

SUBJECT PROMINENCE AND PROCESSING DEPENDENCIES IN PRENOMINAL RELATIVE CLAUSES: THE COMPREHENSION OF POSSESSIVE RELATIVE CLAUSES AND ADJUNCT RELATIVE CLAUSES IN MANDARIN CHINESE

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This article investigates how dependencies are constructed in prenominal relative clauses of Mandarin Chinese by comparing the comprehension of two types of relative clauses: POSSESSIVE RELATIVE CLAUSES (PRCs), where the head noun is associated with a dependent noun phrase in the embedded clause, and ADJUNCT RELATIVE CLAUSES (ARCs), where the head noun takes the whole embedded clause as its complement. The results of a naturalness-rating experiment and two self-paced reading experiments showed distinctive reading patterns of PRCs and ARCs. The comprehension of a PRC is sensitive to the grammatical position of the dependent noun in the prenominal clause: retrieval of a dependent noun at the subject position is less costly than that of a dependent noun at VP-internal nonsubject positions. The comprehension of an ARC reflects the structural frequency of the whole prenominal clause: more-canonical structures like SVO sentences were read faster than less frequent structures such as disposal and passive sentences. These results support the importance of structural locality and subject prominence for constructing gap-filler dependencies in prenominal relative clauses.*

Keywords: sentence processing, relative clauses, Mandarin Chinese, long-distance dependencies, subject prominence

1. INTRODUCTION. Understanding utterances requires the ability to keep track of lexical items and build relations among them. Such a process involves at least the following important tasks: words in a sentence are recognized and temporarily stored, and the combinatorial properties of these words need to be used so that relations among the words can be constructed. Sentence-processing research has investigated these aspects extensively in the past decades. In one particular area of concentrated research, researchers focus on how LONG-DISTANCE DEPENDENCIES in sentences are constructed. It is well known, for example, that in understanding English sentences that contain WH-elements such as 1, the parser stores the WH-word *what* as a filler and attempts to associate it with all potential gap positions implied by the upcoming string of words as they incrementally become available from left to right (e.g. after *want* and after *bring* in 1, per the ACTIVE FILLER STRATEGY of Frazier & d'Arcais 1989).

(1) What_i do you want John to bring [GAP_i]?

Like sentences with WH-words, sentences containing relative clauses present a similar dependency challenge for comprehension. Consider 2, where the noun *the linguist* is followed by *who*, a WH-word functioning as a relativizer. The noun phrase before the relativizer (i.e. the HEAD NOUN) serves as a filler that is interpreted as the subject of the embedded verb in the subordinate clause.

(2) John met *the linguist*_i who [GAP_i] works on relative clauses.

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Much of the research on relative clause processing has so far focused on the extraction of noun phrases from syntactic positions such as subjects and objects in the embedded clause, comparing processing differences between subject-extracted relative clauses (SRs) like 3 and object-extracted relative clauses (ORs) like 4.

(3) the linguist_i who [GAP_i] talked to the child

(4) the linguist_i who the child talked to [GAP_i]

In languages where complex noun phrases are head-initial, the modifying clauses follow the head nouns. A comprehension advantage has been reported for SRs over ORs across all languages investigated (Brazilian Portuguese: Gouvea 2003; Dutch: Frazier 1987; English: Ford 1983, Gibson et al. 2005, King & Just 1991, King & Kutas 1995, Traxler et al. 2002; French: Cohen & Mehler 1996, Frauenfelder et al. 1980, Holmes & O'Regan 1981; German: Mecklinger et al. 1995, Schriefers et al. 1995; Italian: Adani 2011; Spanish: Betancort et al. 2009). This crosslinguistic advantage for SRs has led to the hypothesis that the subject preference for relative clause processing is universal (Kwon et al. 2013, Lin 2006, Lin & Bever 2006).

Typologically, however, the dependencies in 3–4 only partially represent the possible linear relations between fillers and gaps in human languages. A mirroring typological possibility, where the gap linearly precedes the filler, remains less understood. To illustrate this gap-filler dependency, consider an SR and an OR of Standard Chinese in 5.

(5) a. Standard Chinese subject relative clause (SR)¹

[[GAP_i] chuikua maowu] de taifeng_i
 [[GAP] blow.down hut] REL typhoon
 'the typhoon that blew down the hut'

b. Standard Chinese object relative clause (OR)

[taifeng chuikua [GAP_i]] de maowu_i
 [typhoon blow.down [GAP]] REL hut
 'the hut that the typhoon blew down'

The goal of the present study is to investigate how gap-filler dependencies like those in 5 are established in comprehension. While this topic has been continuously studied, the literature presents a puzzling picture. Remarkably different from the consistent SR preference reported for head-initial relative clauses, both SR and OR advantages have been found for head-final relative clauses (OR advantage in Basque: Carreiras et al. 2010; SR advantage in Mandarin: Chen et al. 2012, Jäger et al. 2015, Lin & Bever 2006; OR advantage in Mandarin: Gibson & Wu 2013, Hsiao & Gibson 2003, Lin 2014, Lin & Garnsey 2011, Packard et al. 2011, Qiao et al. 2012, Sung et al. 2016; SR advantage in Japanese: Miyamoto & Nakamura 2003, Ueno & Garnsey 2008; OR advantage in Japanese: Ishizuka et al. 2006; SR advantage in Korean: Kwon et al. 2010, Kwon et al. 2013).² The contrast between the universal SR advantage found in head-initial relative clauses and the diverse SR/OR advantages found in head-final relative clauses suggests that the

¹ Standard Chinese is also known as Mandarin Chinese. Square brackets indicate the embedded relative clause region excluding the relativizer *de* in the Mandarin examples. Identical subscripts indicate coreference. Abbreviations used for glossing include: ACC: accusative case, ADN: adnominal suffix, ASP: aspect marker, BA: *ba* in the causative *ba* construction, BEI: *bei* in the passive construction, CL: classifier, DET: determiner, NOM: nominative case, POSS: possessive marker, REL: relativizer.

² 'Subject/object advantage' is a simplified cover term for the asymmetry. In comparing SRs and ORs, processing differences should be understood in the context of the types of relative clauses contrasted, the discourse contexts in which the relative clauses are presented, the typological properties of the languages studied, and where in the sentence the processing differences are observed.

comprehension of a gap-filler dependency involves different processing factors from that of a filler-gap dependency (Lin 2012). The present study, however, reports experimental evidence from the comprehension of Chinese possessive relative clauses that supports the comprehension advantage for gaps (or dependent nouns) located in the subject position. This new evidence supports the hypothesis that there exists a universal processing advantage for grammatical subjects in sentence processing.

2. COMPREHENSION OF POSTNOMINAL AND PRENOMINAL RELATIVE CLAUSES. For studying dependencies in relative clauses, most research has focused on comparing SRs and ORs. In this section, we consider two prominent groups of theories that have been proposed to account for this processing asymmetry: **MEMORY-BASED THEORIES**, which focus on the cost of storing and retrieving lexical items from working memory, and **EXPECTATION-BASED THEORIES**, which focus on the predictability of a structure or a word in a sentence (see Gibson & Wu 2013 and Levy et al. 2013 for similar theoretical classifications).

2.1. MEMORY-BASED THEORY I: LINEAR LOCALITY. For the processing of filler-gap dependencies, the distance and the properties of the intervening elements between the filler and the gap both contribute to the differential processing costs for SRs and ORs. An important example of memory-based theories for sentence processing is the **DEPENDENCY LOCALITY THEORY (DLT)** (Gibson 1998), which focuses on the cost of keeping a filler active.³ Filler-gap dependencies in which a greater number of new discourse referents intervene are expected to induce greater integration cost and thus be more difficult to comprehend. Comprehension difficulty thus increases as a function of the linear distance between the dependent elements. In postnominal relative clause structures like those in English, SRs are predicted to be easier to process than ORs because the filler-gap distance is shorter in an SR than in an OR.

