

## Comprehending Chinese Relative Clauses in Context: Thematic Patterns and Grammatical Functions

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Processing asymmetries between subject- and object-extracted relative clauses (RCs) have been reported in various languages. This paper examines whether locality or one's experience of canonical thematic patterns better predicts the processing of head-final RCs by manipulating thematic patterns in the contexts. Two self-paced reading experiments of relative clauses preceded by contexts were conducted. In Experiment 1, two factors were manipulated: the *context* prior to the RCs consisted of either *canonical* (Agent-Verb-Patient) or *scrambled* thematic patterns with BA (Agent-BA-Patient-Verb), and the RCs involved *subject or object extractions*. It was found that only when preceded by the canonical Agent-Verb-Patient patterns was an ORC advantage obtained. In Experiment 2, we further used passives in the context, forming thematic patterns of Patient-BE-Agent-Verb. The processing advantage for ORCs was altogether eliminated. We conclude that the processing advantage for Chinese ORCs previously reported was due to thematic priming, not locality. This paper thus shows that in comprehending Chinese relative clauses, the thematic experience in the preceding context is important in determining how easily the relative clause can be comprehended.

### 1. Introduction

The structure and function of relative clauses is a well-investigated research topic owing to how relative clauses demonstrate the intricate recursive property of the human language. Across languages, relative clauses have been identified as clauses that are embedded inside noun phrases, whereby one nominal argument in the clause is co-referenced with the head of the higher noun phrase. Crucially also, across languages, this embedded nominal argument is usually left empty (or deleted). The empty nominal argument can be the subject, the object, or the adjunct of the clause, resulting in subject-extracted, object-extracted, and adverbial relative clauses (see examples of Chinese relative clauses in 1-3).

Decades of psycholinguistic research focused mainly on the processing of English relative clauses such as (4-6), namely the subject relatives, object relatives, and reduced relatives. Various studies have repeatedly demonstrated that subject and object relative clauses such as (4-5) induce different processing costs. For instance, self-paced reading

tasks showed that subject relative clauses are read faster and comprehended with better accuracies than object relatives (King & Just 1991, Gibson, Desmet, Grodner, Watson, & Ko 2005). By tracking the eye movements during reading relative clauses, it was found that subject relatives involved fewer regressions and shorter fixation times on the relative-clause regions than object relatives (Traxler, Morris, & Seely 2002). Studies that investigated individual differences in terms of working memory capacities also found that while people with greater memory capacities process subject relatives and object relatives equally well, those with limited working memory capacities process object relatives not as well as subject relatives (Caplan & Waters 1999). These studies suggest that the comprehension of subject and object relatives consumes different amounts of working memory and that different capacities of working memory would affect the processing of subject and object relatives differently.

- (1) Subject-extracted relative clause:  
 作曲家 愛慕 音樂家 的 作曲家  
~~zuoqujia~~ aimu yinyuejia de zuoqujia  
~~composer~~ adore musician DE composer  
 “the composer who ~~the composer~~ adored the musician”
- (2) Object-extracted relative clause:  
 作曲家 愛慕 音樂家 的 音樂家  
 zuoqujia aimu ~~yinyuejia~~ de yinyuejia  
 composer adore ~~musician~~ rel musician  
 “the musician who the composer adored ~~the musician~~”
- (3) Adverbial relative clause:  
 作曲家 爲什麼 愛慕 音樂家 的 原因  
 zuoqujia ~~wiesheme~~ aimu yinyuejia de yuanyin  
 composer ~~why~~ adore musician rel reason  
 “the reason why the composer adored the musician”
- (4) Subject-extracted relative clause:  
 the composer who ~~the composer~~ adored the musician
- (5) Object-extracted relative clause:  
 the musician who the composer adored ~~the musician~~
- (6) Reduced relative clause:  
 the musician adored by the composer

Prior to turning their attention to the differences between processing subject and object relatives in English, researchers have been focusing on the comprehension of reduced relatives such as (6). These reduced relatives lead to mis-analyses (i.e., garden paths). Bever’s (1970) famous garden-path sentence *the horse raced past the barn fell* illustrated how the human language parser can fail to process linear sequences of words that are misleading. Bever’s example shows that top-down heuristics (such as the strategy

of parsing NVN sequences in English as the logical sequences of AGENT-verb-PATIENT) can dominate the comprehension of sentences. A particularly crucial challenge posed by English reduced relatives is that there is no linguistic clue that indicates the existence of a relative clause until the main verb has appeared.

