

Investigating Filler-Gap Dependencies in Chinese Topicalization

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The present study explored the on-line process of constructing filler-gap dependencies in Chinese topic structures. In a topic structure, extracting the topic from within a sentence is subject to *locality constraints*; for instance, gaps inside islands such as adverbial clauses are prohibited. Interestingly, similar to the parasitic gap (PG) construction in English, a gap in an adverbial clause can be saved if there is a gap in the main clause. Based on the results of a moving-window self-paced reading experiment that investigated the processing of transitive verbs and coverbs inside adverbial clauses, we suggest that filler-gap dependencies are constructed during real-time processing of Chinese topicalization structures. Our results suggest that the parser actively searches for a gap site and is also sensitive to the syntactic restrictions on parasitic gap constructions in Chinese. Our findings are compatible with a movement analysis of Chinese topicalization and provide further support for the existence of parasitic gaps in Chinese.

1. Introduction*

It has been proposed that Chinese topic structures may be derived by A'-movement and thus involve a filler-gap dependency between the topicalized noun (filler) and its trace (gap). The present study aims to answer two questions. First, if Chinese topic structures involve movement, can we find evidence during real-time processing for the construction of a dependency between the filler and the gap? Such evidence would lend support to a movement analysis of Chinese topicalization, suggesting that a topic is actually a fronted element extracted from within the main clause. Second, to what extent is real-time parsing constrained by syntactic and semantic information? To put it in

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another way, do Chinese readers make use of both semantic meanings and grammatical knowledge simultaneously when processing sentences? In all, the findings may shed light on the theoretical inquiries into Chinese topic constructions from a processing perspective.

1.1. On-line processing of filler-gap dependencies

Existing research on on-line sentence comprehension has provided abundant information about the real-time processing of filler-gap dependencies. Most results point towards the conclusion that human parsers are ‘active searchers’. That is to say, after encountering a filler (i.e., a fronted element such as a *wh*-phrase in English questions), the parser posits a gap at the earliest possible gap site, without waiting to confirm that the gap site is not occupied. This strategy can sometimes lead to an incorrect expectation, as demonstrated by the so-called ‘filled-gap’ effect observed in sentences like (1) (adapted from Crain & Fodor 1985).

(1) *Who*_i did the children **force** ^ us to sing the song for *t*_i yesterday?

When reading (1), the fronted *wh*-phrase foretells an incoming gap, and readers are inclined to posit a gap at the earliest possible grammatical position (indicated by a wedge sign ^ in (1)), that is, right after the verb *force*. However, as reading proceeds, the upcoming *us* indicates that the object position of *force* is not an available gap site, so a filled-gap effect is reflected by slower reading times at this point compared to a control sentence. Filled-gap effects at verb positions have been attested by different experimental methods, including reading-time studies (Crain & Fordor 1985; Stowe 1986), eye-tracking studies (Traxler & Pickering 1996), and event-related potential (ERP) measures (Felsler et al. 2003, Phillips et al. 2005).

Furthermore, various studies have shown that the parser is sensitive to island constraints. For example, Stowe (1986) concluded that no gap site is posited inside islands based on the fact that no filled-gap effects are observed in subject islands compared with gapless sentences. Traxler and Pickering (1996) also argued for island sensitivity based on the fact that slower reading times caused by an implausible verb-object combination can be found where the verb is associated with a grammatical gap site, while this effect disappears where the gap site is embedded in a relative clause inside a subject island. The idea that gaps are only posited where they are syntactically licensed is also supported by the results from studies on languages other than English, such as French complex NPs (Bourdages 1992) and Japanese relative clauses (Yoshida et al. 2004).

In sum, although the parser actively searches for a possible gap site as early as possible probably due to the goal of processing efficiency (c.f. Hawkins 1999), grammatical knowledge also plays a role in constraining this process, which suggests that the parser aims at both efficiency and accuracy, as Phillips (2006) concluded.

