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Processing relative clauses in Chinese

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Abstract

This paper reports results from a self-paced reading study in Chinese that demonstrates that object-extracted relative clause structures are less complex than corresponding subject-extracted structures. These results contrast with results from processing other Subject-Verb-Object languages like English, in which object-extracted structures are more complex than subject-extracted structures. A key word-order difference between Chinese and other Subject-Verb-Object languages is that Chinese relative clauses precede their head nouns. Because of this word order difference, the results follow from a resource-based theory of sentence complexity, according to which there is a storage cost associated with predicting syntactic heads in order to form a grammatical sentence. The results are also consistent with a theory according to which people have less difficulty processing embedded clauses whose word order matches the word order in main clauses. Some corpus analyses of Chinese texts provide results that constrain the classes of possible frequency-based theories. Critically, these results demonstrate that there is nothing intrinsically easy about extracting from subject position: depending on the word order in the main clause and in a relative clause, extraction from object position can be easier to process in some circumstances.

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1. Introduction

A major goal in research on human sentence processing is to discover what kinds of information people use in the moment-by-moment comprehension of a sentence. Much recent research has demonstrated that information from a variety of different sources is used, including lexical information, syntactic information, real-world knowledge, and information about the discourse context (for recent reviews, see [Gibson & Pearlmuter, 1998](#);

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Tanenhaus & Trueswell, 1995). An important empirical observation that demonstrates the importance of the use of syntactic (word-order) information in sentence comprehension is provided by the contrast between *nested* structures – structures which fall between the ends of a syntactic dependency – and non-nested structures (Chomsky & Miller, 1963; see Gibson, 1998, for a recent survey). For example, the English sentences in (1a)–(1c) are increasingly nested, and are of increasing complexity. Sentence (1d) is a right-branching (non-nested) control for (1c), and it is correspondingly much easier to understand.

- (1) a. The reporter disliked the editor.
 b. The reporter [that the senator attacked] disliked the editor.
 c. The reporter [that the senator [that John met] attacked] disliked the editor.
 d. John met the senator [that attacked the reporter] [that disliked the editor].

A relative clause (RC) is a clause that modifies a noun, such as “that the senator attacked” or “that John met”. RCs are possible in most locations, but they are very difficult to comprehend when they modify the subject of another RC in an Subject-Verb-Object (SVO) language like English, such as the modification of “the senator” by “that John met” in (1c). The complexity of (1c) cannot be explained by lexical information (e.g. word frequencies), or by the real-world plausibility of the meaning of the sentence, or by the complexity of the discourse context, because all of these factors are the same in sentence (1d), and this sentence is much less complex. As a result, the complexity of a sentence like (1c) must be due to properties of the syntax of this sentence: a complex word order. While this much is known, it remains an open question how to quantify what counts as a complex word order in the human sentence processing mechanism. The point of this paper is to restrict the range of possibilities by examining the processing of RCs in Chinese.

A second contrast between a complex and a less complex word order is the contrast between object- and subject-extracted RCs in English and other SVO languages, as in (2):

- (2) a. Object-extraction: The reporter [that the senator attacked] disliked the editor.
 b. Subject-extraction: The reporter [that attacked the senator] disliked the editor.

The greater complexity of object-extractions is found in a number of measures, including phoneme-monitoring, on-line lexical-decision, reading times (RTs), and response accuracy to probe questions (Ford, 1983; Hakes, Evans, & Brannon, 1976; Holmes & O’Regan, 1981; King & Just, 1991; Wanner & Maratsos, 1978; Waters, Caplan, & Hildebrandt, 1987). Like the nesting contrast, this effect is not driven by lexical frequencies, or real-world plausibility (because this is controlled between the two structures), or discourse context. The difference must be due to a difference in the complexity of the two word orders.

There are at least five word-order factors that have been proposed that can explain these effects:¹

¹ Note that these factors are not necessarily exclusive of one another. More than one could be in effect. In fact, Gibson (1998, 2000) explicitly proposes that both 1 and 2 apply together.

1. Storage resources: the storage of incomplete head-dependencies in phrase structure (Chomsky & Miller, 1963; Gibson, 1991, 1998, 2000; Lewis, 1996; Wanner & Maratsos, 1978). These theories attribute the greater difficulty of the object-extractions to the fact that there are a larger number of temporarily incomplete dependencies in the processing of object-extractions. For example, according to the dependency locality theory (DLT; Gibson, 1998, 2000), storage resources are required to keep track of the syntactic heads that are needed to form a grammatical sentence. There is a greater storage cost in processing the object-extraction in (1a) than the subject-extraction in (1b) as soon as the first word following the wh-filler “who” is processed in each. In particular, after processing “the reporter who the” in (1a), four syntactic heads are required to form a grammatical sentence: a noun for the determiner “the”, a verb for the outer clause, a verb for the inner clause, and an empty noun element associated with the wh-filler “who”. In contrast, only two heads are needed after processing the word “the reporter who attacked” in (1b): a noun for the object position of “attacked” and a verb for the outer clause.
2. Integration resources: the integration of head-dependencies in phrase structure (Ford, 1983; Gibson, 1998, 2000). The process of integration consists of connecting an incoming word to its head or dependent in the current structure for the input. It has been demonstrated that the difficulty of performing an integration depends on the distance of the integration involved (Gibson, 1998; Grodner, Watson, & Gibson, 2000; Pearlmutter & Gibson, 2001; Warren & Gibson, 2002). Object-extractions involve longer distance integrations than subject-extractions. In particular, the integrations at the embedded verb “attacked” in (1a) involve connecting the object position of the verb “attacked” to the wh-filler “who”, an integration that crosses the subject noun phrase (NP) “the senator”. By contrast, the integration at the verb “attacked” in (1b) is more local, and is therefore hypothesized to consume fewer resources.
3. Differences in canonical vs. non-canonical word order (e.g. MacDonald & Christiansen, 2002; cf. Bever, 1970; Mitchell, Cuetos, Corley, & Brysbaert, 1995; Tabor, Juliano, & Tanenhaus, 1997). The word order in English is SVO. This word order is present in a subject-extracted RC, e.g. *who attacked the senator*, such that the wh-filler “who” is the subject of the RC. In contrast, the word order in an object-extracted RC is non-canonical: OSV, e.g. *who the senator attacked*, hence the difficulty.
4. A theory based on accessibility of syntactic positions. This theory attributes the difference between the two extraction types to a difference in accessibility of subject- and object-extractions (Keenan & Comrie, 1977; Keenan & Hawkins, 1987; cf. Dowty, 1991; Hale, *in press*). Subject position is more accessible than object position, and the contrast follows.
5. Perspective shift (MacWhinney, 1977, 1982; MacWhinney & Pleh, 1988; cf. Bever, 1970). Under this theory, processing resources are required to shift the perspective of a clause, where the perspective of a clause is taken from the subject of the clause. A subject-modifying object-extracted RC as in (1a) requires two perspective shifts: (1) from the perspective of the matrix subject to the subject of the RC; and (2) from the perspective of the subject of the RC back to the matrix subject, after the RC is processed. Processing the subject-extracted RC in (1b) requires no perspective shifts, because the matrix subject is also the subject of the RC, so that both clauses come

from the same perspective. Thus, the object-extraction is more complex than the subject-extraction.

This paper examines on-line processing data from Chinese. Although Chinese is an SVO language, Chinese RCs precede their head nouns, unlike RCs in English and French, which follow their head noun. This difference in word order leads to different predictions among the five kinds of theories. In particular, the first three theories make different predictions from the last two theories in these constructions. Consider (3a) and (3b) below.

(3) a. Chinese object-extraction

fuhao yaoching e_i de guanyuan_i shinhuaibugui danshi shanyu yintsang
 tycoon invite gen official have bad intentions but good at hiding
 ‘The official who the tycoon invited has bad intentions but is good at hiding them.’

b. Chinese subject-extraction

e_i yaoching fuhao de guanyuan_i shinhuaibugui danshi shanyu yintsang
 invite tycoon gen official have bad intentions but good at hiding
 ‘The official who invited the tycoon has bad intentions but is good at hiding them.’