For a prenominal relative clause, the comprehension involves detecting a missing argument (i.e. a gap) in the prenominal clause, temporarily storing the words of the embedded clause in working memory, and integrating them with the head noun when it appears. According to the DLT, once a gap is recognized, the parser is engaged in completing a gap-filler dependency. A longer distance between the gap and its filler induces greater integration cost. As 5 shows, since the gap of a Mandarin SR is linearly farther away from the head noun than that of an OR, an SR is expected to be more difficult to comprehend than an OR (Gibson & Wu 2013, Hsiao & Gibson 2003:7). Note that the DLT prediction operates under the assumption that the left end of the dependency has been detected so that the parser is engaged in the search for a filler to complete this dependency.⁴ Due to the lack of reliable markings on the left edge of a prenominal clause

³ A relevant theory, the **SIMILARITY-BASED INTERFERENCE THEORY** (Gordon et al. 2001, Gordon et al. 2002), holds that the semantic properties of the lexical items intervening between the filler and the gap affect how well a filler can be retained. The cost of retaining a filler is greater when the intervening NPs bear similar referential properties and thus produce greater retrieval interference (e.g. all being common nouns or all being pronouns). The **ACTIVATION AND CUE-BASED RETRIEVAL THEORY** (Lewis & Vasishth 2005, Van Dyke & Lewis 2003, and Vasishth & Lewis 2006) posits that the intervening lexical items may interfere with retrieval as well as facilitate reactivation (thus resulting in locality as well as antilocality effects). Most research on the processing of filler-gap dependencies has adopted the position that the filler remains active in the working memory and gets retrieved when the upcoming words suggest a trace site appropriate for the filler to be associated with (e.g. Bever & McElree 1988, MacDonald 1989, Nicol & Swinney 1989, Stowe 1986, Tanenhaus et al. 1989; see also Grodzinsky 2000 for a summary).

⁴ The discussion here focuses on prenominal relative clauses without classifiers. In Chinese, numeral classifiers, which are semantically associated with the head nouns, may appear before the prenominal relative

and the uncertainty regarding whether the missing argument is indeed a relativized gap, it remains uncertain whether the linear-locality accounts are applicable to the establishment of a gap-filler dependency (Hirose 2006, Lin & Bever 2011).

2.2. MEMORY-BASED THEORY II: SYNTACTIC PROMINENCE. In addition to theories that focus on the linear distance between the dependent elements, several memory-based accounts draw a closer connection between processing cost and syntactic structure (Hawkins 2004, Lin & Bever 2006, O'Grady 1997). These accounts focus on the cost of processing dependent elements at different grammatical positions. An influential theory of syntactic prominence is Keenan and Comrie's (1977) *ACCESSIBILITY HIERARCHY* (AH) in 6.

(6) *ACCESSIBILITY HIERARCHY* (Keenan & Comrie 1977:66):

subject > direct object > indirect object > oblique NP > genitive NP > object of comparison

The typological generalization of the AH is that NPs that are higher on the hierarchy bear greater 'psychological ease of comprehension' (Keenan & Comrie 1977:88). If a language can relativize an NP at a particular grammatical position on the hierarchy, then it should also be able to relativize all NPs at higher grammatical positions. This hierarchy makes universal predictions for all languages.

While the AH has been adopted to account for subject/object asymmetries in sentence processing, it has not been clear what contributes to the 'psychological ease' of higher grammatical functions on the hierarchy. From a structural perspective, the different grammatical functions can be understood as being associated with distinct syntactic positions on a syntactic tree, with subject positions being higher than object positions. In this sense, the construction of a filler-gap dependency is sensitive to the number of structural layers involved in connecting a gap and its filler. The head noun, being syntactically above an embedded clause, is structurally closer to a subject gap than to an object gap. SRs are therefore predicted to be easier to comprehend than ORs based on structural proximity (Lin 2006, Lin & Bever 2006). Hawkins's (1999, 2004) *FILLER-GAP DOMAIN* (FGD), which is defined as 'the smallest set of terminal and non-terminal nodes dominated by the mother of a filler and on a connected path that must be accessed for gap identification and processing' (Hawkins 2004:175), is also in line with this conceptualization of structural locality.

From the perspective of discourse status, a subject position can be seen as the default argument position for topic/case (Carreiras et al. 2010, Givón 1983, 1984, Kuno 1976, MacWhinney 2005, Schachter 1973, Tomlin 1983). A subject NP is therefore more prominent than NPs in lower positions on the hierarchy and receives more attention in discourse formation. The processing predictions for postnominal and prenominal relative clauses are identical based on discourse prominence. Assuming that head nouns in relative clauses are preferably associated with NPs of greater discourse prominence, a head noun that is associated with a subject gap meets the prominence expectation, while one that is associated with an object gap, which has less prominent discourse status, invokes greater processing cost. ORs are therefore more costly to process than SRs.

2.3. EXPECTATION-BASED THEORIES. According to expectation-based theories of sentence processing, linguistic materials that are better expected are predicted to be easier

clauses. In such cases, an additional dependency between the classifier and the head noun has to be established. Wu (2012) has suggested that the DLT predictions are not compatible with the reading patterns of Chinese relative clauses preceded by classifiers.

to process. Expectations have been formalized in terms of **SURPRISAL** (i.e. the likelihood for a word to appear given the context preceding it; Hale 2001, Levy 2008) and **ENTROPY REDUCTION** (i.e. the amount of syntactic uncertainty that a word contributes to reducing; Hale 2003, 2006). Both more-constrained sentential contexts and greater exposure to a structure lead to better expectations and consequently easier comprehension. The **PRODUCTION-DISTRIBUTION-COMPREHENSION THEORY** (PDC; Gennari & MacDonald 2009), which posits that the ease of sentence comprehension reflects the frequency distributions of structures, also predicts that a structure that is favored in production should have a higher frequency in corpora and be easier to understand.

As expectation effects are based on frequency distributions, predictions about SR/OR comprehension depend on the frequency metrics adopted. In terms of **CONSTRUCTIONAL PROBABILITY**, SRs have higher frequencies than ORs in English (Roland et al. 2007). In terms of **WORD-ORDER CANONICITY** (Bever 1970, Lin 2013), an SR presents the canonical order of NVN (semantically Agent-verb-Patient), while an OR presents the less common order of NNV (semantically Patient-Agent-verb). Both metrics predict SRs should be easier to comprehend than ORs in English.

For Standard Chinese, since SRs also outnumber ORs in corpora (Lin & Hu 2019, Wu et al. 2011), theories of PDC (Gennari & MacDonald 2009, Hsiao & MacDonald 2013) and surprisal (Hale 2001, Jäger et al. 2015, Levy 2008) both predict that SRs should have a processing advantage over ORs based on constructional probability. In terms of word-order canonicity, however, an OR is predicted to be easier than an SR because an OR in Standard Chinese presents the canonical NVN order (semantically Agent-verb-Patient as in 5b) but an SR presents the less common order of VNN (semantically verb-Patient-Agent as in 5a) (Lin 2013, 2014, 2015).

2.4. CHINESE RELATIVE CLAUSE COMPREHENSION. The theoretical accounts reviewed above all make the same prediction: an SR should be easier to process than an OR in English since English SRs have a shorter linear distance between the filler and the gap, involve a gap at the grammatically and pragmatically prominent position, have greater occurrences in corpora, and present the canonical word order of NVN. Processing research has therefore turned to head-final dependencies such as Chinese relative clauses to tease apart the various accounts.

An important question to pose at this point is whether a head-final relative clause where the gap precedes the filler and a head-initial relative clause where the filler precedes the gap are comparable in on-line comprehension. A key difference between a gap-filler dependency and a filler-gap dependency is that the former is subject to greater uncertainty on the left edge of the dependency as gaps are unpronounced and there exists no reliable grammatical cue that indicates their existence in the embedded clause. The fact that languages such as Chinese, Japanese, and Korean allow the dropping of arguments in main clauses further complicates the processing, as a prenominal clause with a missing argument can be taken to be a main clause with dropped pronouns. Thus, whether the parser has successfully detected a gap and initiated the search for a filler has been an unsettled issue for studying the comprehension of head-final relative clauses (Lin & Bever 2011). So far, most research that pays attention to the uncertainty of head-final relative clause processing has either adopted a referential context to motivate a relative clause or used structural cues to indicate clausal boundaries. With this parsing uncertainty in mind, let us evaluate the theoretical predictions and review previous findings about processing SRs and ORs in Chinese.

Recent comprehension studies of Chinese relative clauses have offered support for as well as challenges to the above theoretical accounts. A group of studies (Gibson & Wu

2013, Lin 2014, Vasishth et al. 2013) used contexts with contrastive referents like 7 to provide discourse motivation for relative clauses since relative clauses serve the pragmatic function of picking out a referent from the background.