Recent years witnessed surging research on the processing of relative clauses that are typologically different from head-initial relatives such as those in English, French, German, and Spanish: the head-final relative clauses, particularly research on the comprehension of relative clauses in Chinese (Hsiao & Gibson 2003; Hsu et al. 2006; Hsu & Chen 2007; Lin & Bever 2006, 2007), Japanese (Miyamoto & Nakamura 2003; Ishizuka et al. 2006; Ueno & Garnsey 2008), and Korean (Kwon et al. 2010). A crucial difference between head-initial and head-final relative clauses is the inverse positions of the filler (i.e., the head noun) and the gap (i.e., the extracted argument position). While the filler precedes the gap in a head-initial relative clause, it follows the gap in a head-final relative.

Head-final relative clauses are particularly challenging to the parser as they pose parsing difficulties similar to those of reduced relatives in English. Two properties of a head-final relative clause make it difficult to parse: the gap precedes the filler, and no grammatical marker indicates the existence of a relative clause (or that of a relativized gap) prior to the appearance of the filler. The fact that these are also languages in which pronouns tend to be dropped makes relativized gaps confusable with the dropped pronouns. This also makes head-final relative clauses confusable with main clauses with missing pronouns. Therefore, *when* and *how* the parser adopts a relative-clause parse in a head-final structure is an important issue in itself.

In studying the processing of Chinese relative clauses, research has so far been concerned with the subject-object asymmetry as well. Previous literature shows mixed results. Some have found faster and better comprehension of subject relatives (Lin & Bever 2006, 2007), while others have found object relatives to be easier (Wu & Gibson 2008). The issue of subject-object asymmetry is thus still very much in debate. In this paper, we aim at exploring the following questions regarding the processing of Chinese relative clauses:

- Is there processing asymmetry on relative clauses in Chinese? Is subject or object relative clause in Chinese easier?
- What accounts for the processing asymmetry between subject and object relatives in Chinese?
- Can this account work crosslinguistically as a universal processing strategy?

The current study extended from the comprehension of relative clauses in isolation to studying relative-clause comprehension in contexts. We tested various processing effects on subject and object relatives by manipulating the preceding contexts. In the following sections, we evaluate the current controversy regarding the processing of Chinese relative clauses in 1.1. In 1.2, we cast the issue of Chinese relative clause processing in a theoretical perspective by considering various sentence processing factors

that may play a role. Section 1.3 discusses the role of context and motivates the experiments conducted in this study. After the introduction, two experiments are presented in Sections 2 and 3, in which the thematic patterning in the contexts were manipulated. The goal of this paper is to show that the thematic patterns in the contexts cause the processing asymmetry of Chinese relative clauses in contexts. At the general discussion, we further consider the implications of this processing study on our understanding of sentence processing in general and on the processing asymmetries of relative clauses across languages.

### **1.1. Controversy of head-final relative-clause processing**

Contrary to the consistent findings that subject relatives are easier than object relatives in head-initial languages, studies on head-final relatives showed mixed results. Research on head-initial languages has adopted various methodologies (including Rapid Serial Visual Presentation—RSVP, self-paced reading tasks, eye-movement monitoring tasks, and event-related potentials).

Several factors need to be considered to understand the significance of these results. First, as discussed in the introduction, head-final relative clauses, like reduced relatives in English, are challenging to the parser because they are not overtly marked as relative clauses at the left edge. Therefore, garden-pathed readings are likely to occur when the relative clauses are read in isolation.

When a relative clause is presented in a single sentence, such garden path is likely to occur. It has been argued that in head-final relatives, an object relative is more likely to be mis-parsed than a subject relative because object relatives present an initial NV sequence that is likely to be mistaken as a main clause. If this is the case, then it is likely that when head-final relative clauses are read in isolation in a word-by-word fashion, subject relatives would be easier than object relatives because people tend to misread object relatives but not subject relatives. While this conjecture is subject to empirical evaluation, it is reasonable that when studying extraction effects of relative clauses, one would try to avoid the potential contamination from these garden path effects.

