Verb Bias in Mandarin Relative Clause Processing

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Recent research has indicated that a verb's preferential subcategorization frame plays a fundamental role in guiding the choice of the type of complement that follows a verb. For example, sentences with a sentential complement-biased verb, such as "admitted", will cause less processing difficulties when it is followed by a sentential complement than when it is followed by a direct object. Such information that verbs carry, a.k.a. verb bias effect, has been shown to influence the processing of languages in head-initial languages such as English. Up to date, no studies have been found to investigate verb bias effect in head-final Mandarin relative clauses. The present paper thus aims to investigate the influence of verb bias during online Mandarin relative clause processing. In addition, the present study also aims to further examine two language processing models, constraint-based model and garden-path model, to see which may be more correct in predicting the processing results. Findings of the present study show that, similar to English speakers, Mandarin speakers are also capable of using the information embedded in the verb to disambiguate and predict sentence structures, thus supporting the predictions of the constraint-based model.

Keywords: psycholinguistics, sentence comprehension, relative clauses, ambiguity, verb bias, Mandarin

1. Introduction

Language comprehension does not always proceed completely smoothly, as is reflected by different kinds of ambiguities in daily conversation.An overarching question in language comprehension concerns how human parser processes language so effortlessly most of the time, despite different types of ambiguities such as lexical (Trueswell 1996), semantic (Garnsey et al. 1997, Pickering et al. 2000) and structural or syntactic ambiguities (Lin and Garnsey 2010). One of the most famous examples which have attracted the attention of psychologists and linguists over the past four decades in structural ambiguity is a sentence constructed by Bever (1970), "The horse raced past the barn fell". Most English speakers, on first encounter, tend to interpret "The horse raced past the barn" as a simple SVO structure and then are forced to reconsider when they are "garden-pathed" by the word "fell", which indicates an initial incorrect analysis. In this example, temporary structural ambiguity arises because English allows the dropping of the words "that was", and the presence of which would have made it clear that the sentence begins with a relative clause, thus preventing the incorrect simple SVO interpretation. Bever's famous example is so

difficult that it remains temporarily ambiguous across several words, and remains unexpected even when the ambiguity is finally resolved. Investigating ambiguous sentences does not always have to involve sentences with extreme examples. Sentences with simpler structures or with relative clauses have demonstrated to be particularly useful because of their systematic differences.

Results from Lin and Garnsey's (2010) study have provided support for constraint-based models with the finding that Mandarin speakers are fast in utilizing animacy cues to disambiguate sentences. In English, however, another kind of information that has been found to be useful for native speakers is knowledge about the kinds of sentence structures particular verbs can participate in. Jackendoff (1972) argued that three kinds of information are contained in a verb, i.e., subcategorization frames, the verb's argument structures, and the rest of its meaning. Different verbs can of course have different argument structures and subcategorization frames, and some verbs have multiple possible argument structures and categorization frames. For example, the argument structure of the verb *put* is <agent theme location> and its subcategorization frame would be <NP1 Verb NP2 PP>. All three arguments of *put* must be present in sentences, as in *John put the candy in the cupboard* to make the sentence understandable. In contrast, the verb *take* can take the same three kinds of arguments, as in *John took the candy from the baby*, but it can also appear in sentences that have only two arguments, as in *John took the candy*. Verbs that have more than one possible argument structure can differ in how likely they are to appear in sentences with each of their different possible structures, and people develop expectations about information that verbs should carry based on their cumulative experience in regard to particular verbs, and this is termed "verb bias effect".

In the following sections, we will first present an overview of two competing models (as in section 1.1), followed by a description of Mandarin relative clauses in section 2. Design, materials and statistical analysis of the current study will be given in section 3 and 4 respectively. Finally, we will present the results and overall discussion in section 5 and 6.