(7) Context with contrastive referents (Crain & Steedman 1985)

A psychologist was counseling two married couples. One of the couples was fighting with him but the other one was nice to him.

Supporting the linear-locality account, Gibson and Wu (2013) found shorter reading times on the head nouns of Mandarin ORs. However, this effect was shown to emerge in the prehead regions in Vasishth and colleagues' (2013) replication, suggesting that word-order canonicity, not integration per se, better accounts for the OR advantage (see also Hsiao & Gibson 2003 and Chen et al. 2008, which reported shorter reading times in the prenominal regions of an OR). Further supporting this possibility, Lin 2014 found shorter reading times in the post-head-noun regions of an OR only when it was preceded by a context that presented the same thematic order as the OR (cf. Wu & Juffs 2016). The OR advantage that has been reported therefore better reflects the effect of word-order canonicity.

By contrast, several studies have adopted structural cues to indicate discontinuous clausal boundaries (Hsu et al. 2006, Jäger et al. 2015). Using the structural conflict between a classifier and an adverbial phrase inside the embedded clause like 8, Jäger and colleagues (2015) found shorter reading times on the head nouns of Mandarin SRs than ORs. Their results are consistent with the syntactic-prominence account and the frequency account.

(8) a. Chinese SR following a structural cue

na-ge [shanggeyue [GAP]_i chuikua maowu] de taifeng_i
 DET-CL [last.month [GAP] blow.down hut] REL typhoon
 'the typhoon that blew down the hut last month'

b. Chinese OR following a structural cue

na-ge [shanggeyue [taifeng chuikua [GAP]_i] de maowu_i
 DET-CL [last.month [typhoon blow.down [GAP]] REL hut
 'the hut that the typhoon blew down last month'

The review above suggests that even with an attempt to disambiguate prenominal relative clauses in Chinese, contradictory findings make it difficult to determine which factors are responsible for the processing of dependencies in SRs and ORs. It is worth noting that the comparison of SRs and ORs is conflated with multiple factors other than the dependency between a filler and a gap. For instance, an SR is more frequent and therefore better expected than an OR, while an OR presents a more common thematic order than an SR. Therefore, finding a processing advantage for an SR or an OR does not speak exclusively to the issue of dependency processing in Chinese relative clauses. In the next section, I introduce two types of relative clauses in Standard Chinese and suggest that they provide a better comparison for studying the positional and distance effects related to processing dependencies in prenominal relative clauses.

3. PROCESSING ADJUNCT RELATIVE CLAUSES AND POSSESSIVE RELATIVE CLAUSES IN STANDARD CHINESE. To shed light on the dependency effects related to the position and distance of the dependent elements, the present research contrasts the comprehension of two types of Mandarin relative clauses that are less studied: adjunct relative clauses (ARCs) as in 9, which involve integrating the head noun with the whole prenominal clause, and possessive relative clauses (PRCs) as in 10, which require constructing a possessive dependency between the head noun and a particular NP in the prenominal clause.

- (9) [fangzi bei fayuan chafeng] de shihou
 [house BEI court confiscate] REL time
 ‘the time when the house was confiscated by the court’
- (10) [fangzi_i bei fayuan chafeng] de xiaokai_i
 [house BEI court confiscate] REL rich.guy
 ‘the rich guy whose house was confiscated by the court’

This comparison has several advantages over the SR/OR comparisons. First, unlike SRs and ORs, which involve different surface orders and lexical items in the prenominal regions, ARCs and PRCs can have identical prenominal regions and differ only on the head nouns. The processing differences between ARCs and PRCs can therefore be more exclusively attributed to the differences in the head nouns: only the PRC head nouns, not the ARC head nouns, hold a dependency with an NP in the prenominal clause. Second, varying the position of the dependent NP in the prenominal clause allows us to investigate how the position of the dependent NP affects the processing of a PRC, but not that of an ARC. In the following subsections, I introduce ARCs and PRCs in greater detail.

3.1. ADJUNCT RELATIVE CLAUSES AND POSSESSIVE RELATIVE CLAUSES. Commonly found in East Asian languages, ARCs like 11–12 have also been called sloppy relative clauses (Tsai 1997) or gapless relative clauses (Cheng & Sybesma 2005, Zhang 2008, contra Cha 1999; see also Beavers & Bender 2004). The head nouns of ARCs express ‘intrinsic characteristics of an eventuality’ (Zhang 2008:1007), including event properties like *difang* ‘location’, *shijian* ‘time’, *gongju* ‘instrument’, *fangfa* ‘method’, and *yuanyin* ‘reason’. Unlike the gapped relative clauses in 5, the prenominal clauses of ARCs do not contain missing arguments and can stand alone as independent argument-complete sentences.

- (11) [Zhangsan xiu che] de difang
 [Zhangsan repair car] REL place
 ‘the place (where) Zhangsan repairs cars’
- (12) a. Japanese
 [atama-ga yoku-naru] kusuri
 [head-NOM good-become] medicine
 ‘the medicine (because of which) head gets better’ (Matsumoto 1997:106)
- b. Korean
 [John-i sakwa-lul kkak-un] khal
 [John-NOM apple-ACC peel-ADN] knife
 ‘the knife (with which) John peeled an apple’ (Cha 1999:27)

Two approaches have been pursued regarding the semantic composition of the prenominal clause and an ARC head noun. The first approach takes the default adjunct position in boldface in 13 to be the gap position for the head noun (Ning 1993).

- (13) Zhangsan **zai cheku** xiu che.
 Zhangsan at garage repair car
 ‘Zhangsan repairs cars at the garage.’

There are several problems with this approach. First, the head noun cannot appear in the proposed gap position for reconstruction, as shown in 14 (Zhang 2008:1008; see also Cha 1999; this is similar to the problem in the English instrumental clause *I can’t find the money to buy my kids new shoes*, as in Beavers & Bender 2004).

- (14) *Zhangsan **difang** xiu che.
 Zhangsan place repair car
 ‘Zhangsan repairs cars at that place.’

Second, as exemplified by the so-called ‘aboutness relatives’ in 15, the head noun and the prenominal clause together denote a sense of ABOUTNESS (similar to *the feeling of being in love* and *the price of him killing Bill* in English; Tsai 1997), where the head noun cannot be placed into an adjunct position for reconstruction.

- (15) [John chao cai] de weidao
[John stir.fry vegetables] REL smell
‘the smell of John’s stir-frying vegetables’

The second approach, argued for by Cheng and Sybesma (2005), Tang (1979), Tsai (1997), and Zhang (2008) and adopted by the present study, places the burden of compositionality on the relational nature of the head noun. Being property nouns such as place, time, instrument, and reason, ARC heads take event-denoting clauses as their arguments. For aboutness relatives, head nouns such as *smell* and *sound* are coerced into a relational noun so that they can take the event-denoting prenominal clause as their complement and arrive at the semantics of aboutness.

Several syntactic contrasts exist between adjunct relatives and regular gapped relatives (Zhang 2008). First, in addition to not having a syntactic position where the ARC head noun can be reconstructed, as shown in 13–14, the embedded clause of an ARC contains no position in which a resumptive pronoun can appear, as shown in 16. In PRCs and gapped relative clauses, by contrast, resumptive pronouns can appear in gap positions (Ning & Lin 2008).

- (16) [Zhangsan (*nali_i) xiu che] de difang_i
[Zhangsan there repair car] REL place
‘the place that Zhangsan repairs cars there’

Second, the compositional relations between the head and the prenominal clauses are different in ARCs and in regular gapped relatives. Regular gapped relative clauses are modifiers and predicates of the head noun, while the prenominal clauses of adjunct relatives can be taken to be subjects that take the relational head nouns as their predicates. As shown in 17–18, while gapped relatives can be stacked as multiple modifiers of the same head noun, adjunct relatives cannot. Such a contrast can be derived from the restriction that ARC head nouns, as predicates of the prenominal clauses, can only be licensed by one adjunct clause (i.e. relational predicates can only take one subject).