To avoid the unwanted garden path, therefore, some studies have adopted extra steps in their experimental methodology. For instance, Lin and Bever (2007) instructed to their participants specifically that they were reading sentences containing relative clauses. They found better comprehension of subject relatives than object relatives in doubly embedded conditions. Hsu and Chen (2007) and Wu and Gibson (2008) both adopted contexts to motivate the appearance of relative clauses. Both studies found faster reading times for object relatives than subject relatives. In the current study, we investigated the processing of relative clauses in context by adopting the same methodology as Hsu and Chen, and Wu and Gibson. Different from those two studies, we manipulated the thematic patterns inside the contexts. We hypothesize that the advantage for object relatives in these studies may have been due to the specific properties of the contexts. Our

goal is to understand what made the object relative clauses easier than the subject relative clauses when relative clauses are presented in contexts.

## 1.2. Theoretical considerations

Even though the processing asymmetry between subject and object relatives in head-initial languages like English is robust, there remains theoretical debates about the cause of this asymmetry. In the following, I provide an overview of the important theoretical accounts for this asymmetry.

Theories accounting for the effect of relative-clause processing can be distinguished into those that focus on the filler-gap relation inside the sentence itself and those that focus on the extra-sentential factors such as dominant word orders in the language, the information status of a relative clause in discourse, animacy, and pragmatics. Theories that focus on the internal filler-gap relations debate on what factors are more important in the construction of this dependency on-line. According to the Active Filler Strategy (Frazier 1987), as soon as a filler is recognized, the parser creates a minimal chain between the filler and a potential position for the gap. In languages like English, the potential gap that minimizes the filler-gap distance (thus creating a minimal chain) in relative clauses is at the subject position. Therefore, the parser prefers subject relatives to object relatives.

The prediction of a structure-based theory is consistent with the typological generalization of Keenan and Comrie (1977 1979), usually referred to as the Keenan-Comrie Accessibility Hierarchy:

- (7) Accessibility Hierarchy: Subject > Object > Indirect Object / Oblique Case > Genitive (revised version, cited from Hawkins 2004: 177)

Their original proposal was that across languages, NPs of different syntactic functions show a universal pattern regarding how easily it can be relativized/extracted. NPs at the subject positions are generally easier to extract in all languages. NPs that are lower in the hierarchy are harder to relativize. Structure-based theories such as O'Grady (1997) and Hawkins (2004) provide structural substance for such universal tendencies. The accessibility hierarchy actually reflects the syntactic positions of the NPs. Those that are higher in the hierarchy are also higher in the syntactic structure and are therefore easier to access than those at lower syntactic positions.<sup>1</sup>

In addition to the structure-based theories, some theories focus on the role of working memory and the cost of processing induced by filler-gap distances. Gibson's

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<sup>1</sup> Hawkins (1999, 2004) offers a structural account for the Keenan-Comrie Hierarchy by measuring the "Filler-Gap Domain" involved in processing. A Filler-Gap Domain is defined as "the smallest set of terminal and nonterminal nodes dominated by the mother of a filler and on a connected path that must be accessed for gap identification and processing (Hawkins, 1999: 248)."

(1998) Syntactic Prediction Locality Theory (SPLT), for example, takes into consideration the computational resources that are required for processing. The two major components of computational resources are the structure integration cost and the structure storage cost. Gibson’s SPLT can be taken as a memory/resource-based theory. The human processor is assumed to possess limited computational resources at each temporal point of processing. Locality is a central theme in SPLT. The constructed syntactic units that are “held in memory over longer distances are more expensive, ..., and longer-distance head-dependent integrations are more expensive (Gibson 1998: 8).” SPLT takes the subject/object asymmetry as one important piece of evidence for the distance-based integration cost. The theory predicts that object relatives in English should be more difficult because of the longer distance between the filler and the gap.

The structure-based theory and the locality-based theory produce similar predictions on head-initial relative clauses but opposite predictions on head-final relative clauses. This is summarized in (8).

