Argument Ambiguities Make Subject Relative Clause More Difficult to Process than Object Relative Clause in Mandarin

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Relative clauses (RCs) processing has been a hot issue in decades. Studies from head-initial languages have found that SRCs were easier to comprehend than ORCs, and many different models were constructed to account for SRCs preference. Chinese are head-final languages and the head noun phrases are behind the internal-clause. Such a great difference in syntactic structure made Chinese to be the optimum material to test the models mentioned above. In the paper, two experiments were carried out using eye-movement tracking methods to explore the difficulty with RCs processing in mandarin, and results showed that: when the two noun phrases were both from animate category, SRCs were more difficult than ORCs, but when the noun phrases in the internal-relative-clause were inanimate and the noun phrases in the matrix were animate, the difficulties with SRCs were greatly reduced. Based on these findings, we hold that the linear syntactic distance between the $gap$ and the $filler$ was not the key reason to the difficulty with SRCs. On the contrary, the ambiguity in argument construction may be the most important.

Keywords: subjective relative clause, object relative clause, argument ambiguity, Mandarin

Introduction

Studies about sentences processing not only aim to investigate the interaction between syntax and semantic, but also to explore whether there were general mechanism underpinned across language processing. In this field, relative clauses (RCs) were the premium stuff because of their special syntactic structure, as well as their prevalence across language (Gibson & Wu, 2013). RCs were some kinds of sentences which were embedded in the matrix to modify noun phrases. Of all the RCs, subject relative clause (SRC) as (1a) and object relative clause (ORC) as (1b) were most popular used in daily, and a well established result showed that SRCs were easier to comprehend than ORCs, although there were no differences between them at the level of words that composed the sentences (Roland, Mauner, O’Meara, & Yun, 2012; Staub, 2010).

(1a) Theteacher$\textcolor{red}{\text{who}_\text{gap}}$ attacked the principal admitted the error. (SRC)
(1b) Theteacher$\textcolor{red}{\text{who}_\text{the\ principal\ attacked}_\text{gap}}$ admitted the error. (ORC)

What’s the reason that caused SRC easier to comprehend than ORC? Gibson (1998) constructed locality dependency theory (LDT) to explain the SRC preference. According to LDT, the key factor that caused the
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Difficulties in RCs processing was the linear syntactic distance between the filler and the gap. In SRC, as in (1a), there were only two syntactic segments (e.g., teacher\who) between the filler and gap, but in ORC, as in (1b), there were five syntactic segments (e.g., teacher\who\the\principal\attacked). That’s to say, people would store temporarily five separate syntactic segments in working memory in ORC processing, while in SRC processing, two syntactic segments were needed to be kept in mind temporarily. This theory has good explanations to Indo-European languages, where relative clauses follow the head noun and are typically headed by a complementizer (Carreras, Duñabeitia, Vergara, de la Cruz-Pavía, & Laka, 2010), such as English (Caplan et al., 2002; Gibson, 1998; Gibson, Desmet, Grodner, Watson, & Ko, 2005; Gordon, Hendric & Johnson, 2004; Traxler, Morris & Seely, 2002; Reali & Christiansen, 2007; Warren & Gibson, 2002), Dutch (Mak, Vonk & Schriefers, 2002; 2006), French (Cohen & Mehler, 1996), Italian (Demenico & Matteo, 2009), Spanish (Betancort, Carreiras, & Sturt, 2009) and Greek (Papadpoulou, & Clahsen, 2003), but did not work well in head-final languages, such as Japanese (Ueno & Garmsey, 2008), Korean (Kwon, Lee, Gordon, Kluender, & Polinsky, 2010), especially Chinese (Hisao & Gibson, 2003; Gibson & Wu, 2012; Jäger, Chen, Li, Lin, & Vasishth, 2015; Sun, Cha, Tu, Wu, & Lin, 2015).

