Consequences of variable accessibility for anaphor resolution in Chinese

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Abstract. The two self-paced reading studies presented here investigate the real-time processing of the complex reflexive *taziji* in Mandarin Chinese. [1] found that real-time anaphor resolution is not fully constrained by syntactic Binding Theory (BT), and that BT-inaccessible antecedents compete during anaphor resolution if they are *sufficiently prominent*. To shed light on what factors influence this prominence, we investigated whether the *variable accessibility* of possessor NPs in Chinese renders them more prominent than their English counterparts. Our results suggest that Chinese possessor NPs are indeed prominent enough to be activated, in contrast to English possessors, even when they are not licensed by BT. Our findings also suggest that gender-marking on pronouns – which is marked in written but not in spoken Chinese – does not constrain real-time processing of written language as strongly as animacy factors do.

1   Introduction

We report two self-paced reading studies on the real-time processing of the complex reflexive *taziji* in Mandarin Chinese. In particular, we focus on questions such as what entities are considered as potential antecedents during real-time anaphor resolution, what constraints regulate real-time anaphor resolution, and whether constraints observed in the processing of anaphors in one language are applicable to another language where anaphors exhibit a different pattern.

A growing body of work on English suggests that the processing of anaphoric expressions is not fully determined by the syntactic principles of Binding Theory (e.g.[1], see also [2] and [3]). In particular, [1] argue – contra early work by [4] – that structurally inaccessible referents are activated early on during the interpretation of object-position reflexives and pronouns in English (but see [5] for evidence that Binding Theory constraints are privileged and apply very early).

More specifically, [1]'s results indicate that referents that are structurally inaccessible according to the syntactic principles of Binding Theory (BT) are nevertheless activated if they are sufficiently prominent in the local discourse. In ex.(1) below, the matrix subject (John/Jane) is inaccessible to *himself*, according to BT. This is because, according to BT, reflexives need to be bound by a local c-commanding subject (Bill), and the matrix subject is inaccessible because it is outside the allowable local domain. However, [1] found that when the matrix subject (John) had the same gender as the reflexive *himself*, reading times were longer than when the matrix subject (Jane) did not match the reflexive in gender. This indicates that processing of the reflexive is sensitive to the matrix subject, despite its structural inaccessibility. More specifically, [1] interpreted the longer reading times in the gender-matched condition as a sign that the BT-inaccessible matrix subject (John) is competing with the BT-accessible local subject (Bill).

However, when the structurally inaccessible referents were located in a less prominent position, such as the possessor position shown in ex.(2), no such slowdown was observed in the gender-matching condition.

(1) **{John/Jane}** thought that Bill$_i$ owed himself$_i$ another opportunity to solve the problem. (from [1])

(2) Jane thought {**Beth/Bill**}'s brother$_i$ owed himself$_i$ another opportunity to solve the problem. (from [1])

[1] conclude that possessor NPs in English are not sufficiently prominent and that this is why they do not result in competition with the BT-licensed antecedent, the possessed NP (brother in ex.(2)). In sum, [1]'s results support what we will call the *prominence constraint*: Structurally inaccessible referents will be activated during anaphor resolution *if they are sufficiently prominent*.

1.1 Chinese complex reflexives

Building upon [1]'s finding that structural prominence plays a role in real-time anaphor resolution, our experiments investigate whether the prominence constraint can be generalized to the interpretation of the Chinese complex reflexive *taziji*. Before discussing the relevant syntactic properties of this form in more detail, it is important to note that *taziji* consists of the gender-marked pronoun *ta* and the simplex reflexive *ziji*. Although the reflexive marker *ziji* is gender-invariant, the written form of the pronoun *ta* is marked for gender. In other words, the *written characters* for the masculine and feminine forms of *ta* are distinct. However, they are pronounced the same, and as a result, the gender distinction is present only in written Chinese.

The interpretation of *taziji* is of interest due to a unique phenomenon that we will call *variable accessibility*. To illustrate this, let us consider the examples in (3a-c). In (3a), the male form of *taziji* can be interpreted as coreferential with the possessor *Zhangsan*, because the possessed noun (*selfishness*) is inanimate (see [6]). (Note that 'Zhangsan' is a male name in Chinese.) However, if the possessed noun is animate, as

in (3b,c), *taziji* cannot 'skip over' it and thus cannot reach the possessor. Thus, in (3b) and (3c), *taziji* must be interpreted as referring to possessed noun.