(8) Theories and predictions (“>” is read as “processed with greater ease than”)

Theory	Predictions on head initial relatives	Predictions on head final relatives
Structure (parser) based theory (Frazier 1987, Keenan & Comrie 1977, O’Grady 1997)	src > orc	src > orc
Locality theory (Gibson 1998)	src > orc	src < orc
Experience-based theory (MacDonald & Christiansen 2002); Top-down heuristics (Bever 1970)	src > orc	src < orc

Relative clauses in Chinese, Japanese, and Korean thus became interesting target languages to verify the validity of these two theories. Previous studies such as Hsiao and Gibson (2003), Hsu and Chen (2007), and Wu and Gibson (2008) found processing advantage for object relatives, thus providing support for the locality account, while Lin and Bever (2006, 2007), Kwon et al. (2010), and Ueno and Garnsey (2008) found processing advantage for subject relatives, providing support for the syntax-based account.

In addition to the factors internal to sentences, theories based on extrasentential, top-down processing heuristics such as canonical thematic patterns (Bever 1970) and structural frequencies and experiences (MacDonald & Christainsen, 2002) also produce predictions of processing asymmetries for subject and object relatives. According to these theories, syntactic processing involves expectations to parse the sentential materials based on language users’ experience with the language. In English (as well as in Chinese), the NVN sequences are predominantly parsed as AGENT-verb-PATIENT. The thematic patterns associated with subject relatives in English follow this dominant pattern but the object relatives do not (illustrated in 9-10). Therefore, subject relatives are easier in

English. The prediction for Chinese relative clauses would be the opposite of those of English, since Chinese object relatives follow the dominant thematic pattern but the subject relatives do not.

- (9) Subject-extracted relative clause:  
the composer who ~~the composer~~ adored the musician  
AGENT verb PATIENT
- (10) Object-extracted relative clause:  
the musician who the composer adored ~~the musician~~  
PATIENT AGENT verb
- (11) Subject-extracted relative clause in Chinese:  
作曲家 愛慕 音樂家 的 作曲家  
~~zuoqijia~~ aimu yinyuejia de zuoqijia  
~~composer~~ adore musician rel composer  
verb PATIENT AGENT  
“the composer who ~~the composer~~ adored the musician”
- (12) Object-extracted relative clause:  
作曲家 愛慕 音樂家 的 音樂家  
zuoqijia aimu ~~yinyuejia~~ de yinyuejia  
composer adore ~~musician~~ rel musician  
AGENT verb PATIENT  
“the musician who the composer adored ~~the musician~~”

### 1.3. Thematic priming and the role of context in processing relative clauses

The referential context preceding a relative clause helps motivate relative clauses. Crain and Steedman (1985: 342) showed that an appropriate referential context facilitated a relative-clause analysis in the target sentence. When they presented a context that was designed to induce a complement clause (e.g., 13a inducing 13c), a complement clause is preferred to a reduced relative clause. When the context was designed to induce a relative clause (e.g., a context with two competing referents as in 13b), a reduced relative clause became the preferred parse. Their study suggested that when there was a need to select among potential candidates in the context, a relative clause was motivated.

- (13) a. Context that induces a complement clause  
*A psychologist was counseling a married couple. One member of the pair was fighting with him but the other one was nice to him.*
- b. Context that induces a relative clause  
*A psychologist was counseling two married couples. One of the couples was fighting with him but the other one was nice to him.*
- c. Complement target sentence  
*The psychologist told the wife that he was having trouble with her husband.*

d. Relative target sentence

*The psychologist told the wife that he was having trouble with to leave her husband.*

Based on Crain and Steedman (1985), a natural way to induce a relative clause is thus to provide a context that is felicitous for relative clauses. Since a relative clause can help select a referent from a set of referents previously mentioned, an appropriate context constructs a situation in which a small set of referents compete to be selected. Then a sentence with a relative clause selects a referent out of the candidates and provides new information about this candidate.

Gibson and colleagues have recently conducted experiments with context that are meant to induce relative clauses. For example, Ishizuka et al. (2006) and Wu and Gibson (2008) adopted referential contexts prior to their target relative clauses (as in 14) to induce an upcoming relative clause in Japanese and Chinese respectively.

- (14) Context used by Ishizuka et al. (2006) and Wu and Gibson (2008) translated into English:

A reporter interviewed a writer on a TV program. Then the writer interviewed another reporter for his new novel.

Taro: “Which reporter stands as a candidate for the election?”

Hanako: “It seems to be the reporter who {the writer interviewed / interviewed the writer}.”