- (17) [Zhangsan xiu [GAP_i]] de [Lisi mai [GAP_i]] de che_i
[Zhangsan repair [GAP]] REL [Lisi sell [GAP]] REL car
‘the car that Zhangsan repaired that Lisi sold’
(18) *[Zhangsan xiu che] de [Lisi mai che] de difang
[Zhangsan repair car] REL [Lisi sell car] REL place
‘the place where Zhangsan repairs cars where Lisi sells cars’

Cheng and Sybesma (2005:72) noted additional semantic constraints on the clausal modifiers of aboutness relatives, which corroborate the existence of an event variable not inside but above the embedded clause of an ARC. For instance, the embedded verbs of aboutness relatives must denote generic activity readings that are not ‘temporally restricted’, because once they are temporally licensed as in 19, the event variable is already bound by the aspect marker and cannot be further bound by the relativizer *de*.

- (19) [John chao(*-le) cai] de weidao
[John stir.fry(-ASP) vegetables] REL smell
‘the smell of John’s stir-frying vegetables’

The prenominal clauses of ARCs are therefore best analyzed as argument-complete clauses that are bound by an EVENT variable above the clause, which satiates the event/argument requirement of the relational head noun. Crucial to the present study, the head

noun of an ARC is integrated with the whole prenominal clause and not tied to a particular gap position inside the clause.

By contrast, in a PRC, as exemplified by 20, a possessive relation exists between the head noun and a noun inside the prenominal clause. The head noun is understood to be the owner of the embedded noun.

- (20) [[GAP]_i erzi haodu] de na-wei guke;
 [[GAP] son like.gambling] REL that-CL client
 ‘the client whose son likes gambling’

Several important properties distinguish PRCs and ARCs. First, the head noun of a PRC, usually a personal noun, has to be semantically capable of ownership and be able to hold a possessive relation with an NP in the prenominal clause. This dependency is different from the one between the relational head noun and the whole clausal complement of an ARC. Second, while the embedded clause of an ARC is an argument-complete clause, the embedded clause of a PRC must contain an NP that serves as the possessee of the head noun. This possessee NP can be an inalienable noun holding a part-whole relation with the head noun (i.e. a kinship or body-part term like *erzi* ‘son’ in 20) or an alienable noun (i.e. a nonkinship, non-body-part term like *xiangji* ‘camera’ in 21). When the dependent NP is inalienable, it hosts an internal possessor argument and links the head noun as its possessor argument (Barker 1995). When the dependent NP is alienable, the head noun is coerced as an external possessor of the embedded NP.

- (21) [xiangji_i bei tou] de na-ge jizhe;
 [camera BEI steal] REL that-CL reporter
 ‘the reporter whose camera was stolen’

Previously, PRCs with alienable possessee like 22 have been found to induce longer reading times on the head nouns than PRCs with inalienable possessee like 23 (Lin 2011). This reading-time difference suggests that the processing of PRCs is sensitive to the semantics of the dependent noun, and that extra cost for coercing a possessive relation is needed for external possessors.

- (22) [yuangong_i bei jingcha zhuazou] de zongcai;
 [employee BEI police take] REL chairperson
 ‘the chairperson whose employee was taken by the police’
 (23) [fuqin_i bei jingcha zhuazou] de zongcai;
 [father BEI police take] REL chairperson
 ‘the chairperson whose father was taken by the police’

Whether or not the dependent NP of a PRC is inalienable, the parser is engaged in constructing a possessive dependency between the head and an embedded noun in processing PRCs. This dependency between the head noun and a particular word in the prenominal clause serves as a critical contrast to the compositional relation between an ARC head noun and the whole prenominal clause.

3.2. PROCESSING ARCS AND PRCs. The present study makes use of the dependency contrast between ARCs and PRCs. Since the head noun of an ARC takes the whole prenominal clause as its complement but the head noun of a PRC is associated with a particular NP in the prenominal clause, the processing of an ARC is expected to reflect the difficulty of the WHOLE prenominal clause, while the processing of a PRC is expected to be sensitive to the position of the dependent NP in the prenominal clause. This contrast forms the basis of three experiments reported in the present article.

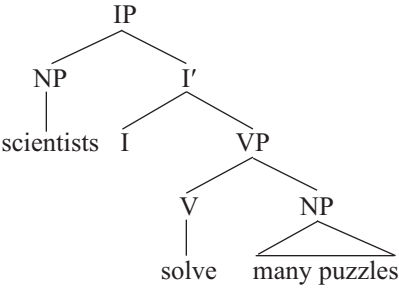
To vary the position of the dependent noun in a sentence, three basic clause structures in Mandarin are used, including the canonical SVO structure (exemplified by 24), the

ba structure (exemplified by 25), and the passive *bei* structure (exemplified by 26). These three clause types denote identical thematic relations between a verb and two nominal entities (meaning ‘the Agent verb-ed the Patient’) but differ on the surface orders of the thematic arguments in relation to the verb.

- (24) Simple canonical SVO structure (Baseline 1a)
kexuejia jie jue le xuduo miti.
scientist solve ASP many puzzle
‘Scientists have solved many puzzles.’
- (25) Simple *ba* structure (Baseline 1b)
kexuejia ba xuduo miti jie jue le.
scientist BA many puzzle solve ASP
‘Scientists have solved many puzzles.’
- (26) Simple passive *bei* structure (Baseline 1c)
xuduo miti bei kexuejia jie jue le.
many puzzle BEI scientist solve ASP
‘Many puzzles have been solved by scientists.’

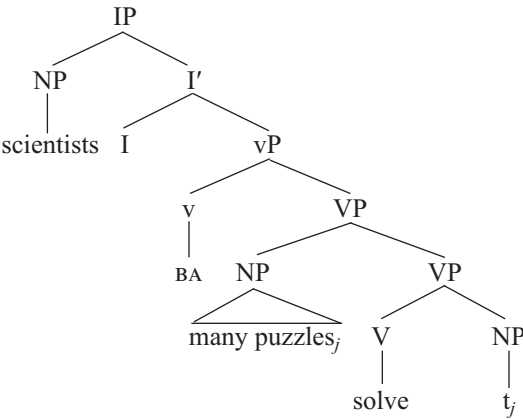
As the canonical word order in Mandarin syntax (Huang et al. 2009:154–55), the SVO structure illustrated by the tree diagram in 27 presents the canonical thematic order of Agent-verb-Patient.

(27) Canonical SVO structure in Mandarin



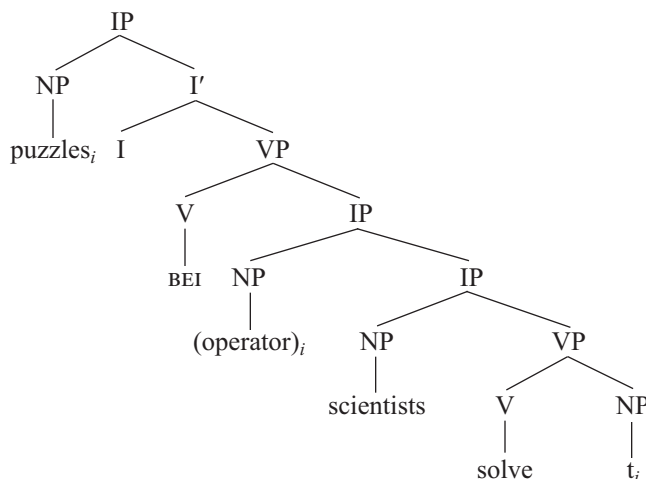
The *ba* structure illustrated by 28 has been analyzed as a causative construction where *ba* functions as a causative light verb (Huang et al. 2009). The patient in the SVO sequence of 27 is realized as the object raised to the specifier position in the VP (Huang 1997, Lin 2001), thus presenting the thematic order of Agent-*ba*-Patient-verb. This sentence can be interpreted as ‘the agent CAUSES the patient to be the undergoer of the verb’.

(28) The *ba* structure in Mandarin



The *bei* structure in 29 is also known as the long passive structure. The patient NP is raised to the subject NP position from the lowest VP-internal object position, presenting the thematic order of Patient-*bei*-Agent-verb.

(29) The *bei* structure in Mandarin



In the above three clause types, the NPs bear the same thematic roles in relation to the verb but appear in different syntactic positions. In the SVO structure, the agent NP is the subject, and the patient NP is the VP-internal object. In the *ba* structure, the agent NP is still the subject, while the patient NP is at the VP-internal specifier position. In the *bei* structure, the agent NP is the specifier of the lowermost IP, while the patient NP is at the topmost subject position.⁵

To investigate whether the processor is sensitive to the structural/linear position of the dependent NP in a PRC, these three clause structures are adopted as the prenominal clauses of the experimental sentences. The patient NP has been used as the targeted dependent NP with which the head noun holds a possessive relation. This dependent NP is located at the object position in the canonical SVO condition, at the specifier-of-VP position in the *ba* condition, and at the topmost subject position in the passive *bei* condition. The possessee-possessor pairs are indicated by boldface in 30–32.⁶

⁵ Not all syntactic theories agree on the analyses of *ba* and *bei*. Both have also been analyzed as prepositions and the NPs following them as oblique objects (e.g. Chao 1968, Li 1990), though Huang and colleagues (2009) persuasively argued against the prepositional analyses and for the structures adopted in 28–29.