The word *de* is a genitive marker in Chinese, which also serves as an RC marker. We have notated it as “gen” in the examples. For notational purposes, the empty subject and object positions are notated as empty categories, “ e ” for short.

According to a storage-based resource theory like the DLT, the subject-extracted RC in (3b) should be more complex than the object-extracted RC in (3a), in contrast to the results from English and French. After processing the first word in the subject-extraction RC (3b) – the verb *yaoching* (“invite”) – the reader realizes that an RC is being processed, because there is no subject for the verb.² As a result, a verb for the top-level sentence is needed, together with the RC genitive marker *de* and an NP object for the verb in the RC. Thus, three syntactic heads are needed at this point. After the object noun *fuhao* (“tycoon”) is processed, two syntactic heads are still needed: the main verb and the RC genitive marker. Processing the object-extraction in (3a) requires fewer predicted heads at each of these positions. In particular, after processing the first word in the object-extraction – the noun *fuhao* (“tycoon”) – only a single head is predicted, a verb for the clause, because this could be the main clause of the sentence. After the next word is processed – the verb *yaoching* (“invite”) – still only one head is predicted, a noun object of the verb. When the genitive marker *de* is processed next in both sentences, the storage cost for each structure is the same.

² Chinese allows null pronominals in many positions, including subject position, but only in contexts where a topic is present. Null pronominals are rare and unpreferred in a null context, such as in these sentences. Thus, people are more likely to assume an RC reading rather than a null pronominal reading.

An integration-based resource theory also predicts that the subject-extracted RC should be more complex than the object-extracted RC in Chinese, but the on-line location of this difficulty is predicted to be later in the sentence. In particular, although there are storage differences through the RC, there are no integration distance differences in this region. But when the RC marker *de* and the head noun for the RC *guanyuan* (“official”) are processed, integration cost differences are predicted: the integration between the pre-verbal subject position of the RC (indicated by *ei* in (3b)) and the noun *guanyuan* (“official”) in the subject-extraction (3b) is a longer distance than the integration between the post-verbal object position of the RC (indicated by *ei* in (3a)) and the noun *guanyuan* (“official”) in the object-extraction (3a).

Like the storage resource theories, the canonical word order theory predicts that the subject-extractions should be more complex than the object-extractions. The object-extracted RC sentence follows the canonical SV word order in its initial clause, before the genitive marker *de* is encountered. In the subject-extracted RC, a non-canonical word order is encountered initially – a verb without its subject – causing more difficult processing. Like the storage theory, this theory predicts that a processing effect will occur during the processing of the RC.

Unlike the resource theories and the canonical word order theory, the last two theories discussed above predict that Chinese RCs should be processed like English RCs, with the result that Chinese subject-extractions should be easier to process than Chinese object-extractions. The accessibility-based theory makes this prediction independent of the word order, because subjects are more accessible and are therefore easier to extract than objects. The perspective-shift theory makes this prediction because perspective is not shifted in processing a subject-extracted RC when it modifies a subject NP as in (3b), whereas perspective is shifted when an object-extracted RC modifies a subject NP, as in (3a).

The predictions as described above do not consider potential differences between the two structures due to temporary ambiguity. One such ambiguity should be considered: the object-extracted RC is likely to be temporarily analyzed as the main clause. When the RC particle *de* is encountered, this analysis must be given up in favor of an RC analysis. There is no such temporary ambiguity in the subject-extraction. In particular, the subject-extracted RC is known to be an RC from the onset of the first verb, because there is no subject for this verb. As a result of this difference in temporary ambiguity across the two structures, a behavioral difference in support of the latter two theories would be difficult to interpret, because of the confounding influence of temporary ambiguity. By the same token, a behavioral difference in favor of the first three theories would be strong evidence for these theories, because such a difference would occur in spite of a potential temporary ambiguity effect in the opposite direction.

In this paper we used self-paced reading to test these predictions.

2. Experiment

Two pairs of conditions were tested, as exemplified in (3) above and (4) below. The RCs to be compared in (3) are singly embedded, whereas the RCs in (4) are doubly embedded.

(4) a. Chinese doubly-embedded object-extracted RC

fuhao yaoching e_i de faguan_i gojie e_k de guanyuan_k shinhuaibuguiN1 V1 de₁ N2 V2 de₂ N3 ...

tycoon invite judge conspire official have bad intentions

‘The official who the judge who the tycoon invited conspired with has bad intentions.’

b. Chinese doubly-embedded subject-extracted RC

 e_i yaoching e_k gojie faguan de fuhao_k de guanyuan_i shinhuaibuguiV1 V2 N1 de₁ N2 de₂ N3 ...

invite conspire judge tycoon official have bad intentions

‘The official who invited the tycoon who conspired with the judge has bad intentions.’

We tested doubly-embedded versions in addition to singly-embedded versions because it was possible that the predicted effects might be difficult to measure in singly-embedded versions, because of the small difference in word order between the two. The critical region of comparison in the singly-embedded versions in (3) consists of the first three words: N1 V1 de/V1 N1 de. The critical region in the doubly-embedded versions in (4) consists of the first six words: N1 V1 de₁ N2 V2 de₂/V1 V2 N1 de₁ N2 de₂. Each of these comparisons involves the same words in a different order, so lexical frequency is controlled overall. We controlled for plausibility using a norming study, as described below.

The predictions for the doubly-embedded structures are largely the same for each theory as for the singly-embedded structures. The accessibility and perspective-based theories predict that the subject-extractions in (3b) and (4b) should be less complex than the object-extractions in (3a) and (4a). Resource theories make the opposite prediction: that the object-extracted RCs should be less complex than the subject-extracted RCs. The storage theory predicts this effect during the RCs, whereas the integration theory predicts the effect later, towards the end of the RC and at the head noun in the main clause. Like the resource theories, the canonical word order theory predicts that object-extractions should be less complex than subject-extractions in the singly-embedded versions. Furthermore, the canonical word order theory predicts that object-extractions should be less complex than subject-extractions in the doubly-embedded versions, under the assumption that the word *de* (which usually functions as a genitive marker in Chinese) functions as an RC pronoun in an RC.³ In particular, under this assumption, the doubly-embedded object-extracted RC consists of the elements Subject-Verb-Object

³ This is not necessarily the right assumption, but it gives the right processing results below. We are not aware of any existing analysis of Chinese RCs that assumes overt relative pronouns in Chinese and in particular analyzes *de* as a relative pronoun. As a matter of fact, Keenan (1985) conducted a cross-linguistic survey of RCs and concluded that no language with pre-nominal RCs has relative pronouns. Below we list references to analyses of Chinese RCs, none of which analyzes *de* as a relative pronoun: He (1996) treats *de* as a complementizer; Li and Thompson (1981) analyze it as a nominalizer; and Kayne (1994) treats it as an inflection marker. Refer to these papers for justifications of their analyses.

Subject-Verb-Object, thus following SVO word order in each of the two RC clauses. In contrast, the doubly-embedded subject-extracted RC consists of the elements Verb-Verb-Object-Subject-Object-Subject, which does not follow SVO word order in either RC.

3. Method

3.1. Participants

Forty subjects participated in the experiment. Six were from MIT and the surrounding community. Seven resided in Taiwan, and were attending a wedding in California at the time of the experiment. The other 27 were based in and around Los Angeles. All were native speakers of Mandarin Chinese spoken in Taiwan and were naive as to the purposes of the study. Furthermore, although most of the participants also spoke English, Mandarin Chinese was the primary language that they used in their day-to-day life.

3.2. Materials

Twenty-four sets of sentences were constructed, typed in Chinese characters, each with the four conditions in (3) and (4). The target sentences were split into four lists in a Latin-Square design. Each list was combined with 72 fillers of various types. Because all sentences were presented in a null context, none of the fillers contained any null discourse-based pronominals. Thus, it is unlikely that participants analyzed the target stimuli as containing such pronominals. Appendix A provides a complete list of the stimuli. The stimuli were pseudo-randomized separately for each participant so that at least one filler item intervened between two targets.

3.3. Procedure

The task was self-paced, word-by-word reading, using a moving window display (Just, Carpenter, & Woolley, 1982). Linger 1.7 by Doug Rohde was the software used to run the experiments. All experiments were run on a single PC laptop.