In both studies, it was found that object relatives were easier. Several crucial aspects about Gibson’s experiments need to be considered to evaluate the significance of these results. While a context potentially motivates the occurrence of a relative clause, it also brings additional irrelevant effects. As discussed earlier, Chinese object relatives follow the dominant thematic pattern--AGENT-verb-PATIENT--in the language. By providing a context prior to the relative clauses, we speculate that the effect of this dominant thematic pattern has been strengthened so as to lead to the processing advantage for object relatives in their study.

In the following, we examine the thematic patterns in the contexts adopted by Wu and Gibson (2008), which are schematically represented in (26-27).

- (15) Context of Ishizuka et al. (2006) and Wu and Gibson (2008):
- a. A verbed B, and AGENT-verb-PATIENT
  - b. B verbed another A. AGENT-verb-PATIENT

- (16) Target sentence of Wu and Gibson (2008):
- a. Subject relative clause:  
 [\_\_ verbed B] relativizer A (meaning ‘the A that verbed B’)  
 verb-PATIENT-AGENT



- b. Object relative clause:  
 [B verbed \_\_] relativizer A (meaning ‘the A that B verbed’)  
 AGENT-verb-PATIENT

The context itself profiled the canonical orders of syntactic categories and thematic patterns in the language (NVN mapping onto AGENT-verb-PATIENT in Chinese). The fact that (16b) maps directly onto the context (15b), while (16a) does not, potentially makes (16b) easier than (16a). To test this possibility, we conducted two experiments manipulating the thematic patterns in the contexts.

## 2. Experiment 1

Experiment 1 attempted to examine if thematic patterning was the main cause for the processing advantage of object relatives in Wu and Gibson (2008). To test this possibility, we manipulated the thematic patterns in the contexts. If the thematic mapping between (16b) and (15b) was the actual reason for the object-relative advantage, then we predict that when the thematic pattern in (15b) is altered (so that it does not map directly onto 16b), the object advantage would disappear.

We used two kinds of syntactic patterns in the context: the canonical NVN sentences (identical to those used in the Gibson studies) and sentences using the BA structure, where the NVN sequence is scrambled into *N ba N V*:

- (17) Context of Experiment 1:
- |    |  |  |
|----|--|--|
| a. | A verbed B, and<br>B verbed another A.       | AGENT-verb-PATIENT<br>AGENT-verb-PATIENT |
| b. | A BA B verbed, and<br>B BA another A verbed. | AGENT-PATIENT-verb<br>AGENT-PATIENT-verb |

The target sentences in Experiment 1 are subject and object relative clauses in Chinese, identical to those of Wu and Gibson (2008). Sample materials are provided in (30).

- (18) Target sentences of Experiment 1:
- a. Subject relative clause:  
 [\_\_ verbed B] relativizer A (meaning ‘the A that verbed B’)  
 verb-PATIENT-AGENT
- b. Object relative clause:  
 [B verbed \_\_] relativizer A (meaning ‘the A that B verbed’)  
 AGENT-verb-PATIENT

- (19) Sample materials in Experiment 1:

**Context:**

兩個小女孩和一個小男孩在公園裡玩耍時吵了起來。  
 Two girls and a little boy were playing in the park.

- A) 其中一個女孩先打了小男孩一巴掌，然後那個男孩就接著打了另一個女孩一巴掌。  
 B) 其中一個女孩先**把**小男孩打了一巴掌，然後那男孩就接著**把**另一個女孩打了一巴掌  
 One of the girls slapped the boy. The boy then slapped the other girl.

小明說:我想幼稚園園長在三點的時候看到了其中一個女孩，在三點半的時候看到了另外一個。園長三點的時候是看到哪個女孩?

Xiaoming: I think the principal saw one of the girls at 3 and the other girl at 3:30. Who's the girl seen at 3?

**Target:**

- A) 小美說: 男孩打的女孩是園長在三點看到的女孩。  
 Xiaomei: The girl that the little boy slapped was the girl the principal saw.  
 B) 小美說: 打男孩的女孩是園長在三點看到的女孩。  
 Xiaomei: The girl that slapped the little boy was the girl the principal saw.