RCs were also more popular in Chinese, but there were many differences in syntactic structure between Chinese and English, as well as other languages from Indo-European literature. Of them, the key difference was that Chinese was head-final language, that’s to say, the internal-clauses were ahead of the head noun phrase. Such differences in syntactic not only made the location of the filler and the gap changed in Chinese RC, but also made the linear syntactic distance between the filler and the gap changed. As showed in (2), the syntactic distance between the gap and the filler is four syntactic segments (encounter/president/de/daughter) in Chinese SRC, but in ORC, the syntactic distance is two (de/daughter). So according to DLT, ORCs would be easier to comprehend in Chinese, not SRCs. Gibson and his colleagues (Hisao & Gibson, 2003), using self-paced reading method, did find that ORCs were easier to process than SRCs at regions of the internal-clause (underlined parts) and the head noun phrase (女儿, “daughter”) in the matrix. So they claimed that the LDT also worked well in Chinese, but which made ORCs to be easier to comprehend, not SRCs.

(2a) Subject-extracted relative clause (SRC):

\[\text{碰到总统的}女儿\text{感到非常荣幸。}\]

Encounter/president/de/daughter/feel/very pleasure

The daughter that Gapped encountered with the president felt very pleasure.

(2b) Object-extracted relative clause (ORC):

\[\text{总统碰到}女儿\text{感到非常荣幸。}\]

President/encounter/de/daughter/feel/very pleasure

The daughter that the president encountered with Gapped felt very pleasure.

Although Gibson and his colleague found SRCs were more difficult to comprehend than ORCs in Chinese, we thought there were some shortcomings for their explanations, for difficulties in processing with SRCs might come from in part the argument ambiguities, not the distance between the gap and the filler! Unlike the Indo-European language, Chinese RCs have no definite relational markers as “that” and “who” in English. In Chinese, 的 (de) serves as the relative clause marker in the sentence, but its function is not same as the word “that” or “who” in English. In Chinese, besides being a relative marker, the word 的 (de) is also used as an
adjective marker (e.g., 蓝色的天空, “the blue sky”) or a possessive marker (e.g., 我的书包, “my book”). Hence, it’s difficult to identify whether the sentence being processed contains a RC or not as well as identifying the boundary of the relative clause (He, Xu, & Ji, 2017). As showed in (2a), (碰到总统的 女儿 感到非常荣幸), readers can segment the sentence as followed, (碰到总统的 的/ 女儿 感到非常荣幸), which means someone’s daughter encountered with the president by chance and the daughter felt very pleasure. But the sentence could also be segmented in another way, (碰到/ 总统 的/ 女儿 感到非常荣幸), which means someone encountered with the president’s daughter by chance and (someone) felt very pleasure. As well known, Chinese is a pro-drop language (Huang & James, 1984), which means arguments that would be pronominalized in English can sometimes be omitted completely in Chinese. Therefore, one interesting property of Chinese relative clauses is that the head noun can be omitted, especially when it is recoverable via pragmatics or from context. But this phenomenon would not be happened in processing ORC as in (2b), there was only one way for readers to segment the sentence, (总统碰到的/ 女儿 / 感到非常荣幸), which means that the president encountered with someone’s daughter by chance and the daughter felt very pleasure. Considering the differences in syntactic attachment between SRCs and ORCs, we argued that difficulties with SRC found in Hisao and Gibson’s study (2003) might partly be from the ambiguity in constituent attachment. To prove our hypothesis right or not, two experiments using eye-movement tracking were designed as followed.

**Experiment 1**

The first experiment was intended primarily as a manipulation check. We used sentences like (3a) and (3b), where both the sentential subject and the noun-phrase in the relative clause were confusable (e.g., both were animate, human) and both were good agents for the action described by the matrix verb and the verb in the relative clause. If difficulties with SRC were from the distance between the gap and the filler as LDT said, differences in reading time would be found at regions of the internal-clause, de, the head noun phrase and the head verb in matrix (underlined parts). If difficulties were from the ambiguity in constituent attachment, differences in reading time would be found at regions of the head noun phrase and the head verb in matrix (framed parts).

**Methods**

**Participants**

36 undergraduates at the Qufu Normal University, China, participated in Experiment 1. All of the participants were native speakers of Chinese and had normal vision and hearing, they were all right handed. After experiment, they were paid ¥30 (about $5) for their participation.

