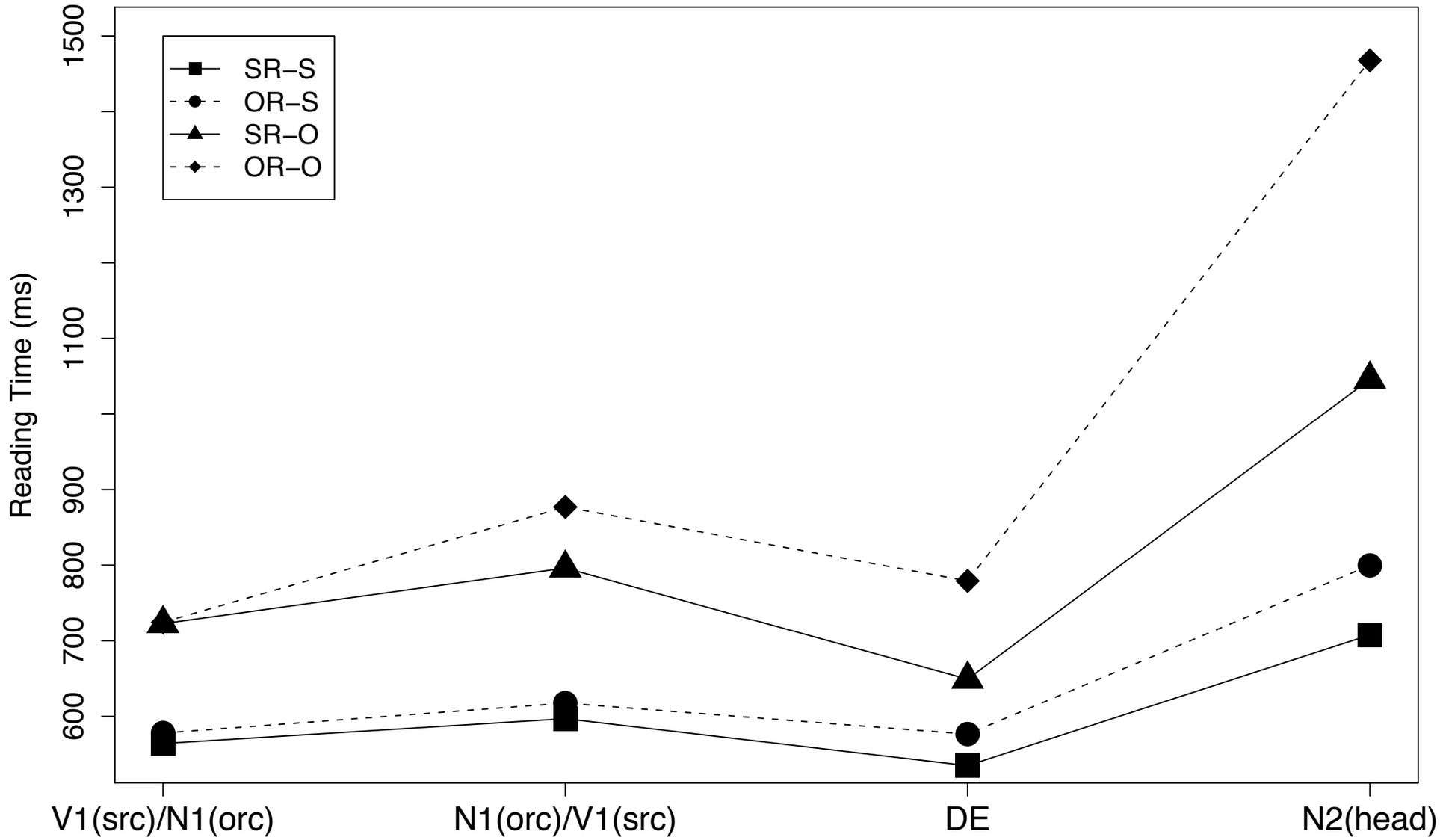
Lin & Bever (2006, 2011)



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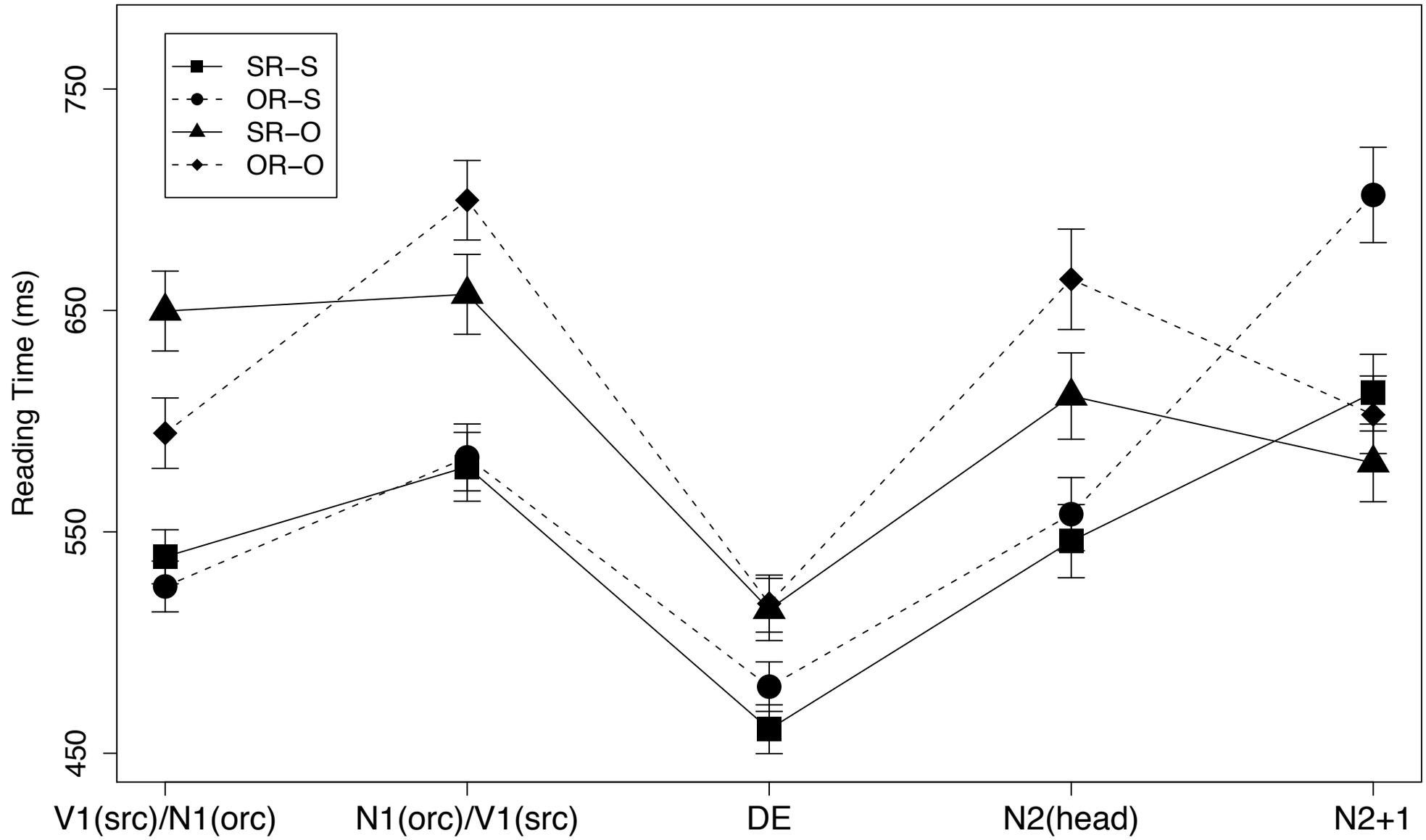
reporter hit tycoon invite

Chen, Li, Kuo, Vasishth (submitted)



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- is a model of sentence processing difficulty
- is built on a language model, such as a PCFG
- quantifies the "unlikelihood" (surprise) of integrating a word in the sentence
- is used to predict word-by-word reading times

Surprisal: an example

A six-word string:

0 The 1 horse 2 raced 3 past 4 the 5 barn 6

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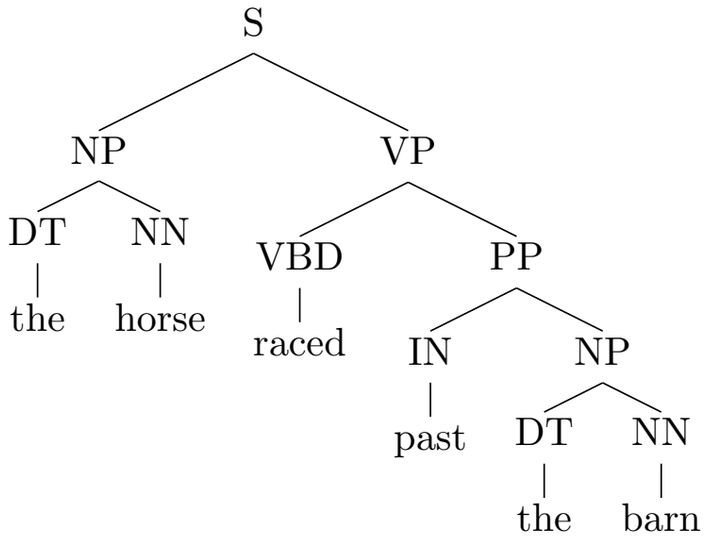

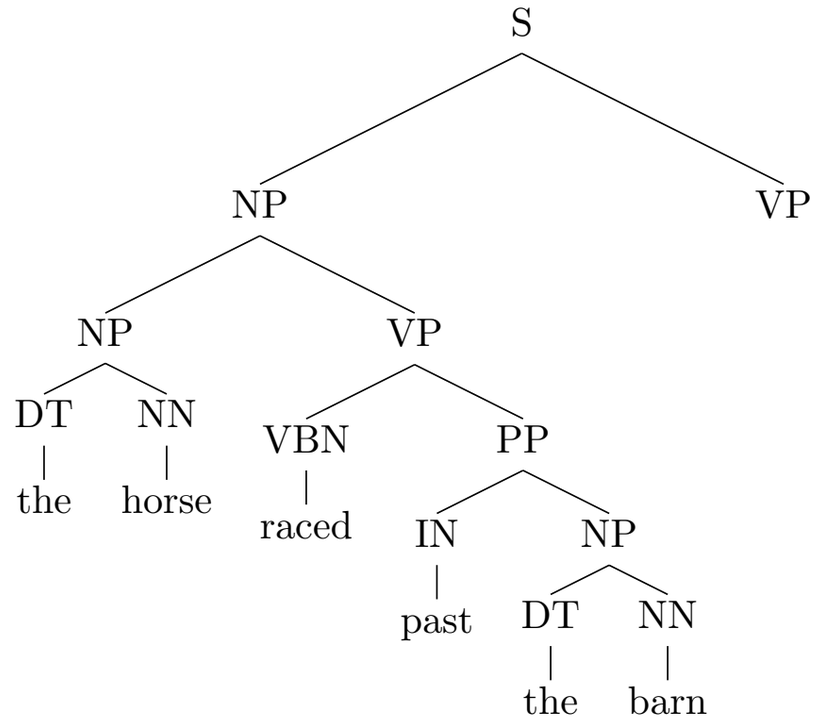

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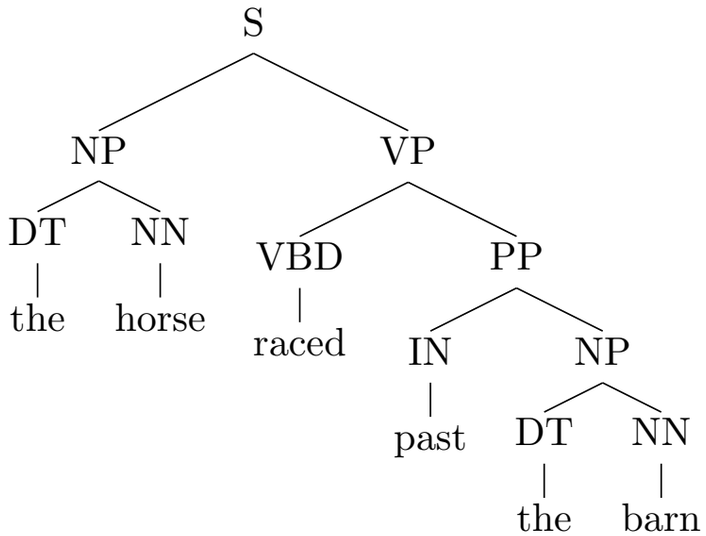
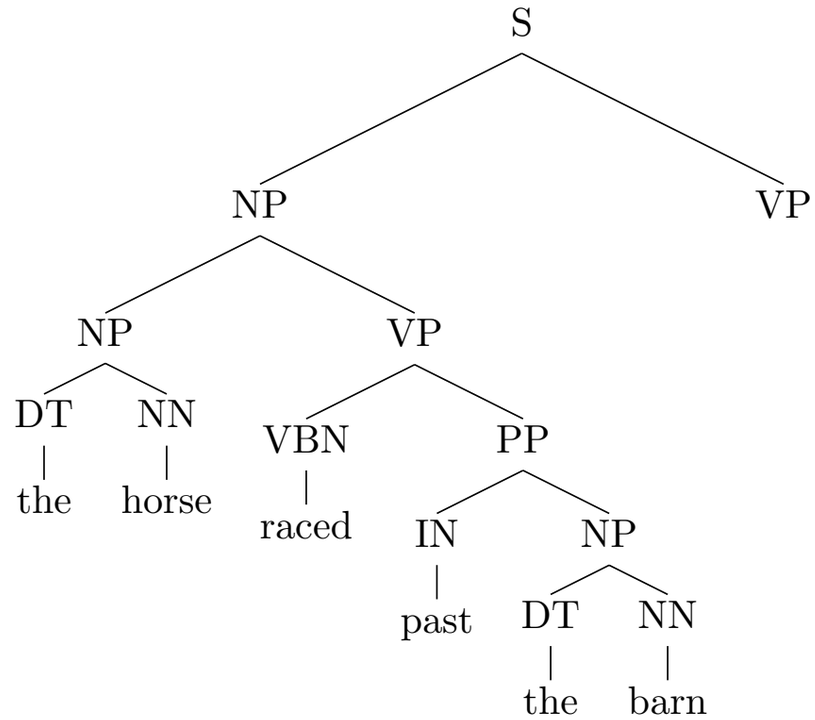