Twenty-four Taiwanese college students, who are native speakers of Mandarin Chinese, participated in Experiment 1. The participants had normal vision, and were naïve to the purpose of the experiment. This self-paced reading experiment, with a moving-window presentation, was conducted using Linger 2.94 developed by Doug Rohde at MIT. No spaces were inserted between words or phrases since the standard writing of Chinese does not contain spaces. All materials were presented randomly, with consecutive occurrences of the target items avoided. In each trial, participants took their own pace to hit the space bar to read regions of a sentence. After the last word of each sentence, the whole sentence disappeared. A comprehension question on the content of that sentence appeared. The comprehension question was either a true/false question or a multiple-choice question. No feedback was given if the participant response was correct. Participants were instructed to read the sentences at a natural rate, and to understand the sentences in order to answer the comprehension questions correctly. The reading time for each region, the time taken to answer the comprehension questions, and the responses to the comprehension questions were recorded. The whole experiment took an average of 30 minutes to complete.

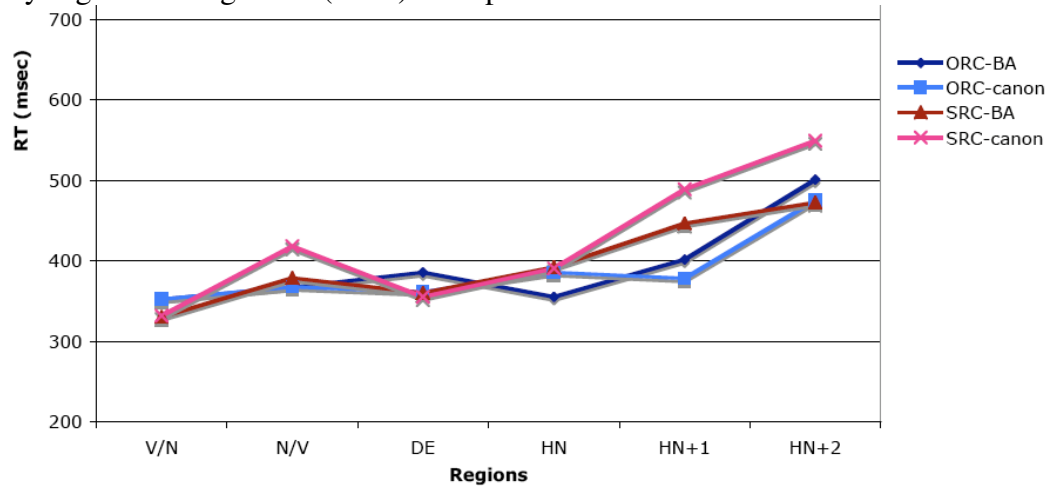
The reading times on each region of the target sentences are presented in (20). No significant difference was found on the critical regions (the relativizer *de* and the head nouns). Significant interactions were found on the two regions after the head noun ( $p < .05$ ), showing that only when the thematic patterns in the context followed the canonical AGENT-verb-PATIENT pattern was there a significant difference between subject and object relatives. When BA structures were used in the context, the difference no longer existed. The bar charts in (21) summarize these interactions.

These results suggested that Chinese subject and object relatives were only processed differently (with the object relatives being read faster at the post head-noun regions) when they were preceded by a context, in which the thematic patterns followed the canonical patterns (AGENT-verb-PATIENT) in Chinese. When the thematic patterns in the context were altered, as was manipulated in Experiment 1 by using BA structures, we