Each trial began with a series of dashes marking the length and position of the words in the sentences, printed approximately a third of the way down the screen. Participants pressed the spacebar to reveal each word of the sentence. As each new word appeared, the preceding word disappeared. The amount of RT the participant spent on each word was recorded as the time between key-presses.

After the final word of each item, a yes/no comprehension question appeared which asked about information contained in the preceding sentence. Participants pressed one of two keys to respond “yes” or “no”. After an incorrect answer, an equivalent sentence in Chinese meaning “Sorry, your answer was incorrect” flashed briefly on the screen. No feedback was given for correct responses. Participants were asked to read sentences at a natural rate and to be sure that they understood what they read. The comprehension questions for target items questioned the content of the main clause or one of the RCs.

For example, two possible questions for sentence (3a) would be “Did the official invite the tycoon?” (no) or “Did the official have bad intentions?” (yes).

4. Plausibility norming survey

A questionnaire was conducted in order to control for potential plausibility differences between the two conditions in each pair of conditions. Thirty-three native Chinese-speaking participants from North America and Taiwan who did not take part in the self-paced reading experiment completed the survey. Similar to the participants in the main experiment, many of these participants also spoke English, but Mandarin Chinese was the primary language that they used in their day-to-day life. The items tested in this questionnaire consisted of the simple transitive clauses that made up each RC. For the singly-embedded versions in (3), the materials consisted of one simple SVO clause in each version, as in (5). For the doubly-embedded versions in (4), there were two simple clauses for each item, as in (6) and (7).

- (5) a. One clause object-extracted control: The tycoon invited the official.
b. One clause subject-extracted control: The official invited the tycoon.
- (6) a. Two clause object-extracted control, verb 1: The tycoon invited the judge.
b. Two clause subject-extracted control, verb 1: The official invited the tycoon.
- (7) a. Two clause object-extracted control, verb 2: The judge conspired with the official.
b. Two clause subject-extracted control, verb 2: The tycoon conspired with the judge.

Participants rated the plausibility of these sentences on a scale of 1 (natural) to 7 (unnatural). They were asked to judge the naturalness in the real world of the events described in the sentences, that is, how likely they were to occur.

The results of the survey were that four of the 24 items were found to be significantly more plausible ($P < 0.05$ by *t*-test) in one version. These four items were therefore omitted from the RT analyses. The remaining 20 items were matched for plausibility across all versions (means: 2.55 for (5a), 2.54 for (5b), 2.62 for (6a), 2.50 for (6b), 2.67 for (7a), and 2.65 for (7b)). The plausibility ratings for each item are presented along with the items in Appendix A.

5. Results

The results were analyzed using Lingalyzer 1.1, an analysis program written by Doug Rohde. The four items in which one version was less plausible than another were omitted from analyses, leaving 20 items to be analyzed. Three participants' data were omitted from the analyses because of poor comprehension question performance (<67% accuracy

Table 1
Mean (standard error) comprehension question performance in percent correct by condition

1 clause object RC	1 clause subject RC	2 clause object RC	2 clause subject RC
75.7 (3.2)	70.5 (3.4)	75.9 (3.3)	64.2 (3.7)

overall, as compared with a mean of 87% for the other participants). Two participants' data were omitted due to repeated interruptions during their testing sessions.

5.1. Comprehension question performance

The percentages of correct answers for each condition are presented in Table 1. Although comprehension question performance was numerically better in the one-clause object-extracted sentences than in the one-clause subject-extracted sentences, this difference did not reach significance ($F_s < 2.1$). In the two clause sentences, performance was better in the object-extracted versions, but this effect was fully significant only in the participants' analysis ($F_1(1, 34) = 6.35$, $MS_{\text{within}} = 0.033$, $P < 0.05$; $F_2(1, 19) = 3.11$, $MS_{\text{within}} = 0.052$, $P = 0.09$). Although comprehension performance in the target items was relatively low (71.6% overall), this was probably because (1) the subject-extracted versions were complex, and (2) the questions for these items were difficult. Mean performance on the filler items was much better at 88.7%, so the participants were certainly paying attention in the task.

5.2. RTs

Because people made a substantial percentage of errors in answering the comprehension questions, we report the RT data from an analysis of all trials, independent of whether the questions were answered correctly. Analyses in which only correctly answered trials were analyzed revealed the identical patterns. In particular, there were no differences in any statistical tests whether or not the data were included. Fig. 1 plots mean RTs per word in the singly-embedded RCs in (2).

An ANOVA for the first two words (N1 V1/V1 N1) revealed that object-extractions were processed faster than subject-extractions ($F_1(1, 34) = 5.38$, $MS_{\text{within}} = 5042$, $P < 0.05$; $F_2(1, 19) = 5.50$, $MS_{\text{within}} = 1980$, $P < 0.05$). There were no significant differences on the third word, the genitive marker *de* ($F_s < 1$), nor on any subsequent region.

Turning now to the doubly-embedded conditions, Fig. 2 plots mean RTs per word by region by participants. There was no significant difference at the first or second word ($F_s < 1.9$). We did not compare RTs at the third word by itself because this word was the high frequency, short function word *de* in the object-extraction condition, whereas the same position was a noun in the subject-extraction condition. The same issue was present at the fourth word, which was the function word *de* in the subject-extraction condition, but a noun in the object-extraction condition. As a result, we collapsed the third and fourth words together as a single region for comparisons. This way the region contained the same words across the two conditions, but in a different order. An ANOVA on this region revealed that object-extractions were processed faster than subject-extractions

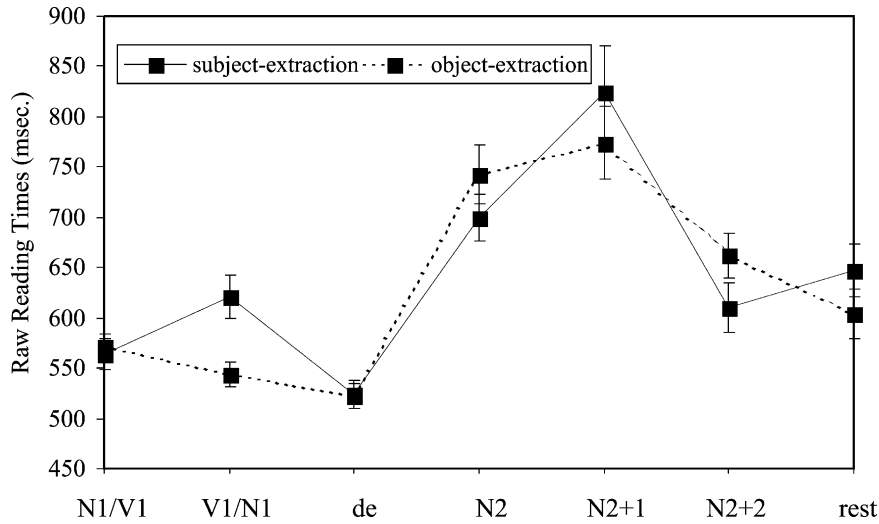


Fig. 1. Plot of mean (standard error) raw RTs per word for the singly-embedded conditions in (2).

($F(1, 34) = 24.2$, $MS_{\text{within}} = 20114$, $P < 0.001$; $F(1, 19) = 23.4$, $MS_{\text{within}} = 10917$, $P < 0.001$). At each of the fifth and sixth words, an ANOVA revealed similar effects (word 5: $F(1, 34) = 9.0$, $MS_{\text{within}} = 76964$, $P = 0.005$; $F(1, 19) = 4.3$, $MS_{\text{within}} = 90848$, $P = 0.05$; word 6: $F(1, 34) = 11.1$, $MS_{\text{within}} = 278539$, $P < 0.005$; $F(1, 19) = 22.7$, $MS_{\text{within}} = 57551$, $P = 0.001$). Over the first six words taken as a whole, object-extractions were read faster than subject-extractions ($F(1, 34) = 27.3$, $MS_{\text{within}} = 15088$, $P < 0.001$; $F(1, 19) = 43.5$, $MS_{\text{within}} = 4905$, $P < 0.001$).