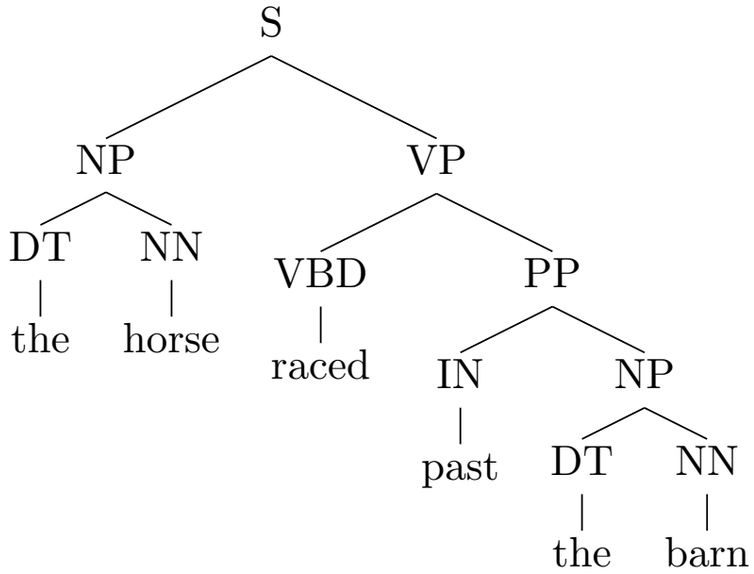


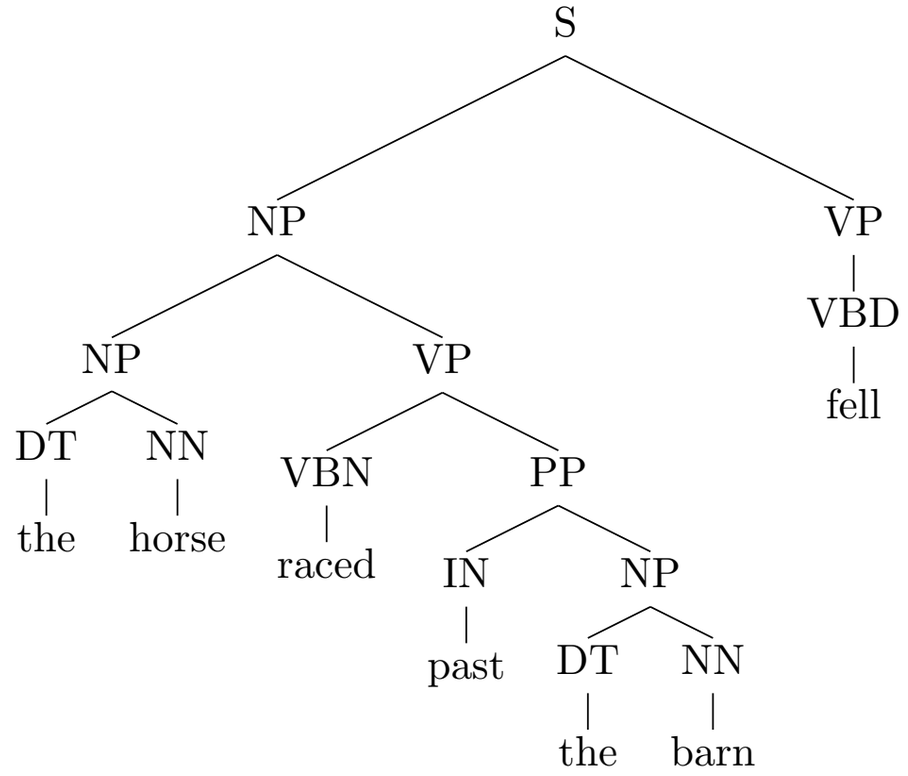
main-clause reading >> reduced RC reading

Surprisal: an example

The next word leads to a structural reanalysis:

0 The 1 horse 2 raced 3 past 4 the 5 barn 6 ***fell*** 7





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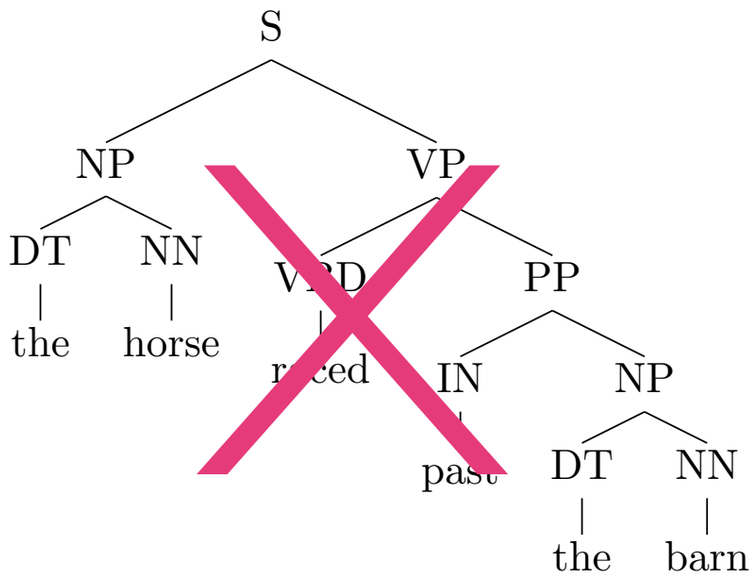

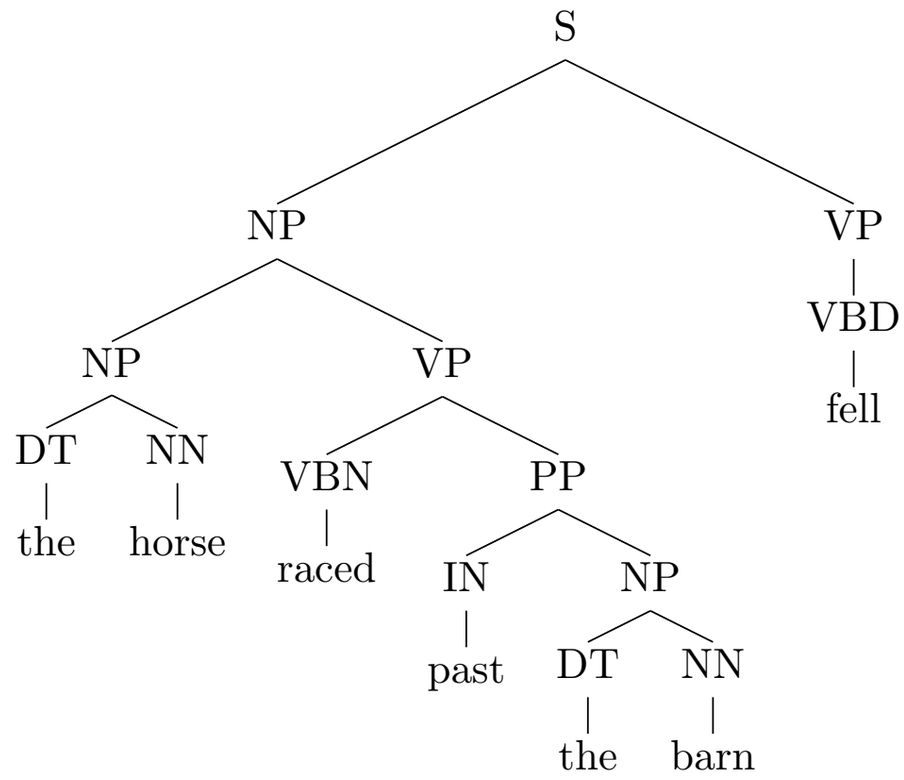

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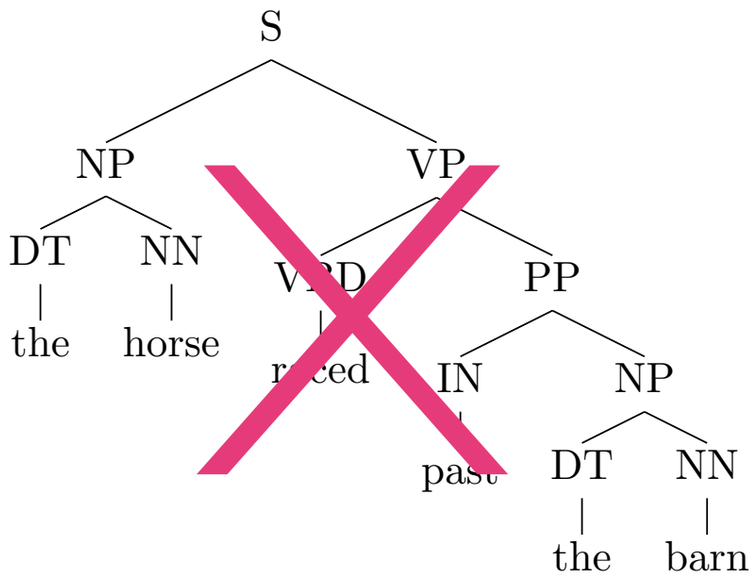

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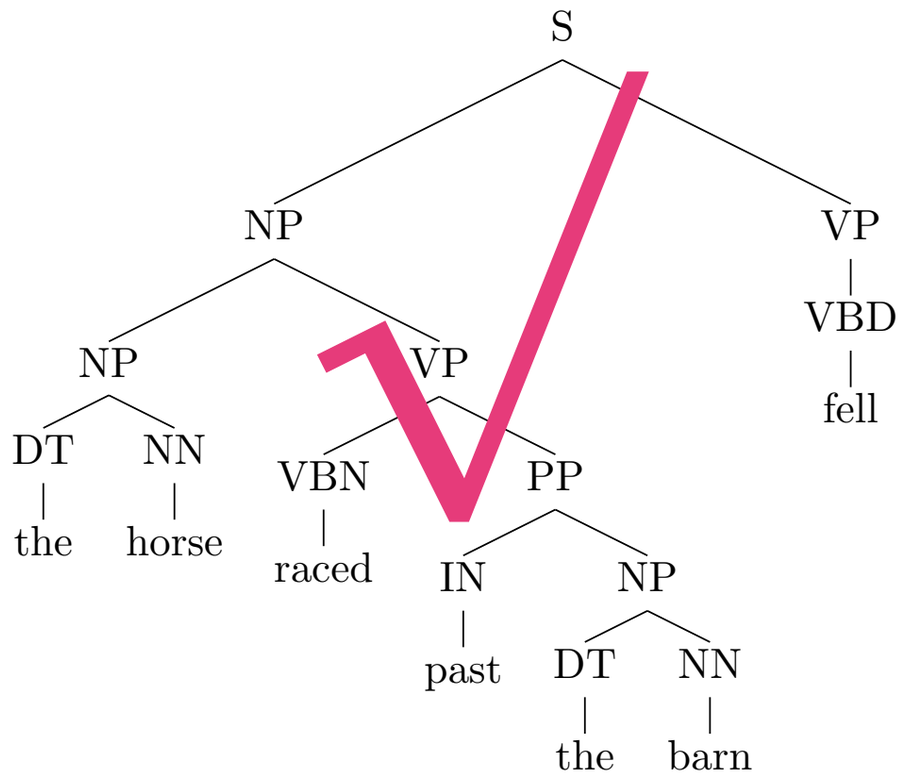

reduced-relative reading

Surprisal: the calculation

0 The 1 horse 2 raced 3 past 4 the 5 barn 6 fell 7

$$surprisal = \log_2(\frac{\alpha_{(0,6)}}{\alpha_{(0,7)}})$$

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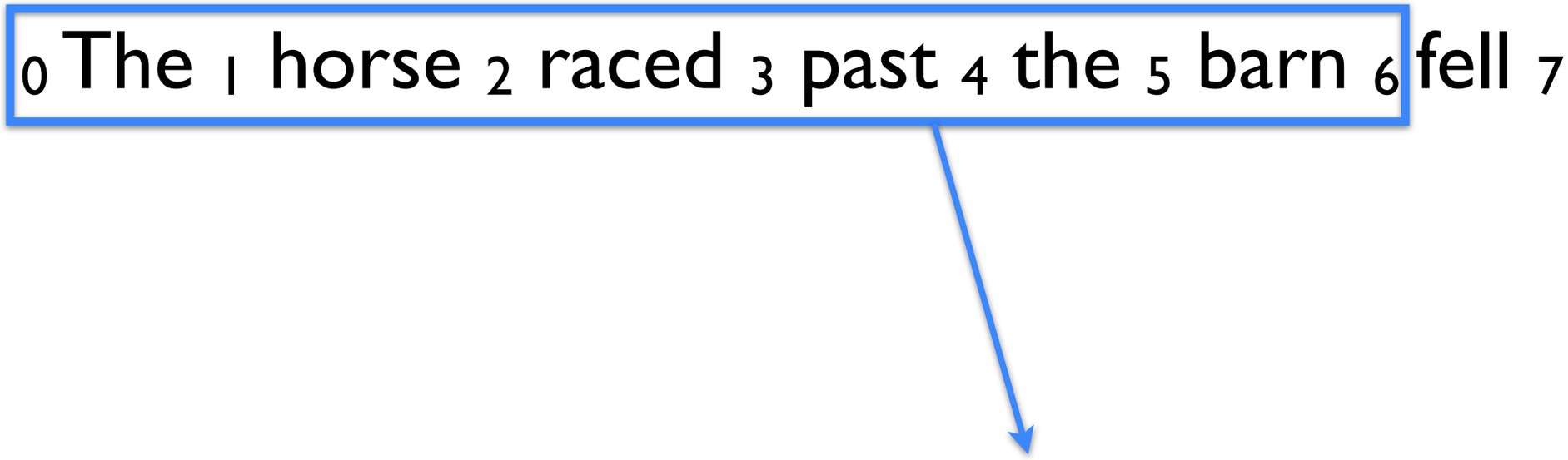