⁶ In the present study, gapped PRCs such as 30–32, rather than resumptive PRCs like (i), are used so that the prenominal regions of PRCs and ARCs can be matched on the number of words and arguments (see Table 1 and Table 2).

(i) [taiyang shaishang ta_i (de) bizi] de na-ge yuanding_i
 [the.sun burn he POSS nose] REL that-CL gardener
 'the gardener whose nose the sun burned'

One of the referees suggests that a resumptive pronoun is required for PRCs whose possessee NPs appear in nonsubject positions. While resumptive pronouns may enhance the naturalness of some PRCs, evidence from several studies suggests that the choice between a resumptive pronoun and a gap in a Chinese PRC is not an issue of grammaticality but one related to the cost of processing. In Cantonese, Francis and colleagues' (2015) sentence-production study corroborated the grammaticality of gapped PRCs and the facilitative function of resumption. Native Cantonese speakers were prompted to produce PRCs (with kinship terms serving as the dependent NPs) by putting together two given clauses. A total of seventy-three PRCs were collected. When the dependent NP was at the subject position as in 20, the gap strategy was adopted in 28.2% of the PRCs produced (resumptive strategy: 71.8%). When the dependent NP was at the object position as in (i), the gap strat-

(30) Mandarin PRCs (canonical SVO version)

[taifeng chuikua **maowu**_i] de **nongren**_i hen nanguo.

[typhoon blow.down hut] REL farmer very sad

‘The farmer whose hut the typhoon blew down felt very sad.’

(31) Mandarin PRCs (*ba* version)[taifeng ba **maowu**_i chuikua] de **nongren**_i hen nanguo.

[typhoon BA hut blow.down] REL farmer very sad

‘The farmer whose hut the typhoon blew down was very sad.’

(32) Mandarin PRCs (passive *bei* version)[**maowu**_i bei taifeng chuikua] de **nongren**_i hen nanguo.

[hut BEI typhoon blow.down] REL farmer very sad

‘The farmer whose hut was blown down by the typhoon was very sad.’

These three basic clause types are also used in ARCs, which are exemplified in 33–35.

(33) Mandarin ARCs (canonical SVO version)

[liwei shanchu yusuan] de liyou hen huangmiu.

[legislator cut budget] REL reason very ridiculous

‘The reason why legislators cut the budgets was ridiculous.’

(34) Mandarin ARCs (*ba* version)

[liwei ba yusuan shanchu] de liyou hen huangmiu.

[legislator BA budget cut] REL reason very ridiculous

‘The reason why legislators cut the budgets was ridiculous.’

(35) Mandarin ARCs (passive *bei* version)

[yusuan bei liwei shanchu] de liyou hen huangmiu.

[budget BEI legislator cut] REL reason very ridiculous

‘The reason why the budgets were cut by the legislators was ridiculous.’

Sentences with ARCs serve as a contrast to the gap-filler dependencies of PRCs since the head nouns of ARCs are relational nouns that take the whole prenominal clauses as their event arguments. Incrementally from left to right, the prenominal regions of an ARC are expected to be initially parsed as an independent clause. The relativizer *de* fol-

egy was adopted in 23.5% of the PRCs produced (resumptive strategy: 76.5%). The fact that more than 23% of PRC production adopted the gap strategy suggests that the choice between resumptive PRCs and gapped PRCs is not driven by binary grammaticality decisions but by processing demand (Francis et al. 2015:73; cf. Lau 2016).

These studies suggest gapped PRCs in Chinese are well formed, albeit difficult. Note that the referee cited Xu (2012), who proposed that Chinese requires a gap in PRCs like 20 where the dependent NP is at the subject position and a resumptive pronoun in PRCs like (i) where the dependent NP is at a nonsubject position. Xu’s proposal was based on a corpus study (with 1,236 relative clauses collected from five Chinese novels), in which only eight PRCs were found. Of these eight PRCs, seven were gapped PRCs with the dependent NP at the subject position; only one was a resumptive PRC with the dependent NP at the object position. Given the tenuous data collected from a specialized written genre (i.e. novels), Xu’s proposal will need further examination. In addition to the Cantonese study, Ning and Lin (2008) compared gapped PRCs whose dependent NPs appeared at the embedded subject positions like 20 and their resumptive counterparts in Standard Chinese, and found that gapped PRCs and resumptive PRCs were rated equally acceptable. Their self-paced reading experiment also confirmed no reading-time difference between gapped PRCs and resumptive PRCs. At the subject position, at least, whether a gap strategy or a resumptive strategy should be adopted is not distinguishable. An eye-tracking study (Ning et al. 2014) further supports the facilitative processing function of resumptive pronouns in Chinese PRCs. The authors found that resumptive pronouns were less dispreferred when the structure gets more complicated and that regression-path durations were shorter when ORs had resumptive pronouns than when they had gaps.

lowing the prenominal clause serves as the morphosyntactic indicator of a subordinate clause, marking the prenominal regions as an embedded clause. Given the relational nature of the head, the *WHOLE* prenominal clause is then taken as an event argument to the head noun. The processing cost of an ARC is expected to reflect the difficulty of the whole prenominal clause.

Regarding the processing of PRCs, the prenominal regions may also first be parsed as an independent clause. When the personal head noun is reached, the parser recognizes the possessive nature of the dependency and initiates a search for a dependent noun in the prenominal clause. Processing difficulty is expected to reflect the construction of the dependency between the head and the dependent noun in the prenominal clause.

Of particular theoretical interest to the current study are the predictions of the memory-based accounts and expectation-based accounts. Consider first expectation-based predictions for the three basic clause types. Based on structural probabilities, the canonical SVO structure presents the unmarked word order that has the highest structural frequency in Mandarin syntax and is expected to be the least costly to process. *Ba* and *bei* sentences are less frequent, by contrast (14.4% and 14.8%, respectively, in the Sinica Corpus; Chen et al. 1996).⁷ Based on structural frequencies, the canonical SVO structure is predicted to be the easiest of the three.

For ARCs and PRCs, ease of processing can be predicted based on the frequency of the different word orders as they appear in the prenominal clauses. To explore the frequencies of different word orders cooccurring with PRCs and ARCs, a corpus study was conducted with 3,075 embedded clauses extracted from the Sinica Treebank 3.0 (Chen et al. 2003).⁸ These relative clauses were manually coded, and thirty-three were identified as ARCs and nine as PRCs. Among the thirty-three ARCs, the canonical SV(O) order appeared in thirty-two tokens, and the *ba* structure appeared once. None of the ARCs contained a *bei* structure. The prenominal regions of all nine PRCs collected were in the canonical SV order. With tenuous corpus data, only tentative predictions can be made. The conditional structural probabilities of ARCs and PRCs suggest that the canonical SVO order should be the easiest to process—an effect that is similar to the predictions for simple clauses.⁹

Regarding memory-based predictions for the dependency effects of PRCs, tree diagrams are given in 36 to illustrate the syntactic structures of the three PRC variants; possessive dependencies are indicated by connecting lines.

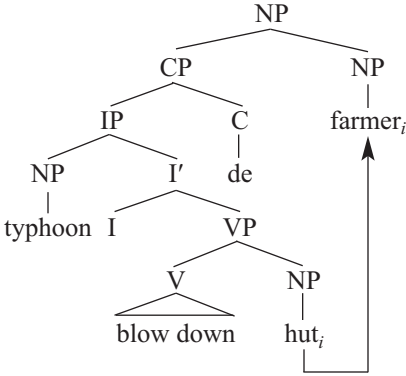
⁷ The word counts were retrieved from the Sinica Corpus (<http://elearning.ling.sinica.edu.tw/CWordfreq.html>) on December 15, 2017.

⁸ Information about Sinica Treebank 3.0 can be found at <http://rocling.iis.sinica.edu.tw/CKIP/engversion/treebank.htm>.