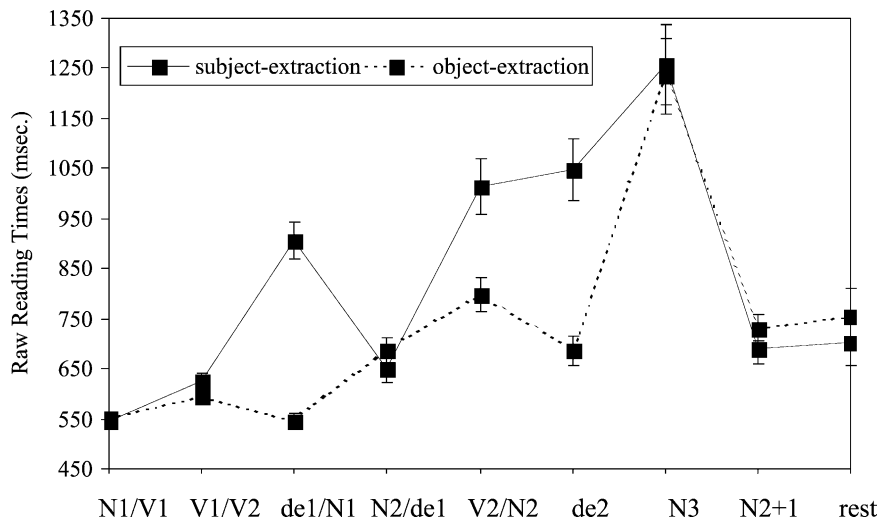


Fig. 2. Plot of mean (standard error) raw RTs per word for the doubly-embedded conditions in (3).

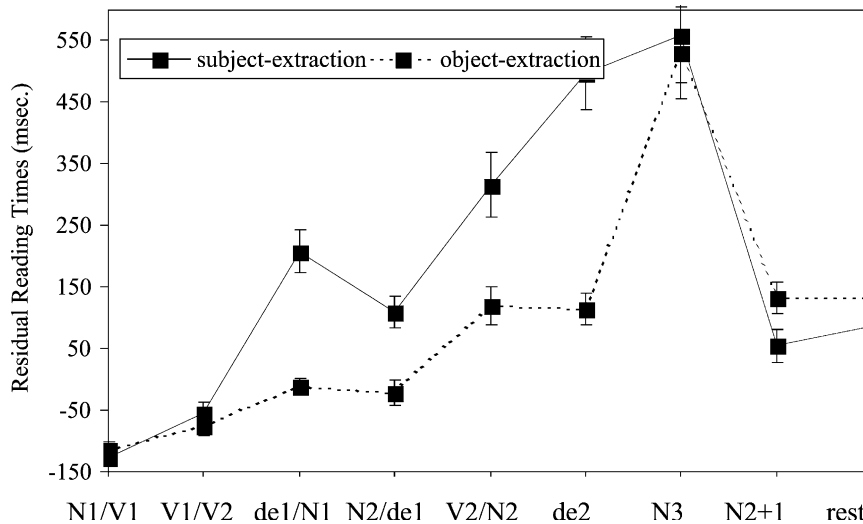


Fig. 3. Plot of mean (standard error) residual RTs per word for the doubly-embedded conditions in (3).

Because the content of the regions being compared in the doubly-embedded conditions differed substantially at certain word positions (e.g. the genitive marked *de* is compared with a noun at the third word position), we also conducted an analysis of RTs that were adjusted for differences in word length. In order to do this, a regression equation predicting RT from word length was constructed for each participant, using all filler and experimental items (Ferreira & Clifton, 1986; see Trueswell, Tanenhaus, & Garnsey, 1994, for discussion). At each word position, the RT predicted by the participant's regression equation was subtracted from the actual measured RT to obtain a residual RT. Mean word-by-word residual RTs computed across participants are plotted in Fig. 3.

The results were similar for the analyses of residual RTs. An ANOVA in the first two words revealed no significant effects ($F_s < 1.2$). The subject-extractions were read more slowly over positions three and four ($F_1(1, 34) = 30.2$, $MS_{\text{within}} = 18630$, $P < 0.001$; $F_2(1, 19) = 26.1$, $MS_{\text{within}} = 11131$, $P < 0.001$). At each of the fifth and sixth words, an ANOVA revealed similar effects (word 5: $F_1(1, 34) = 8.2$, $MS_{\text{within}} = 75545$, $P < 0.01$; $F_2(1, 19) = 5.2$, $MS_{\text{within}} = 67624$, $P < 0.05$; word 6: $F_1(1, 34) = 12.1$, $MS_{\text{within}} = 269862$, $P = 0.001$; $F_2(1, 19) = 32.4$, $MS_{\text{within}} = 45371$, $P < 0.001$). Over the first six words taken as a whole, object-extractions were read faster than subject-extractions ($F_1(1, 34) = 30.4$, $MS_{\text{within}} = 14114$, $P < 0.001$; $F_2(1, 19) = 78.5$, $MS_{\text{within}} = 2926$, $P < 0.001$).

6. Discussion

The evidence that was gathered here demonstrates that subject-extracted RCs are more complex than object-extracted RCs in Chinese, contrary to the results in the literature for the same construction in other languages. The reaction time data in comparisons involving

both singly- and doubly-embedded conditions provided the strongest evidence for this observation, with the response accuracy data providing some additional support.

These results are as predicted by storage-based resource theories and the canonical word order theory, but they clearly contradict the predictions of the accessibility theory and the perspective-shift theory. The predictions of the integration-based theory were also not ratified. Critically, these results demonstrate that there is nothing intrinsically easy about extracting from subject position: depending on the word order in the main clause and in a RC, extraction from object position can be easier to process in some circumstances. We discuss the resource theories and the canonical-word-order theory in turn below.

First, consider the storage-based resource theory, in particular the on-line storage theory proposed by Gibson (1998, 2000), in which there is a storage cost associated with predicting syntactic heads. This theory correctly predicts the contrast between subject- and object-extractions in both singly- and doubly-embedded structures. Furthermore, this theory correctly predicts the locus of the effect, during the processing of each RC. Not all storage-based resource theories can explain these results. In particular, the theory of Lewis (1996) proposes that there is interference cost associated with maintaining multiple incomplete phrase-structure dependencies only when they are the same kind of syntactic dependency. In particular, incomplete subject-verb dependencies interfere with one another, but not with other incomplete dependencies. Although this theory can account for the results of the comparisons involving the doubly-embedded structures, it does not account for the results of the comparisons involving the singly-embedded structures. In particular, there is at most one incomplete dependency of any single type during the processing of the singly-embedded subject-extracted RC, the same as during the processing of the object-extracted RC. Thus, a storage cost theory based on predicted heads in which different kinds of predictions cause additive difficulty fares better on the singly-embedded structures than a theory in which interference cost only accumulates when multiple incomplete dependencies of the same kind are present.

The integration-distance resource theory correctly predicted that object-extractions should be less complex than subject-extractions in Chinese, but the locus of this effect was not correctly predicted, especially in the singly-embedded structures. In particular, the integration-distance theory predicts no differences during the processing of the RC, and it predicts a difference at the head noun, the point at which people are connecting the positions in the RC to the head noun. But no difference was observed in this region, contrary to prediction. The processing difference that was observed during the RC is more consistent with the prediction of the storage-based resource theory.