1.2. On-line processing of parasitic gap constructions

Parasitic gap (abbreviated hereafter as PG) constructions are intriguing linguistic phenomena and have inspired extensive discussion in syntactic theories for more than two decades (see Culicover 2001 for an overview). A PG is an illicit gap inside a syntactic island, which can be rescued by a licit gap in the main clause, as shown in (2) (from Phillips 2006). In (2a), a gap inside a subject complex NP island results in ungrammaticality. In contrast, (2b) contains only a main-clause (MC) gap and is grammatical. Interestingly, in (2c), a PG inside an island is rescued by a MC gap linked to the same *wh*-phrase.

- (2) a. *What did the attempt to repair ___ ultimately damage the car?
 b. What did the attempt to repair the car ultimately damage ___?
 c. What did the attempt to repair PG ultimately damage ___?

From the perspective of on-line processing, PG constructions like (2c) represent an exception to the generalization that gaps may not occur inside islands. They also pose a ‘look-ahead’ problem (Phillips 2006) for incremental parsing since the PG in (2c) occurs *before* the MC gap that licenses it. Since parsing proceeds from left to right, how does the parser decide whether the PG is a possible gap site or not before it encounters the subsequent licensing gap?

It is important to note that the distribution of PGs is restricted. For example, a gap in a finite clause inside a subject island (see (3a)) cannot be rescued by a MC gap. Unlike (2c), (3c) remains ungrammatical even if a MC gap is present.

- (3) a. *What did the reporter that criticized ___ eventually praise the war?
 b. What did the reporter that criticized the war eventually praise ___ ?
 c. *What did the reporter that criticized PG eventually praise ___ ?

Phillips (2006) accounts for the difference between (2c) and (3c) in terms of the strength of the island environments where the PGs occur. In (2c), the only island is the subject NP. Infinitival clauses typically do not give rise to island effects. In contrast, in (3c), in addition to the subject NP island, the finite relative clause is an island itself, and thus their combination creates a strong island effect.

Phillips hypothesizes that if the parser aims at both incrementality and accuracy, it should actively posit a gap only inside islands that support a PG (e.g. (2c)), but not inside islands where a PG is impossible (e.g. (3c)). The results of a self-paced reading study (Phillips 2006) support this. In this experiment, the factors of *finiteness* (infinitival vs. finite clauses) and *plausibility* between the *wh*-phrase and its subcategorizing verb were manipulated. A sample item is shown in Table 1. Note that although none of the experimental items contained actual PGs, a PG could potentially have occurred after the verb in the infinitival conditions ((i) and (ii)) but not in the finite conditions ((iii) and

(iv)).

	Plausible	Implausible
Infinitival	(i) The school superintendent learned which schools the proposal to expand [PG?] drastically and innovatively upon the current curriculum would overburden ____ during the following semester.	(ii) The school superintendent learned which high school students the proposal to expand [PG?] drastically and innovatively upon the current curriculum would overburden ____ during the following semester.
Finite	(iii) The school superintendent learned which schools the proposal that expanded drastically and innovatively upon the current curriculum would overburden ____ during the following semester.	(iv) The school superintendent learned which high school students the proposal that expanded drastically and innovatively upon the current curriculum would overburden ____ during the following semester.

Table 1. Sample set of experimental conditions in Phillips (2006).

(Boldface indicates *wh*-phrase and verb inside subject island)

Phillips found that if the clause containing the verb before the possible PG site was an *infinitival* complement of the subject NP ((i) and (ii)), the implausible condition had slower reading times at the verb region compared to the plausible condition. He attributes this slowdown to a semantic mismatch between the *wh*-phrase and the verb that arises as a result of the parser positing a PG after the verb. On the other hand, if the clause containing the critical verb was a *finite* clause modifier of the subject NP ((iii) and (iv)), there was no plausibility-related slowdown in the implausible condition compared to the plausible condition, suggesting that the parser did not posit a PG in a finite clause at all.

1.3. Parasitic gaps in Chinese topicalization

The canonical word order in Chinese is SVO (e.g. 4(a)), but a sentence with a topicalized object has OSV order (e.g. 4(b)).

- (4) a. Zhangsan hen xi-huan zhe-ben shu. (SOV)
 Zhangsan very like this-Cl book
 ‘Zhangsan likes this book very much.’
- b. Zhe-ben shu, Zhangsan hen xihuan. (OSV)
 This -Cl. book, Zhangsan very like.
 ‘This book, Zhangsan likes (it) very much.’