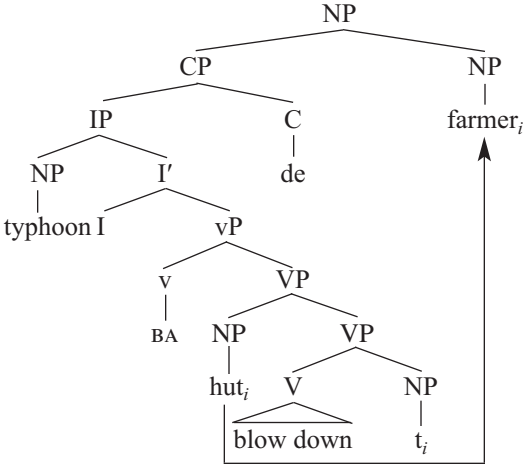
⁹ The dependent NPs in the nine PRCs collected were all located at the subject position of the embedded clauses. If the expectation-based prediction is made based on *WHERE* the dependent NP of a PRC most likely is, then the prediction will be similar to those of subject prominence and the AH below; that is, a dependent NP is more expected at the subject NP position of a PRC. However, a frequency explanation like this may run the risk of circular reasoning (see also Kwon et al. 2010 and Polinsky & Kluender 2007:278 for similar concerns), given that the frequency-based distributions can also be interpreted as the result, rather than the cause, of the subject-prominence effect.

(36) PRCs with different prenominal structures

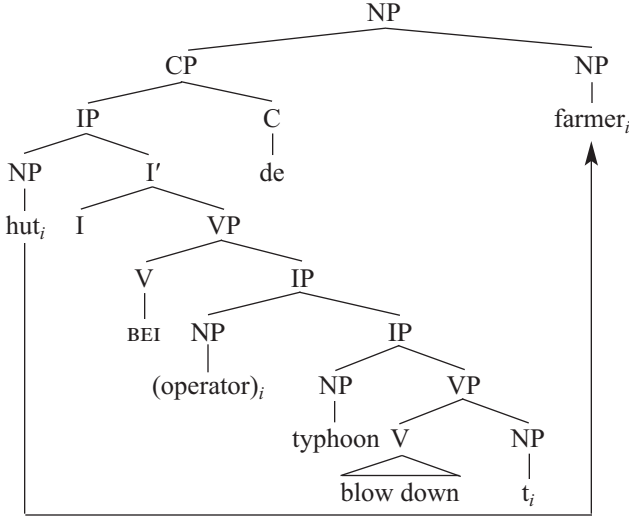
a. PRC with the SVO structure



b. PRC with the *ba* structure



c. PRC with the passive *bei* structure



A memory-based account operating on linear locality predicts greater integration cost as the dependent NP is located farther away from the head. Thus, 36a is expected to be

easier to process since the linear distance between the possessee NP and the head noun is the shortest. The linear distance between the possessee and the possessor is longer in the PRC with the *ba* structure, as in 36b, and longest in the PRC with the passive *bei* structure, as in 36c. Linear locality thus predicts the following ease-of-processing hierarchy: canonical SVO order < *ba* construction < passive *bei* construction (where '<' means 'less difficult than').¹⁰ Similarly, from the perspective of memory retrieval operating on push-down automata, more recently encountered words are expected to be easier to retrieve. The same prediction can be made without subscribing to the assumption that the dependent gap has been postulated in the prenominal clause.

Memory-based accounts operating on structural proximity and structural prominence (such as the AH) give primacy to dependent NPs that are located at syntactically higher/more prominent positions. Dependent NPs that are located at the subject position (as in 36c) are expected to be easier to retrieve than dependent NPs at the other positions (as in 36a and 36b). When viewed in terms of the number of maximal projections that connect the head noun and the dependent NP (e.g. Hawkins's 2004 FGD), passive PRCs are also expected to be the easiest to process among the three variants. Both accounts make the following ease-of-processing prediction: passive *bei* construction < canonical SVO order/*ba* construction.

4. METHODS. Three experiments were conducted to test the above predictions, including a naturalness-rating experiment (experiment 1) and two self-paced reading experiments (experiments 2 and 3). Experiments 1 and 2 used the same four sets of experimental sentences, including sentences with ARCs, sentences with PRCs, and two sets of baseline sentences. Because the prenominal clauses of the ARCs and PRCs are different in experiments 1 and 2, experiment 3 further controlled for the potential lexical variance by using identical words in the prenominal regions.

4.1. PARTICIPANTS. Participants in all three experiments were native speakers of Standard Chinese with normal or corrected-to-normal vision from a national university in Taipei. Fifty-nine undergraduate students between the ages of nineteen and twenty-two (forty-three female, ten male, six unidentified) voluntarily participated in a paper-based questionnaire in experiment 1. For experiments 2 and 3, twenty-six undergraduate students (eighteen female, eight male) between the ages of nineteen and twenty-two, and seventy-two students (forty-two female, thirty male) between the ages of nineteen and twenty-eight, respectively, were paid for their participation.

4.2. MATERIALS. Experiment 1 was a paper-based naturalness-rating questionnaire that contained a total of 173 sentences, including four sets of experimental sentences and seventy-seven filler sentences. To set the range for the naturalness ratings, the filler sentences included twenty-nine that had obvious word-order or grammaticality violations (as in 37), twenty-seven where syntactic or semantic violations were less straightforward (as in 38), and twenty-one that were well formed (as in 39).

(37) **ta bei laoshi lai le.*

he BEI teacher come ASP

*'He was come by the teacher.'

(38) ?*wo zai zhuoshang jiao ren fang le yi ben shu.*

I at table.top ask person put ASP one CL book

? 'I on the table asked someone to put a book.'

¹⁰ This prediction again bears on the assumption that the dependent possessee NP has been recognized as the left end of a dependency.

- (39) Zhongyanyuan jintian juban guoji yantaohui.
Academia.Sinica today hold international conference
'Academia Sinica is holding an international conference today.'

Experiment 2 was a self-paced reading experiment that used the same ninety-six experimental sentences as experiment 1, and 104 filler sentences, which were well-formed sentences containing various syntactic structures. The four sets of experimental sentences in experiments 1 and 2 included simple sentences (baseline 1 in 24–26), sentences that contain complex NPs (baseline 2 in 40–42), sentences with ARCs (like 33–35), and sentences with PRCs (like 30–32).¹¹

- (40) Canonical SVO structure with a complex NP (Baseline 2a)
jingcha lanxia le [weifan guize de cheliang].
policeman stop ASP [violate law REL car]
'The policeman stopped the car that violated the law.'
- (41) *ba* structure with a complex NP (Baseline 2b)
jingcha ba [weifan guize de cheliang] lanxia le.
policeman BA [violate law REL car] stop ASP
'The policeman stopped the car that violated the law.'
- (42) Passive *bei* structure with a complex NP (Baseline 2c)
[weifan guize de cheliang] bei jingcha lanxia le.
[violate law REL car BEI policeman stop ASP]
'The car that violated the law was stopped by the policeman.'

These four experimental sets were crossed with the three basic word orders (i.e. the SVO order, the *ba* structure, and the *bei* structure) and assigned to experimental lists using a Latin-square design. Experiments 1 and 2 both had a mixed between- and within-items design, with sentence types being a between-items factor and word orders being a within-items factor. The critical experimental conditions—sentences with ARCs and sentences with PRCs—were created with matching regions, illustrated in Table 1.

SENT TYPE	WORD ORDER	N1	Ø/BA/BEI	V/N2/N2	REGIONS N2/V/V	DE	HN	HN+1	HN+2
ARC	CANON	liwei		shanchu	yusuan	de	liyou	shifen	huangmiu
	SVO	legislator		cut	budget	REL	reason	very	ridiculous
	BA	liwei	ba	yusuan	shanchu	de	liyou	shifen	huangmiu
		legislator	BA	budget	cut	REL	reason	very	ridiculous
	PASS	yusuan	bei	liwei	shanchu	de	liyou	shifen	huangmiu
	BEI	budget	BEI	legislator	cut	REL	reason	very	ridiculous
PRC	CANON	taifeng		chuikua	maowu	de	nongren	shifen	nanguo
	SVO	typhoon		blow.down	hut	REL	farmer	very	sad
	BA	taifeng	ba	maowu	chuikua	de	nongren	shifen	nanguo
		typhoon	BA	hut	blow.down	REL	farmer	very	sad
	PASS	maowu	bei	taifeng	chuikua	de	nongren	shifen	nanguo
	BEI	hut	BEI	typhoon	blow.down	REL	farmer	very	sad

TABLE 1. ARCs and PRCs in experiments 1 and 2. Note: HN: head noun; HN+1: first region after head noun, HN+2: second region after head noun. Translation of the ARC examples: 'The reason why legislators cut the budgets was ridiculous.' Translation of the PRC examples: 'The farmer whose hut the typhoon blew down felt very sad.'