The second theory that can successfully account for the results presented here is the canonical word order theory. Under the assumption that the word *de* serves as an RC pronoun, this theory correctly predicts that object-extracted RCs should be processed more easily than subject-extracted RCs in Chinese, for both singly- and doubly-embedded constructions (but see footnote 3 for some alternative analyses of *de* from the syntax literature). It remains an open question how to formalize this theory so that it makes more detailed predictions. One version of this kind of theory is a frequency-based theory, such that people have less difficulty with word orders that they encounter more frequently: the canonical word orders. If stated purely in terms of tabulating frequencies of input (e.g. the tuning theory of Mitchell et al., 1995), such a comprehension theory makes no prediction

about what kinds of word orders could serve as canonical, or about what kinds of attachment preferences people might have when faced with ambiguity: any word order could serve as canonical, and any structure may be preferred over any other in the face of ambiguity (see [Desmet & Gibson, in press](#); [Gibson & Schutze, 1999](#), for further discussion of such theories).⁴ Alternatively, a canonical-word-order comprehension theory may be driven in part by architectural limitations, which may constrain the processability of different word orders and attachment preferences. Connectionist systems provide examples of this kind of model (e.g. [Christiansen & Chater, 1999](#); [Rohde, 2002](#); [Tabor et al., 1997](#)). The architecture of such a system may then give rise to a resource theory, such as the storage- or integration-based theories discussed above ([Gibson, 1998](#)). Because some versions of a canonical word order theory consist of different levels of analysis of resource theories, it may be impossible to provide evidence that demonstrates that one theory is correct and the other is wrong. Rather, aspects of both may turn out to be correct. Relatedly, these kinds of theories make the same predictions with respect to many phenomena, including the behavioral data discussed here. Specifically, the current results do not provide evidence relevant to distinguishing the canonical-word-order theory from resource-based theories.

One prediction of a frequency-based canonical word order theory that is worthy of discussion is that there should be a correlation between (1) structural frequencies in corpora and (2) behavioral measures such as RTs. But because no current frequency-based theory makes a specific hypothesis of what granularity of structures is being tabulated, it is difficult to quantify exactly what one of these theories predict for any given structural comparison. One potential frequency-based theory is one in which RC frequencies are tabulated independent of main clause structures. Such a theory is consistent with the spirit of the tuning hypothesis of [Mitchell et al. \(1995\)](#). Under such a theory, Chinese object-extracted RCs should be more frequent in the input than corresponding subject-extracted RCs, because object-extracted RCs are easier to comprehend. In order to test this hypothesis, we analyzed the Chinese Treebank, version 3.0, published by the Linguistic Data Consortium. The Chinese Treebank is a parsed corpus consisting of approximately 100,000 words that were taken from the Xinhua newswire between 1994 and 1998. All instances of RCs from this corpus were initially examined, but we restricted our counts to RCs that matched the target RCs in the experiment at a broad level. In particular, we examined only active RCs (omitting passives) and instances of argument relativization (omitting adjunct relativizations such as *the reason why he left*). We also did not count simple phrases that lacked copula verbs that could be analyzed as reduced subject-extracted RCs, e.g. prepositional phrases such as ‘The company in China’ cf. ‘The company that is in China’, or adjectival phrases such as ‘The big company’ vs. ‘The company that is big’. We thought that the inclusion of such items could artificially increase the number of subject-extracted RCs. In total, 882 instances were found in the corpus, 375 (42.5%) of which were object-extracted RCs. The remaining 507 (57.5%) instances were subject-extracted RCs. Interestingly, subject-extracted RCs are more frequent, despite being harder to comprehend. This result therefore disconfirms

⁴ It is possible that there are no such constraints on comprehension, but that a theory of production constrains the kinds of word orders and ambiguity preferences that are produced ([MacDonald, 1999](#)).

a version of the tuning hypothesis, one in which structural frequencies are tabulated at this level of granularity.

We performed a second narrowed-down search of these 882 instances that matched the experimental items more closely. The RCs included in the first analysis were heterogeneous, and generally had many properties that distinguished them from the experimental items. For example, the verbs in the corpus RCs could be either transitive or intransitive, and the subjects and objects of the RCs consisted of various kinds of NPs: (definite, indefinite, animate, inanimate, human, non-human, pronouns, proper names, empty categories such as *pro*), etc. We thus conducted a fine-grained search of the RCs for items that matched the experimental items such that they all included transitive verbs, definite human subjects and definite human objects. There were only six instances of RCs matching this description, all of which were subject-extracted RCs in the subject position of a sentence. Thus, we see no support for a tuning hypothesis at this extremely fine grain of corpus frequency matching either.

The results of the current RT study are interesting for two additional reasons. First, the benefit for object-extracted RCs over subject-extracted RCs occurred in spite of the fact that there is a potential temporary ambiguity in the object-extraction, but not in the subject-extraction. These results therefore provide an important data point in formalizing theories of sentence reanalysis (see e.g. Fodor & Ferreira, 1998; Grodner, Gibson, Argaman, & Babyonyshev, *in press*; Sturt, Pickering, & Crocker, 1999). In particular, the lack of difficulty associated with this ambiguity suggests that a main clause structure for the initial string of the object-extracted RC is probably used in the construction of the RC structure. This is possible because no restructuring in thematic role assignments is needed in the switch from main clause to embedded clause. Furthermore, the phrase structure associated with a main clause analysis of an initial Subject-Verb sequence is the same phrase structure as is present in a RC.

Second, these results also provide evidence relevant to the syntactic representation of Chinese RCs. In particular, the fact that object-extracted RCs incur more processing difficulty than subject-extracted RCs in Chinese makes an analysis unlikely in which there is an empty *wh*-pronoun on the left of the RC, mediating the head noun for the RC to the right and the empty position inside the RC. Such an analysis would make the structure of RCs more similar across languages, but is not compatible with the current data. If there were such a position, and integrations to it incurred processing cost (as they do in English), then there would be no processing advantage for object-extractions over subject-extractions in Chinese. The fact that there is such an advantage makes it likely that there is no empty *wh*-pronoun initiating Chinese RCs.

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Appendix A. Experimental items

1.

- a. 助教質疑的學生很不高興所以四處投訴 (2.18)
 zhujiao zhiyi e, de xuesheng, hen bugaoxing suoyi sichu tousu
 TA question student very unhappy thus everywhere complain
 'The student who the TA has doubts about is very unhappy and thus complains to everyone.'
- b. 質疑助教的學生很不高興所以四處投訴 (2.61)
 e, zhiyi zhujiao de xuesheng, hen bugaoxing suoyi sichu tousu
 question TA student very unhappy thus everywhere complain
 'The student who has doubts about the TA is very unhappy and thus complains to everyone.'
- c. 助教質疑的教授輔導的學生很不高興 (3.39) (1.79)
 zhujiao zhiyi e, de jiaoshou, fudao e_k de xuesheng_k, hen bugaoxing
 TA question professor advise student very unhappy
 'The student who the professor who the TA has doubts about advises is very unhappy.'
- d. 質疑輔導助教的教授的學生很不高興 (2.58) (2.18)
 e, zhiyi e_k fudao zhujiao de jiaoshou_k de xuesheng, hen bugaoxing
 question advise TA professor student very unhappy
 'The student who has doubts about the professor who advises the TA is very unhappy.'

2.

- a. 老闆信任的工程師工作很認真效率又高 (2.09)
 laoben xinren e, de gongchengshi, gongzuo hen renzhen xiaolu you gao
 boss trust engineer work very hard efficiency also high
 'The engineer who the boss trusts works very hard and is also very efficient.'
- b. 信任老闆的工程師工作很認真效率又高 (2.45)
 e, xinren laoben de gongchengshi, gongzuo hen renzhen xiaolu you gao
 trust boss engineer work very hard efficiency also high
 'The engineer who trusts the boss works very hard and is also very efficient.'
- c. 老闆信任的秘書喜歡的工程師工作很認真 (2.12) (2.64)
 laoben xinren e, de mishu, xihuan e_k de gongchengshi_k, gongzuo hen renzhen
 boss trust secretary like engineer work very hard
 'The engineer who the secretary who the boss trusts likes works very hard.'
- d. 信任喜歡秘書的老闆的工程師工作很認真 (2.45) (2.33)
 e, xinren e_k xihuan mishu de laoben_k de gongchengshi, gongzuo hen renzhen
 trust like secretary boss engineer work very hard
 'The engineer who trusts the boss who likes the secretary works very hard.'