(3) a.　Zhangsan$_i$ DE zisi　　　hai　LE　　**taziji**$_i$ (masc.).
　　　　Zhangsan$_i$ DE selfishness　hurt　Perf-asp　**he-self**$_i$**.**
　　　　'*Zhangsan$_i$'s selfishness hurt **him**$_i$.'*

　　b.　Zhangsan DE gege$_i$　　hai　　LE　**taziji**$_i$ (masc.).
　　　　Zhangsan DE brother$_i$　hurt　Perf-asp　**he-self**$_i$.
　　　　'*Zhangsan's brother$_i$ hurt **himself**$_i$.'*

　　c.　*Zhangsan DE meimei hai　　LE　　**taziji**$_{*i}$ (masc.).
　　　　Zhangsan$_i$ DE sister　hurt　Perf-asp　**he-self**$_{*i}$.
　　　　'*Zhangsan$_i$'s sister hurt **him**$_i$.'*

Because the written form of *taziji* is marked for gender, the gender of the potential antecedents also matters. *Zhangsan* is a male name in Chinese, and thus the male version of *taziji* can be interpreted as coreferential with *Zhangsan* in (3a), and with *gege* ('brother') in (3b). However, if the masculine form of *taziji* is used in a situation where the possessed noun is animate and feminine, as in (3c), the sentence is ungrammatical. In other words, whether or not *taziji* can be coreferential with the possessor NP depends crucially on the animacy status of the possessed NP.

　The possessor's variable accessibility raises an important question: Do Chinese possessors resemble English possessors, i.e., are they too low in prominence to compete with the possessed NPs during real-time reference resolution? Or, are Chinese possessors more prominent due to their variable accessibility and therefore able to interfere with the potential coreferential relation between the object-position reflexive and the possessed NP? By investigating the potential effects of variable accessibility, we can contribute to our understanding of what factors influence referent prominence.

　Overall, our experiments aim (i) to further our understanding of the real-time interpretation of complex reflexives in Chinese, and (ii) to determine whether the variable accessibility of possessor NPs in Chinese renders them prominent enough to compete during processing. In addition, these studies will also test whether [1]'s claim that non-BT-accessible referents can be activated during anaphor resolution can be replicated in Chinese.

2　Experiment 1

2.1 Background and design

To investigate the consequences of *variable accessibility* during the real-time processing of Chinese reflexive *taziji*, we looked at the following three configurations:

Condition I: [Inanimate]: The possessed NP is inanimate, and *taziji* refers to the possessor (ex.4a). In this condition, the possessor is a BT-licensed antecedent, because the possessed NP is inanimate ([6]).

Condition II: [+Multiple]: The possessor and the possessed NPs both agree with *taziji* in gender (ex.4b). However, the possessor NP is not BT-accessible, due to the blocking effect triggered by the animate possessed NP ([6]).

Condition III: [-Multiple]: In this condition, the possessed NP agrees with *taziji* in gender but the possessor does not (ex.4c). Thus, there is only one gender-matching antecedent available for *taziji*, namely the animate possessed NP.

(4) Sample target item:
   a. **[Inanimate]**:
     Songli$_i$ (fem.) DE **qiongkun** molian LE **taziji**$_i$ (fem.), …
     Songli$_i$ (fem.) DE **impoverishment** discipline Perf-asp. she-self$_i$, …
     '*Songli$_i$'s (fem.) **improverishment** disciplined her$_i$, …*'

   b. **[+Multiple]**:
     Songli (fem.) DE **meimei**$_i$ molian LE **taziji**$_i$ (fem.), …
     Songli (fem.) DE **sister**$_i$ discipline Perf-asp. **she-self**$_i$, …
     '*Songli's (fem.) **sister**$_i$ disciplined her$_i$, …*'

   c. **[–Multiple]**:
     Songgang (masc.) DE <u>**meimei**$_i$</u> molian LE **taziji**$_i$ (fem.), …
     Songgang (masc.) DE **sister**$_i$ discipline Perf-asp. **she-self**$_i$, …
     '*Songgang's (masc) **sister**$_i$ disciplined herself$_i$, …*'

 [wrap-up clause, same in all three conditions]
 … dajia dou juede lisuodangran.
 … everyone all think reasonable
 '…everyone thought it was reasonable.'