1.1 Two sentence comprehension models

The influence of probabilistic knowledge about verbs has been one of the disagreements between two-stage and constraint-based models (Clifton et al. 1984,

Holmes et al. 1989, Garnsey et al. 1997, Kennison 2001). The most influential two-stage model is the "garden-path" model originally proposed by Frazier (Frazier 1979, Frazier and Fodor 1978, Frazier and Rayner 1982). Frazier's garden-path model has a modular architecture in which the syntactic parser plays a dominant role in structuring the initial language comprehension. During the first stage of processing, the system builds an initial representation based on purely syntactic information. Crucially, information other than syntactic information such as semantic plausibility, verb bias, or context, has no impact on this initial representation. These other kinds of information come into play during the second stage, where reanalysis occur and cause the parser to re-interpret the structure. When there is ambiguity about the possible structure, the model uses a small number of heuristics (e.g., Minimal Attachment, Late Closure) to decide which one to pursue.

A more recent version of a two-stage model, "Construal", has been developed by Frazier and Clifton (1997), in order to accommodate a growing number of findings that are not consistent with the original garden-path model. The construal approach divides phrases into two types, i.e., primary and nonprimary phrases. Primary phrases are attached into phrase structure trees using purely structural information and applying the same heuristics as the garden-path model when there's structural ambiguity. Primary phrases include the subject and main predicate of a finite clause, and their complements and obligatory constituents. In contrast, decisions about how to attach non-primary phrases into phrase structure trees are based on both syntactic and non-syntactic information. Non-primary phrases include relative clauses, adjunct predicates, and phrases related by conjunction. One challenge faced by the construal model is how to identify which phrases are primary and which are non-primary in head-final structures such as those found in Mandarin.

Constraint-based models, on the other hand, assume that the processing system can make use of multiple types of information at the earliest stages of processing, including both syntactic subcategorization information and non-syntactic information such as probabilistic biases, semantic plausibility, and discourse context. These different sources of information can be activated in parallel and provide multiple interacting probabilistic constraints on interpretation. Within these models, ambiguity resolution is a continuous constraint-satisfaction process. Processing difficulty occurs when there is inconsistent biasing information (e.g., a prior context that supports a less frequent alternative or a subsequent disambiguating phrase that favors an

unsupported alternative).

One type of probabilistic constraint that has been studied is verb bias. Several studies have found that English speakers use verb bias information rapidly to develop expectations about the upcoming syntactic structures (e.g., Wilson and Garnsey 2009, Garnsey et al. 1997, Kennison 2001). In response to studies finding verb bias effect, Frazier (1995) and Binder et al. (2001) argued that existing measurement techniques are not fine-grained enough to distinguish whether verb bias influences readers' earliest processing steps or instead only comes into play when revision becomes necessary. The idea is that when a sentence requires revision, that revision will be easier if the sentence structure is consistent with the bias of the critical verb in the sentence. Furthermore, Frazier (1995) argued that the readers' faster reading time that was used as an indication to supporting constraint-based theory can be attributed to these readers' faster reanalysis. She suggested that distinguishing between these two possibilities required showing verb bias effects even when there should be no need for revision. Wilson and Garnsey (2009) responded to that challenge and demonstrated that verb bias influenced the reading times for temporarily ambiguous sentences that should never have required any revision according to the garden-path model. They used sentences that had a temporary ambiguity about the relationship between a verb and the noun immediately following it. The verbs were ones that could take either simple direct objects or sentential complements as arguments. When what follows such a verb is in fact a sentential complement, it seems at first to be a simple direct object because English allows the dropping of the complementizer *that*, as illustrated in example (1a) below.

(1)
a. The historian read the manuscript had been destroyed in the fire.
b. The historian read the manuscript before it was published.