- 3.
- a. 教授認識的作家很有名著作也很多 (2.24)
 jiaoshou renshi e, de zuojia, henyoming zhuzuo ye henduo
 professor know writer very famous works also very many
 ‘The writer who the professor knows is very famous and has written many works (books).’
- b. 認識教授的作家很有名著作也很多 (2.12)
 e, renshi jiaoshou de zuojia, henyoming zhuzuo ye henduo
 know professor writer very famous works also very many
 ‘The writer who knows the professor is very famous and has written many works (books).’
- c. 教授認識的記者訪問的作家很有名 (2.76) (1.70)
 jiaoshou renshi e, de jizhe, fangwen e, de zuojia, henyoming
 professor know reporter interview writer very famous
 ‘The writer who the reporter who the professor knows interviewed is very famous.’
- d. 認識訪問教授的記者的作家很有名 (2.39) (2.12)
 e, renshi e, fangwen jiaoshou de jizhe, de zuojia, henyoming
 know interview professor reporter writer very famous
 ‘The writer who knows the reporter who interviewed the professor is very famous.’
- 4.
- a. 聲樂家讚美的指揮家很有天份但是也很驕傲 (2.06)
 henyuejia zanmei e, de zhihuejia, hen you tienfen danshi ye hen jiaoao
 opera singer praise conductor very have talents but also very prideful
 ‘The conductor who the opera singer praised is very talented but is also very prideful.’
- b. 讚美聲樂家的指揮家很有天份但是也很驕傲 (2.03)
 e, zanmei shengyuejia de zhihuejia, hen you tienfen danshi ye hen jiaoao
 praise opera singer conductor very have talents but also very prideful
 ‘The conductor who praised the opera singer is very talented but is also very prideful.’
- c. 聲樂家讚美的作曲家推薦的指揮家很有天份 (1.79) (2.39)
 shengyuejia zanmei e, de zuoqujia, tuijian e, de zhihuejia, hen you tienfen
 opera singer praise composer recommend conductor very have talents
 ‘The conductor who the composer who the opera singer praised recommended is very talented.’
- d. 讚美推薦作曲家的聲樂家的指揮家很有天份 (2.03) (2.15)
 e, zanmei e, tuijian zuoqujia de shengyuejia, de zhihuejia, hen you tienfen
 praise recommend composer opera singer conductor very have talents
 ‘The conductor who praised the opera singer who recommended the composer is very talented.’
- 5.
- a. 店員不喜歡的經理站在門口招攬生意 (2.03)
 dianyuan buxihuan e, de jingli, zhan zai dianmenkou zhaolan shengyi
 clerk dislike manager stand store entrance try to attract business
 ‘The manager who the clerk dislikes is standing by the store entrance.’
- b. 不喜歡店員的經理站在門口招攬生意 (2.33)
 e, buxihuan dianyuan de jingli, zhan zai dianmenkou zhaolan shengyi
 dislike clerk manager stand store entrance try to attract business
 ‘The manager who dislikes the clerk is standing by the store entrance.’

- c. 店員不喜歡的顧客認識的經理站在門口 (2.55) (2.15)
 dianyuan buxihuan e, de guke, renshi e_k de jingli, zhan zai dianmenkou
 clerk dislike customer know manager stand store entrance
 ‘The manager who the customer who the clerk dislikes knows is standing by the store entrance.’
- d. 不喜歡迎顧客的店員的經理站在門口 (2.33) (2)
 e, buxihuan e, renshi guke de dianyuan_k de jingli, zhan zai dianmenkou
 dislike know customer clerk manager stand store entrance
 ‘The manager who dislikes the clerk who knows the customer is standing by the store entrance.’
- 6.
- a. 市長打擾的議員整天講電話因為事情多 (2.61)
 shichang daorao e, de yiyuan, zhengtian jiang dianhua yinwei shiching duo
 mayor disturb senator talk on the phone all day because things many
 ‘The senator who the mayor disturbed talks on the phone all day because there are many things to do.’
- b. 打擾市長的議員整天講電話因為事情多 (2.06)
 e, daorao shichang de yiyuan, zhengtian jiang dianhua yinwei shiching duo
 disturb mayor senator talk on the phone all day because things many
 ‘The senator who disturbed the mayor talks on the phone all day because there are many things to do.’
- c. 市長打擾的律師辯護的議員整天講電話 (2.91) (2.21)
 shichang daorao e, de lushi, bianhu e_k de yiyuan, zhengtian jiang dianhua
 mayor disturb lawyer defend senator talk on the phone all day
 ‘The senator who the lawyer who the mayor disturbed defends talks on the phone all day.’
- d. 打擾辯護市長的律師的議員整天講電話 (2.70) (2.27)
 e, daorao e, bianhu shichang de lushi, yiyuan, zhengtian jiang dianhua
 disturb defend mayor lawyer senator talk on the phone all day
 ‘The senator who disturbed the lawyer who defends the mayor talks on the phone all day.’
- 7.
- a. 老太太遇見的女孩頭髮很長而且也長得很漂亮 (2.06)
 laotaitai yujian e, de nuhai, toufa hen chang erqie ye chang de hen piaoliang
 old lady meet girl hair very long and also look very beautiful
 ‘The girl who the old lady met has very long hair and is also very beautiful.’
- b. 遇見老太太的女孩頭髮很長而且也長得很漂亮 (1.85)
 e, yujian laotaitai de nuhai, toufa hen chang erqie ye chang de hen piaoliang
 meet old lady girl hair very long and also look very beautiful
 ‘The girl who met the old lady has very long hair and is also very beautiful.’
- c. 老太太遇見的送報童假裝沒看見的女孩頭髮很長 (2.09) (3.03)
 laotaitai yujian e, de songbaotong, jiazhuang meikanjian e, de nuhai, toufa hen chang
 old lady meet newspaper boy pretend not to see girl hair very long
 ‘The girl who the newspaper boy who the old lady met pretends not to see has very long hair.’

- d. 遇見假裝沒看見老太太的送報童的女孩頭髮很長 (2.55) (2.91)
 e_i yujian e_k jiazhang meikanjian laotaiyai de songbaotong_k de nubai, toufa hen chang
 meet pretend not to see old lady newspaper boy girl hair very long
 ‘The girl who met the newspaper boy who pretends not to see the old lady has very long hair.’
- 8.
- a. 歌手羨慕的演員想往其它方面發展可是沒機會 (2.21)
 geshou xianmu e_i de yan yuan, xiang wang quta fangmian fazhan keshi mei jihui
 singer envy actor want to explore other areas but no opportunity
 ‘The actor who the singer envies wants to explore other areas but hasn’t had opportunities (to do so).’
- b. 羨慕歌手的演員想往其它方面發展可是沒機會 (2.30)
 e_i xianmu geshou de yan yuan, xiang wang quta fangmian fazhan keshi mei jihui
 envy singer actor want to explore other areas but no opportunity
 ‘The actor who envies the singer wants to explore other areas but hasn’t had opportunities (to do so).’
- c. 歌手羨慕的導播提拔的演員想往其它方面發展 (2.45) (1.64)
 geshou xianmu e_i de daobo, tiba e_k de yan yuan, xiang wang quta fangmian fazhan
 singer envy producer promote actor want to explore other areas
 ‘The actor who the producer who the singer envies promoted wants to explore other areas.’
- d. 羨慕提拔歌手的導播的演員想往其它方面發展 (2.18) (2.15)
 e_i xianmu e_k tiba geshou de daobo_k de yan yuan, xiang wang quta fangmian fazhan
 envy promote singer producer actor want to explore other areas
 ‘The actor who envies the producer who promoted the singer wants to explore other areas.’
- 9.
- a. 大伯拜訪的鄰居家境不好常需要朋友幫忙 (2.58)
 dabo baifang e_i de lin ju, jiajing bu hao chang xuiyao pengyou bangmang
 uncle visit neighbor financially not in a good condition often need friend help
 ‘The neighbor who (my) uncle visited is financially not in a good condition and often needs friends to help them.’
- b. 拜訪大伯的鄰居家境不好常需要朋友幫忙 (2.39)
 e_i baifang dabo de lin ju, jiajing bu hao chang xuiyao pengyou bangmang
 visit uncle neighbor financially not in a good condition often need friend help
 ‘The neighbor who visited (my) uncle is financially not in a good condition and often needs friends to help them.’
- c. 大伯拜訪的老人家不理會的鄰居家境不好 (2.55) (3)
 dabo baifang e_i de laorenchia bulihue e_k de lin ju, jiajing bu hao
 uncle visit old person ignore neighbor financially not in a good condition
 ‘The neighbor who the old person who (my) uncle visited ignores is financially not in a good condition.’
- d. 拜訪不理會大伯的老人家不理會的鄰居家境不好 (2.55) (2.94)
 e_i baifang e_k bulihue dabo de laorenchia_k de lin ju, jiajing bu hao
 visit ignore uncle old person neighbor financially not in a good condition
 ‘The neighbor who visited the old person who ignores (my) uncle is financially not in a good condition.’