¹¹ For baseline 2, so that different types of relative clauses are counterbalanced, half of these relative clauses involved subject extractions; the other half involved object extractions. Half of the complex NPs appeared at the matrix subject position, half at the matrix object position.

Factors such as the animacy of the embedded NPs in the ARCs and PRCs and the alienability of the dependent NPs in the PRCs were counterbalanced. The head nouns of the ARCs and those of the PRCs bear intrinsic differences by necessity of the comparison. The ARC head nouns belong to a small set of inanimate nouns that tend to have higher frequencies; the PRC head nouns are animate personal nouns of lower frequencies (log-transformed frequency times 100,000: 10.52 for ARC head, $SE = 0.35$; 9.48 for PRC head, $SE = 0.35$; $t(36) = 2.12$, $p = 0.04$). Most of the head nouns of the ARCs fall into the category of instrument adjuncts, which allow a more diverse lexical selection. The lengths of the head nouns in the two groups were controlled for (number of syllables: ARC = 2.29, $SE = 0.14$; PRC = 2.38, $SE = 0.13$; $t(46) = 0.432$, $p = 0.67$).

To further control for the potential variance due to different words in the prenominal regions of ARCs and PRCs, experiment 3 was designed using ARCs and PRCs with identical prenominal clauses. Clauses with the three word orders (canonical SVO, *ba*, and *bei* structures) were paired with relational head nouns to form ARCs and with personal head nouns to form PRCs. Using a 2×3 within-items design, eighteen experimental sentences were created in addition to 142 filler sentences of various syntactic structures. To diversify the head nouns of the ARCs, eleven of the head nouns were of the event-property type, similar to those in experiment 2; seven were of the noun-complement structure like 43. In Standard Chinese, gapless ARCs like 11, aboutness ARCs like 15, and noun-complement clauses like 43 are not syntactically distinguishable in the prenominal regions.

- (43) [ta cizhi] de xiaoxi
 [he quit.job] REL news
 ‘the news that he quit his job’

Recall that Chinese relative clauses are prenominal and may be taken to be main clauses before the relativizer and the head noun. In experiment 3, an additional PRC condition was included where a classifier-noun mismatch cue was added to indicate the start of the embedded clause. In previous research, this cue has successfully indicated a clausal boundary for relative clauses in Japanese (Yoshida et al. 2004), Korean (Yoshida & Yoon 2014), and Mandarin Chinese (Hsu et al. 2014, Wu et al. 2009, Wu et al. 2014; cf. Jäger et al. 2015 for using the determiner-classifier-adverbial clash). This cue is based on the required semantic agreement (i.e. shape, animacy, and humanness) between a classifier and its complement noun phrase. When the noun immediately following a classifier does not carry a semantic feature matching the classifier, it must be analyzed as part of an embedded clause that intervenes between the classifier and its complement NP. A structural discontinuity indicating the start of an embedded clause can thus be created.

As an example, in Table 2 the DETERMINER-CLASSIFIER (DCL) sequence *na wei*, which carries the feature [+HUMAN], disagrees with the semantic feature of the local NPs, *fayuan* ‘court’ and *fangzi* ‘house’, which are both nonhuman entities. A clausal boundary is established, indicating the shaded regions as subordinate clauses. The head noun *xiaokai* ‘rich guy’, which carries an agreeing semantic feature [+HUMAN], completes the classifier-noun dependency. The classifier-noun mismatch condition was not included in sentences with ARCs because the head nouns of ARCs do not usually appear with DCLs.

The regions and examples of the ARC and PRC sentences in experiment 3 are provided in Table 3. All participants read ARCs following a sentence-initial adverbial phrase. Half of the participants read PRCs following a sentence-initial adverbial phrase; the other half read PRCs following a classifier-noun mismatch cue (a DCL). Given that *de* in Standard Chinese is ambiguous between a relativizer and a genitive marker, in creating the materials, care was taken to make sure that the *N2 de HN* sequences in the

		REGIONS						
		DCL	N1	Ø/BA/BEI	V/N2/N2	N2/V/V	DE	HN
CANONICAL SVO	na wei	fayuan			chafeng	fangzi	de	xiaokai
	that CL	court			confiscate	house	REL	rich.guy
	[+HUMAN]	[-HUMAN]						[+HUMAN]
		<div></div>						
BA	na wei	fayuan	ba	fangzi	chafeng	de	xiaokai	
	that CL	court	BA	house	confiscate	REL	rich.guy	
	[+HUMAN]	[-HUMAN]					[+HUMAN]	
		<div></div>						
PASSIVE BEI	na wei	fangzi	bei	fayuan	chafeng	de	xiaokai	
	that CL	house	BEI	court	confiscate	REL	rich.guy	
	[+HUMAN]	[-HUMAN]					[+HUMAN]	
		<div></div>						

TABLE 2. Classifier-noun mismatch in PRCs.

canonical SVO conditions are not semantically plausible to be interpreted as ‘the HN of N2’. As in experiment 2, the alienability of the dependent NP (i.e. N2 in the nonpassives and N1 in the passives) was counterbalanced. Half of the items contained an inalienable noun as the dependent NP, and the other half an alienable noun. The experimental sentences were assigned following a Latin-square design and presented in random orders along with the filler sentences. The ARC and PRC head nouns were all two syllables in length. The frequencies of the head nouns were different by necessity of such comparisons: the ARC head nouns were of higher frequencies than the PRC head nouns (log-transformed frequency times 100,000: 7.25 for ARC head, *SE* = 0.33; 5.68 for PRC head, *SE* = 0.36; *t*(31) = 3.02, *p* < 0.01). The full list of experimental materials is provided in the appendix.

SENT TYPE	WORD		REGIONS								
	ORDER	Adv/DCL	N1	∅/BA/BEI	V/N2/N2	N2/V/V	DE	HN	HN+1	HN+2	HN+3
ARC post Adv	CANON SVO	qunian last.year	fayuan court		chafeng confiscate	fangzi house	de REL	shihou time	women we	haibu still.not	renshi know
	BA	qunian last.year	fayuan court	ba BA	fangzi house	chafeng confiscate	de REL	shihou time	women we	haibu still.not	renshi know
	PASS BEI	qunian last.year	fangzi house	bei BEI	fayuan court	chafeng confiscate	de REL	shihou time	women we	haibu still.not	renshi know
PRC post Adv	CANON SVO	qunian last.year	fayuan court		chafeng confiscate	fangzi house	de REL	xiaokai rich.guy	women we	bingbu not	renshi know
	BA	qunian last.year	fayuan court	ba BA	fangzi house	chafeng confiscate	de REL	xiaokai rich.guy	women we	bingbu not	renshi know
	PASS BEI	qunian last.year	fangzi house	bei BEI	fayuan court	chafeng confiscate	de REL	xiaokai rich.guy	women we	bingbu not	renshi know
PRC post DCL	CANON SVO	nawei that.CL	fayuan court		chafeng confiscate	fangzi house	de REL	xiaokai rich.guy	women we	bingbu not	renshi know
	BA	nawei that.CL	fayuan court	ba BA	fangzi house	chafeng confiscate	de REL	xiaokai rich.guy	women we	bingbu not	renshi know
	PASS BEI	nawei that.CL	fangzi house	bei BEI	fayuan court	chafeng confiscate	de REL	xiaokai rich.guy	women we	bingbu not	renshi know

TABLE 3. ARC and PRC sentences in experiment 3. Note: HN: head noun, HN+1: first region after head noun, HN+2: second region after head noun, HN+3: third region after head noun. Translation of the ARC examples: ‘When the court confiscated the house last year, we did not know each other.’ Translation of the PRC examples: ‘The rich guy whose house the court confiscated (last year), we did not know (him).’