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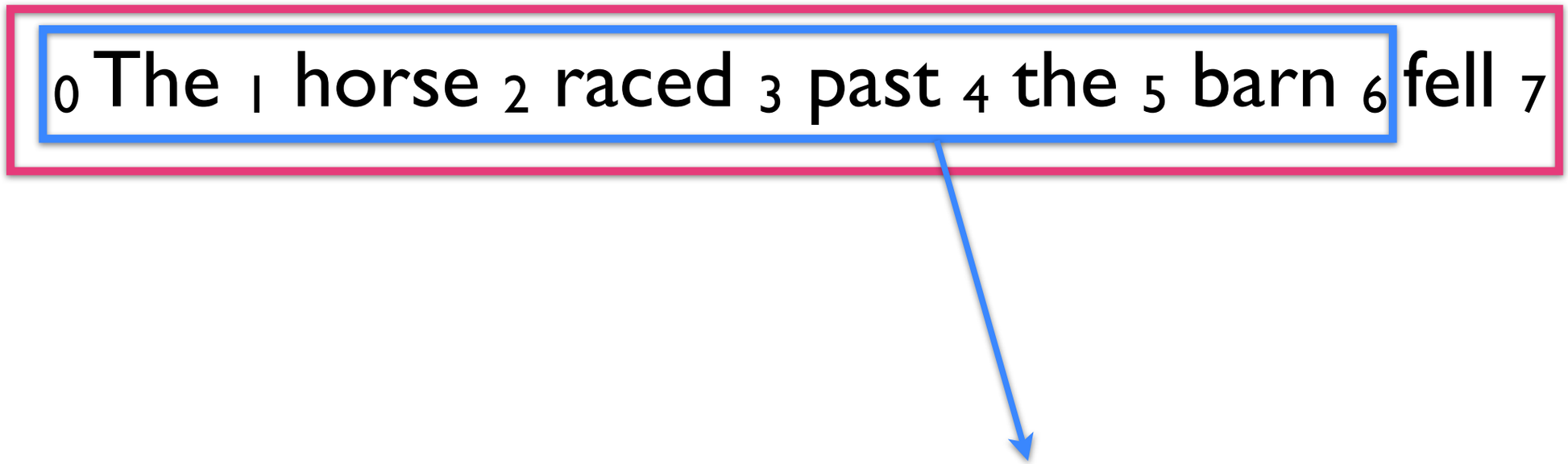

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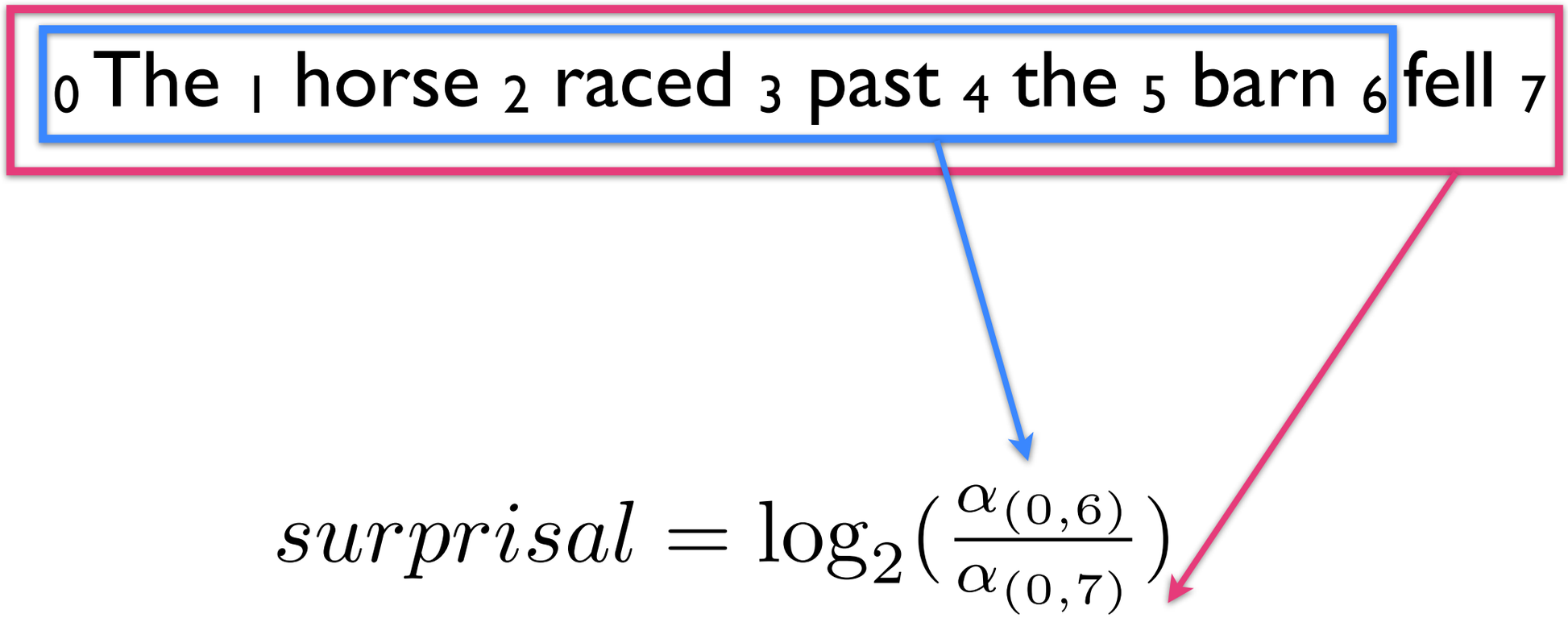

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Probabilistic Grammar

Type	Count
noun subject	10870
pro subject	14921
RC subject	2057
noun object	14041
pro object	109
RC object	2273
SRC	895
ORC	613

0.9261	S	→	NPSBJ	VP				
0.0739	S	→	NPRC	VP	0.5	V	→	*yaoqing*
0.5935	NPRC	→	CPSR	NP	0.5	V	→	*dale*
0.4065	NPRC	→	CPOR	NP	0.3333	N	→	*fuhao*
0.8615	VP	→	V	NPOBJ	0.3333	N	→	*guanyuan*
0.1385	VP	→	V	NPRC	0.3334	N	→	*jizhe*
1.0	CPSR	→	VP	DEC	1.0	DEC	→	*de*
1.0	CPOR	→	S/NP	DEC	1.0	NP/NP	→	ϵ
1.0	S/NP	→	NPSBJ	VP/NP	1.0	pro	→	ϵ
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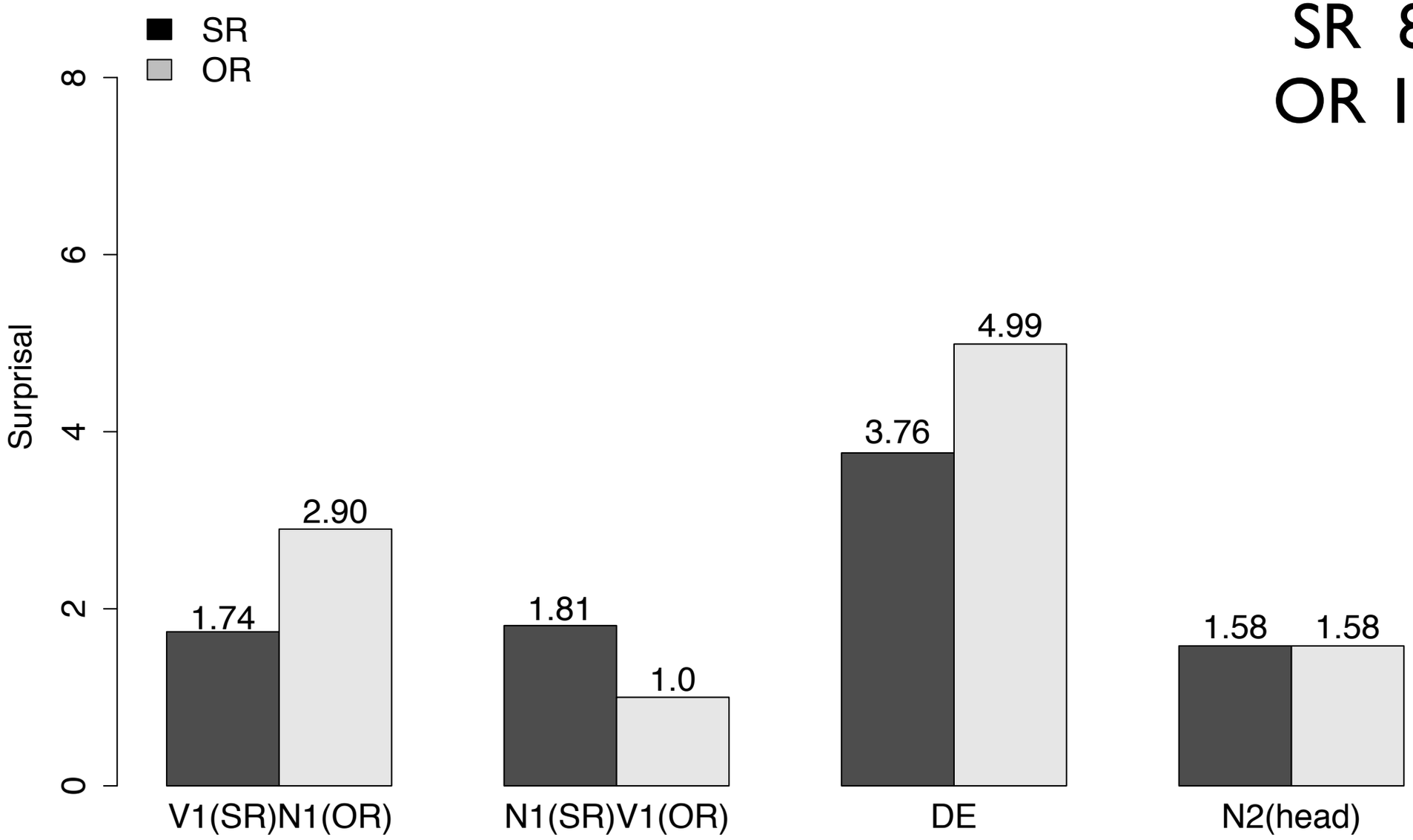
Parser

- bottom-up chart-parsing algorithm (Goodman, 1999)

- the incremental parser considers multiple parses at each position.

Results: Subj-modifying RC

Total:
SR 8.89
OR 10.47



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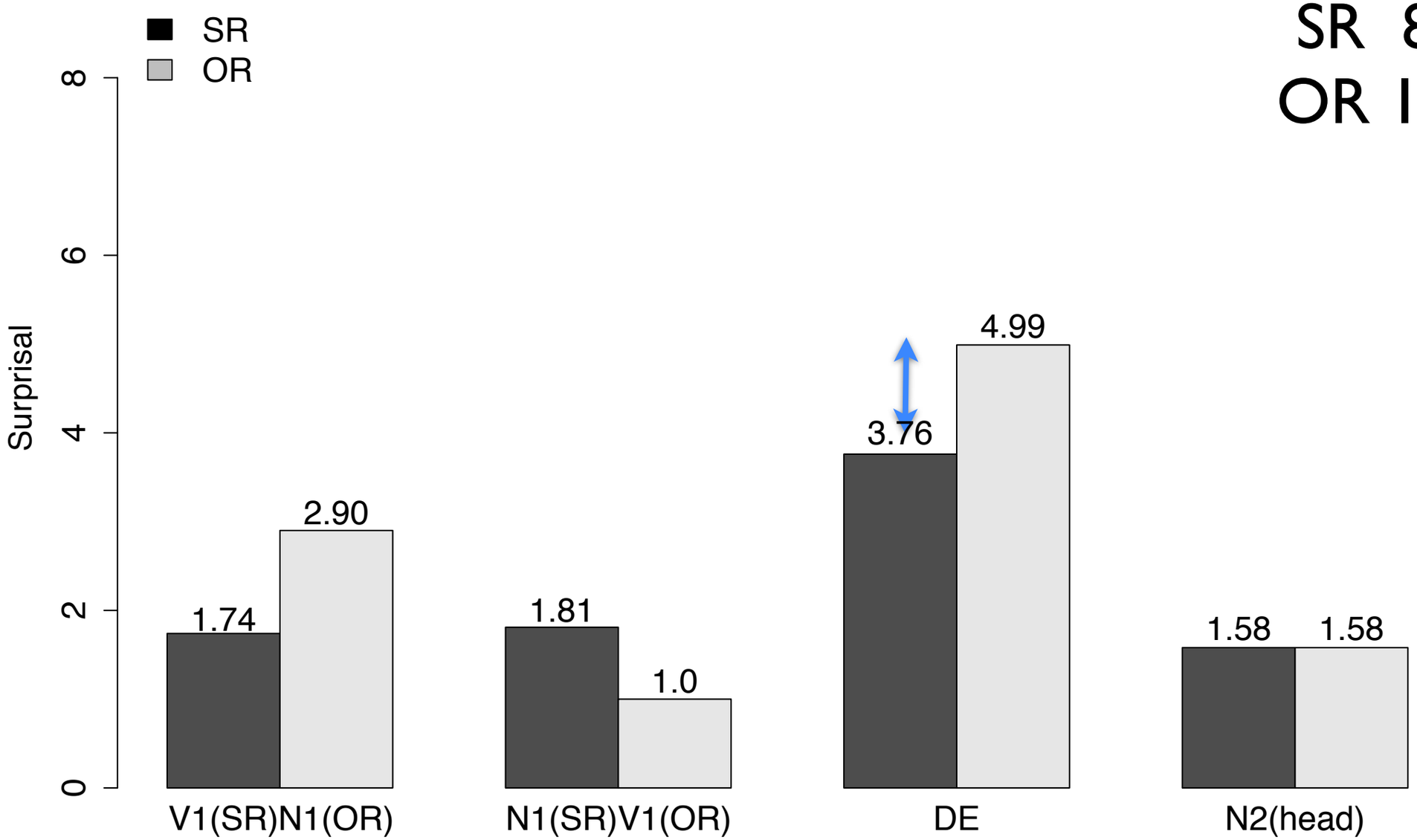