**Material and design**

24 sets of Chinese RCs as (3) were compiled. Subject-relative and object-relative clauses were created by changing the order of the words in the relative clause. Thus, the items were matched for length and frequency across conditions. To ensure there was no difference in the semantic plausibility across the two conditions, a separate group of 40 students were asked to rate the plausibility of these sentences on a scale of 1 (more natural) to 5 (more unnatural). No significant differences in the plausibility were found ($M_{3a} = 1.61, M_{3b} = 1.66, t =—.94, p = .35$).

The twenty four sets of experimental sentences were divided into two lists, using a Latin square design, so that participants saw either SS or SO version of each sentence. Each list contained 72 filler sentences of various
grammatical types. Thus, each participant read 96 sentences which were pseudo-randomized so that at least three filler sentences intervened between target sentences.

**Procedure**

Subjects were tested individually, and eye movements were recorded using an EyeLink 1000 (SR Research, Toronto, Ontario, Canada) eyetracker, interfaced with a PC computer. The sampling rate was 1000 Hz. Stimuli were displayed on a 21° CRT monitor. Subjects were seated 55 cm from the computer screen. At this distance, 24-point characters subtended 0.8° of visual arc. Viewing was binocular, but only the right eye was recorded. All critical sentences were displayed on a single line. Sentences were presented in 24-point font in black. Before the experiment began, each participant was instructed to read for comprehension in a normal manner. A calibration procedure was then performed, and re-calibration was carried out between trials as needed. The participant triggered the onset of each sentence by fixating a box on the left edge of the computer screen. The experiment lasted approximately 40 min. The experiment was implemented using the Eye-Track software, and the data were addressed using SPSS.

**Results**

Prior to analysis, 4 participants’ data were deleted for their lower accuracy on comprehension. In addition, fixations less than 80 ms or more than 3000 ms were deleted as extremum (27 cases). Of the remaining, data beyond ±3 SD were deleted, and about 2.84% of the total data were deleted.

For the purpose of analysis of the eye movement data, the critical sentences were divided into 5 interested regions by “/” as illustrated in (3).

(3a) Subject-extracted relative clause (SRC):

/ 目遇总统的的女儿感到非常荣幸.

1 2 3 4 5

Encounter/president/de/daughter/feel/very pleasure

The daughter[that encountered with the president] felt very pleasure.

(3b) Object-extracted relative clause (ORC):

/总统遇到的的女儿感到非常荣幸。

1 2 3 4 5

President/encounter/de/daughter/feel/very pleasure

The daughter[that the president encountered with] felt very pleasure.

For each region of interested, three reading time measures were computed. First fixation duration is the duration of the reader’s first fixation on the word, for those trials on which the region was fixated on the reader’s first pass through the sentence. Regression path duration (also called go-past duration) is the sum of all fixations from the first fixation on the target word up to, but excluding the first fixation downstream from the target word (if the word is skipped during first-pass reading then the regression path duration is 0). No data of regression path duration were recorded for region 1 because of its initial position in sentences. Total time is the sum of all of the fixations within a region.
Comprehension question performance

Table 1

| Sentence type                  | Participants (F1) | Items (F2) |
|--------------------------------|-------------------|------------|
| Subject relative clause (SRC)  | 94.8 (4.53)       | 94.2 (4.36)|
| Object relative clause (ORC)   | 93.9 (4.54)       | 93.4 (5.03)|

The percentages of correct answers for each condition are presented in Table 1. Separate one-way ANOVAs were performed both by participants (F1) and by items (F2) on the correct comprehension percentage. The effect of sentence type was not significant, F < 1.

Reading time data

Table 2

| Region 1 (碰到总统) | Region 3 (女儿) | Region 4 (感到) | Region 5 (非常荣幸) |
|---------------------|-----------------|-----------------|---------------------|
| First fixation      |                 |                 |                     |
| SRC                 | 280(79)         | 243(57)         | 248(42)             | 271(79)             |
| ORC                 | 270(90)         | 232(42)         | 234(40)             | 268(46)             |
| RC type effect      | 10              | 11              | 14                  | 3                   |
| Regression path duration |       |                 |                     |
| SRC                 | 431(112)        | 472(127)        | 672(90)             |
| ORC                 | 371(75)         | 417(99)         | 654(95)             |
| RC type effect      | 60              | 55              | 18                  |
| Total time          |                 |                 |                     |
| SRC                 | 1422(518)       | 669(141)        | 570(156)            | 734(205)            |
| ORC                 | 1334(550)       | 589(137)        | 489(92)             | 711(144)            |
| RC type effect      | 88              | 80              | 81                  | 22                  |

For each region of interest (1-5), we performed separate two-factor ANOVAs by participants (F1) and items analysis (F2) as Table 2.