When *that* is omitted as in (1a), it may initially seem that what the historian read was the manuscript, but then it becomes clear at *had been destroyed* that the manuscript is not what was read. According to the garden-path model, the first preference should always be for the simple direct object option in sentences like these, since it is the structurally simpler option (according to Minimal Attachment). Previous studies (Garnsey et al. 1997) had shown that when the sentence turned out to have a

sentential complement as in (1a), reading times were faster at the critical disambiguating word (*had*) when the verb was biased toward taking sentential complements (unlike *read*, which is biased toward taking direct objects). This is the kind of result that Frazier argued was not capable of determining when verb bias comes into play. Sentences like (1a) should always require revision, according to the garden-path model, and such revision might take place too rapidly to be differentiated from the initial parse with existing measures, so it could be the revision that is influenced by verb bias rather than the initial parse. However, Wilson and Garnsey (2009) showed that verb bias also influenced reading times in sentences like (1b) that turned out to have the simple direct object structure, which according to the garden-path model should require no revision. Wilson and Garnsey have successfully argued that these results showed that verb bias influences sentence comprehension from the beginning and thus supported constraint-based models over two-stage models. Simply put, faster reading times when verbs are biased towards taking a preferential structure cannot be attributed to structure reanalysis, as proposed by Frazier (1995).

Verb bias has not yet received very much attention in the literature on Mandarin sentence comprehension, let alone in Mandarin relative clause literature. Wilson and Garnsey (2009) have provided evidence to show the influence of verb bias in English. Although the evidence is clear, we need to point out that English is a head-initial language, where comprehenders encounter head noun right at the beginning. Given the many different properties between head-initial and head-final languages, it is important to know whether verb bias information is also used in head-final languages, such as Mandarin. The goal of the current study is thus two-fold. First, we want to investigate whether verb bias effect can also be observed in head-final languages. Second, given that Mandarin speakers can make use of different information to disambiguate sentences, we want to examine whether verb bias information is also available to Mandarin speakers.

2. Mandarin relative clauses

There are several advantages of using Mandarin to study sentence comprehension. First of all, one advantage in using Mandarin is that Mandarin has a number of structures that are not found in the Germanic and Romance languages. For example,

an object-focusing particle (*BA*) requires a change from the default SVO word order to S *BA* OV order. When we embed BA construction into Mandarin relatives, it will allow us to further examine theoretical claims such as asymmetrical processing difficulties between subject and object relative clauses. Another advantage is that all modification precedes the modified head noun in Mandarin, including relative clauses. Thus, unlike head-initial English, Mandarin relatives are one of the head-final languages similar to Korean and Japanese. This difference is another advantage in that Mandarin provides a test ground to tease apart the various theories that have been developed to explain English relative clause processing.

Relative clauses in Mandarin use the word "DE", which functions as a relativizer, or relative clause marker, but also has several other functions. In relative clauses, DE functions like the relative pronoun in English and it is used with both animate and inanimate head nouns. Although English and Mandarin both have default SVO basic word order, in Mandarin relative clauses the head noun occurs at the end of the clause. Mandarin relative clauses are thus said to be "head-final". The following examples illustrate the construction of Mandarin relative clauses occurring at the sentential object position.

(2)

a. Mandarin object relative clause

人們　　完全　　　不　相信　[伯爵　　批評　　_t_　的　公主]。

Renmen wanquan　　bu　xiangxin　bojue　piping　　　de　gongzhu.

people　totally　　　not　believe　[count　criticize _t_ DE　princess]

　　　　　　　　　　　　　　　　　　　　S　　　　V　　　　　　　O

'People definitely do not believe [the princess who(m) the count criticized].'

b. Mandarin subject relative clause

人們　　完全　　　不　相信　[_t_ 批評　　伯爵　　的　公主]。

Renmen wanquan　　bu　xiangxin　　piping　bojue　de　gongzhu.

people　totally　　　not　believe　[_t_ criticize　count　DE　princess]

　　　　　　　　　　　　　　　　　　　　　V　　　O　　　　　S

'People definitely do not believe [the princess who criticized the count].'