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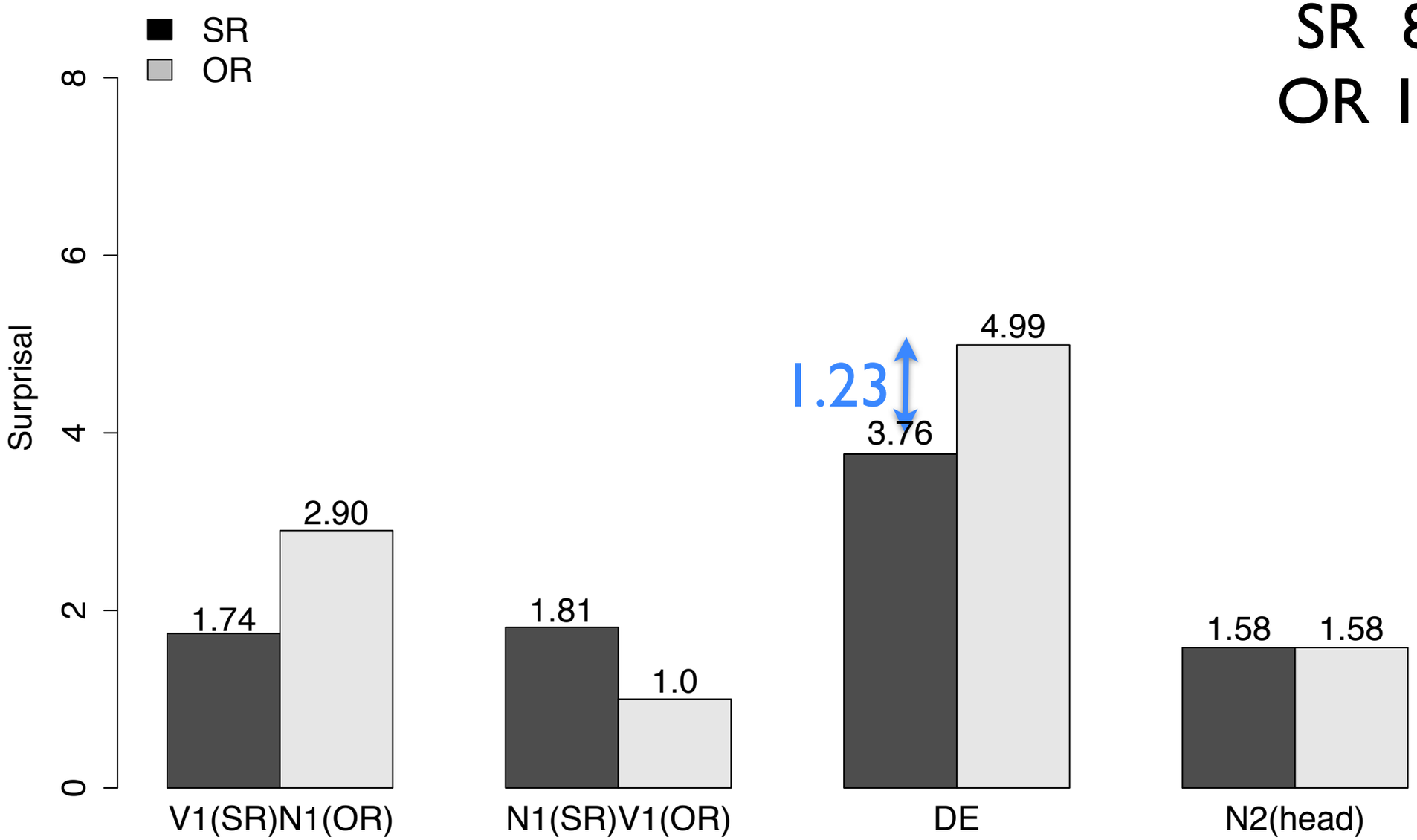
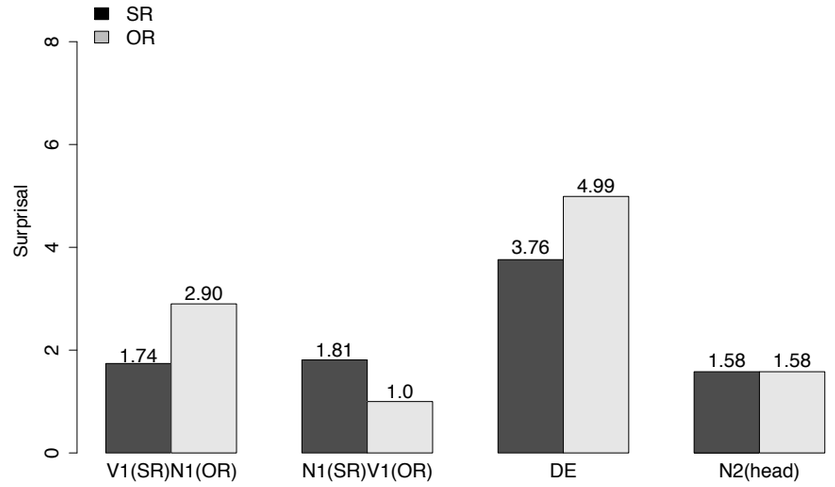
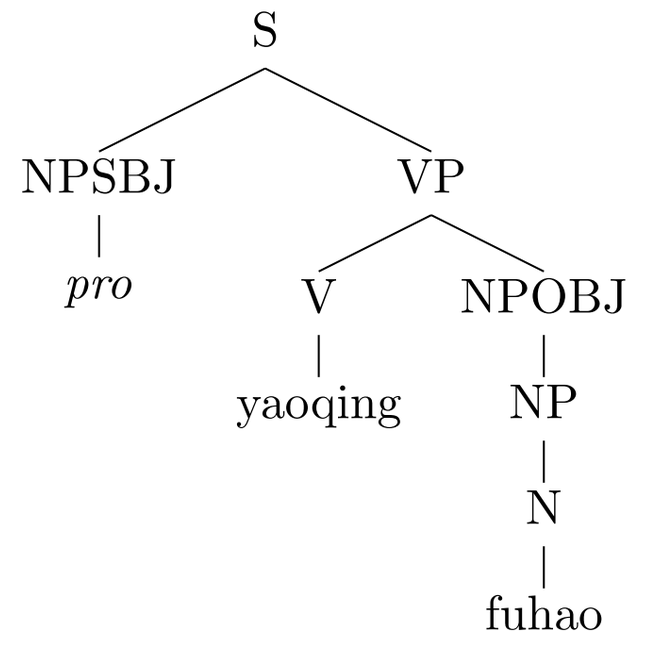


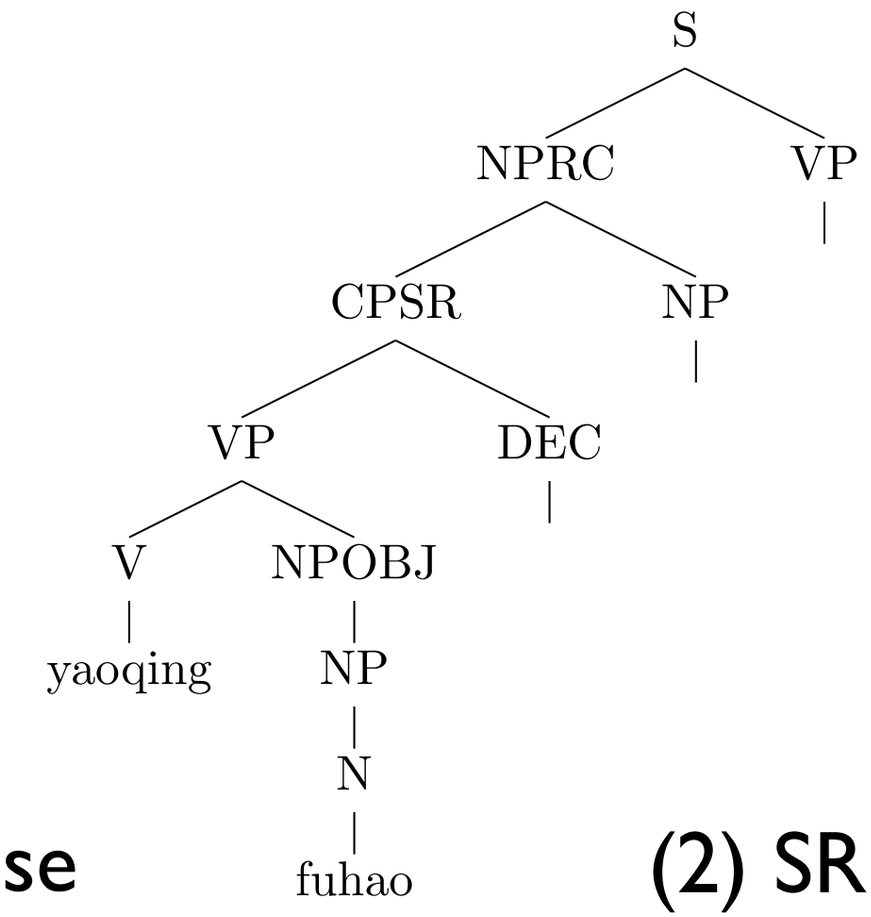
Calculate surprisals



- In SR-S, before "de": V N "invite tycoon ..."



(1) *pro*-drop main clause



(2) SR

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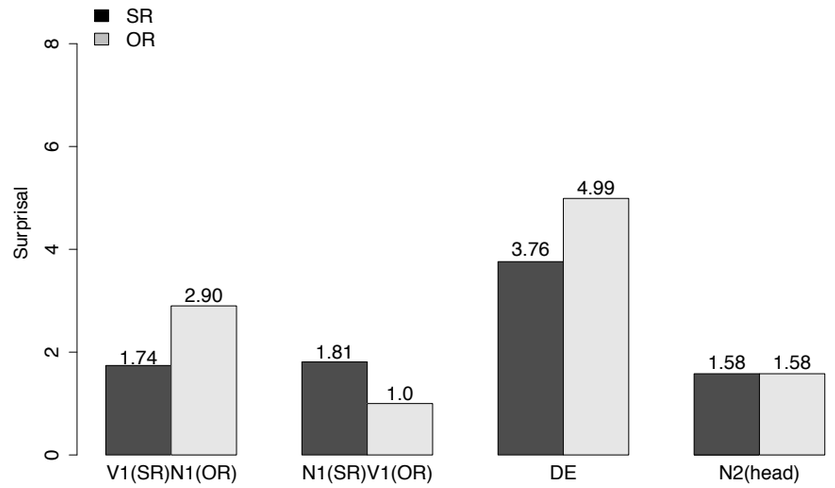

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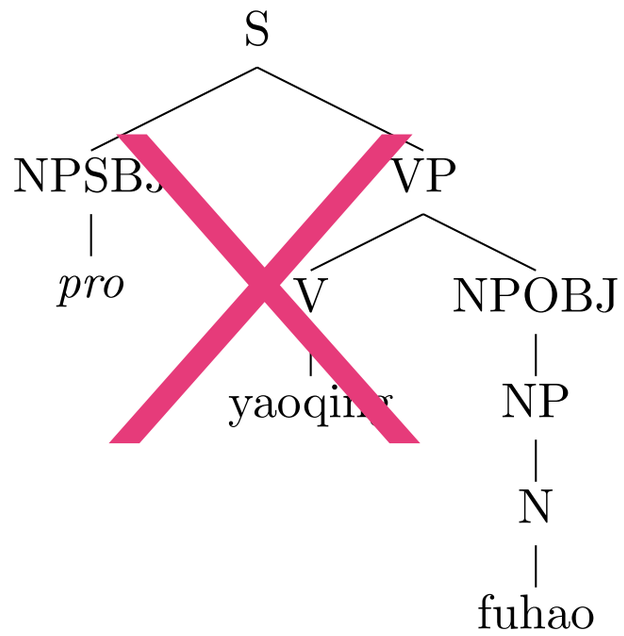

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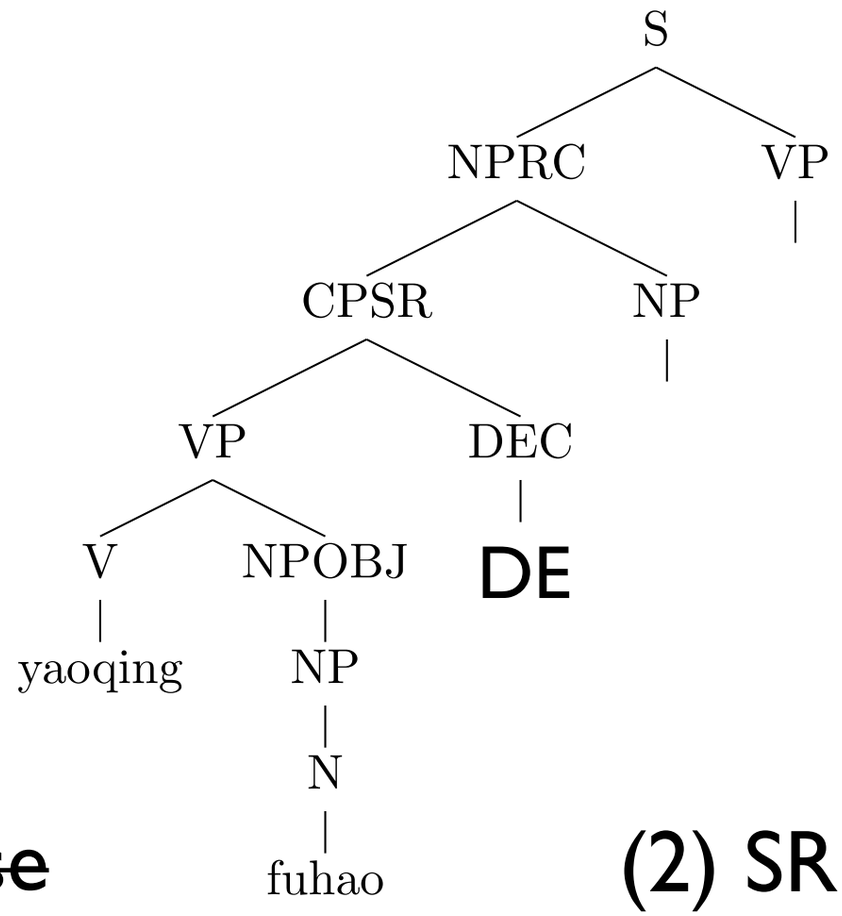