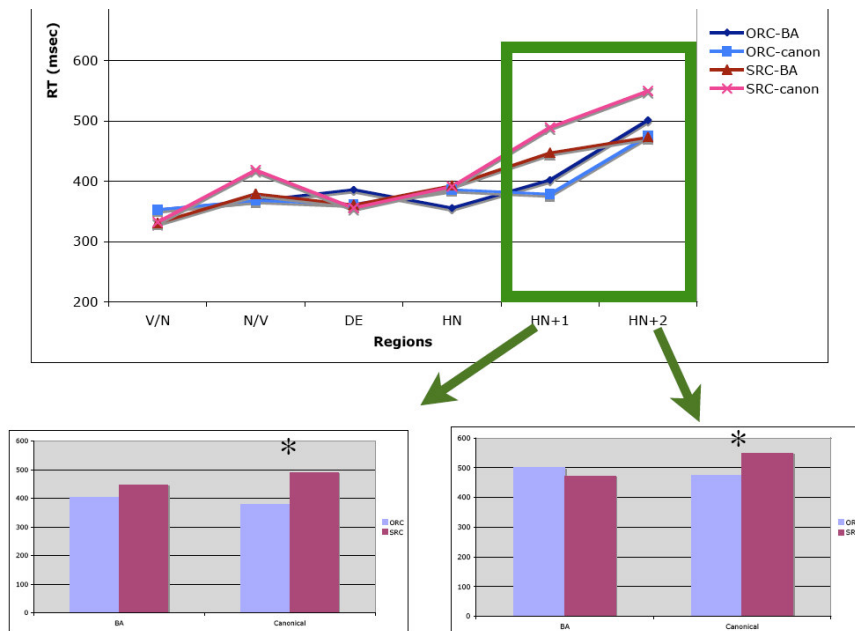
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no longer obtained the processing advantage for object relatives. It is thus reasonable to conclude that the processing advantage for object relatives found by Wu and Gibson (2008) was not due to the local filler-gap relation, but owing to the object relatives having thematic patterns that match those provided by the context.

(20) By-region reading times (msec) in Experiment 1:



(21) Reading times and significant interactions on the two regions after the head noun:



In Experiment 2, we modified the thematic pattern in the context that was relevant to the priming of thematic patterns in object relatives by adopting the passive construction to test our hypothesis.

### 3. Experiment 2

Experiment 2 further investigated if modifying the context minimally by removing the thematic priming for the object relatives would remove the processing advantage for object relatives completely. Again, if thematic patterning was the main cause for the processing advantage of object relatives in Wu and Gibson (2008), then the processing advantage would disappear if we remove the source of the priming effect in the context. To test this possibility, we used passive constructions in Chinese in Experiment 2.

The contexts used in Experiment 2 contained both the canonical NVN pattern (identical to those used in the Gibson studies) and passive sentences using the BEI structure, where the NVN sequence is changed to *N bei N V*:

- (22) Context of Experiment 2:
- |                         |                    |
|-------------------------|--------------------|
| A verbed B, and         | AGENT-verb-PATIENT |
| Another A BEI B verbed. | PATIENT-AGENT-verb |

The target sentences in Experiment 2 are subject and object relatives clauses in Chinese, identical to Experiment 1. Sample materials are provided in (23).

- (23) Sample materials in Experiment 2:

**Context:**

兩個小女孩和一個小男孩在公園裡玩耍時吵了起來。

Two girls and a little boy were playing in the park.

其中一個女孩被小男孩先打了一巴掌，然後另一個女孩就接著打了那男孩一巴掌。

**One of the girls was slapped by the little boy. The other girl then slapped the little boy.**

小明說:我想幼稚園園長在三點的時候看到了其中一個女孩，在三點半的時候看到了另外一個。園長三點的時候是看到哪個女孩?

Xiaoming: I think the principal saw one of the girls at 3 and the other girl at 3:30. Who's the girl seen at 3?

**Target:**

A) 小美說: 男孩打的女孩是園長在三點看到的女孩。

Xiaomei: The girl that the little boy slapped was the girl the principal saw.

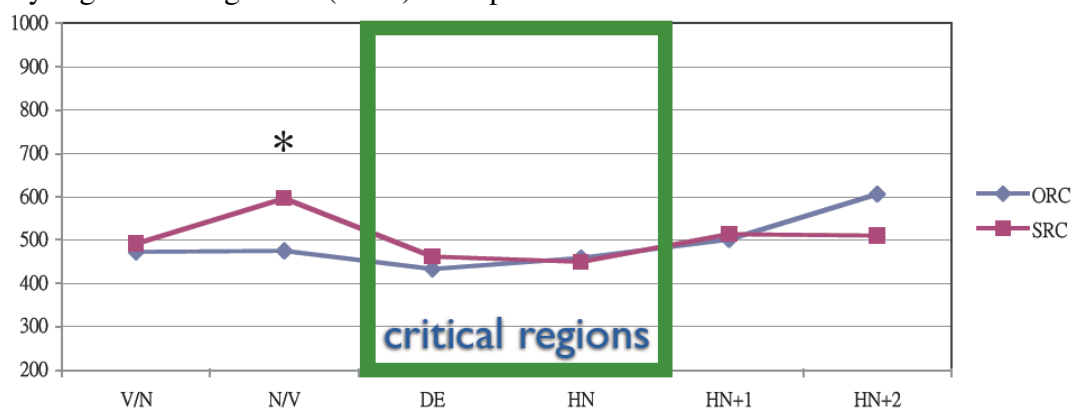
B) 小美說: 打男孩的女孩是園長在三點看到的女孩。

Xiaomei: The girl that slapped the little boy was the girl the principal saw.