Although Chinese does not have *wh*-movement, and *wh*-words normally stay *in-situ*, it has been proposed that Chinese topic structures are derived by movement (Qu, 1994; Shyu, 1995) due to the following facts. First, reconstruction effects can be found if the topic (i.e., the filler) is placed back to its original position (i.e., the gap). For example, in

(5), although *Zhangsan* does not bind the reflexive *ziji* ‘self’ on the surface, it is proposed that the anaphor forms a chain with the object where it is originated and thus can be bound by an antecedent in the main clause through chain-binding (see Huang, Li & Li (in preparation) for an overview).

- (5) *Ziji_i de shu, Zhangsan_i hen xi-huan t_i.*
 Self DE book Zhangsan very like
 ‘Self’s book, Zhangsan likes (it) very much.’

Second, extraction of topics must respect various locality constraints (Shi 1992, 2000). For example, in (6), extraction of *Lisi* is not possible from within a complex NP island, suggesting that movement is involved.

- (6) * *Lisi_i, wo ren-shi [hen-duo [[xi-huan t_i] de ren]].*
 Lisi I know many like DE people
 ‘Lisi, I know many people who like (him).’

Extraction of topics from within an adverbial clause is also ungrammatical (e.g. (7a)), whereas extraction of topics from within a main clause is fine (e.g. (7b)). This asymmetry suggests that sentence-initial topics reach their final position by movement and are not base-generated there. Interestingly, similar to the PG constructions in English, an illicit gap in the adverbial clause can be saved if there is a licit gap in the main clause (e.g. (7c)). Sentences like (7c) have been argued to be PG constructions licensed by topicalization in Chinese (Ting & Huang 2008).

- (7) a. **Na-ge yuan-gong [zai lao-ban **jian-guo** __ zhi-hou] da-jia ji-xu kai-hui.*
 That-Cl. employee at boss meet-ASP after everyone continue meeting
 ‘That employee, after the boss met (him) , everyone continued the meeting.’
- b. *Na-ge yuan-gong ,[zai lao-ban **jian-guo** jing-li zhi-hou],__ li-ke jiu bei kai-chu le.*
 That-Cl. employee at boss meet-ASP manager after immediately was fired PAR
 ‘That employee, after the boss met the manager, (he) was immediately fired.’
- c. *Na-ge yuan-gong [zai lao-ban **jian-guo** PG zhi-hou] __li-ke jiu bei kai-chu le.*
 That-Cl. employee at boss meet-ASP after immediately was fired PAR
 ‘That employee, after the boss met (him), (he) was fired immediately.’

Furthermore, just as in English, Chinese PGs are sensitive to the island strength. For example, inside an adverbial clause, PGs are possible at the object position of a *transitive* verb (e.g. (7c)), but not possible if at the object position of a *coverb*¹ (e.g. (8)). In a

¹ Coverbs refer to a class of verbs that are described as having grammatical properties of both verbs and prepositions. They resist extraction of their objects by topicalization, a fact which is

non-island environment, the object of a transitive verb is allowed to be fronted to the topic position, while the object of a coverb is not. Similar to Phillip's infinitival and finite conditions, we claim that a PG in sentences like (7c) occurs in a weak island, while a PG in sentences like (8) occurs in a strong island that violates multiple constraints.

- (8) * Na-ge yuan-gong [zai lao-ban **tong** __PG jian-guo zhi-ho] __ li-ke bei kai-chu le.
 That-Cl. employee at boss with meet-ASP after immediately was fired PAR
 'That employee, after the boss met with (him), (he) was fired immediately.'

