Effects of Classifier (mis-)match on filler-gap dependencies in Mandarin

Xiaoyi Tang, Peter Nelson, Rebecca Tollan

University of Delaware

Introduction

Subject advantage in relative clauses

- Many studies have demonstrated a “subject advantage” in processing filler-gap dependencies such as in relative clauses.
  - SRC: [The dog [that ____ chased the cat] broke the window.
  - ORC: [The dog [that the cat chased ____] broke the window.

- This is well-tested in head-initial languages like English, German, French, and Dutch, and also extends to other SVO languages.

- However, it remains unsettled whether this effect is universal.

Mixed findings in Mandarin

- Findings for processing of Mandarin Chinese RCs are mixed
  - SRC advantage (e.g., Lin, 2008; Sung, Cha, et al., 2016; Wu et al., 2018)
  - ORC advantage (e.g., Hsiao&Gibson, 2003; Gibson & Wu, 2013; Sung, Tu, et al., 2016)
- This may due to the word order combinations in Mandarin relative clauses

SVO canonical word order;
Mandarin RC is pre-nominal

Genitive marker

laoshi	zhuizhu	[_____	you	shu	de]	xuesheng.
teacher	chase	[_____	have	book	DE]	student.

"The teacher chased the student [who _____ has the book."

English RC is post-nominal

Predictions and competing theories

- The disrupted word order combinations in RCs might result in mixed results of processing preference in RCs in Mandarin.
- SRCs and ORCs in Mandarin:

SRC

[____	zhuizhu	mao	de]	gou	chi-le	quqi
[____	chase	cat	DE]	dog	ate	cookie

'The dog [that __ chased the cat] ate a cookie.'

ORC

[mao	zhuizhu	_____	de]	gou	chi-le	quqi
[cat	chase	_____	DE]	dog	ate	cookie

'The dog [that the cat chased ___] ate a cookie.'

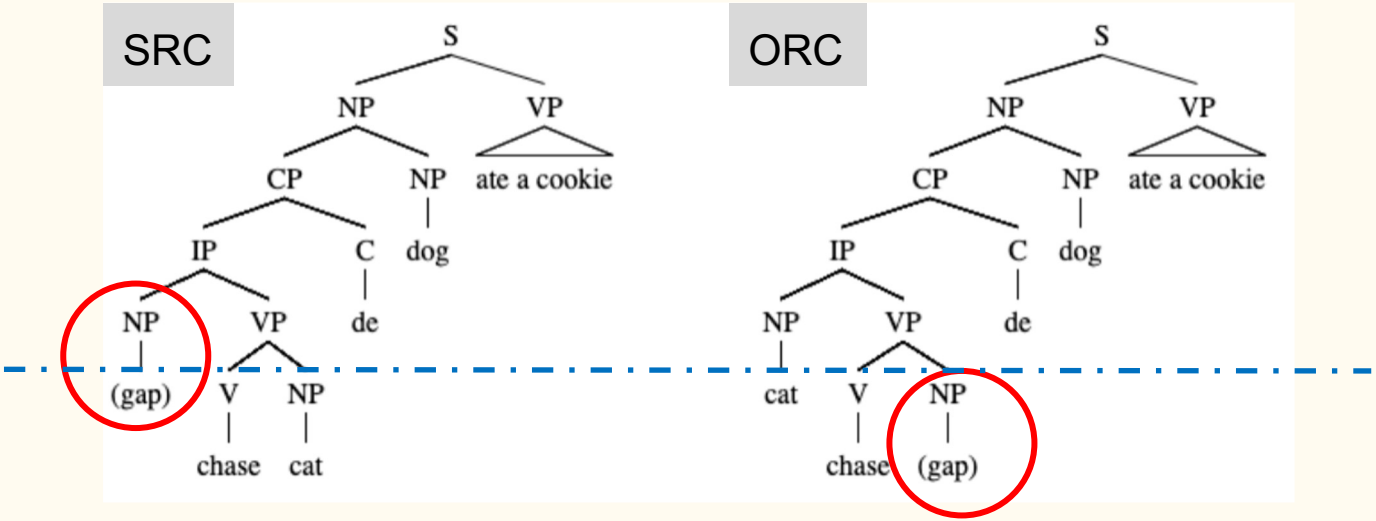
Word order in SRCs:
[_VO(de)] S

Word order in ORCs:
[SV _ (de)] O

- Competing theories of the subject advantage predict different outcomes.
- In self-paced reading studies, the processing difficulty is illustrated by different perspectives such as *structure-based accounts* and *memory-based theories*.