At the region of internal-relative-clause (region 1), no significant differences were found for the first fixation time, F < 1, and the total time was also not significant, F(1, 31) = 1.37, MSE = 123026, p = .25, η² = .04; F(1) < 1.

No analysis were carried at regions of 的(或) for the rate of skipping is too high (M_{SRC} = 69%, M_{ORC} = 53%).

At the region of the head noun phrase in matrix (region 3), no significant differences were found for first fixation time, F < 1; but there were significant differences for regression path duration, F(1, 31) = 6.14, MSE = 58948, p < .05, η² = .16; F(1, 23) = 10.12, MSE = 63626, p < .01, η² = .34, and the total time, F(1, 31) = 4.82, MSE = 101776, p < .05, η² = .14, F(1, 23) = 4.71, MSE = 364616, p < .05, η² = .17, SRCs were more difficult to comprehend.

At the region of the head verb in matrix (region 4), participant analysis for the first fixation time was marginal significant, F(1, 31) = 3.53, MSE = 2907, p = .07, η² = .10, but no significant differences were found.
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for the item analysis, $F_2 < 1$. For the regression path duration, participant analysis was marginal significant, $F_1(1, 31) = 3.18, \text{MSE} = 47180, p = .08, \eta^2 = .09$, item analysis was significant, $F_2(1,23) = 4.81, \text{MSE} = 50237, p<.05, \eta^2 = .17$, SRCs were difficult to comprehend. The total time also indicated that SRCs were more difficult to comprehend than ORCs, $F_1(1, 31) = 5.16, \text{MSE} = 104959, p<.05, \eta^2 = .14; F_2(1,23) = 13.15, \text{MSE} = 96483, p<.01, \eta^2 = .36$.

At regions of the rest (region 5), participant analysis was not significant, $F_1(1, 31) = 1.80, \text{MSE} = 8752, p = .19, \eta^2 = .06$, but item analysis was significant, $F_2(1,23) = 4.49, \text{MSE} = 8262, p<.05, \eta^2 = .16$, which showed SRCs were difficult to comprehend. No significant differences were found for both the regression path duration and the total time, $F_5 < 1$.

Discussion

In Experiment 1, using eye-movement tracking, we explored the difficulties in processing SRC and ORC in mandarin, and the results showed that, when the head noun phrases in the internal-relative-clause (e.g., president) and the matrix (e.g., daughter) were both from animate category, SRCs were more difficult to comprehend than ORCs at regions of the head noun phrase (region 3), the head verb (region 4). The results were consistent with our speculations that difficulties with SRCs were partly from the syntactic ambiguity in constituent attachment, but which also gave supports to LDT, for there were still differences in the total time at regions of the internal-relative-clause (region 1) between SRCs and ORCs (1422 ms & 1334 ms), although the differences were not significant statistically.

In sum, results from Experiment 1 showed that SRCs were more difficult to comprehend than ORCs as Hisao and Gibson (2003), Chen et al., (2008), He et al., (2017) had found, although we could not make clear the innate reason.

Experiment 2

In Chinese, the word order “V+N1+de+N2” appeared in SRC was a typical ambiguity structure, which was not only regarded as VP structure “V+[N1+de]+N2”, but also PP structure “[V+N1]+de+N2”. What’s the reason that underpinned the ambiguity in constituent attachment? The principal arch-criminal might be due to N1 and N2 were both from animate category! If N1and N2 were from different category, the ambiguity in constituent attachment would be resolved. For example, in the structure “曝光/新闻/的/记者 (disclose/news/de/reporter)”, N1 (新闻 “news”) from inanimate category, while N2 (记者 “reporter”) is from animate category, so it’s very easy for readers to regard the structure as “曝光新闻/的/记者 (the reporter that disclosed the news)”.