However, despite the locality constraints and reconstruction effects in topicalized structures, and what looks like a striking similar ability of a main clause gap to license an illicit gap in both Chinese and English, it is not universally agreed that topicalization in Chinese involves movement. Proponents of the non-movement analysis argue that the topic is syntactically based-generated, and is not subcategorized by the verb of the main clause. In other words, the topic is not syntactically related to a position inside the main clause (e.g. Li & Thompson 1981, Tsao 1990, Ning 1993). However, given that the topic is nevertheless interpreted as connected to a position in the main clause, non-movement analyses face the challenge of explaining how this takes place. Huang's (1984) proposal that there is no object *pro* in Chinese rules out the possibility of the topic being connected to a null pronoun in the main clause, and it has been suggested that the empty category in question is instead a 'free empty category' that does not need to be licensed by a gap (Xu 1990) or an 'empty resumptive pronoun' (Kim 2001). In addition to facing questions regarding the status of the empty category, non-movement analyses do not offer a straightforward way of capturing the reconstruction effects and island sensitivity patterns discussed above. In contrast, a movement analyses is able to capture these patterns straightforwardly.

2. Research questions

The present study aims to investigate Chinese PG constructions licensed by topicalization from a processing perspective. We want to answer the following questions. First, can we find evidence for the construction of a filler-gap dependency between a topic and its trace? Given that evidence from island effects and reconstruction effects suggests that Chinese topicalization may involve A'-movement, we expect to find evidence for constructing a dependency between the topic and its trace during on-line processes. Results from Phillips (2006) indicate that the human parser posits gaps inside islands only in environments where PGs are acceptable. Following his approach, we compare reading times between impossible and possible gap sites in Chinese.

often explained in terms of a preposition-stranding constraint (e.g. Huang, 1982; Li, 1990). Six coverbs were included in the present study: *dui* 'to', *xiang* 'to', *gen* 'with', *yong* 'use', *tong* 'with', *rang* 'allow'.

Second, if construction of filler-gap dependencies does take place in Chinese topicalized sentences, where is the gap posited? If it appears after a transitive verb inside an adverbial clause (i.e., the possible site for PG), this suggests that the parser acts incrementally, without waiting for top-down information to confirm the presence of a licensing gap (i.e., the site for a gap in the main clause).

Third, is the parser able to distinguish between syntactic environments that support PGs and environments that do not license PGs? If the parser aims at accuracy as well as efficiency, construction of filler-gap dependencies should be found at transitive verbs but not at coverbs inside adverbial clauses, since only the former supports PGs.

3. Method

3.1. Participants

Participants were thirty-two graduate students aged from 20-30, with normal or corrected to normal eyesight. Twenty were males and twelve were females. All were native speakers of Mandarin Chinese living in Taiwan.

3.2. Materials

The experiment had a 2x2 factorial design, crossing factors *verb type* (transitive verb vs. coverb inside an adverbial clause) and *plausibility* (whether or not the topic is a plausible object of the verb in the adverbial clause). In Chinese, transitive verbs allow PGs, but, crucially, PGs are ungrammatical in the coverb conditions. Following Phillips, we also manipulated plausibility: the topicalized object was either a plausible or implausible object of the verb inside the adverbial clause. (Recall that if the parser posits a PG, the PG would be posited right after the verb in the adverbial clause.)

Twelve target items were distributed among four lists in a Latin Square design, along with 24 filler items. Each participant was presented with one of the four versions composed of 12 target items and 24 fillers in pseudorandom order.

A few things need to be mentioned about the design of target items. First, all target items were topicalized sentences. Since topicalized sentences might sound odd out of context, each target item was preceded by a sentence serving as background information. The background sentence was identical across conditions within each item. Furthermore, in the topicalized sentences, the number of Chinese characters before the verb associated with a (potential) PG was the same across four conditions within each item, in order to minimize any spill-over effect. Most important of all, following the design of Phillips (2006), possible sites for a PG inside adverbial clauses were always filled with a plausible object. In other words, none of the trials actually involved PGs. For example, as shown in (9a), in the sample sentence the potential PG site after the verb ‘try’ in the adverbial clause was actually occupied by the plausible object ‘many brands’. Thus, globally speaking, the topic ‘German imported car’ was only related to the MC gap before the main verb ‘make’. This setup had two advantages: First, it ensured that each target item was grammatical, since PGs are not supported in the coverb conditions. Moreover, since

PGs did not exist in the target items, any evidence for actively constructing gaps inside adverbial clauses cannot be attributed to a priming effect (Phillips 2006).