Structural-based accounts

- Structural distance predicts a (universal) subject advantage (O'Grady et al., 2003). A gap located at a higher structural position is easier to access than one at a lower (more embedded) position.
- SRCs should be easier to process than ORCs (Sung, Cha, et al., 2016).



Dependency Locality Theory

- Since memory cost is measured by storage cost and integration cost, Dependency Locality Theory (DLT) (Gibson, 1998, 2000) predicts:
  - the longer the linear distance between a head and its dependent in terms of intervening discourse referents (specifically, nouns and verbs), the greater the integration cost in establishing the dependency
  - → ORCs are more difficult to process than SRCs because SRCs require more working memory resources (Gibson&Wu, 2013).

SRC

[_____	zhuizhu	mao	de]	gou	chi-le	quqi
[_____	chase	cat	DE]	dog	ate	cookie

'The dog [that __ chased the cat] ate a cookie.'

ORC

[mao	zhuizhu	_____	de]	gou	chi-le	quqi
[cat	chase	_____	DE]	dog	ate	cookie

'The dog [that the cat chased ___] ate a cookie.'

Temporary ambiguity

- Structural distance → subject advantage; linear distance → object advantage
- SVO + prenominal RCs → temporary ambiguity: SRCs can be mis-parsed as pro-V-O; ORCs can be mis-parsed as a matrix S-V clause. Disambiguation occurs at DE.

(1a) SRC:	*[__zhuizhu*	*na*	*ma*	*de] zhu*	(1b) ORC:	*[na*	*ma*	*zhuizhu __de] zhu*
	[__chase	the	horse	DE] pig		[the	horse	chase __DE] pig
Misparse:	***pro*** **V**		**O**		**Misparse:**	**S**		**V**
	"The pig that chased the horse"					*"The pig that the horse chased"*		

- Difficulties in resolving dependencies in ORCs vs. SRCs <u>are not</u> easily isolated from difficulties caused by having to re-analyze (i) an N-V mis-parse as an ORCs vs. (ii) a pro-V-O mis-parse as an SRC.

Introducing classifiers

Word order with a classifier

na	san	**pi**	**ma**
“The three		**CL(modifying horse)**	**horse**”

- Classifiers match with the nouns they modify, providing information about shape, function, size, class, etc.
- For the position, the classifier in a Mandarin RC could be dislocated from versus adjacent to its head noun.
  - Matching: if the head noun is adjacent to the classifier that exactly modifies it
  - Mismatching: if there are intervening constituents between the classifier and the head noun, though the classifier *agreeing* with the head noun; the mismatching classifier often is followed by another NP that does not agree with the classifier.

(mis-)matching classifier

- The presence of a classifier (CL) that mismatches with the adjacent noun but matches with the head noun helps disambiguate the structure before DE.
- In other words, classifier mismatch (such as “tou”) potentially serves as a predictor for the upcoming RC as in (c).

c. ORC mismatching

na	**tou**	[ma	zhuizhu ___	de]	**zhu**	zhuangle	shitou
the	**CL (modifying pig)**	[horse	chase ____	DE]	**pig**	hit	rock

‘The pig [that the horse chased ___] hit the rock.’

d. ORC matching

na	**pi**	**[ma**	zhuizhu ____	de]	zhu	zhuangle	shitou
the	**CL (modifying horse)**	**[horse**	chase ___	DE]	pig	hit	rock

‘The pig [that the horse chased ___] hit the rock.’

Current study

- To isolate difficulty of SRC vs. ORC dependency formation from concomitant recovery from matrix N-V vs. pro-V-O mis-parses, the current study investigates:
  - Does an SRC or ORC advantage emerge in processing Mandarin RCs with (mis-) matching classifiers?
  - Does the presence of a mismatching classifier remove the confound of temporary ambiguity?
  - Which classifier property (i.e., matching or mismatching) would facilitate RC processing?