DE serves as the relative marker in the relative clause and a trace (marked above

as *t*) is posited at the position where the head noun would be if it were not moved to the end of the relative clause. For Mandarin object relative clauses, the trace position is between the relative clause verb and DE, while for subject relative clauses, the trace is at the beginning of the clause. As illustrated in (2), an important difference between English and Mandarin is that in Mandarin it is object relative clauses that have SVO word order, which is the canonical word order in Mandarin. Subject relative clauses, on the other hand, begin with a verb and have a VOS word order, which is non-canonical and thus less frequent. Thus, Mandarin and English differ in which kind of relative clause has default word order.

The head-final order of Mandarin relative clauses together with the late position of the relative marker creates temporary ambiguities during comprehension. For example, object relative clauses that begin with SV order may initially look like simple SVO structures. Then when the relative clause marker DE appears, comprehenders realize that they have to reanalyze the input so far. In contrast, since subject relatives begin with the less typical VO order, therefore it is less likely that comprehenders will be garden-pathed and have to reanalyze the structure. The word order differences between English and Mandarin discussed relative clauses lead to different predictions some theories that have been developed to account for English relative clauses discussed about which kind of relative clauses should be more difficult in the two languages, while other theories make the same predictions for both languages. Thus, comparing relative clause comprehension in the two languages provides a much stronger test of the theories.

The purpose of the current study aimed to make use of the head-final property in Mandarin relatives by placing the Mandarin object relatives at the sentential object position. By placing it in the sentential object position, the researchers were able to manipulate the subcategorization information of the main clause verb to see if Mandarin speakers could use such information to disambiguate sentences. More specific details in regards to the design of the study will be given in the following section.

3. Materials and design

Verbs in the main clause with a bias toward taking either a direct object (DO-bias) or a sentential complement clause (Clause-bias) were manipulated to determine

whether Mandarin speakers could make use of this information to help disambiguate temporary ambiguous relative clause region. The verbs chosen in the current study were first taken from those used in Garnsey et al. (1997) and these verbs' biases were checked against a corpus study done by Lu and Garnsey (2008, 2009). Lu and Garnsey investigated a partially overlapping set of verbs using Chinese GigaWord, which is a Mandarin newspaper corpus. Counts were based on hand-coding of the structures of the first fifty sentences in the corpus using particular verbs. Of the verbs used here, 86% were included in Lu and Garnsey's study, and for all of those the corpus-based biases matched the biases of the original English verbs. The other 14% of the verbs used in the present study were not normed in the corpus study, so their verb bias classification was based on native-speaker intuition. Native Mandarin speakers who did not participate in the self-paced reading study helped to inspect the stimuli for their naturalness before the study was implemented. The specific construction of target stimuli will be described in the following paragraph.

Three kinds of syntactic structures with different experimental purposes were used as stimuli in this study. The first syntactic structure using a simple SVO structure such as (3a) below served as the baseline in the experiment. The other two structures used sentences with Mandarin object relative clause embedded in them. In the second condition, illustrated in (3b) below, a DO-bias main verb (e.g., *disliked*) was followed by a direct object that was modified by an object relative clause. In the third condition, a Clause-bias main verb (e.g., *believed*) was followed by the same noun plus object relative as in (3c), but that whole phrase then turned out to be the subject of an embedded sentential complement clause rather than the main clause direct object.

(3)
a. Baseline

老師　　討厭　　那個　　家長　　　。
Laoshi　taoyan　nage　　jiazhang　.
teacher　dislike　that　　parent　　period
'The teacher disliked that parent.'

b. Direct-object verb plus object relative clause

老師	討厭	那個	家長	痛罵	的	學生	。
Laoshi	taoyan	nage	jiazhang	tongma	de	xuesheng	.
teacher	dislike	that	parent	scold	DE	student	period

'The teacher disliked the student whom the parent scolded.'

c. Sentential-complement verb plus object relative clause

老師	相信	那個	家長	痛罵	的	學生	成績
Laoshi	xiangxin	nage	jiazhang	tongma	de	xuesheng	chengji
teacher	believe	that	parent	scold	DE	student	grade

進步	。
jinbu	.
improve	period

'The teacher believed that the student whom the parent scolded has improved in his grades.'