(9) Sample item

(Note: the bar sign illustrates word segmentation and doesn't appear on the screen)

(9a) Transitive plausible condition:

王先生|的|老爺車|已經|開了|十多年|了。王太太|一直|要|他|換|一部|新車。
那輛|標榜|高科技|的|德國|進口車,在|王先生|試過|許多|廠牌|的|車子|之後|令|他|最|心
動。

Mr. Wang |DE| old car |already| run-ASP| more than ten years.| Mrs. Wang| keep| ask| him| change| one-Cl
|.new car. | That-Cl |advertise| high-tech| DE |German |**imported car**,| at | Mr .Wang | **try-ASP**
V-4 V-3 V-2 V-1 V
many| brands |DE | car | after| make |him |most | desire
V+1 V+2 V+3 V+4

'Mr. Wang's old car has run for more than a decade. Mrs. Wang keeps telling him to buy a new car. The high-tech imported **car** from German, after Mr. Wang **tried** many brands, ___ made him want most.'

(9b) Transitive implausible condition:

王先生|的|老爺車|已經|開了|十多年|了。王太太|一直|要|他|換|一部|新車。
陪著|王先生|四處|看|車|的|王太太,在|王先生|試過|許多|廠牌|的|車子|之後|勸|他|買|日本
車。

Mr. Wang |DE| old car |already| run-ASP| more than ten years.| Mrs. Wang| keep| ask| him| change| one-Cl |
| new car. |Accompany | Mr. Wang | everywhere| look | car |DE| **Mrs. Wang** ,| at | Mr. Wang | **try-ASP**
V-4 V-3 V-2 V-1 V
| many | brands | DE | car | after | persuade | him | buy | Japanese car.
V+1 V+2 V+3 V+4

'Mr. Wang's old car has run for more than a decade. Mrs. Wang keeps telling him to buy a new car. **Mrs. Wang**, who has hunted for cars all around with Mr. Wang, after Mr. Wang **tried** many brands, ___ persuaded him to buy a Japanese car.'

(9c) Coverb plausible condition:

王先生|的|老爺車|已經|開了|十多年|了。王太太|一直|要|他|換|一部|新車。
陪著|王先生|四處|看|車|的|王太太,在|王先生|同|朋友們|討論|很多次|之後
勸|他|買|日本車。

Mr. Wang |DE| old car |already| run-ASP| more than ten years. | Mrs. Wang| keep| ask| him| change| one-Cl
| new car. |Accompany | Mr. Wang | everywhere| look | car |DE| **Mrs. Wang** ,| at | Mr. Wang |**with** |
V-4 V-3 V-2 V-1 V
friends | discuss| many times| after| persuade | him | buy | Japanese car.
V+1 V+2 V+3 V+4

‘Mr. Wang’s old car has run for more than a decade. Mrs. Wang keeps telling him to buy a new car. **Mrs. Wang**, who has hunted for cars all around with Mr. Wang, after Mr. Wang discussed many times **with** his friends, ___ persuaded him to buy a Japanese car.’

(9d) Coverb implausible condition:

王先生|的|老爺車|已經|開了|十多年|了。王太太|一直|要|他|換|一部|新車。
那輛|標榜|高科技|的|德國|進口車,在|王先生|同|朋友們|討論|很多次|之後
令|他|最|心動。

Mr. Wang |DE| old car |already| run-ASP| more than ten years. | Mrs. Wang| keep| ask| him| change| one-Cl
| new car. | That-Cl |advertise| high-tech| DE |German |**imported car**,| at | Mr.Wang | **with** |
V-4 V-3 V-2 V-1 V
friends | discuss | many times | after | made | him |most | desire.
V+1 V+2 V+3 V+4

‘Mr. Wang’s old car has run for more than a decade. Mrs. Wang keeps telling him to buy a new car. The high-tech imported **car** from German, after Mr. Wang discussed many times **with** his friends, ____ made him want most.’