10.

- a. 郵差撞到的送花童背著很多東西走路東倒西歪 (3.61)
 youchai zhuangdao e_i de songhuatong, beizhe hen duo dongsì zoulù dongdaoxiwai
 mailman collide into flower boy carry a lot of stuff walk not in a straight line
 ‘The flower boy who the mailman collided into was carrying a lot of stuff and was not walking in a straight line.’
- b. 撞到郵差的送花童背著很多東西走路東倒西歪 (3.58)
 e_i zhuangdao youchai de songhuatong, beizhe hen duo dongsì zoulù dongdaoxiwai
 collide into mailman flower boy carry a lot of stuff walk not in a straight line
 ‘The flower boy who collided into the mail man was carrying a lot of stuff and was not walking in a straight line.’
- c. 郵差撞到的路人尋找的送花童背著很多東西 (3.21) (4.58)
 youchai zhuangdao e_i de luren, xunchao e_k de songhuatong, beizhe hen duo dongsì
 mailman collide into pedestrian look for flower boy carry a lot of stuff
 ‘The flower boy who the pedestrian who the postman collided into was looking for was carrying a lot of stuff.’
- d. 撞到尋找郵差的路人的送花童背著很多東西 (3.15) (3.76)
 e_i zhuangdao e_k xunchao youchai de luren_k de songhuatong, beizhe hen duo dongsì
 collide into look for mailman pedestrian flower boy carry a lot of stuff
 ‘The flower boy who collided into the pedestrian who was looking for the mail man was carrying a lot of stuff.’

11.

- a. 私家偵探跟蹤的警探想知道真相所以很積極 (3.33)
 sijiāzhentan genzong e_i de jingtān, xiāng zhīdào zhēnxiāng suoyì hèn jījī
 private detective follow detective want to know the truth thus very aggressive
 ‘The police detective who the private detective followed wants to know the truth and is thus very aggressive.’
- b. 跟蹤私家偵探的警探想知道真相所以很積極 (3)
 e_i genzong sijiāzhentan de jingtān, xiāng zhīdào zhēnxiāng suoyì hèn jījī
 follow private detective detective want to know the truth thus very aggressive
 ‘The police detective who followed the private detective wants to know the truth and is thus very aggressive.’
- c. 私家偵探跟蹤的線民畏懼的警探想知道真相 (2.48) (2.64)
 sijiāzhentan genzong e_i de xiānmín, wèijū e_k de jingtān, xiāng zhīdào zhēnxiāng
 private detective follow informer fear detective want to know the truth
 ‘The police detective who the informer who the private detector followed feared wants to know the truth.’
- d. 跟蹤畏懼私家偵探的線民的警探想知道真相 (2.18) (3.06)
 e_i genzong e_k wèijū sijiāzhentan de xiānmín_k de jingtān, xiāng zhīdào zhēnxiāng
 follow fear private detective informer detective want to know the truth
 ‘The police detective who followed the informer who fears the private detective wants to know the truth.’

12.

- a. 小丑模仿的喜劇演員很受群眾歡迎常被要求簽名 (2.03)
 xiaochou mofang e, de xijuyanyuan, hen shou qunchong huanying chang bei yaoqiu
 qianming
 clown imitate comedian be very popular with the public often passive ask
 autograph
 ‘The comedian who the clown imitates is very popular with the public and is often asked
 to autograph.’
- b. 模仿小丑的喜劇演員很受群眾歡迎常被要求簽名 (2.06)
 e, mofang xiaochou de xijuyanyuan, hen shou qunchong huanying chang bei yaoqiu
 qianming
 imitate clown comedian be very popular with the public often passive ask
 autograph
 ‘The comedian who imitates the clown is very popular with the public and is often asked
 to autograph.’
- c. 小丑模仿的政治家不欣賞的喜劇演員很受群眾歡迎 (2.18) (2.76)
 xiaochou mofang e, de chengchijia, buxinshang e_k de xijuyanyuan, hen shou qunchong
 huanying
 clown imitate politician not like comedian be very popular with the
 public
 ‘The comedian who the politician who the clown imitates does not like is very popular
 with the public.’
- d. 模仿不欣賞小丑的政治家的喜劇演員很受群眾歡迎 (1.58) (2.88)
 e, mofang e_k buxinshang xiaochou de chengchijia_k de xijuyanyuan, hen shou qunchong
 huanying
 imitate not like clown politician comedian be very popular with the
 public
 ‘The comedian who imitates the politician who does not like the clown is very popular
 with the public.’

13.

- a. 鋼琴師很受不了的小提琴家脾氣不好對人大吼大叫 (3.64)
 gangchinshi hen shoubuliao e, de xiaotichinjia, pichi buhao duiren dahodajia
 pianist cannot stand violinist have a bad temper to people yell loudly
 ‘The violinist who the pianist cannot stand has a bad temper and yells loudly at people.’
- b. 很受不了鋼琴師的小提琴家脾氣不好對人大吼大叫 (3.70)
 e, hen shoubuliao gangchinshi de xiaotichinjia, pichi buhao duiren dahodajia
 cannot stand pianist violinist have a bad temper to people yell loudly
 ‘The violinist who cannot stand the pianist has a bad temper and yells loudly at people.’
- c. 鋼琴師很受不了的小喇叭手追求的小提琴家脾氣不好 (3.24) (2.85)
 gangchinshi hen shoubuliao e, de xiaolabashou, zhuiqi e_k de xiaotichinjia, pichi buhao
 pianist cannot stand trumpeter court violinist have a bad
 temper
 ‘The violinist who the trumpeter who the pianist cannot stand is courting has a bad
 temper.’
- d. 很受不了追求鋼琴師的小喇叭手的小提琴家脾氣不好 (3.33) (2.82)
 e, hen shoubuliao e_k zhuiqi gangchinshi de xiaolabashou_k de xiaotichinjia, pichi buhao
 cannot stand court pianist trumpeter violinist have a bad
 temper

- 14.
- a. 屠夫瞧不起的清潔工衣服總是很髒身上也有股怪味道 (3.70)
 tufu chiabuchi e, de chingjieong, yifu zongshi hen zang shenshang ye you gu guaiweidao
 butcher despise cleaning person clothes always very dirty have also smell funny
 ‘The cleaning person who the butcher despises, his clothes are always very dirty and he also smells funny.’
- b. 瞧不起屠夫的清潔工衣服總是很髒身上也有股怪味道 (3.76)
 e, chiabuchi tufu de chingjieong, yifu zongshi hen zang shenshang ye you gu guaiweidao
 despise butcher cleaning person clothes always very dirty have also smell funny
 ‘The cleaning person who despises the butcher, his clothes are always very dirty and he also smells funny.’
- c. 屠夫瞧不起的搬運工人討厭的清潔工衣服總是很髒 (3.73) (3.91)
 tufu chiabuchi e, de banyungongren, tauyen e_k de chingjieong, yifu zongshi hen zang
 butcher despise mover detest cleaning person clothes always very
 dirty
 ‘The cleaning person who the mover who the butcher despises, his clothes are always very dirty.’
- d. 瞧不起討厭搬運工人的屠夫的清潔工衣服總是很髒 (3.76) (3.85)
 e, chiabuchi e_k tauyen banyungongren de tufu_k de chingjieong, yifu zongshi hen zang
 despise detest mover butcher cleaning person clothes always very
 dirty
 ‘The cleaning person who despises the butcher who detests the mover, his clothes are always very dirty.’
- 15.
- a. 明星愛上的詩人充滿不切實際的幻想整天做白日夢 (2.73)
 mingshing aishang e, de shiren, chongman buqieshiji de huanshiang zhangtian zuo
 bairimong
 superstar fall in love with poet have unrealistic expectations all day daydream
 ‘The poet who the superstar fell in love with has unrealistic expectations and daydreams all the time.’
- b. 愛上明星的詩人充滿不切實際的幻想整天做白日夢 (2.58)
 e, aishang mingshing de shiren, chongman buqieshiji de huanshiang zhangtian zuo
 bairimong
 fall in love with superstar poet have unrealistic expectations all day daydream
 ‘The poet who fell in love with the superstar has unrealistic expectations and daydreams all the time.’
- c. 明星愛上的模特兒崇拜的詩人充滿不切實際的幻想 (2.18) (2.88)
 mingshing aishang e, de moteer, chongbai e_k de shiren, chongman buqieshiji de
 huanshiang
 superstar fall in love with model adore poet have unrealistic expectations
 ‘The poet who the model who the superstar fell in love with adores has unrealistic expectations.’
- d. 愛上崇拜明星的模特兒的詩人充滿不切實際的幻想 (2.58) (2.24)
 e, aishang e_k chongbai mingshing de moteer_k de shiren, chongman buqieshiji de
 huanshiang
 fall in love with adore superstar model poet have unrealistic expectations
 ‘The poet who fell in love with the model who adores the superstar has unrealistic expectations.’