Method

Materials

- 2x2 within-subjects;
- 40 items (16 criticals + 24 fillers); latin-square design;
- All RCs had 2 animate DP arguments (animals with different classifiers)

	Relative clause type	
Classifier type	SRC	ORC
Mismatching	Na-pi piejian lv de ma yidong xiangzi The-**CL (modifying horse)** glimpsed donkey DE **horse** moved box 'The horse [that glimpsed the donkey] moved the box.'	Na-pi lv piejian de ma yidong xiangzi The-**CL(modifying horse)** donkey glimpsed DE **horse** moved box 'The horse [that the donkey glimpse] moved the box.'
Matching	Piejian na-tou lv de ma yidong xiangzi Glimpsed the-**CL(modifying donkey) donkey** DE horse moved box 'The horse [that glimpsed the donkey] moved the box.'	Na-tou lv piejian de ma yidong xiangzi The-**CL(modifying donkey) donkey** glimpsed DE horse moved box 'The horse [that the donkey glimpsed] moved the box.'

Method

- **Participants**:
  - 53 native speakers of Mandarin Chinese recruited from the University of Delaware community.
- **Procedure**:
  - Self-paced reading; Read 40 Chinese sentences phrase-by-phrase and answer a comprehension question (e.g., “Did the horse chase the pig?”) after each one.
- **Reading presentation regions:**

Condition	Presentation windows by regions							
	1	*2*	*3*	*Pre-critical*	*DE*	*HeadN*	*Verb*	*Object*
SRC mismatching	pro	CL	V1	N1	DE	**N2**	V2	N3
ORC mismatching	pro	CL	N1	V1	DE	**N2**	V2	N3
SRC matching	V1	V1	CL	N1	DE	**N2**	V2	N3
ORC matching	pro	CL	N1	V1	DE	**N2**	V2	N3