A different group of sixteen Taiwanese college students, who are native speakers of Mandarin Chinese, participated in Experiment 2. The experimental procedures were identical to those of Experiment 1.

The reading times on each region of the target sentences are presented in (24). No significant difference was found on the critical regions (the relativizer *de* and the head nouns), nor on any regions after the head noun. The only region with significant difference on reading time was the second region inside the relative clause. This difference, which was also observed by Wu and Gibson (2008), was mainly an effect of processing a clause with missing arguments, not having to do with integration effects associated with relative clauses.

(24) By-region reading times (msec) in Experiment 2:



These results, together with the results of Experiment 1, suggested that when Chinese subject and object relatives were processed in contexts, the processing differences between subject and object relatives mainly have to do with the thematic patterns in the context. When the context provides thematic patterns consistent with the relative clause, then the relative clause became easier to understand. When the context does not provide a consistent thematic pattern, the observed processing advantage no longer exists.

## 4. General Discussion

### 4.1. Summary of the findings

In this paper, we examined the processing advantage for object relatives found by Wu and Gibson (2008) (and also by Ishizuka et al. 2006 in Japanese). The previous argument was that this processing advantage supported a locality theory because in both Chinese and Japanese, the filler-gap distance was closer in object relatives than in subject relatives. Our study proposes a competing theory that focuses on how language users' linguistic experiences with thematic patterns affect their sentence processing behaviors. We hypothesized that the thematic patterns in the contexts adopted in previous studies actually facilitated the processing of object relative clauses, but not subject relatives)

because in these languages, the thematic patterns in object relatives are more consistent with the thematic patterns in the context.

To test this hypothesis, two experiments were conducted. Experiment 1 found that object relatives in Chinese were only facilitated when they followed a context in which the thematic pattern of Agent-Verb-Patient was presented. When this thematic pattern in the context was altered in a BA sentence (Agent-BA-Patient-Verb), while the thematic relations were kept constant, the object relatives were no longer read faster than the subject relatives. Furthermore, in Experiment 2, we minimally changed the Agent-Verb-Patient pattern, which facilitated the object relatives, into a passive (Patient-Bei-Agent-Verb). The processing advantage for object relatives was again not found. These two experiments suggested that locality was not a correct predictor for the processing asymmetry between subject and object relatives presented in contexts. Thematic patterning was.

#### 4.2. Processing of relative clauses across languages

Let us now return to the three questions proposed in the introduction:

- Is there processing asymmetry on relative clauses in Chinese? Is subject or object relative clause in Chinese easier?
- What accounts for the processing asymmetry between subject and object relatives in Chinese?
- Can this account work crosslinguistically as a universal processing strategy?

This study found that the processing asymmetry in Chinese relative clauses is dependent on the thematic pattern that is cognitively dominant at the time when the language users process these relative clauses. The language processor actively maps the structural information onto a thematic template that is dominant in the language. The dominant pattern in Chinese is Agent-Verb-Patient, which serves as a prominent logical template for semantic interpretation. Sentences that provide a linear order that is consistent with this semantic template are less difficult to process. When processing complex structures such as relative clauses, this thematic pattern is especially useful. Chinese object relative clauses can, therefore, be easier than subject relatives when the context provides a thematic pattern that maps consistently onto the thematic sequences in the object relatives.

Previous debates on what causes the processing asymmetry between subject and object relatives should, therefore, reconsider the underestimated effect—namely, the top-down processing heuristics. After all, language processing usually occurs in contexts. Language users' experiences can, therefore, be a powerful blueprint for sentence processing. Through this study, we show that locality (and working memory) may not be the ultimate reason for the processing asymmetry since it does not produce effects when the thematic patterns in the context are altered. The implication of this study is that the same top-down processing heuristics can be the reason why subject relatives are easier

than why object relatives in English and object relatives are easier than subject relatives in Chinese.

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