3.3. Procedure

The task was a word-by-word, noncumulative, moving-window self-paced reading task (Just et al. 1982). All sentences were typed in traditional Chinese characters. The experiment was conducted on an ASUS -W5F laptop running the Linger software developed by Doug Rohde at MIT. Sentences initially appeared as a sequence of dashes. At each space-bar press, a new word appeared and the preceding word disappeared. The reading time for each word was the time between space-bar presses and was measured in milliseconds. As is standard in self-paced reading, there was no chance for back-tracking. Participants were instructed to read at normal reading pace. The experiment began with a screen of instructions and three practice trials. To ensure participants’ concentration

throughout the experiment, a comprehension question was presented after each item. Participants answered yes/no by pressing buttons on the keyboard and received immediate visual feedback. Each experimental trial took about 15-20 minutes. Analyses were conducted on both comprehension accuracy and reading times.

4. Predictions

If the parser posits parasitic gaps whenever syntactically possible, we expect to see a plausibility effect in the transitive conditions but not in the coverb conditions. More specifically, in the transitive conditions, if the topicalized object is an implausible object of the verb inside the adverbial clause (ex.(9b)), positing a PG is predicted to trigger a semantic mismatch between the verb and the object. This mismatch is expected to disrupt processing, resulting in slower reading times than in conditions where the topicalized object is a plausible object of the subcategorizing verb (ex.(9a)). In contrast, no plausibility effect is expected in the coverb conditions. If the parser is indeed sensitive to syntactic constraints, we expect that it will not posit a PG in the coverb conditions and no semantic mismatch will arise.

5. Results

5.1. Comprehension accuracy

Mean accuracy rate on the yes/no comprehension questions for the experimental items was 90.1%.²

A 2x2 repeated measures ANOVA on accuracy scores showed that there were no main effects of verb type or plausibility in either the items or the participants analyses. Also, there was no interaction of verb type and plausibility.

It is noteworthy that the accuracy on the transitive implausible condition (84.4%) was somewhat lower than the other three conditions (92% on average). It seems likely that the semantic mismatch between the topic and the subcategorizing verb in the adverbial clause caused difficulty in comprehension. Interestingly, such an effect was not found in the coverb implausible condition.

5.2. Self-paced reading

Mean reading times in milliseconds for all four conditions are shown in Figure 1. Region (V) is the verb inside the adverbial clause (i.e., the critical verb region associated with a potential PG). Regions (V-1), (V-2), (V-3) and (V-4) are the four words before the verb, and (V+1) through (V+4) are the four words after the verb. For each target item, the (V-2) region corresponded to *zai* “at”, marking the beginning of an adverbial clause; the (V-1) region corresponded to the subject of the adverbial clause; the (V) region corresponded to the transitive verb or coverb, and the (V+1) position corresponded to the

² All of the participants except two achieved an accuracy rate equal to or higher than 75%. The experimental data of all 32 participants have been included in the analysis of reading times.

object NP or part of the object NP. Furthermore, for each item, the adverbial clause (i.e. from (V-2) to (V+4)) was identical within the transitive conditions (e.g. (9a) and (9b)) and within the coverb conditions (e.g. (9c) and (9d)). The remaining positions (V-3) and (V-4) varied in parts of speech from item to item.