In our experiments, we used the moving-window, non-cumulative self-paced reading paradigm. In this paradigm, participants read the test sentences in a word-by-word fashion. Participants press a key to reveal the next word, and the previous word disappears. This technique is widely used in psycholinguistic research to investigate sentence processing, because it has been shown that reading time/speed is highly correlated with processing load. One of the factors that has been found to influence reading speed is the presence of competing alternatives. In particular, existing research on pronoun resolution has found evidence for a so-called *multiple-candidate effect*: Extra processing – as indicated by longer reading times – is needed to resolve a pronoun that has more than one candidate antecedent, in comparison to a pronoun with only one possible antecedent ([7], see also [1]). In other words, multiple antecedents competing with each other result in a slowdown. (It is worth noting that such slowdown effects do not necessarily surface on the referential form itself; they

may appear on the following words, exhibiting a so-called *spill-over* effect that is fairly common in self-paced reading.)

In the current study, we investigated participants' word-by-word reading times in the three conditions described above. By comparing [+Multiple] and [-Multiple], we wanted to test whether competition effects (the *multiple-candidate effect*, as indicated by an increase in RT) arise when multiple antecedents are present ([+Multiple]). By comparing [-Multiple] and [Inanimate], we wanted to see how availability of a single gender-matching antecedent in a prominent head-NP position ([-Multiple]) compares to the availability of a single animacy-matched antecedent in a low-prominence possessed position ([Inanimate]).

During the self-paced reading task, participants read the sentences word-by-word, and the reading time for each word was recorded. Twenty-one adult native speakers of Mandarin Chinese were tested individually with *Linger*, a program designed to collect self-paced reading data ([8]). To encourage participants to pay attention to what they were reading, experimental items were followed by comprehension and probe-recognition questions on an intermittent basis. In Experiment 1, to control for word length, *taziji* was presented as two 'words', *ta* and *ziji*.

2.2 Results

In our discussion of the reading time patterns, we focus on the reading times for the two parts of the complex reflexive (*ta* and *ziji*) and the spill-over region (the two words immediately following *ziji*, e.g. *dajia* and *dou* in ex.(4)).

In the *ta*-region, the fastest reading times occurred in the [+Multiple] condition (average RT: 320 ms), which was significantly faster than the [Inanimate] condition (average RT: 335 ms) and the [-Multiple] condition (average RT: 341 ms) (p's < .05). This effect was unexpected, and may be connected to the fact that *ta* is also a freestanding pronoun in Chinese and thus potentially subject to a range of salience-related constraints.

In the *ziji*-region, the reading times the [Inanimate] condition (average RT: 392 ms) are significantly faster ($p < .05$) than reading times in the [-Multiple] condition (average RT: 437 ms), and also marginally faster than reading times in the [+Multiple] condition (average RT: 431 ms, $p = .07$).

Reading times on the first word following *ziji* (e.g. *dajia* in ex.(4)) showed no significant differences between the three conditions, although raw reading times showed that that [Inanimate] conditions are read the fastest and [+Multiple] conditions the slowest. These effects become clearer at the second word in the spill-over region (e.g. *dou* in ex.(4)): At this word, the [Inanimate] condition (average RT: 347 ms) was significantly faster than the [+Multiple] condition (average RT: 369 ms) ($p < .05$). On the other hand, no significant difference was observed between [-Multiple] (average RT: 364 ms) and [Inanimate] at this position ($p > 0.1$).

While we predicted that [Inanimate] should be read faster than [+Multiple] (because there is only one available antecedent in [Inanimate], due to the inanimacy of the possessed NP), we also predicted that [-Multiple] should show relatively fast reading times. This is because only one possible antecedent is present in the [-Multiple] condition, given that the reflexive was gender-incompatible with the