Thus, a further study was made by manipulating the animacy configuration of the two nouns in the internal-relative-clause (N1 was inanimacy) and the matrix (N2 was animacy). Due to the ambiguity in constituent attachment was resolved by manipulating the animacy configuration of N1 and N2 in SRCs, we speculated that the difficulties with SRCs at regions of the head noun phrase (region 3) and the verb (region 4) in matrix would disappear. But according to LDT, SRCs were still more difficult to comprehend at regions of the internal-relative-clause (region 1), the head noun phrase (region 3) and the head verb (region 4), for the distance between the gap and the filler in SRCs was still longer than that in ORCs.
Methods

Participants

32 undergraduates at the Qufu Normal University, China, participated in Experiment 2. All of the participants were native speakers of Chinese and had normal vision and hearing, they were all right handed, and also not took part in Experiment 1. After experiment, they were paid ¥ 30 (about $5) for their participation.

Material and design

24 sets of Chinese RCs as (4) were compiled. Subject-relative and object-relative clauses were created by changing the order of the words in the relative clause. Thus, the items were matched for length and frequency across conditions. To ensure there was no difference in the semantic plausibility across the two conditions, a separate group of 40 students were asked to rate the plausibility of these sentences on a scale of 1 (more natural) to 5 (more unnatural). No significant differences in the plausibility were found ($M_{3a} = 1.67, M_{3b} = 1.71, t = -1.1, p = .28$).

The twenty-four sets of experimental sentences were divided into two lists, using a Latin square design, so that participants saw either SS or SO version of each sentence. Each list contained 72 filler sentences of various grammatical types. Thus, each participant read 96 sentences which were pseudo-randomized so that at least three filler sentences intervened between target sentences.

Procedure

The procedure was identical to Experiment 1.

(4a) Subject-extracted relative clause (SRC):

1 2 3 4 5

disclose/news/de/reporter/attract/government’s attention

The reporter that disclosed the news attracted government’s attention.

(4b) Object-extracted relative clause (ORC):

1 2 3 4 5

news/disclose/de/reporter/attract/government’s attention

The reporter that the news disclosed attracted government’s attention.

Results

Prior to analysis, 2 participants’ data were deleted for their lower accuracy on comprehension. In addition, fixations less than 80 ms or more than 3000 ms were deleted as extremum (46 cases). Of the remaining, data beyond $\pm 3 \text{SD}$ were deleted, and about 3.65% of the total data were deleted.

Table 3

| Sentence type               | Participants ($F_1$) | Items ($F_2$) |
|-----------------------------|----------------------|---------------|
| Subject relative clause (SRC) | 96.9 (2.6)           | 96.8 (3.1)    |
| Object relative clause (ORC) | 98.6 (1.8)           | 98.4 (2.3)    |
The percentages of correct answers for each condition are presented in Table 3. Separate one-way ANOVAs were performed both by participants ($F_1$) and by items ($F_2$) on the correct comprehension percentage. The effect of sentence type was not significant, $F_3 < 1$.

**Reading time data**

Table 4

| Mean First Fixation, Regression path Duration and Total Time by Condition and Region |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Region 1 (曝光新闻) | Region 3 (记者) | Region 4 (引起) | Region 5 (政府的关注) |
|---------------------|-----------------|-----------------|-----------------|
| **First fixation**  | 243(91)         | 248(58)         | 261(60)         | 263(87)         |
| SRC                 | 226(54)         | 219(40)         | 231(36)         | 237(53)         |
| RC type effect      | 17              | 29              | 30              | 26              |
| **Regression path duration** | 355(83) | 432(160) | 750(122) | |
| SRC                 | 309(72)         | 399(132)        | 693(67)         | |
| RC type effect      | 46              | 33              | 57              | |
| **Total time**      | 1220(325)       | 461(125)        | 455(109)        | 864(355)        |
| SRC                 | 1241(463)       | 471(134)        | 443(80)         | 732(189)        |
| Type effect         | -21             | -10             | 12              | 132             |

For each region of interest (1-5), we performed separate two-factor ANOVAs by participants ($F_1$) and items analysis ($F_2$) as Table 4.

At the region of internal-relative-clause (region 1), no significant differences were found for the first fixation time, $F_1(1, 29) = 1.37$, $MSE = 123026$, $p = .25$, $\eta^2 = .04$; $F_2 < 1$, and the total time was also not significant, $F_3 < 1$.