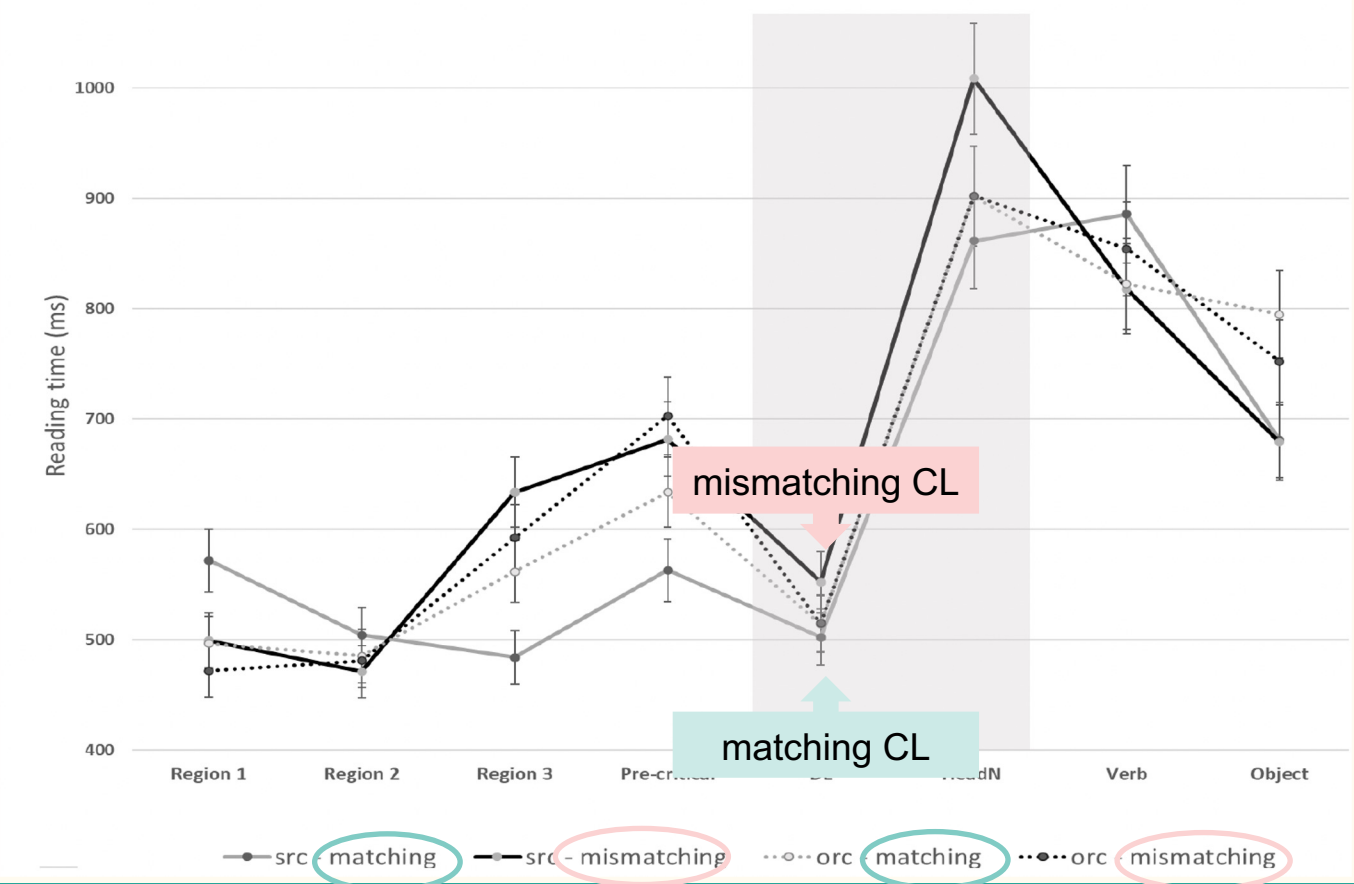
Results

Comprehension question performance

- 1 participant excluded due to low accuracy (< 75%) on comprehsnison questions.
- The mean accuracy for the remaining 52 participant was 96.6%.
  - No significant effects.
- We then analysed data from 804 critical trials which yielded correct responses.