3.1 Predictions

Thirty-six sets of sentence triplets like those in (3) were constructed. The main interest lies in the contrast of reading times between (3b) and (3c) at the relative clause verb *scolded*. As shown in (3b) and (3c), the two sentences are identical at the initial seven positions except the second position where we used a DO verb *dislike* in (3b) and an SC verb *believe* in (3c). Sentences like these with identical surface structure except the critical word position serves as great stimuli since noise and other confound factors could be ruled out and the remaining effect should be attributed to verb bias effect.

It was hypothesized that if Mandarin speakers were to use the information embedded in main clause verb quick enough, they would be able to use such information to disambiguate sentences. In other words, they would be more likely to interpret the phrase *that parent* as the direct object of a simple SVO after a DO-bias verb as in (3b) than after a Clause-bias verb as in (3c). That should lead to longer reading times on *scolded* in (3b) than in (3c) when they find out that the sentence turns out to be a non-simple SVO. Moreover, since readers should be expecting a clause including another verb in (3c), they should not be surprised when another verb

appears, and thus longer reading times would not be observed in this condition. There is an additional feature of the sentences like (3c), though, which is that it subsequently turns out that the second verb is actually part of a relative clause rather than being the verb of an embedded sentential complement clause. The noun phrase including that relative clause then turns out to be a modifying noun phrase of grade.

Given that constraint-based model would predict that Mandarin speakers would be able to make use of such verb bias information, and the two-stage model predicts the opposite, we could use the reading times at the *scold* position to support either of these two models. If there is no reliable difference at *scold* position between (3b) and (3c), it suggests that Mandarin speakers could not use verb bias information, as reflected by the surprise of seeing another verb and thus slowing down in their comprehension. However, if Mandarin speakers did make use of this information, a reliable difference in reading times would be observed, thus supporting constraint-based model.

If we further look at the positions following our interested "scold" region for (3b) and (3c), other interesting reading times differences would also be expected to be observed. First of all, in terms of (3b), *scold* position would be the first indication for comprehenders that they were not processing a simple SVO structure. However, the next position *DE* would complicate the structure even more since it shed lights on them that the structure was actually a relative clause. Given the two layers of difficulty, we would expect reading times to elevate after *scold*. In terms of (3c), since comprehenders already expect the occurrence of another verb in the embedded clause, the first indication of an unusual structure would be *DE*, which would also help to inform comprehenders the coming of a relative clause. If our prediction is correct, we would expect to see elevated reading times after *DE* position in (3c)

3.2 Procedure

The paradigm of this experiment employed an online self-paced reading paradigm where subjects pressed space bar to control their reading speed. Forty-five native speakers of Taiwanese Mandarin were recruited and the study was run in Taiwan. Most of the participants were college undergraduate students at National Taiwan Normal University and National Taipei University of Education. The subjects' ages ranged from 19-22 years old. They read sentences presented word-by-word on a

computer screen in the self-paced moving window reading paradigm. All characters were initially replaced with the pound/number sign (#). Participants pressed the spacebar on the computer keyboard to control their reading speed, and reaction times were recorded for each keypress. With each subsequent keypress, a new word was revealed and the previous one reverted to the pound sign. Thus, only one word was visible at a time and the position of that word stepped across the screen.

Each participant read one of three lists of 161 sentences, each of which included 36 experimental items and 125 distracter sentences. Experimental items and distracters were presented in a pseudo-random order, and the lists were counterbalanced so that each participant read only one of the three sentence versions in each sentence triplet (see (3) above), and there were equal numbers of trials in each condition and equal numbers of comprehension questions requiring "yes" or "no" responses in each list. The experiment lasted approximately 30 minutes.