No analysis were carried at regions of 的 (de) for the rate of skipping is too high (M$_{SRC} = 68\%$, M$_{ORC} = 73\%$).

At the region of the head noun phrase in matrix (region 3), for the first fixation time, participant analysis was significant, but item analysis was not, $F_1(1, 29) = 4.14$, $MSE = 12255$, $p < .05$, $\eta^2 = .14$; $F_2 < 1$, SRCs were difficult to comprehend. There were no significant differences for regression path duration, $F_1(1, 29) = 4.09$, $MSE = 31575$, $p = .06$, $\eta^2 = .12$; $F_2(1,23) = 1.45$, $MSE = 13401$, $p = .24$, and the total time were also not significant, $F_3 < 1$.

At the region of the head verb in matrix (region 4), participant analysis for the first fixation time was significant, $F_1(1, 29) = 4.36$, $MSE = 13687$, $p < .05$, $\eta^2 = .13$, item analysis was not significant, $F_2(1, 23) = 2.23$, $MSE = 1001$, $p = .15$, $\eta^2 = .09$. For the regression path duration, no significant differences were found, $F_1 < 1$; $F_2(1,23) = 2.62$, $MSE = 17597$, $p = .12$. The total time was also not significant, $F_3 < 1$.

At regions of the rest (region 5), no significant differences were found for the first fixation time, $F_1(1, 29) = 1.72$, $MSE = 9755$, $p = .20$, $\eta^2 = .06$; $F_2 < 1$; and the regression path durations were also not significant, $F_3 < 1$; for the total time, participant analysis was marginal significant and item analysis was significant, $F_1(1, 29) = 3.59$, $MSE = 260586$, $p = .07$, $\eta^2 = .11$; $F_2(1,23) = 10.11$, $MSE = 132730$, $p < .01$, $\eta^2 = .31$, which showed SRCs were difficult to comprehend.
**Discussion**

In Experiment 2, we investigated the difficulties in processing RCs with inanimate noun phrase in the internal-relative-clause and animate noun phrase in the matrix. The results showed that no differences were found at regions of the internal-relative-clause (region 1), the head noun phrase (region 3) and the verb (region 4) in matrix between SRCs and ORCs, which demonstrated that the disappearing of the ambiguity in constituent attachment would greatly reduces the difficulty associated with SRCs in mandarin.

The ambiguity in constituent attachment by itself does not account for the increased difficulty associated with SRCs, for we also found SRCs were still more difficult to comprehend than ORCs at the rest regions (region 5). Hence, we prefer an account under which syntactic preferences and configurational information jointly determine how much difficulty readers will experience processing a given sentence.

**General Discussion**

Experiment 1 tested sentences in which the subject noun and the noun in the relative clause were both animate, and both were plausible agents of the action described in the relative clause. Readers had greater difficulty processing sentences with SRCs than with ORCs. In the second experiment, when the ambiguity in constituent attachment was resolved by manipulating the animacy configuration of the noun phrases in the internal-relative-clause and the matrix, the difficulty with SRCs reduced greatly!

As aforementioned, findings from Indo-European language consistently proved that ORCs were more difficult to comprehend than SRCs under conditions with the subject noun and the noun in the relative clause were both animate. The key reason, as Gibson (1998) claimed, is the linear syntactic distance between the filler and the gap. According to LDT (Gibson, 1998; Hisao & Gibson, 2003), readers would instantly integrate the incoming segments with sentence unfolding from left to right on-line processing, the segments that could not integrate in time would restore in working memory temporarily. Hence, the number of segments needed to be integrated as well as the capacity of working memory jointly decided the difficulty with sentence in processing. This account is fully compatible with findings from head-initial language, such as English. In these languages, there was definite relativizers such as “that” or “who”, readers would realize that they were processing a relative clause when encountering with the relativizer, and would seek for the gap with active in order to build connectivity between the filler and the gap. Hence, the longer the distance between the filler and the gap, the more cognitive resource would be paid.