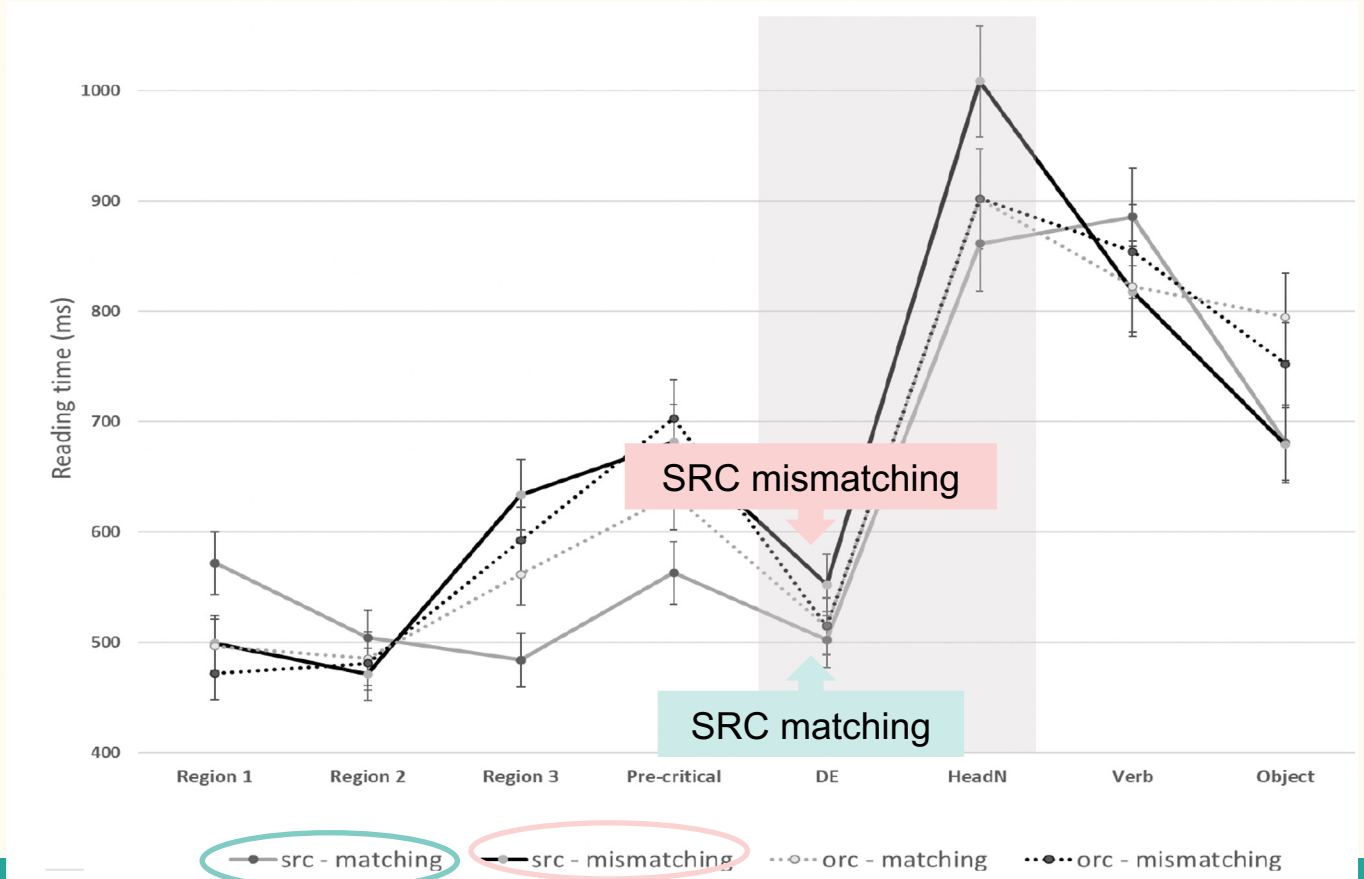
Reading times - DE

critical post-RC regions (i.e., DE and the head noun; shaded region).