possessor NP. Because both the [Inanimate] and [-Multiple] conditions contain only one accessible antecedent (the possessor NP in the [Inanimate] condition and the possessed (head) NP in the [-Multiple] condition), we predicted that they would be read faster than [+Multiple]. This is because [+Multiple] should show a slowdown due to the *multiple-candidate effect*, if possessors in Chinese are prominent enough to compete. Thus, the finding that, at *ziji*, both [+Multiple] and [-Multiple] resulted in slowdowns relative to [Inanimate] was surprising.
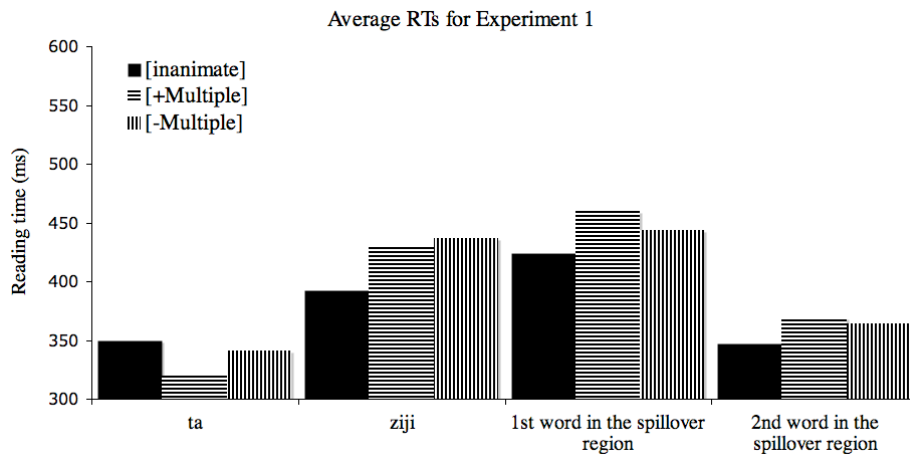

Fig. 1. Average reading times for the three conditions for *taziji* and for the spillover-region.

The finding that [+Multiple] resulted in a slowdown relative to [Inanimate] (marginal at *ziji* and significant at the second spill-over word) suggests that, in contrast to English, possessor NPs in Chinese are prominent enough to interfere in the processing of the complex reflexive *taziji*. We attribute this to their variable accessibility.

In addition, the finding that [-Multiple] also resulted in a slowdown relative to [Inanimate] at *ziji* suggests that in Chinese, animacy may be a more salient constraining cue than gender. In other words, it appears that [+Multiple] and [-Multiple] resemble each other in showing a slowdown. Given that we interpret the slowdown in [+Multiple] as being due to the presence of two competing antecedents, the presence of a slowdown in [-Multiple] suggest that this condition is also interpreted as having multiple antecedents. In other words, it seems that perhaps comprehenders are not sensitive to the gender-mismatch between *ziji* and the possessor in sentences like ex.(4c), and treat the possessor as a competitor as well.

The important role of animacy fits with existing research on other constructions showing that animacy is a strong cue that plays a central role in language processing (See [9] and [10]). We discuss the weak gender effects in more depth in Section 3 and suggest that they may be connected to the absence of gender-marking in spoken Chinese.

3   Experiment 2

3.1   Background and design

In Experiment 1, *taziji* was segmented into the gender-denoting pronoun *ta* and the simple reflexive *ziji* in order to control for word length. However, separating *ta* and *ziji* meant that participants encountered the gender-marked pronoun *ta* before the reflexive *ziji*. Recall that, in the [-Multiple] condition, the *ta* in *taziji* did not match the possessor NP in gender. Thus, when participants reached *ta* while reading sentences like ex.(4c) repeated below, there was no antecedent available in the sentence at this point. Existing work has shown that slowdowns in self-paced reading can also occur as the result of 'missing antecedent' situations (e.g., [1] and [7]). This finding, combined with the existence of spillover effects, brings up a crucial question: Could the absence of a gender-matching antecedent be responsible for the unexpected slowdown at *ziji* in the [-Multiple] condition? Recall that, in Experiment 1, we predicted that [+Multiple] would result in a slowdown if both of the gender-matched antecedents are competing, but we did not expect to see a slowdown with [-Multiple], which only contains one gender-matching antecedent for *taziji*.

(4) c. **[–Multiple]**:
     Songgang (masc.) DE **meimei**$_i$ molian   LE   **taziji**$_i$ (fem.), …
     Songgang (masc.) DE **sister**$_i$ discipline Perf-asp. **she-self**$_i$, …
     *'Songgang's (masc) **sister**$_i$ disciplined **herself**$_i$, ...'*

    To test whether the unexpected finding that [-Multiple] also resulted in a slowdown could be attributed to *ta* and *ziji* being segmented into two units, we conducted a follow-up study where *taziji* was presented as a *single unit*. The stimuli and the procedure were otherwise identical to Experiment 1. Eighteen native speakers of Mandarin Chinese, who had not participated in Experiment 1, took part in this study.