4. Data analysis procedures

Reading times were analyzed using Generalized Linear Mixed Models (GLMM)—an approach that is becoming widely accepted in the sentence comprehension literature due to its appropriateness for the kinds of data typically collected in such studies (Jaeger 2008). One reason is that reaction times are generally skewed and fit a gamma distribution better than the normal distribution assumed in ANOVA approaches. Since traditional ANOVA analyses do not fit reaction time data well, there has been a shift toward using GLMM approaches in the field; GLMM approaches have enjoyed growing popularity for the analysis of data in many research areas, including business, education, and psychology. Research done in these domains typically uses nested design structures, for example, with employees nested within an organization, or students nested within a class. Observations taken from the same setting typically show more homogeneity than observations taken from different settings, so observations within a setting tend to be more correlated than observations across settings. To handle these kinds of designs, Bryk and Raudenbush (1992) introduced a repeated measures component to GLMM in order to analyze data collected using repeated measures designs. This approach has proved to be quite useful in many domains, including the analysis of reaction times in sentence comprehension studies (Jaeger 2008).

There are several benefits of the GLMM approach for analyzing the reading times collected in this study. First, during instances when observations are not independent, as in the nested design used here, the GLMM approach helps to correctly model the correlated errors by applying either maximum likelihood estimation or restricted maximum likelihood estimation. It also handles the cross-level interactions inherent in a nested design. In sentence comprehension experiments using the word-by-word moving window paradigm, words are presented to subjects one by one. Thus, words are nested within sentences and sentences are further nested within subjects. Therefore, a three-level GLMM analysis can be performed with word positions as level-1, sentences as level-2, and subjects as level-3. Thus, a single analysis can take both subjects and sentence items into account at the same time, while ANOVA requires separate subject-based and item-based analyses and then combine the results from the two analyses (Clark 1973). In all of the experiments reported here, the data were analyzed using the GLIMMIX procedures in the SAS statistical software package. Word positions served as level-1 data, sentence items as treated as level-2, and subjects as level-3.

Comprehension question responses were analyzed using logistic regression since they required a binary response.

5. Results

The accuracy level was high overall in responding to the yes/no comprehension questions after each sentence, showing that participants generally did not have difficulty understanding the sentences. Questions were answered correctly 96% of the time for the baseline condition, 92% for the condition with DO-bias verbs in the main clause, and 89% for the condition with Clause-bias main verbs. Logistic regression analyses on the question responses revealed reliable differences between the simple SVO baseline and both the condition with DO-bias verbs ($\chi^2 (1)$=5.63, p<.05) and the condition with Clause-bias verbs ($\chi^2 (1)$=13.54, p<.01). The difference between the condition with Clause-bias verbs was also marginally different from that with DO-bias verbs ($\chi^2 (1)$=2.79, p<.1). Given the greater length and complexity of the sentences containing Clause-bias verbs, it is not surprising that readers had a slightly harder time in answering these questions after them.

The overall mean reading time was 593 msec/word. Figure 1 below shows the grand mean reading times for all three conditions at each word position. Reading times were nearly identical across the first four positions (all p>.05), as they should be since the sentences were identical across those positions.