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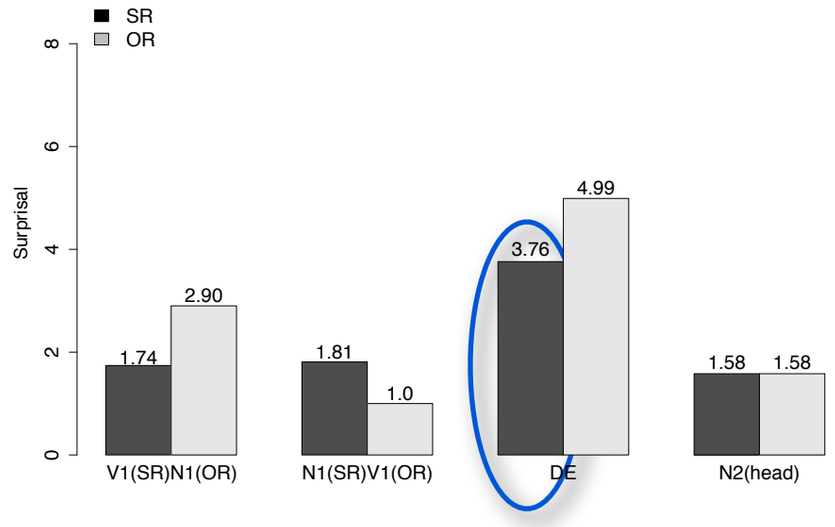

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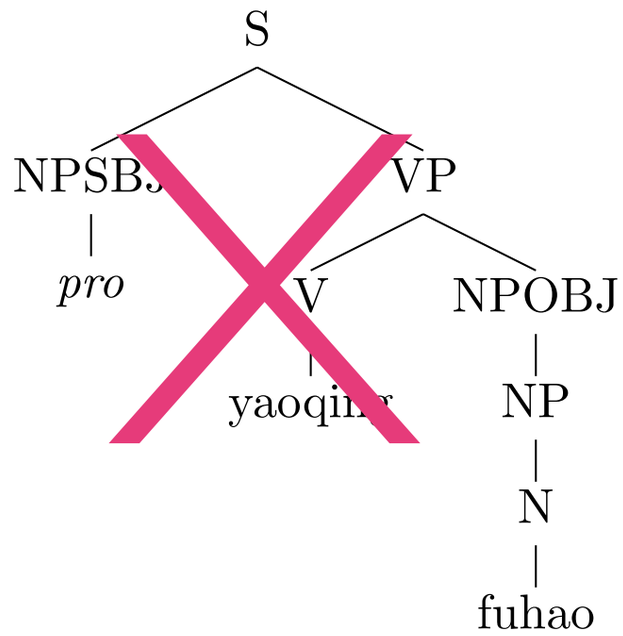

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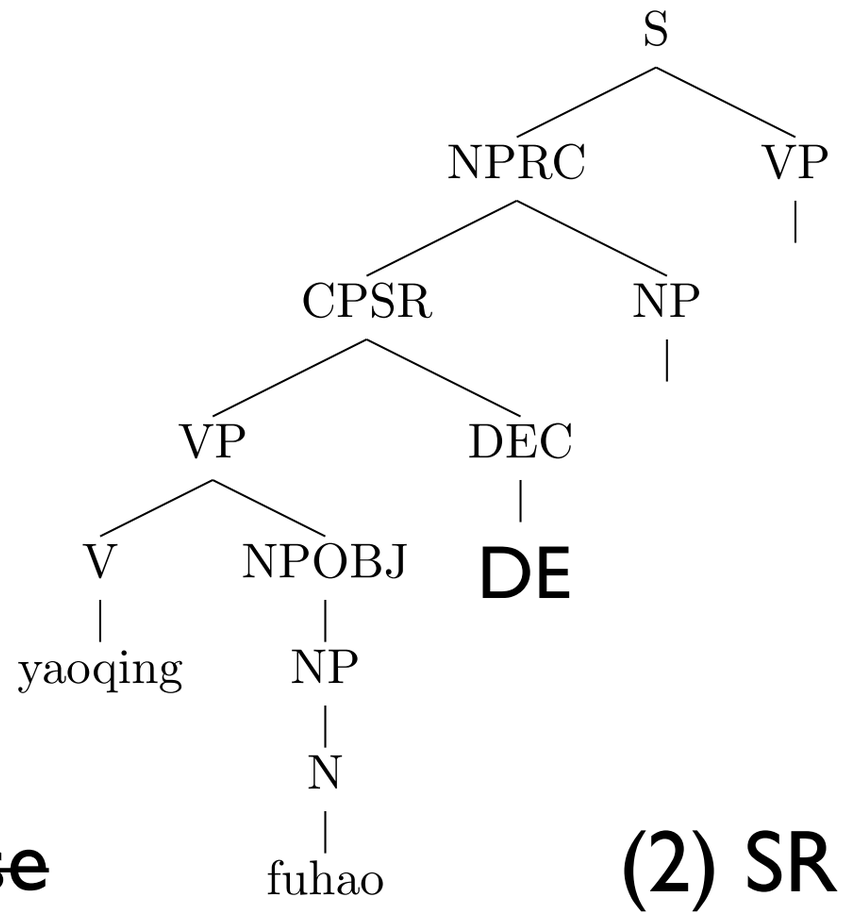

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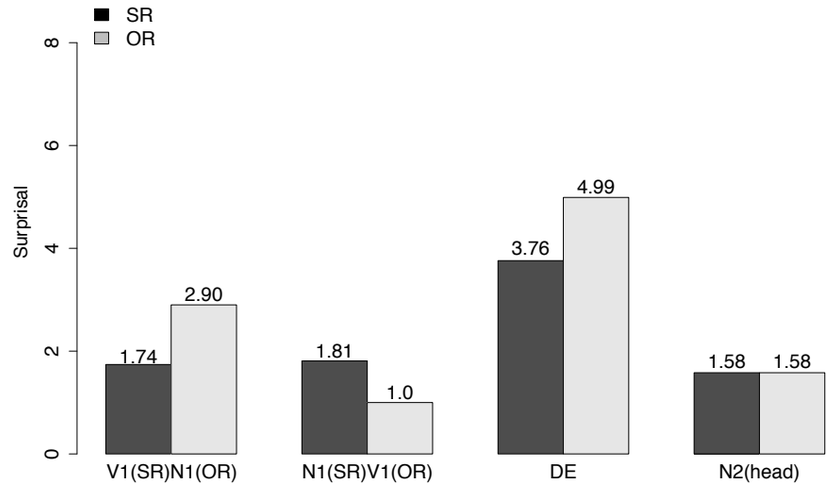
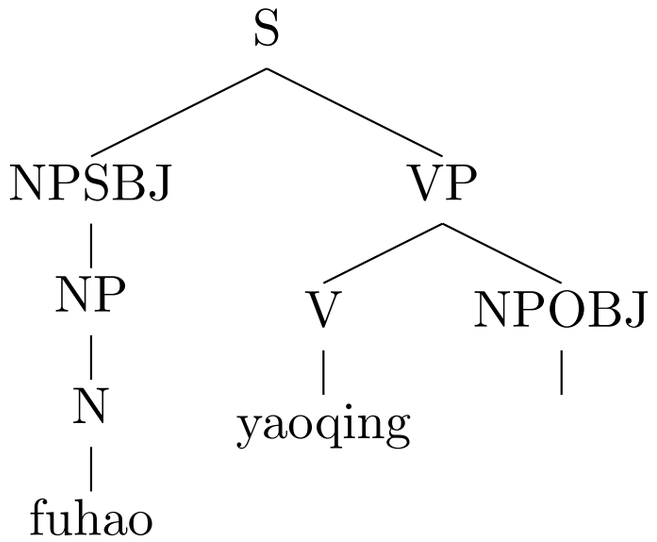
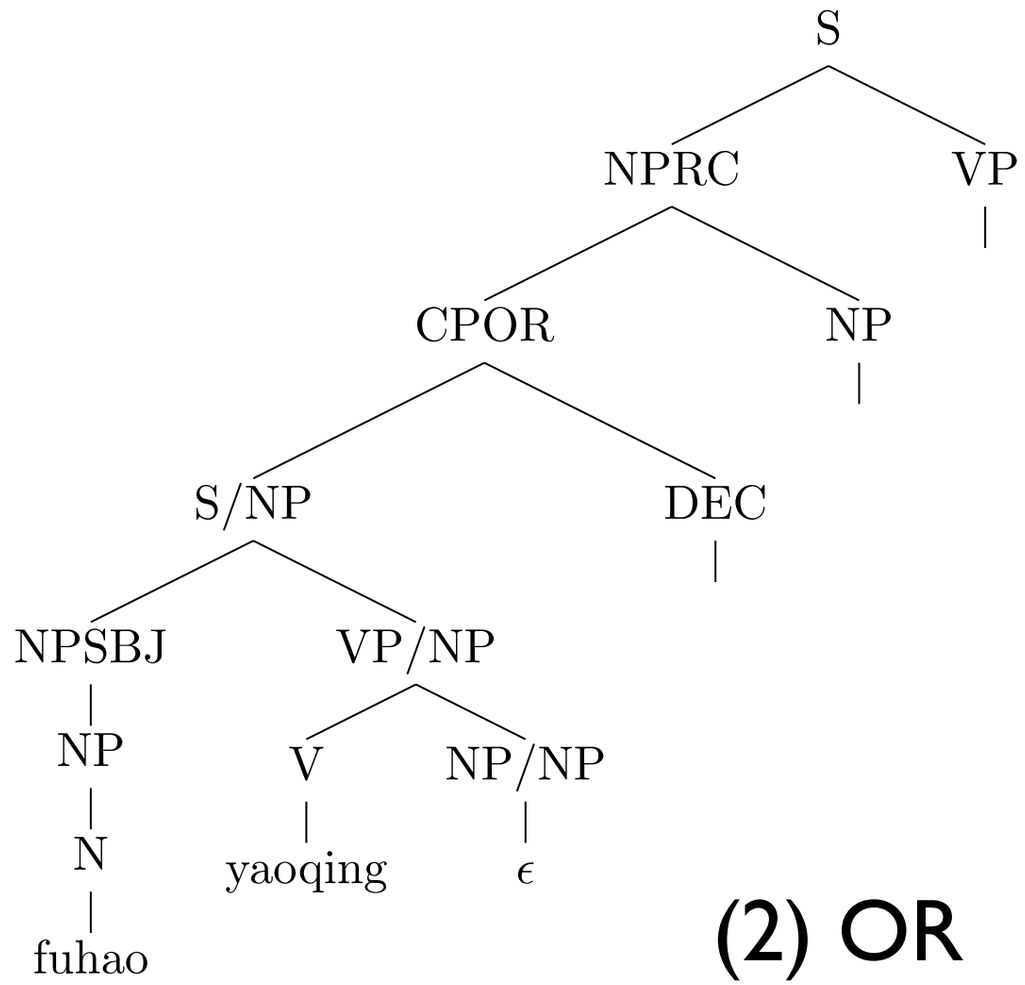


- In OR-S, before "de": N V "tycoon invite ..."