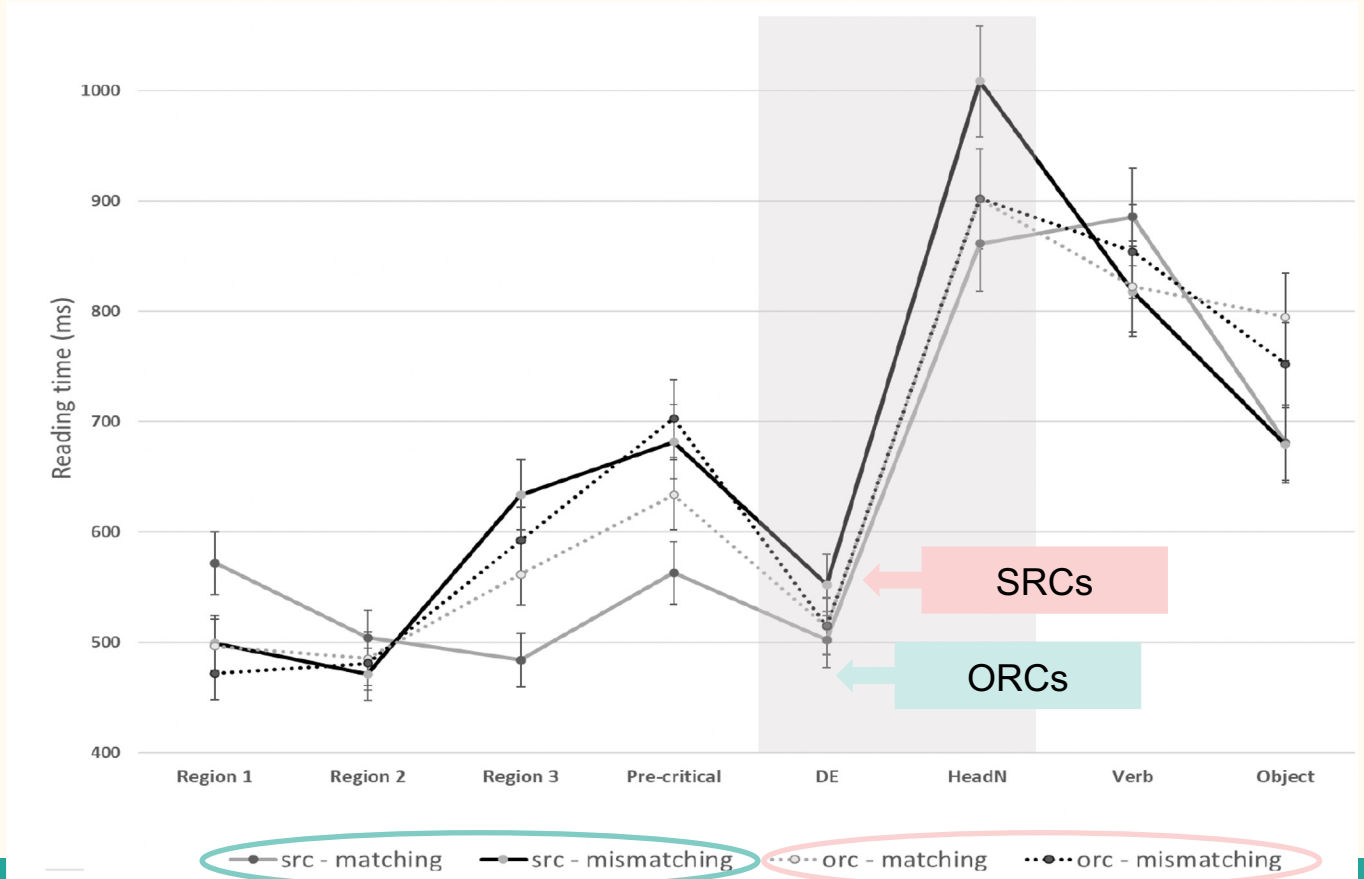
Reading times - DE

critical post-RC regions (i.e., DE and the head noun; shaded region).