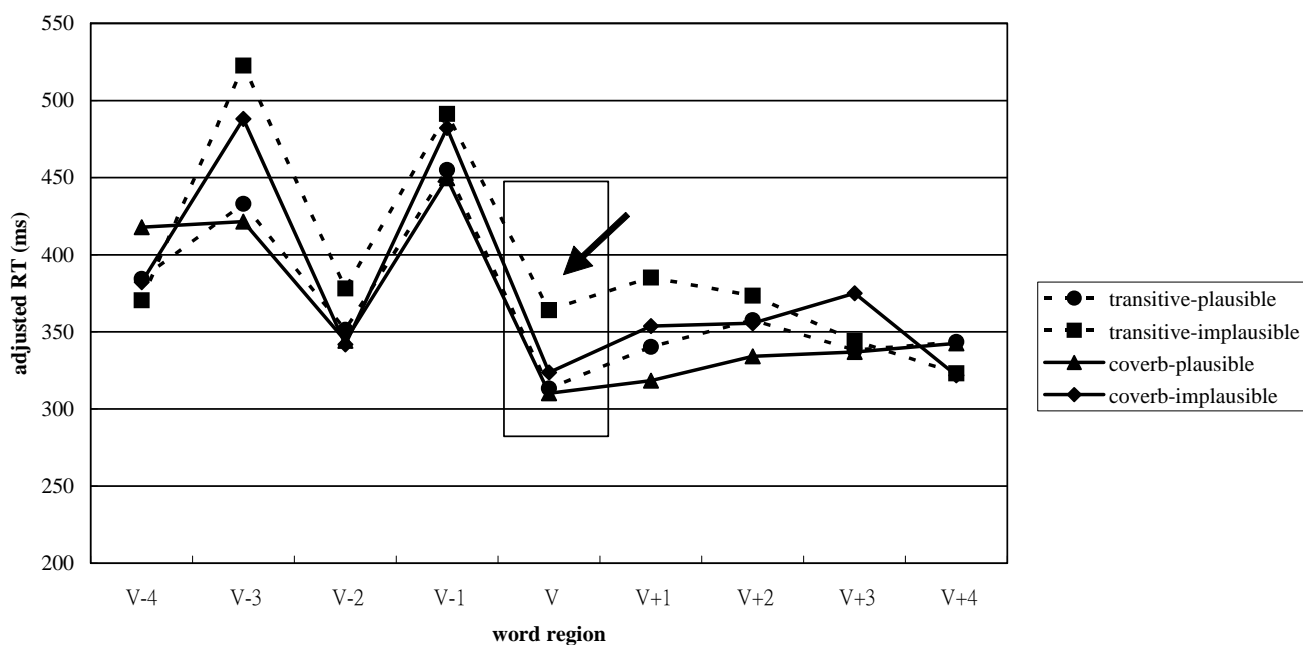


Figure 1. Mean reading times in four conditions

The reading times for regions (V-2), (V-1), (V) and (V+1) were entered into a 2x2 repeated measures ANOVA for the participants analysis ($n=32$), with the factors *verb type* (transitive verb vs. coverb) and *plausibility* (plausible vs. implausible). At the **(V-2) region**, the preposition *zai* ‘at’ introduced the parser into the domain of an adverbial clause, an island for topicalization in Chinese. At this position, there were no significant effects of verb type or plausibility and no interaction. Paired samples t-tests showed no significant effects of plausibility in either the transitive conditions or the coverb conditions.

At the **(V-1) region**, the parser encountered the subject of the adverbial clause, which was always an animate noun. The overall increase in reading times at this region, relative to the preceding region, may be due to word length (average length of characters=3, whereas the preceding region was only 1 character in length). Nevertheless, like the (V-2) position, there were no significant effects of verb type or plausibility and no

interaction.³ Paired samples t-tests revealed no effects of plausibility in either the transitive conditions or the coverb conditions

In Phillips's study, evidence for constructing dependencies between *wh*-phrases and PGs appeared at the verb inside subject islands. In the present study, the **(V) region** was where we expected to find the same evidence in Chinese. At this region, we found significant main effects of verb type and plausibility (both p 's $<.05$), as well as a marginal interaction between verb type and plausibility ($p=.076$). Crucially, mean reading times for the (V) region in the transitive-implausible condition were significantly longer than those in the transitive-plausible condition, suggesting that the verb associated with a PG was read significantly slower in the implausible condition than in the plausible condition. In contrast, the mean reading times for the (V) region were not significantly different between the coverb plausible and coverb implausible conditions, suggesting that there was no plausibility effect.

At the **(V+1) region**, which corresponded to the direct object NP or part of the object NP, both verb type and plausibility were found to have significant main effects (p 's $<.05$), but there was no significant interaction. Paired sample t-tests showed that transitive-plausible and transitive-implausible did not differ significantly from each. However, somewhat unexpectedly, coverb-plausible and coverb-implausible showed a marginally significant difference ($p=0.056$). We address this issue in the Discussion section.