3.2 Results

Given the results of Experiment 1, we focus here on the reading times at the reflexive *taziji* and the two following words. At the reflexive *taziji*, the [Inanimate] condition (Average RT: 458 ms) was read marginally faster than the [+Multiple] condition (Average RT: 503 ms) ($p < 0.1$). No other differences approached significance. However, as shown in Fig.2, at the two word positions immediately following the reflexive, the [Inanimate] condition (average RT: 1st word: 440 ms; 2nd word: 382 ms) was read significantly faster than both the [+Multiple] condition (average RT: 1st word: 514 ms; 2nd word: 429 ms) and the [-Multiple] condition (average RT: 1st word: 546 ms; 2nd word: 421 ms) ($p's < 0.05$). Thus, even when *ta* and *ziji* are presented as the single unit *taziji*, we find that [+Multiple] and [-Multiple] pattern alike in being

slower than [Inanimate]. This suggests that the slowdown in the [-Multiple] condition is not a segmentation artifact.
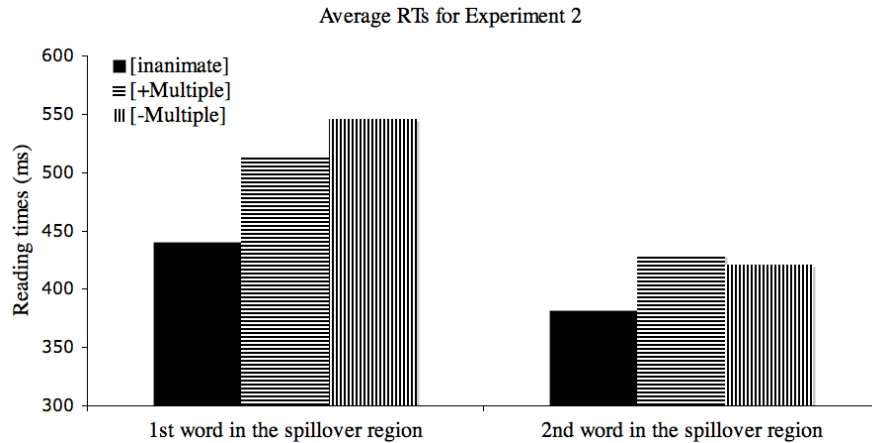

Fig. 2. Average reading times for the three conditions for the spillover-region in Experiment 2.

3 Conclusions

The results of the two self-paced reading studies presented in this paper contribute to our understanding of the nature of real-time referential processing. In particular, our aim was to investigate what influences which referents compete with each other during anaphor resolution. [1] found that BT-inaccessible antecedents competed during processing if they are *sufficiently prominent*. Our experiments were designed to further our understanding of what influences referent prominence by testing whether the *variable accessibility* of possessor NPs renders them more prominent than their English counterparts. Our results suggest that Chinese possessor NPs are indeed prominent enough to compete with possessed NPs, and support our hypothesis that the increased prominence of possessor NPs in Chinese is due to their variable accessibility.

More generally, our finding that BT-inaccessible referents compete during the real-time interpretation of complex reflexives in Chinese corroborates [1]'s claim that multiple constraints guide the process of anaphor resolution (see also [2]). In other words, contra early work by [4], our results fit with the view that the syntactic principles of BT do not fully regulate the initial moments of real-time anaphor resolution.

In addition, our results also suggest that in Chinese, gender seems to be only a rather weakly constraining cue during real-time anaphor resolution. The finding that [+Multiple] and [-Multiple] resemble each other and differ from [Inanimate] suggests that comprehenders were not very sensitive to the gender-mismatch in [-Multiple]. We suggest that the weakness of the gender effects may be due to the missing gender distinction in the spoken form of *taziji*. In other words, it seems that even though the

masculine and feminine forms of *taziji* are written differently, the fact that there is no gender distinction in spoken Chinese means that Chinese speakers may not use gender as a strong cue during on-line processing, even when the stimuli are presented in writing. Future studies should investigate how gender is processed and cognitively encoded in Chinese or in any languages in which gender is only marked orthographically.

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