SVO: Teacher   dislike   that   parent   PERIOD
DO-Bias: Teacher dislike   that   parent   scold   DE   student   PERIOD
SC-Bias:Teacher   believe   that   parent   scold   DE   student   grade   improve   PERIOD
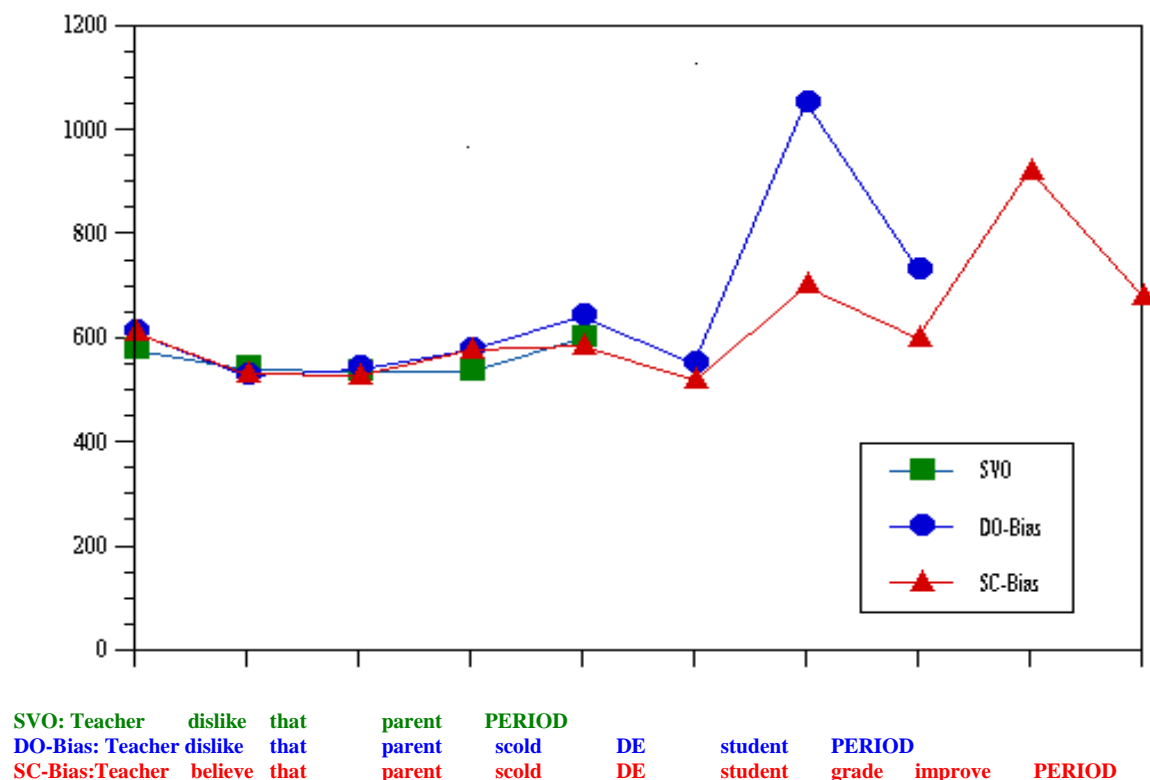
Figure 1. Reading times for simple SVO, DO-bias, and Clause-bias sentences

The fifth position was a sentence-final period in the simple SVO condition while it was a second verb in the other two conditions, so no meaningful comparison can be made across all three conditions at that point. However, the comparison between the conditions with DO-bias and Clause-bias verbs is meaningful and informative at this position, since this is where an effect of the bias of the main verb was predicted to appear. Readers slowed down reliably on this word after a DO-bias main verb compared to after a Clause-bias main verb (t(1004)=2.23, p<.05), suggesting that they were surprised by the appearance of a second verb after a DO-bias verb but not after a Clause-bias verb. As stated previously, the initial seven positions between (3b) and (3c) were identical except at the main clause verb position. Before comprehenders come to DE, they might interpret the structure as another sentential clause. Thus the prolonged reading times at the scold position can be used to argue the verb bias effect

that the current study had tried to manipulate.

Even though we have gained evidence that Mandarin speakers make use of verb bias effect to disambiguate sentences, reading times at the following positions also deserved our attention. If we look at (3b), we learned that the reading times at the last two positions got much elevated than those positions in (3c) and this could be attributed to the double layers of difficulties associated with the structure while there is only one layer of difficulty in (3c), as reflected by the fact that the slowest reading times in (3b) was much slower than that in (3c). Reading times remained reliably slower in the condition with DO-bias main verbs across the rest of the sentence (DE: $t(1004)=2.34$, $p<.05$; RC Head Noun: $t(1004)=4.68$, $p<.01$; RC Head Noun plus one: $t(989)=3.88$, $p<.01$), suggesting that readers had long-lasting difficulty when a DO-bias verb was followed by a clause, even when it turned out that that clause was a relative clause modifying a direct object.