But this account couldn’t fully fit Chinese because of the followed several reasons. Firstly, there was something wrong with Hisao and Gibson’s (2003) assumptions about SRCs processing in Chinese. According to their assumptions, readers would thought that there were a gap at the initial position when encountering with structure as “V+N+de+”, and they would also look for the filler in order to build syntactic connection between them as did in English. However, the actual conditions were not as they thought. In Chinese, subject-drop is very popular (Huang & James, 1984; Wang, Schlesewsky, Philipp, & Bornkessel-Schlesewsky, 2011), it’s very easy for people to regard the structure “V+N+de+” as a simple sentence with subject dropped “(N)+V+N+”. Secondly, Chinese is head-final language (Hu, Gavarró, & Guasti, 2016; Gibson & Wu, 2013; Xiaoxia et al., 2016), and the head noun is behind the internal-relative clause, that’s to say, readers had finished syntactic
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construction before encountering with the head noun, they needn’t to restore some separate constituents in working memory. Thirdly, most languages from Indo-European literature are word-driven language, such as English, but Chinese is semantic-driven or thematic-driven language (Packard, Zheng, & Zhou, 2011; Philipp, Bornkessel-Schlesewsky, Bisang, & Schlesewsky, 2008). Readers mostly rely on thematic roles to construct sentence, not fully word characteristic. Difficulties with sentence processing would increase if there were ambiguity in arguments construction, such as SRCs in Chinese. But when the noun phrases in the internal-relative-clause and the matrix are from different animate category, it’s easy for readers to construct argument (He & Chen, 2013; Wu, Kaiser, & Andersen, 2012).

The animacy configuration effects in RCs processing were also accounted by the similarity-based interference theory (Gordon, Hendrick, & Johnson, 2001; 2004), according to this theory, if the two noun phrases in the internal-relative-clause and the matrix were from the same category, they would be interfered with each other while retrieving from working memory during ORCs processing, which made ORCs more difficult to comprehend than SRCs. But we think such account also could not fit RCs processing in Chinese, for readers had constructed argument based on one noun phrase before encountering with another noun phrase from the matrix.

The last question for us to ponder is what’s the innate reason that caused the ambiguity in SRC to be resolved when the two noun phrases were from different category? We think the best explanations may be from the thematic role proposition (Mak, Vonk, & Schriefers, 2002; 2006). According to this opinion, animate entities were aptly in the subject position, acted as agents, while inanimate entities were aptly in the object position, acted as patient. In Experiment 2, when the noun phrases in the internal-relative-clause (e.g., "新闻 news") were inanimate and the noun phrases in matrix were animate, it’s easy for readers to regard "记者 reporter" as agent. So there wouldn’t be ambiguity in constituent attachment in a context of this sort. As Lin and Bever (2006) had pointed, the difficulties with SRCs found in Hisao and Gibson’s (2003) study, in some ways, were from the syntactic ambiguity of their materials, if the syntactic ambiguity were controlled, the difficulty with SRCs would reduced greatly.

In that sense, the reasonable thematic roles were helpful for ambiguity resolving, such conclusion was also be drawn from eye-movement indexes. As showed in Experiment 1 & 2, no significant differences were found for the first fixation duration, but for the regression path duration and the total time, we found significant differences between SRCs and ORCs. Considering first fixation duration mostly reflects the early stage in sentence processing, such as word recognition, regression path duration and total time mainly reflect later stage in sentence processing, such as semantic retrieving, thematic roles assignment, argument construction, as well as reanalysis of the syntactic (Inhoff, Briihl, & Schwarz, 1996; Calvo, Meseguer, & Carreiras, 2001), we hold that ambiguity resolution mainly occurred in this stage when semantic was retrieved, thematic roles were assigned and arguments were constructed.

**Conclusion**

In this paper, two experiments were carried out using eye-movement tracking methods to explore why SRCs were more difficult to comprehend than ORCs in Chinese. The findings told us that the linear syntactic distance between the gap and the filler was not the key reason, on the contrary, the ambiguity in argument construction may be the most important. As Lin and Bever (2006) had pointed, the difficulties with SRCs found in Hisao and
Gibson’s (2003) study, in some ways, were from the syntactic ambiguity of their materials, if the syntactic ambiguity were controlled, the difficulty with SRCs would reduced greatly.

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