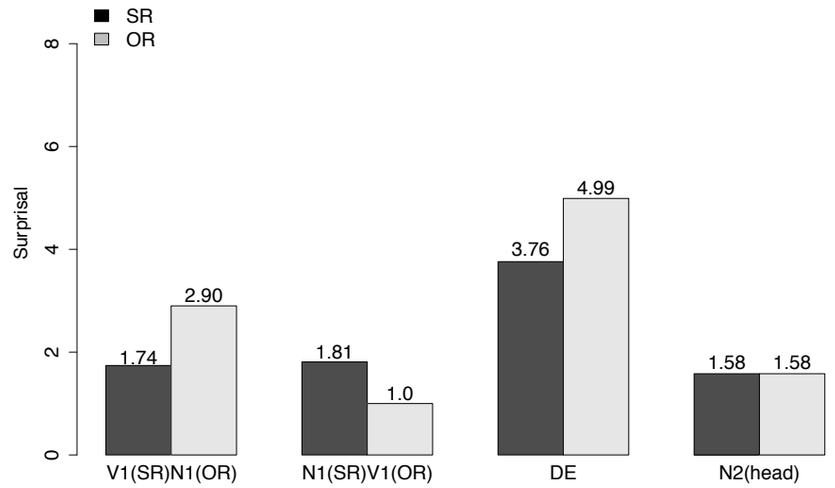


(1) main clause

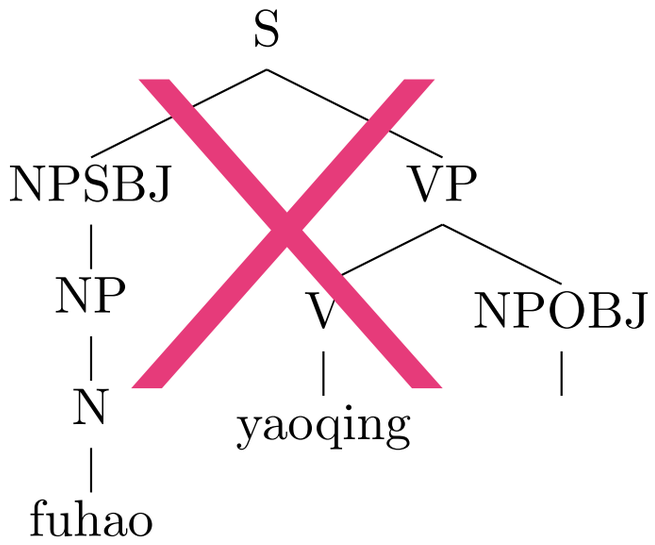


(2) OR

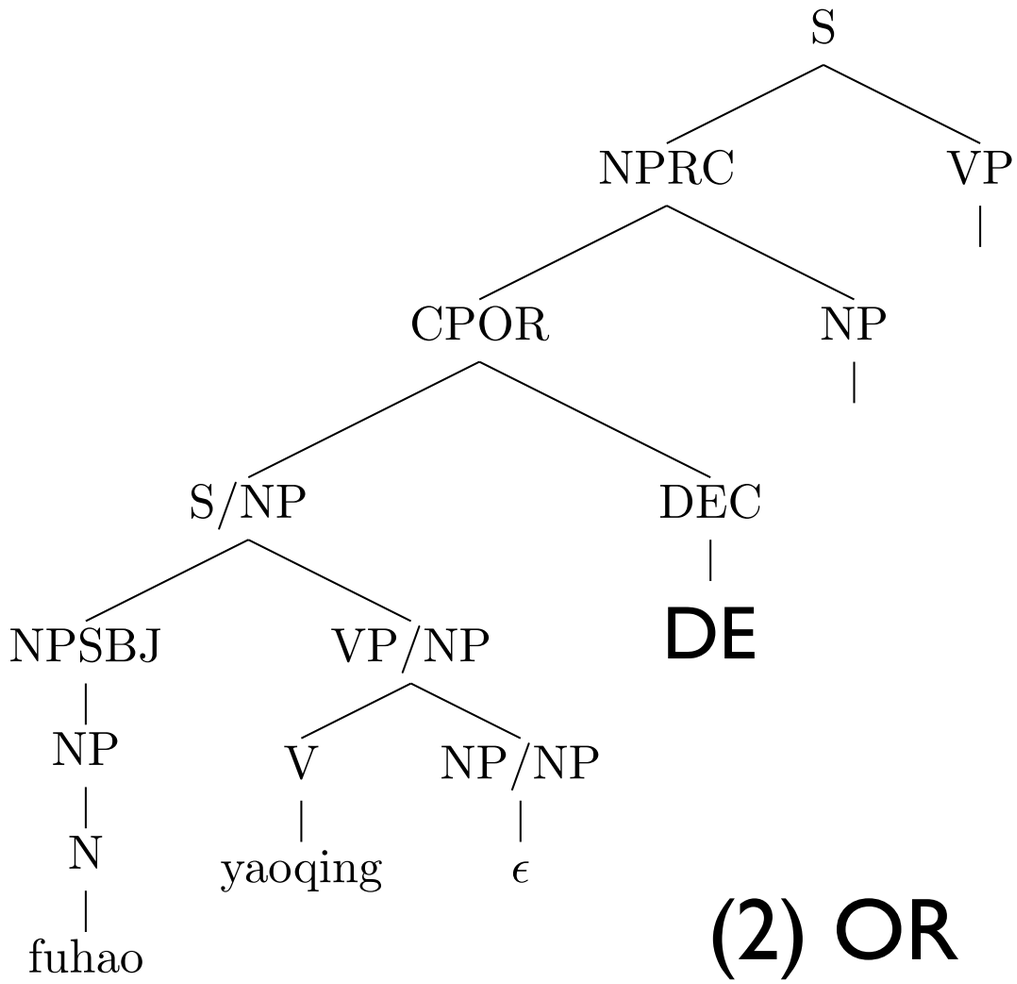
Calculate surprisals



- In OR-S, after "de": N V "tycoon invite de ..."

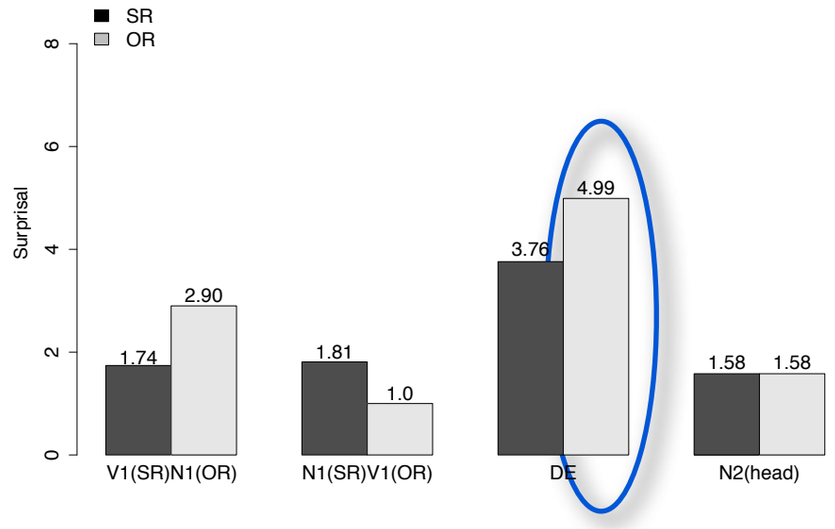


~~(1) main clause~~

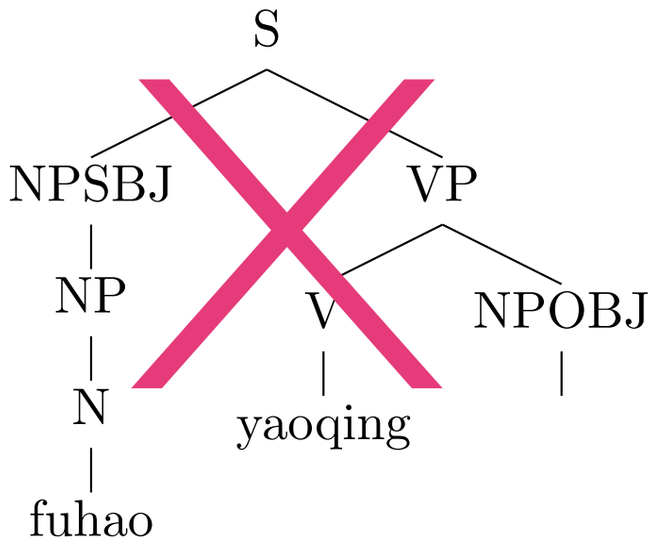


(2) OR

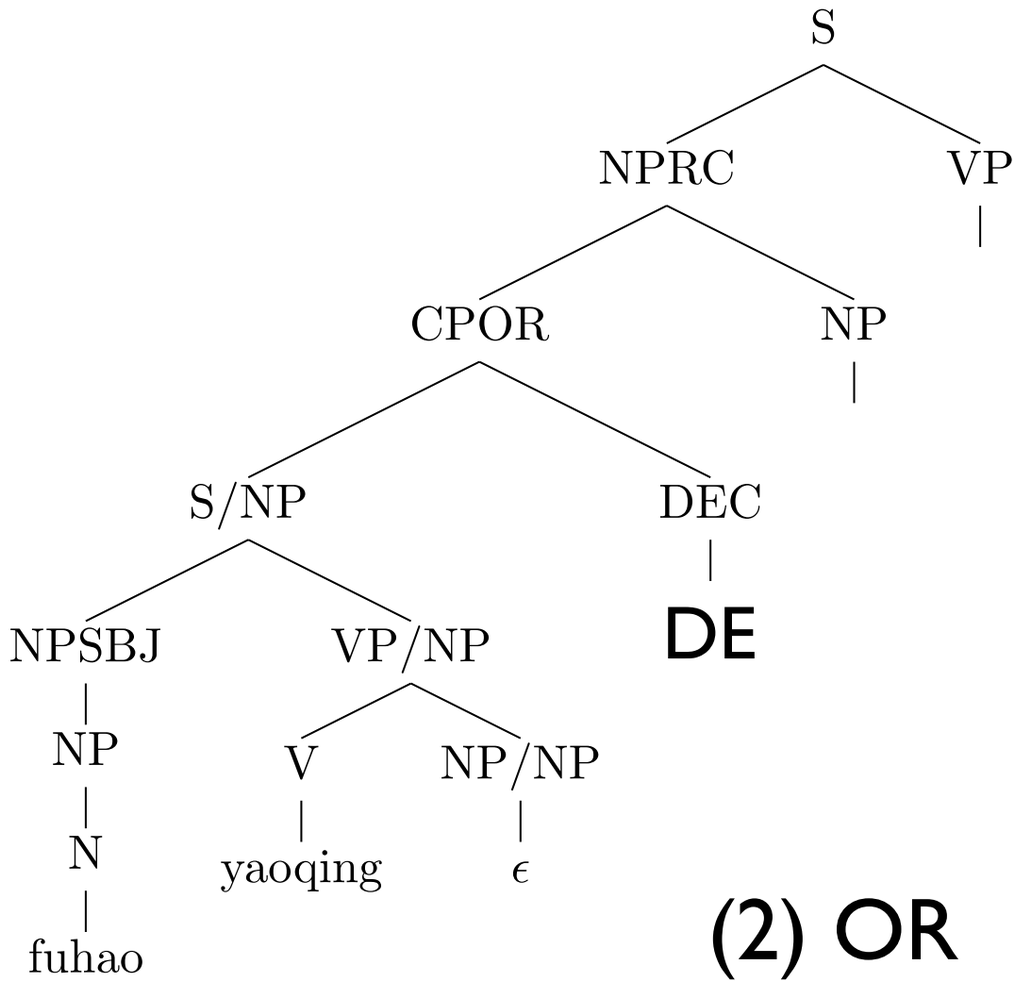
Calculate surprisals



- In OR-S, after "de": NV "tycoon invite de ..."