6. Discussion

The structural bias of the main verb in the sentence influenced readers' expectations about whether another verb would appear downstream. When the sentence's main verb was DO-bias (e.g., *disliked*), readers were not expecting another verb and thus slowed down when one (e.g., *scolded*) appeared. There was no similar slowing on the second verb when the first verb was Clause-biased (e.g., *believed*). As stated previously, given that the two structures in comparison are identical from region one to region five, the difference in reading times can be attributed to verb bias effect since we have ruled out the other possibility such as the coming of another structure. Our study therefore showed that Mandarin speakers were able to make use of probabilistic knowledge about verb argument structure preferences just as English speakers do. These results are most consistent with constraint-based language processing models that combine multiple kinds of information interactively throughout the comprehension of sentences. Even though a two-stage model may suggest that the faster reading times could reflect comprehenders' faster reanalysis, the model is not able to explain the difference shown up in this study: why one structure elicited faster responses while the other did not when the two structures are identical except at the manipulated position.

In the experimental items used in this experiment, the sentence always ended with

a structure that was consistent with the verb's bias. That is, sentences with DO-bias verbs always had a DO-structure (where the DO included a relative clause) and sentences with Clause-bias verbs always had a sentential complement structure (where the subject of the sentential complement included a relative clause). Few of the distractor items included verbs that could take both DO and SC structures, and none of them used verbs like these in sentences that did not match their bias. Thus, it is possible that subjects learned to strategically rely more heavily on knowledge about verb bias than they would under more normal circumstances. However, this seems unlikely for two reasons. First, people generally do not have reliable intuitions about verbs' structural preferences, even though their reading times pattern in accordance with them. Second, in studies investigating the effects of verb bias in English, the effects remain robust even when half of the experimental trials use the verbs in structures that do not match their bias (Garnsey et al. 1997, Wilson and Garnsey 2009). If subjects were learning over the course of the experiment not to rely on bias because of its unreliability, or if immediate experience in the context of the experiment were shifting their biases, then verb bias effects should go away under these circumstances, but they do not. Therefore, a follow-up study that fully crosses verb bias with sentence completion type in Mandarin sentences should be conducted to rule out the opportunity for strategic processing. Another reason that such a follow-up study should be done is to determine whether the influence of verb bias on Mandarin speakers' comprehension is similar to those effects observed for English when the bias exists in both simple direct object structures and more complex sentential complement structures (Wilson and Garnsey 2009).

In sum, the current study has shown that, like English native speakers, Mandarin speakers can make use of the information that is carried inside the verb to disambiguate sentences. Even though difficult structures with relative clauses were used as stimuli, the study indicated still showed readers faster reading times when the sentence structure is matched with the readers' expectation.

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動詞結構意涵對中文關係子句之處理

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　　近來研究指出動詞內的結構意涵對語句處理有重要影響。舉例來說，英文中的「admitted」後面比較常接子句，而非直接受詞。在語句處理時，若讀者發現「admitted」後面果真接著子句時，讀者所產生的處理困難會因此減少。目前為止，這些研究針對的大部分都是英文。然而此一現象是否可以推論至中文卻不得而知，因為就關係子句來說，英文和中文的結構相距甚遠！在英文裡，關係子句之「頭」出現在關係子句之首。而在中文裡，它出現在關係子句之尾。此特殊的結構剛好提供學者得以操弄並進一步確認語言學上不同派別的理論與假設。本文旨在研究在中文關係子句之「頭」在子句尾出現的狀況下，以中文為母語的使用人士是否仍得以借用到動詞本身的結構意涵來預測並處理語句。研究發現儘管中文的結構和英文截然不同，中文使用者仍然可以快速的接收動詞內的結構意涵，並用此處理語句。此外，本文結果也支持語言使用者在閱讀中文句子的時候會同時接收不同訊息來處理句子。

關鍵詞：心理語言學、語句處理、關係子句、歧異、動詞結構意涵、
　　　　中文