6. Discussion

Participants' reading times showed sensitivity to the plausibility manipulation in transitive conditions, as we predicted. Specifically, the transitive-implausible conditions had significantly slower reading times at the (V) region than the transitive-plausible conditions, but these two conditions did not differ significantly from each other before or after the critical verb region. The slowdown at the verb in the transitive-implausible condition fits with the idea that the parser was trying to construct a filler-gap dependency but faced a semantic mismatch between the fronted object and the subcategorizing verb. Our results are compatible with those of Phillips's study in regard to the critical region where a gap is being constructed, that is, at the verb associated with a PG. This suggests that in both English and Chinese, the parser actively searches for a gap site without waiting to confirm the gap site is available. In other words, the parser does not wait until the point when it encounters an empty object or, in the case of PG construction, a licensing gap in the main clause.

³ There is a marginal main effect of plausibility at positions (V-2) and (V-1) ($p=.08$), indicating that regardless of verb type, plausible conditions are read slightly faster than implausible conditions in the (V-1) and (V-2) regions. This is unexpected, because the plausibility manipulation does not become apparent until the verb. The reasons underlying this marginal effect are not clear, and we leave it as a question for future investigation.

Could one argue that the difference between the transitive-plausible and transitive-improbable conditions is simply a plausibility effect, and has nothing to do with syntactic dependency formation? The fact that we did not find a plausibility effect in the critical region in the coverb conditions argues against this conclusion. If semantic implausibility necessarily leads to a slowdown, we should have found a slowdown at the verb in *both* the transitive and in the coverb conditions.

We would like to suggest that a possible explanation of the asymmetry between the transitive and coverb conditions is that, in contrast to the transitive conditions, no gap was being constructed at the coverb, and thus whether the fronted object was semantically compatible with the coverb or not did not make a difference. In other words, the asymmetry between the transitive conditions and the coverb conditions suggests that the parser is sensitive to the syntactic information or grammatical knowledge that a PG is not allowed after a coverb inside an adverbial clause due to a strong island effect. Thus, the parser not only actively searches for a gap, but also manages to avoid making mistakes. This conclusion converges with Phillips (2006): the human parsing mechanism is both incremental and accurate.

An alternative explanation is that the parser constructs a gap inside the adverbial clause even in the coverb conditions, but due to spill-over effects, the plausibility effect does not show up till a later point, namely at the direct object of the coverb. So-called spill-over effects are known to occur in self-paced reading, and refer to a situation where a particular effect is not detectable at the critical word itself but appears later – in other words, ‘spills over’ onto the following word(s). This explanation would account for the marginal plausibility effect we found at the (V+1) region in the coverb conditions. However, it seems rather unlikely that the transitive conditions and coverb conditions would result in such different amounts of spill-over, if we assume that human parsers function consistently. Nevertheless, the marginal plausibility effect at the (V+1) region in the coverb conditions still requires explanation. This is an important issue for future research.

In addition to highlighting the incremental nature of the parsing process, the finding of the present study seems to support a movement analysis of Chinese topic structures. In contrast, it is not clear how a non-movement analysis could account for the observed island sensitivity. As a whole, our findings are compatible with Ting & Huang’s claim (2008) that a PG exists inside an adverbial clause, which is connected to the topic via a filler-gap dependency.

7. Conclusions

The results of the present study suggest that when parsing topic structures, native speakers of Chinese tend to construct a filler-gap dependency incrementally (i.e., after a transitive verb in an adverbial clause, a possible site for PG), instead of waiting for top-down information (i.e., the licensing gap site in the main clause). Evidence for this comes from the asymmetrical sensitivity that transitive verbs and coverbs exhibited to the

plausibility manipulation in our self-paced reading experiment. In the transitive conditions, where PGs are possible, the critical verb region in the implausible condition exhibited a slowdown relative to the plausible condition. In addition, the absence of such a plausibility effect at the same region in the coverb conditions suggests that although the parser actively constructs a gap, it is also sensitive to syntactic information, and thus does not posit a gap in the coverb conditions, where PGs are not supported. Although more research is needed to further test these observations, in particular the behavior of the coverb conditions, our findings nevertheless support the view that the parsing mechanism aims at achieving both accuracy and efficiency, and also provide further evidence for a movement analysis of Chinese topicalization and the existence of parasitic gaps in Chinese.

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