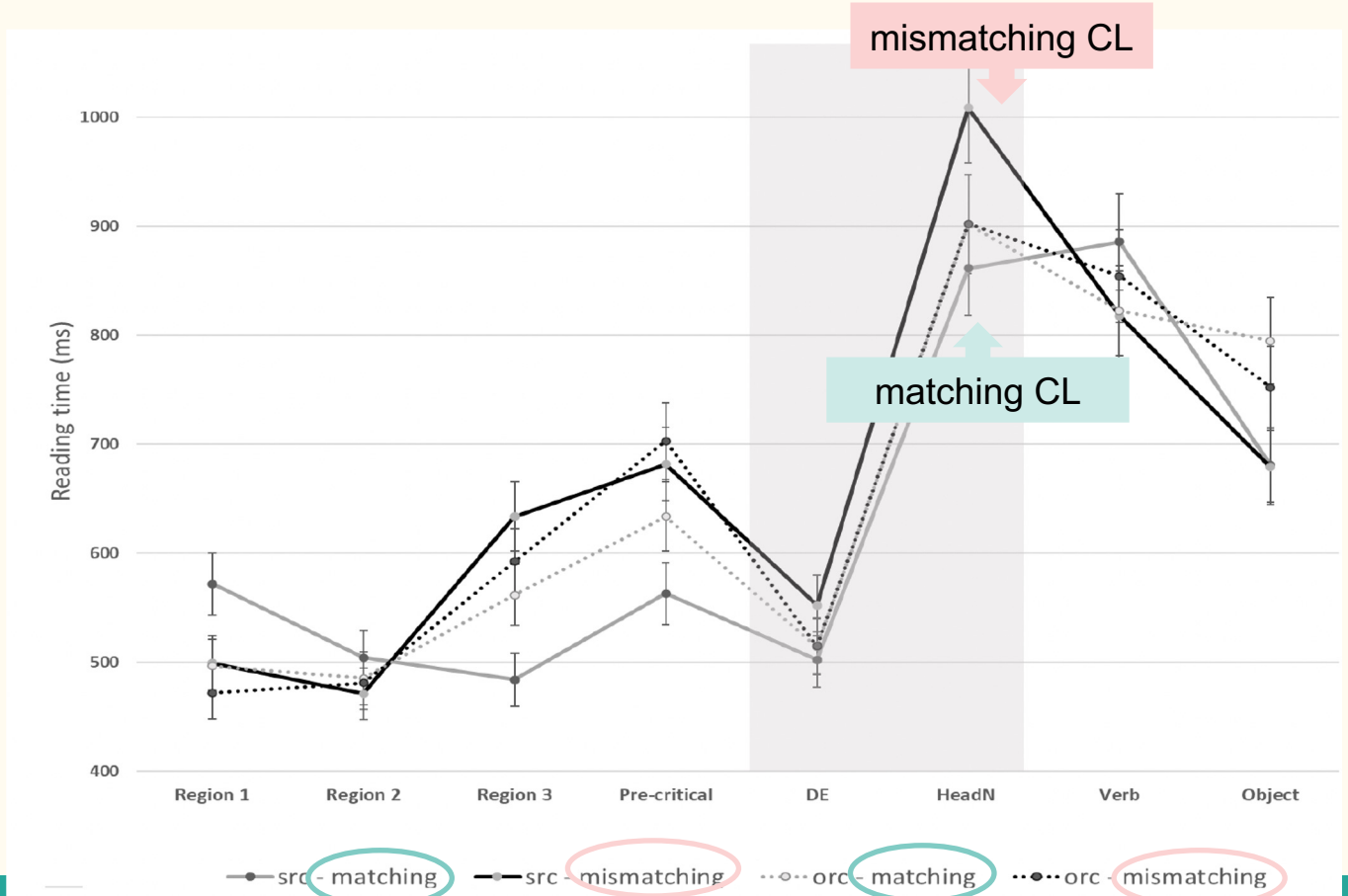
Reading times - DE

critical post-RC regions (i.e., DE and the head noun; shaded region).



Reading times- head noun

critical post-RC regions (i.e., DE and the head noun; shaded region).



Reading time

- Mixed-effects linear regression for log-transformed RTs.
- Critical region: DE
  - Main effect of classifier type, with reading times for RCs with matching CL significantly shorter than those with mismatching CL (508 ms vs. 533ms; t=-2.485, p=.013)
  - No main effect of RC type (p=.386).
  - Significant interaction (t=-2.284, p=.023)
    - Planned comparisons showed this effect to be driven by the **mis-**matching conditions, where there is no local ambiguity: here, ORCs were faster than SRCs (t = -2.2, p = .027): an ORC advantage. There was no difference between SRCs and ORCs in the matching (temporarily ambiguous) condition (p = .3).
- Critical region: head noun, we found only a main effect of CL match type in the same direction as at DE.

Conclusion

Conclusion

- RCs with locally **matching** classifiers are parsed more easily than those with mismatching classifiers
  - Storing a classifier before it gets matched with its corresponding N increases processing load
- We find no evidence of any overall SRC or ORC advantage in online processing of Mandarin RCs.
  - When local parsing ambiguity is eliminated via presence of a CL which does not match with the adjacent noun (i.e., cueing the presence of an RC), then we find evidence for **an ORC advantage.**
  - **Offline**, we find an **SRC advantage** (accuracy in answering comprehension questions).
- Together these results provide new support for the role of Dependency Locality Theory (Gibson&Wu, 2013; Hsiao&Gibson, 2003; Gibson, 1998) in **online** RC comprehension.

Thank you!

Dr. Rebecca Tollan

Dr. Peter Nelson

For helpful discussion and comments on drafts of this study, the authors thank the members of the University of Delaware Experimental Syntax Lab and SySeL group.

References

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

Gibson, E. (2000). The dependency locality theory: A distance-based theory of linguistic complexity. In Y. Miyashita, A. Marantz, & W. O'Neil (Eds.), Image, language, brain (pp. 95-126). Cambridge, MA: MIT Press.

Gibson, E., & Wu, H. H. I. (2013). Processing Chinese relative clauses in context. Language and Cognitive Processes, 28(1–2), 125–155. https://doi.org/10.1080/01690965.2010.536656

Hsiao, F., & Gibson, E. (2003). Processing relative clauses in Chinese. Cognition, 90(1), 3–27.https://doi.org/10.1016/S0010-0277(03)00124-0

O'Grady, W., Lee, M., & Choo, M. (2003). A Subject-Object Asymmetry In The Acquisition Of Relative Clauses In Korean As A Second Language. Studies in Second Language Acquisition, 25(3), 433–448. https://doi.org/10.1017/S0272263103000172

Sung, Y. T., Cha, J. H., Tu, J. Y., Wu, M. Da, & Lin, W. C. (2016). Investigating the Processing of Relative Clauses in Mandarin Chinese: Evidence from Eye-Movement Data. Journal of Psycholinguistic Research, 45(5), 1089–1113. https://doi.org/10.1007/s10936-015- 9394-y

Sung, Y. T., Tu, J. Y., Cha, J. H., & Wu, M. Da. (2016). Processing preference toward object extracted relative clauses in mandarin Chinese by L1 and L2 speakers: An eye-tracking study. Frontiers in Psychology, 7(JAN), 1–14. https://doi.org/10.3389/fpsyg.2016.00004

Wu, F., Kaiser, E., & Vasishth, S. (2018). Effects of Early Cues on the Processing of Chinese Relative Clauses: Evidence for Experience-Based Theories. Cognitive Science, 42, 1101–1133. https://doi.org/10.1111/cogs.12551

Thank you!