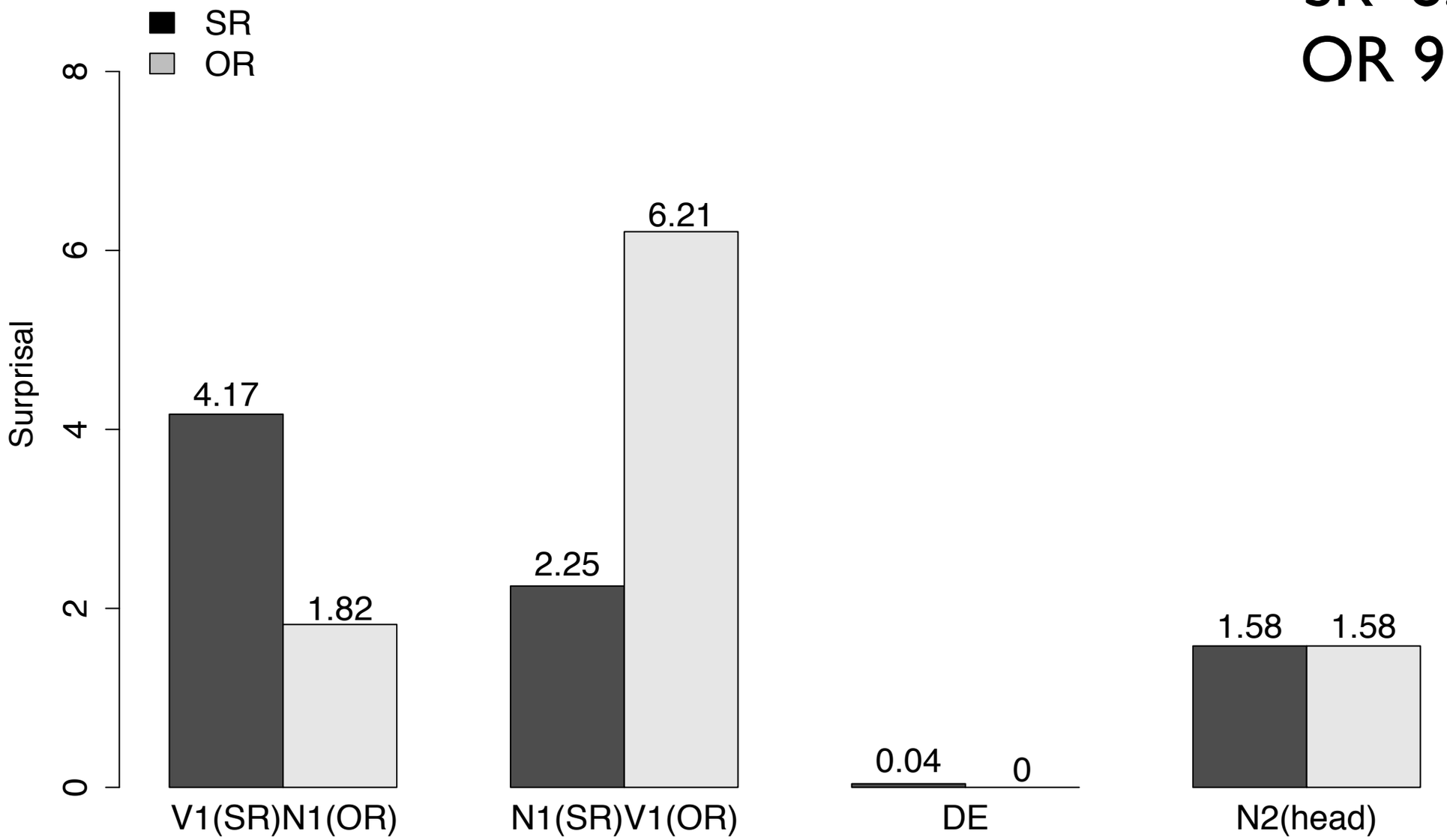
~~(1) main clause~~



(2) OR

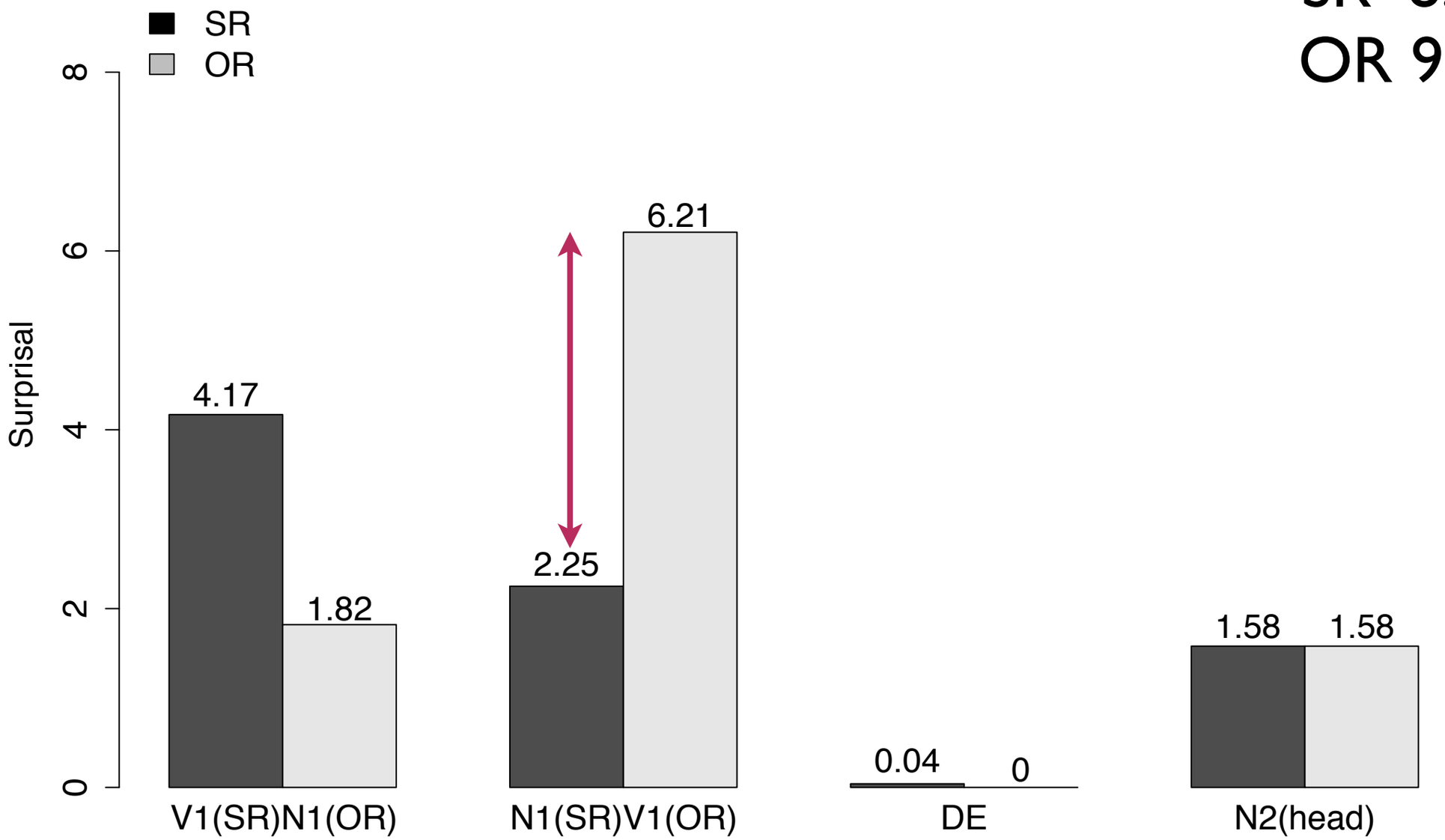
Results: Obj-modifying RC

Total:
SR 8.04
OR 9.61



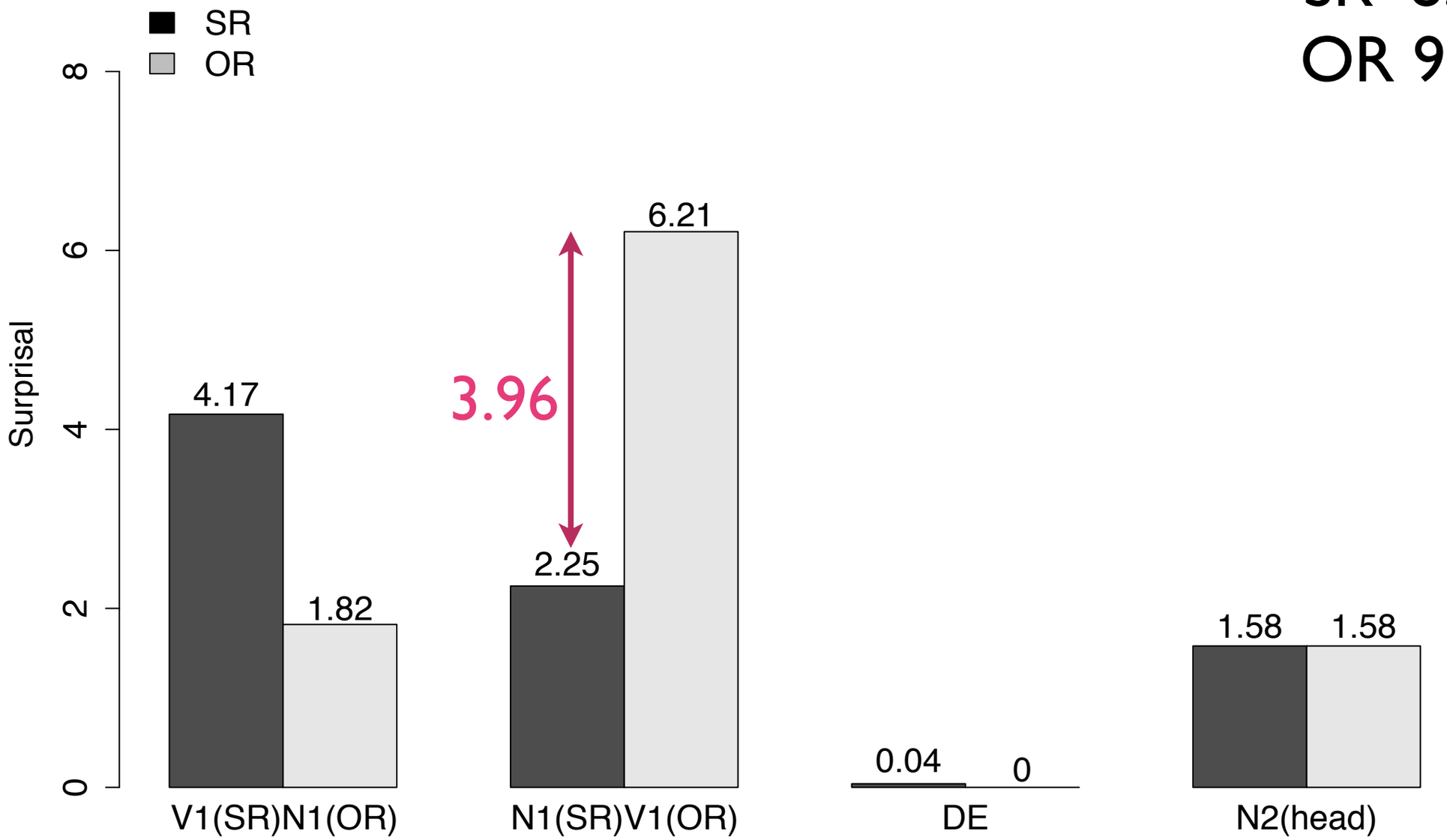
Results: Obj-modifying RC

Total:
SR 8.04
OR 9.61

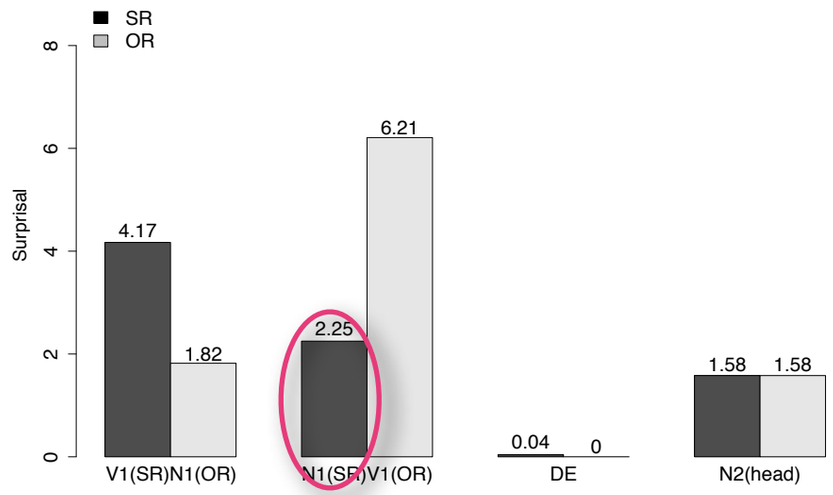


Results: Obj-modifying RC

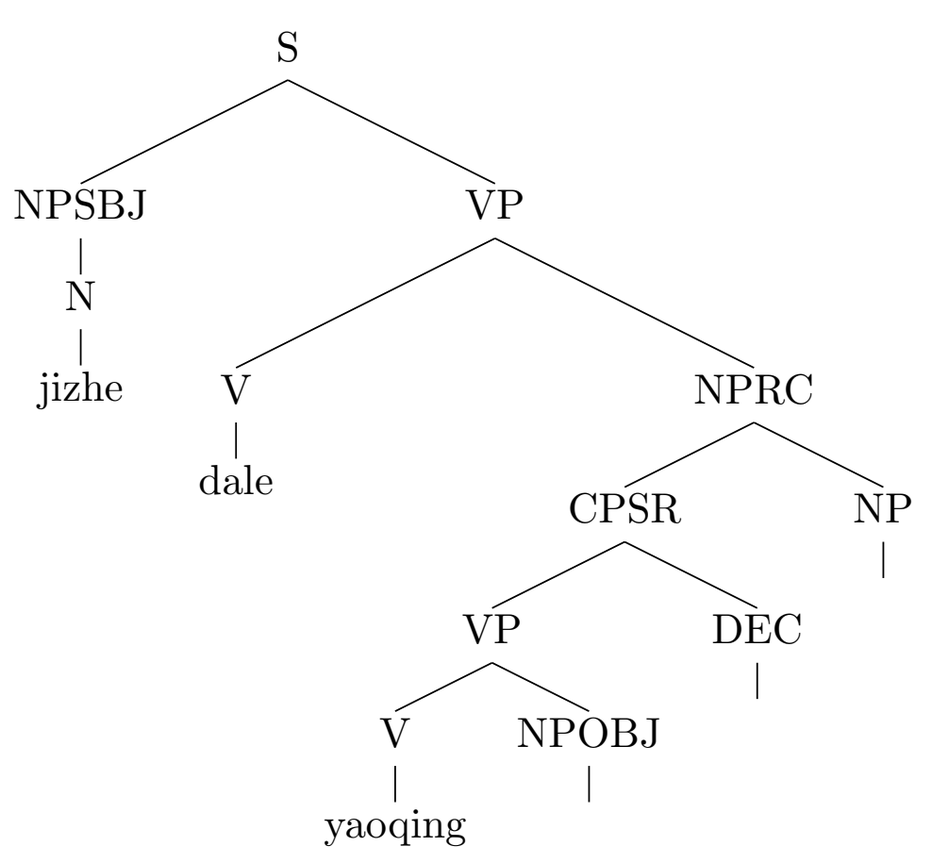
Total:
SR 8.04
OR 9.61

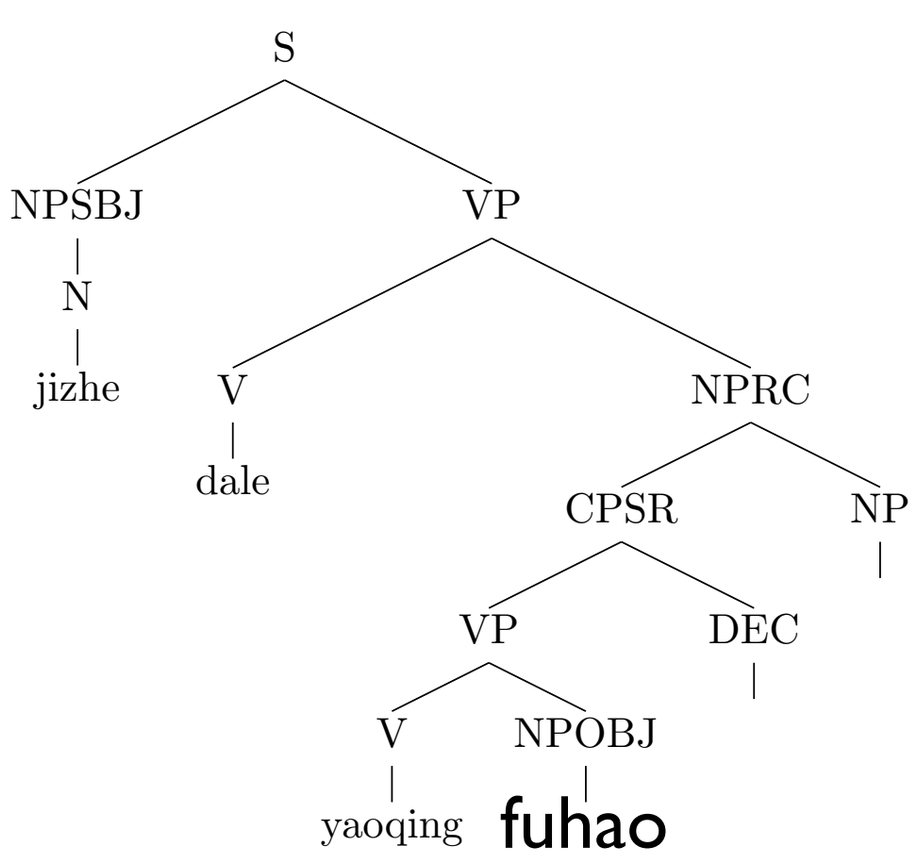


Calculate surprisals



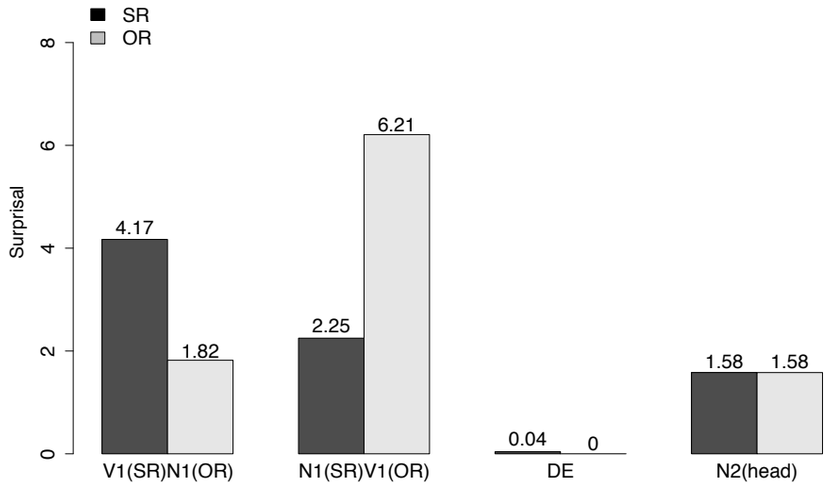
- In SR-O, NVV "reporter hit invite ..." → NVV N



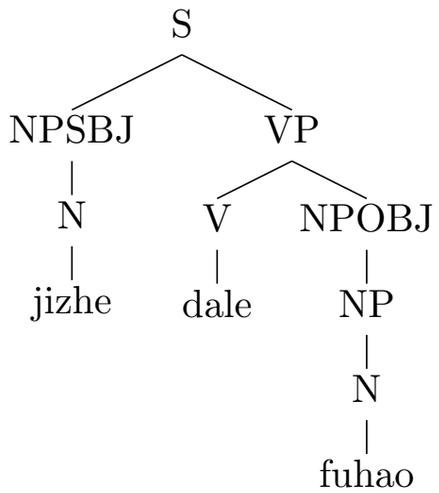


SR reading has already been recognized.