16.

- a. 寡婦嘲笑的老處女很想交男朋友整天要人幫她作媒 (3.48)
 guafu chaoshiao e_i de laochunu_i henshiang jiao nānpengyou zhengtian yaoren bang ta zuo mei
 widow laugh at spinster desire to have a boyfriend all day want people help her match making
 ‘The spinster who the widow laughs at desires to have a boyfriend and wants people to set her up with someone all the time.’
- b. 嘲笑寡婦的老處女很想交男朋友整天要人幫她作媒 (3.48)
 e_i chaoshiao guafu de laochunu_i henshiang jiao nānpengyou zhengtian yaoren bang ta zuo mei
 laugh at widow spinster desire to have a boyfriend all day want people help her match making
 ‘The spinster who laughs at the widow desires to have a boyfriend and wants people to set her up with someone all the time.’
- c. 寡婦嘲笑的無賴喜歡調戲的老處女很想交男朋友 (3.24) (2.48)
 guafu chaoshiao e_i de wulai_i xihuan tiaosi e_k de laochunu_i henshiang jiao nānpengyou
 widow laugh at rotter like to flirt with spinster desire to have a boyfriend
 ‘The spinster who the rotter who the widow laughs at likes to flirt with desires to have a boyfriend.’
- d. 嘲笑喜歡調戲寡婦的無賴的老處女很想交男朋友 (3.24) (2.42)
 e_i chaoshiao e_k xihuan tiaosi guafu de wulai_i de laochunu_i henshiang jiao nānpengyou
 laugh at like to flirt with widow rotter spinster desire to have a boyfriend
 ‘The spinster who laughs at the rotter who likes to flirt with the widow desires to have a boyfriend.’

17.

- a. 流氓威脅的逃犯害怕被警察抓整天提心吊膽 (2.61)
 liumang weixie e_i de taufan_i hai pa bei jingcha zhua zhengtian tishindiaodan
 scamp threaten fugitive be scared of getting caught by the police all day worried
 ‘The fugitive who the scamp threatened is scared of getting caught by the police and is worried all the time.’
- b. 威脅流氓的逃犯害怕被警察抓整天提心吊膽 (2.85)
 e_i weixie liumang de taufan_i hai pa bei jingcha zhua zhengtian tishindiaodan
 threaten scamp fugitive be scared of getting caught by the police all day worried
 ‘The fugitive who threatened the scamp is scared of getting caught by the police and is worried all the time.’
- c. 流氓威脅的小偷陷害的逃犯害怕被警察抓 (2.55) (2.55)
 liumang weixie e_i de xiaotao_i xienhai e_k de taufan_i hai pa bei jingcha zhua
 scamp threaten thief plot against fugitive be scared of getting caught by the police
 ‘The fugitive who the thief who the scamp threatened plotted against is scared of getting caught by the police.’
- d. 威脅陷害小偷的流氓的逃犯害怕被警察抓 (2.85) (2.55)
 e_i weixie e_k xienhai xiaotao de liumang_i de taufan_i hai pa bei jingcha zhua
 threaten plot against thief scamp fugitive be scared of getting caught by the police
 ‘The fugitive who threatened the scamp who plotted against the thief is scared of getting caught by the police.’

18.

- a. 富豪邀請的官員心懷不軌但是善於隱藏 (1.48)
 fuhao yaoqing e, de guanyuan, shinhuaibugui danshi shanyu yintsang
 tycoon invite official have bad intentions but good at hiding
 ‘The official who the tycoon invited has bad intentions but is good at hiding them.’
- b. 邀請富豪的官員心懷不軌但是善於隱藏 (1.76)
 e, yaoqing fuhao de guanyuan, shinhuaibugui danshi shanyu yintsang
 invite tycoon official have bad intentions but good at hiding
 ‘The official who invited the tycoon has bad intentions but is good at hiding them.’
- c. 富豪邀請的法官勾結的官員心懷不軌 (1.91) (2.27)
 fuhao yaoqing e, de faguan, gojie e, de guanyuan, shinhuaibugui
 tycoon invite judge conspire official have bad intentions
 ‘The official who the tycoon invited conspired with has bad intentions.’
- d. 邀請勾結法官的富豪的官員心懷不軌 (1.76) (2.06)
 e, yaoqing e, gojie faguan de fuhao, de guanyuan, shinhuaibugui
 invite conspire tycoon judge official have bad intentions
 ‘The official who invited the tycoon who conspired with the judge has bad intentions.’

19.

- a. 居民協助的軍官受傷了被送往醫院 (1.97)
 jumin xiechu e, de junguan, shoushang le bei song wang yiyuan
 resident assist soldier get hurt perfe. passive send to hospital
 ‘The soldier who the resident assisted got injured and was sent to the hospital.’
- b. 協助居民的軍官受傷了被送往醫院 (2.06)
 e, xiechu jumin de junguan, shoushang le bei song wang yiyuan
 assist resident soldier get hurt perfe. passive send to hospital
 ‘The soldier who assisted the resident got injured and was sent to the hospital.’
- c. 居民協助的難民憎恨的軍官受傷了 (2.45) (3)
 jumin xiechu e, de nanmin, zenghen e, de junguan, shoushang le
 resident assist refugee hate soldier get hurt perf.
 ‘The soldier who the refugee who the resident assisted hates got injured.’
- d. 協助憎恨難民的居民的軍官受傷了 (2.06) (2.97)
 e, xiechu e, zenghen nanmin de jumin, de junguan, shoushang le
 assist hate refugee resident soldier get hurt
 ‘The soldier who assisted the resident who hates the refugee got injured.’

20.

- a. 司機報怨的乘客總是大聲喧嘩很令人受不了 (2.27)
 siji baoyuan e, de chengke, zongshi daoshengxuanhua hen lingren shoubuliao
 driver complain about passenger be always very loud very for people intolerable
 ‘The passenger who the driver complained about is always very loud and people can’t stand it.’
- b. 報怨司機的乘客總是大聲喧嘩很令人受不了 (1.79)
 e, baoyuan siji de chengke, zongshi daoshengxuanhua hen lingren shoubuliao
 complain about driver passenger be always very loud very for people intolerable
 ‘The passenger who complained about the driver is always very loud and people can’t stand it.’

- c. 司機報怨的收票員不理會的乘客總是大聲喧嘩 (2.64) (2.91)
 siji baoyuan e, de shoupiaoyuan, bulihue e, de chengke, zongshi daoshengxuanhua
 driver complain about ticket collector ignore passenger be always very loud
 ‘The passenger who the ticket collector who the driver complained about ignored is
 always very loud.’
- d. 報怨不理會收票員的司機的乘客總是大聲喧嘩 (1.79) (3.24)
 e, baoyuan e, bulihue shoupiaoyuan de siji, de chengke, zongshi daoshengxuanhua
 complain about ignore ticket collector driver passenger be always very loud
 ‘The passenger who complained about the driver who ignored the ticket collector is
 always very loud.’

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