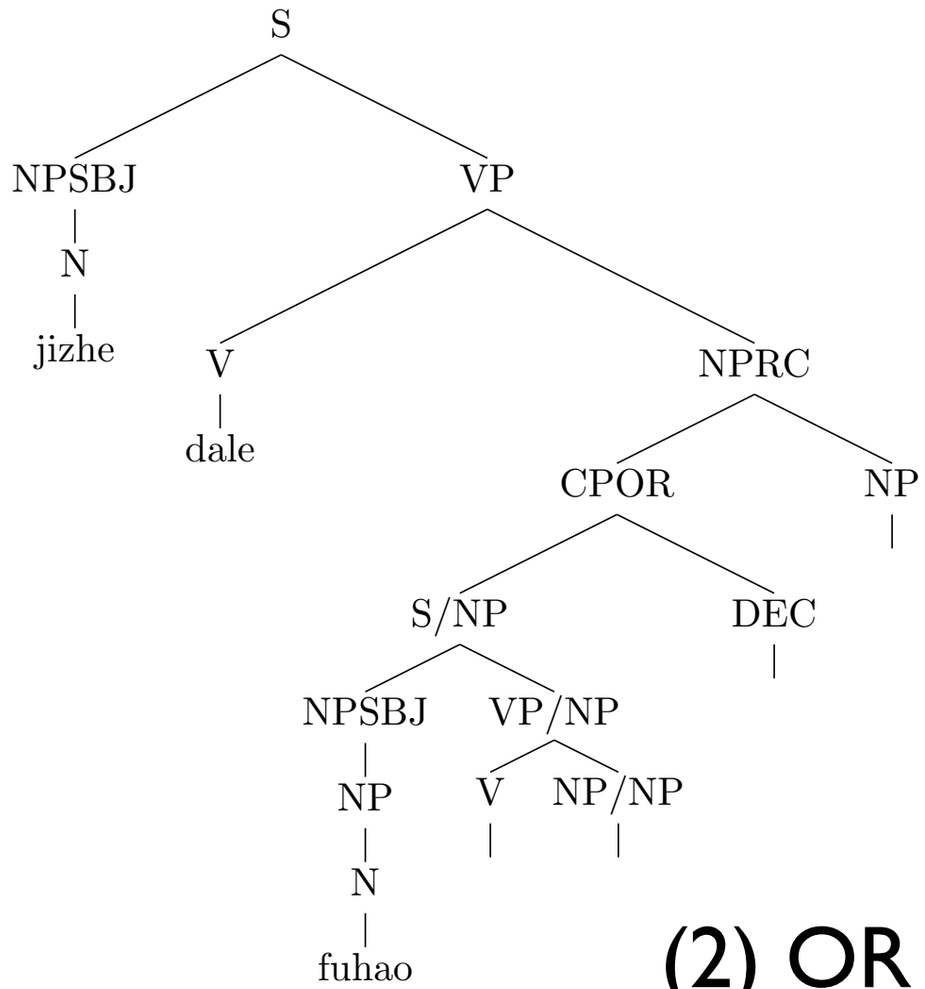
Calculate surprisals



- In OR-O, N V N "reporter hit tycoon ..."

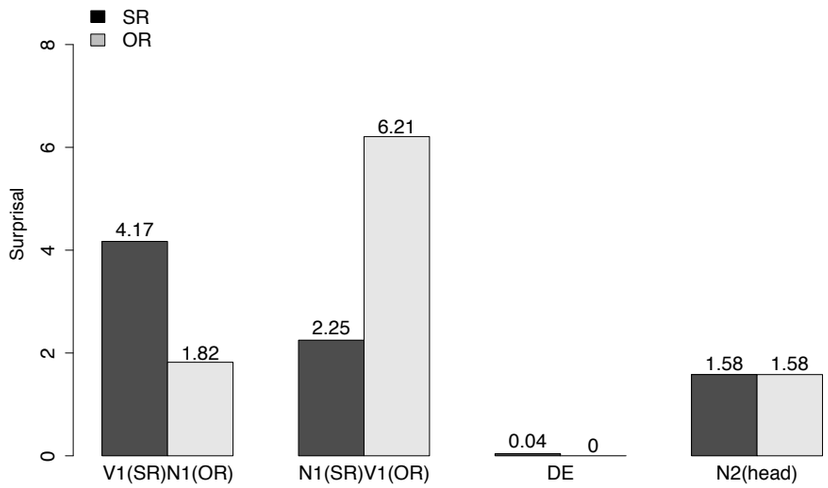


(1) main clause

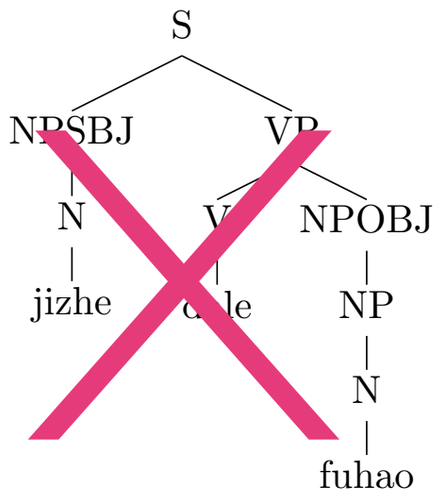


(2) OR

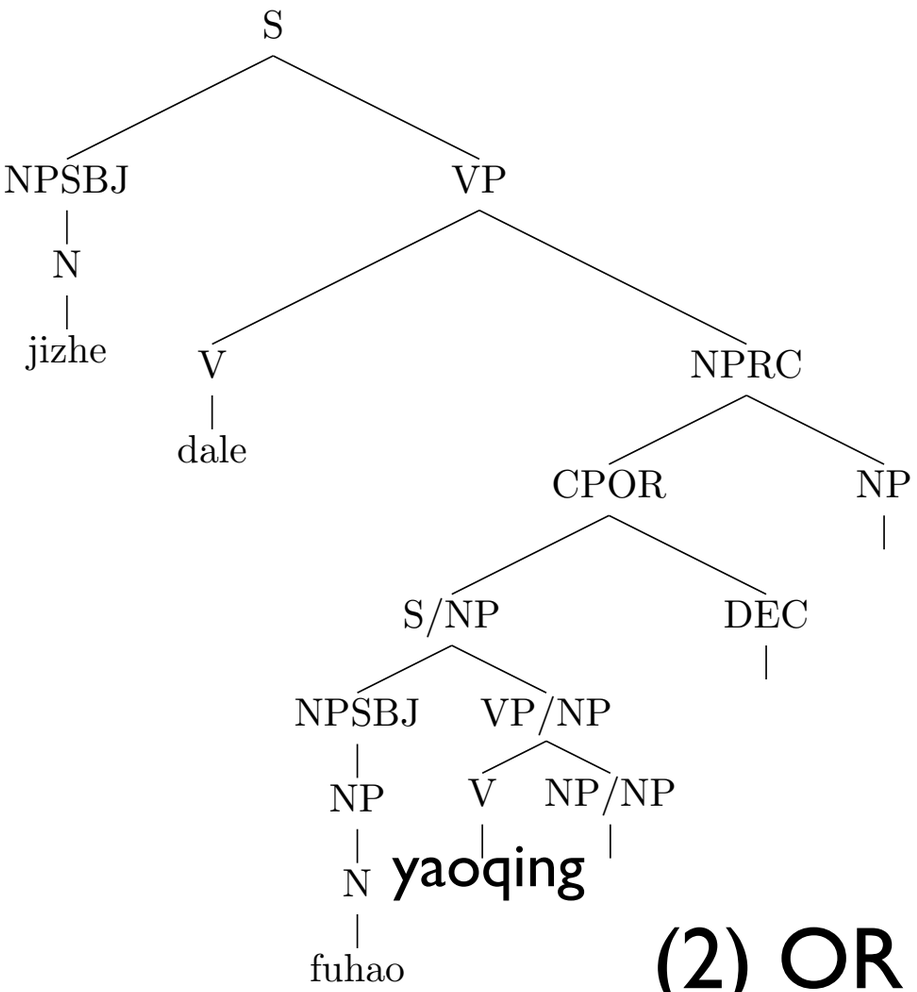
Calculate surprisals



- In OR-O, N V N V "reporter hit tycoon invite ..."

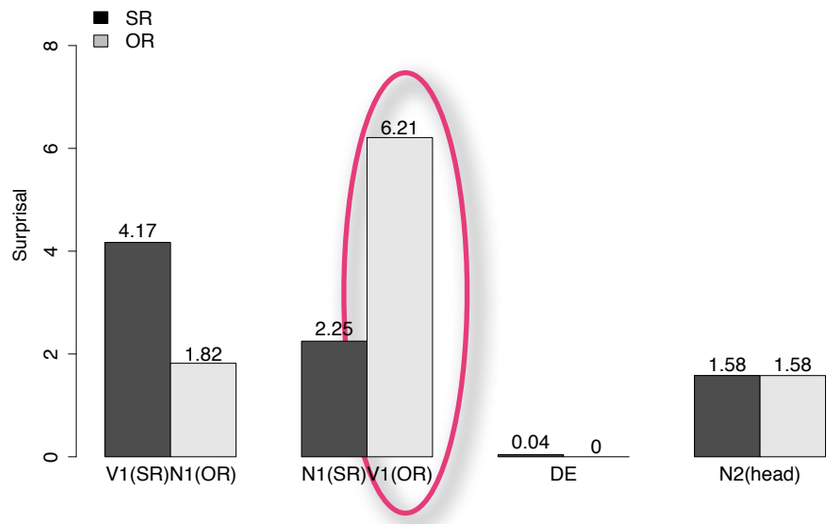


~~(1) main clause~~

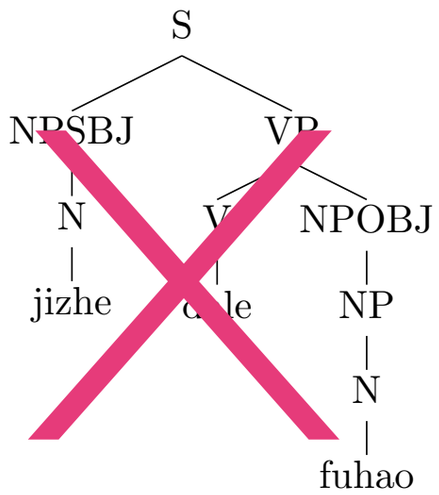


(2) OR

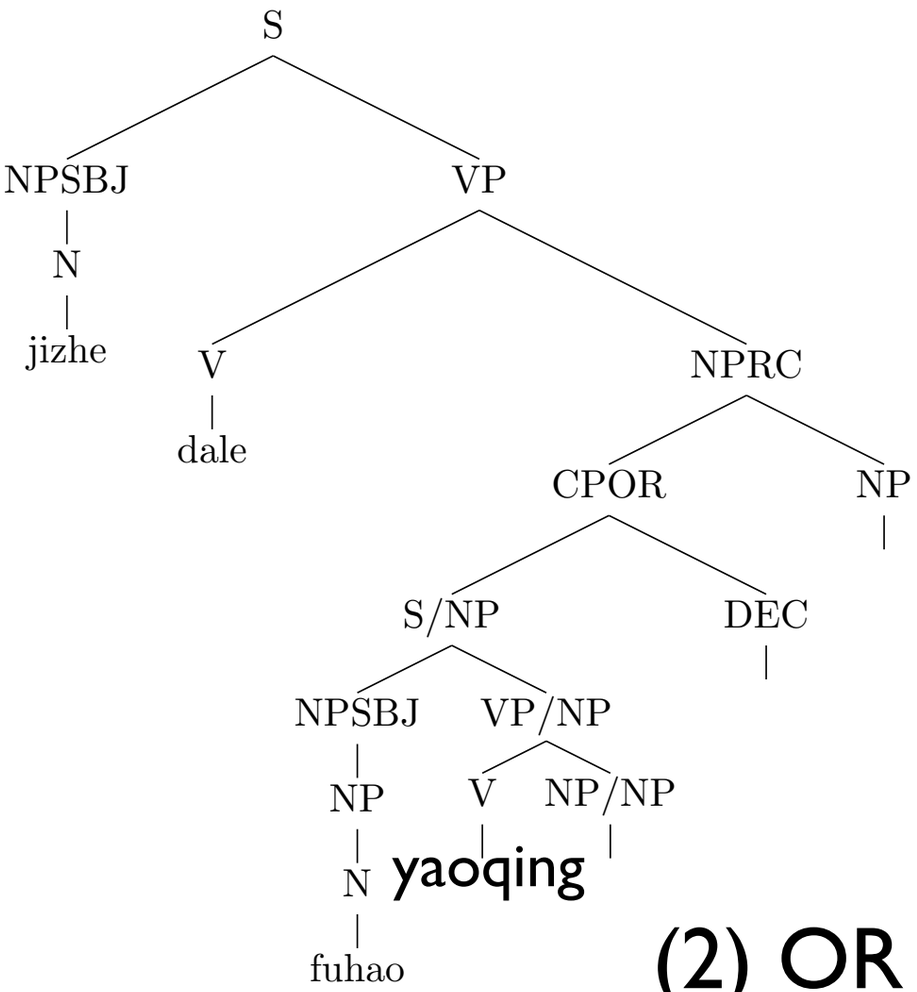
Calculate surprisals



- In OR-O, N V N V "reporter hit tycoon invite ..."



~~(1) main clause~~



(2) OR

Outline

- Introduction
- Chinese RC
- Modeling
- Conclusion

Conclusion

Conclusion

Surprisal

- uses structural frequencies as a reflection of readers' linguistic experience
- models the resolution of incremental ambiguity

Conclusion

Surprisal

- uses structural frequencies as a reflection of readers' linguistic experience
- models the resolution of incremental ambiguity

Results are consistent with recent empirical data

- argue against the memory-based account
- support the experience-based account

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- Chien-Jer Charles Lin (Indiana)
- Shravan Vasishth (Potsdam)
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谢谢！

Thank you!

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No strong effect