4.3. PROCEDURE. For experiment 1, each participant was randomly given a paper-based questionnaire, which started with questions about the participant's linguistic background, followed by instructions and examples. Participants were instructed to rate the naturalness of each sentence on a scale of 1 (*hen ziran* 'very natural', *hen tongshun* 'very smooth') to 6 (*hen bu ziran* 'very unnatural', *hen aokou* 'very strange').¹² The average time for completing each questionnaire was twenty-five minutes. For experiment 2, sentences were presented using the moving-window self-paced reading paradigm as implemented in Linger 2.94 (Rohde 2005). Each trial started with a line of dashes presented at the vertical center of the computer screen (each dash in place of a Chinese character). Hitting the space bar revealed the first word in the sentence. Each subsequent press revealed the next word and changed the previous word back to dashes. After the last word of a sentence, participants were given a true/false comprehension question. For experiment 3, sentences were presented using the centered self-paced reading paradigm (E-Prime 2.0 pro). Each trial started with a cross at the center of the monitor serving as a fixation point. Hitting a button on a response box revealed the first word in the sentence, with each subsequent press replacing the previous word with the next word in the sentence. After the last word of a sentence, participants were given a true/false comprehension question. For both experiments 2 and 3, feedback was given whenever the participant's response was incorrect. Participants were instructed to read sentences at a natural pace in order to answer the comprehension questions correctly. The reading time for each word, the time taken to answer the comprehension questions, and the responses to the comprehension questions were recorded. Experiments 2 and 3 took an average of thirty and fifteen minutes, respectively, to complete.

5. RESULTS AND DISCUSSION. Linear mixed models were fit on the naturalness ratings and reading-time data using the lme4 package version 1.1-7 of R (version 3.2.0; Bates et al. 2015). Participants and items were both treated as random effects in the models on the intercepts and the slopes. To stabilize variance and achieve normal residuals, naturalness ratings and reading times were log-transformed before analyses. Residuals were checked to ensure that the normality requirement is met. A *t*-value of 2 or above is taken to be equivalent to the statistical significance at $\alpha = 0.05$. Question accuracies (i.e. binary responses) were fit by using generalized linear mixed models with a binomial link function.

5.1. EXPERIMENT 1 NATURALNESS RATINGS. The dependent measure in experiment 1 was naturalness rating. Fixed effects included sentence types (Baseline 1, Baseline 2, ARCs, and PRCs), word orders (SVO, BA, and BEI), the animacy of the agent NP, and the animacy of the patient NP.¹³ Four participants (three female, one male) were excluded from the analyses due to two having incorrect ratings on more than 55% of the

¹² In addition to the naturalness ratings, participants decided if each sentence was grammatical, ungrammatical, or in-between immediately following each naturalness rating. Because the naturalness and grammaticality ratings show consistent patterns, only the results of the naturalness ratings are reported.

¹³ For the sentence types, three contrasts were defined, contrasting PRCs with the first set of baseline sentences (PRCs coded as +1, first set of baseline sentences as -1), contrasting PRCs with the second set of baseline sentences (PRCs coded as +1, second set of baseline sentences as -1), and contrasting PRCs with ARCs (PRCs coded as +1, ARCs as -1). For the word-order types, two contrasts were defined, contrasting passives with the SVO order (passive coded as +1, SVO as -1) and with the *ba* order (passive coded as +1, *ba* as -1). For animacy, animate NP was coded as +1, and inanimate NP as -1. Effects interacting with the NP animacies and effects related to the alienability of the patient NPs in PRCs were checked in separate models. The same naturalness-rating patterns were observed regardless of animacy and alienability, and the effect of alienability was not significant; therefore, only model results that included the NP animacies as fixed effects but not their interactions with the other effects are reported.

ungrammatical filler items and the other two having begun to learn Mandarin after the age of seven. The analyses were based on the remaining fifty-five questionnaires (forty female, nine male, six unidentified). The average of all naturalness ratings including the filler sentences was 3.12 ($SE = 0.02$). The mean naturalness rating for the filler items was 3.90 ($SE = 0.03$). Among the fillers, the grammatical sentences (12% of total) had an average rating of 1.95 ($SE = 0.04$), the ungrammatical sentences (17% of total) an average rating of 5.30 ($SE = 0.03$), and the in-between sentences (16% of total) an average rating of 3.89 ($SE = 0.05$). Figure 1 provides a bar chart for the naturalness ratings as a function of the word orders and sentence types. Statistical results of the model estimates are given in Table 4.

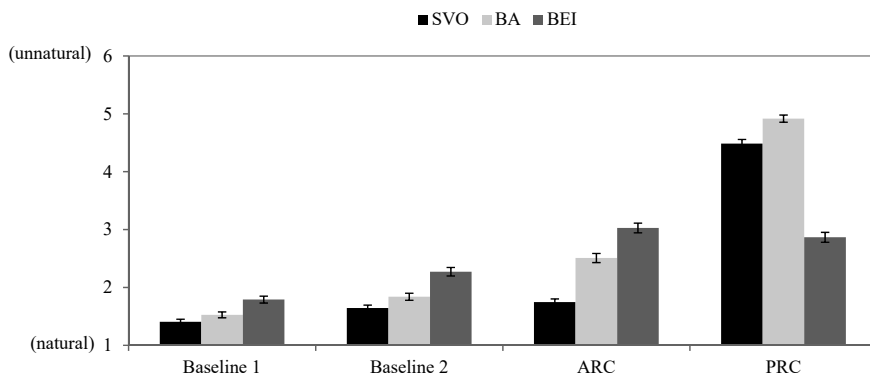


FIGURE 1. Naturalness scores in experiment 1 (error bar indicates one standard error).

CONTRAST	COEF	SE	t-VALUE
(intercept)	0.52	0.06	9.24
sentence_type PRC-ARC	0.64	0.06	11.31
sentence_type PRC-Baseline 2	0.81	0.06	13.27
sentence_type PRC-Baseline 1	0.95	0.06	16.02
word_order bei-SVO	0.10	0.02	6.30
word_order bei-ba	-0.05	0.02	-2.77
animacy_Agent	0.13	0.05	2.48
animacy_Patient	0.16	0.04	3.76
sentence_type PRC-ARC × word_order bei-SVO	-1.09	0.05	-23.61
sentence_type PRC-Baseline 2 × word_order bei-SVO	-0.85	0.05	-18.38
sentence_type PRC-Baseline 1 × word_order bei-SVO	-0.77	0.05	-16.79
sentence_type PRC-ARC × word_order bei-ba	-0.91	0.05	-19.80
sentence_type PRC-Baseline 2 × word_order bei-ba	-0.88	0.05	-19.16
sentence_type PRC-Baseline 1 × word_order bei-ba	-0.84	0.05	-18.27

TABLE 4. Effects of sentence types, word orders, animacy, and interactions in experiment 1 (significance at $\alpha = 0.05$ indicated by boldface; model: sentence_type × word_order + animacy_Agent + animacy_Patient + (1|Subject) + (1|Item)).

Significant interactions were found between word orders and sentence types when comparing passives with SVO sentences and when comparing passives with *ba* sentences in different sentence types. In baseline 1, baseline 2, and ARCs, the passive variant was rated as less natural than the SVO order and the *ba* structure. In PRCs, however, the passive variant was rated as more natural than the SVO order and the *ba* structure. The animacy of the agent NP (N1) and of the patient NP (N2) also showed significant effects, with animate agents and animate patients being rated as less natural. While it is understandable that patient NPs are preferably inanimate (Wu et al. 2011), there is no clear explanation of why animate agent NPs were disfavored.

5.2. EXPERIMENT 2: SELF-PACED READING A. Dependent measures in experiment 2 included comprehension accuracies, latencies of the responses to comprehension questions, the average per-character reading time of whole sentences, and the reading times in each of the four regions after the prenominal clause (i.e. the relativizer *de*, the head noun, and two regions after the head noun) in the sentences with ARCs and in those with PRCs. The same statistical treatments as those in experiment 1 were defined for comprehension accuracies, latencies, and the average per-character reading times of whole sentences. For the by-region reading times in ARCs and PRCs, fixed effects included sentence types (ARCs and PRCs), word orders (SVO, BA, and BEI), the animacy of the agent NP, and the animacy of the patient NP. Alienability was additionally included as a predictor in a separate model to check if it would interact with the effect of word orders for sentences with PRCs; fixed effects included word orders (passives vs. nonpassives), alienability of the dependent NP, the animacy of the agent NP, and the animacy of the patient NP.¹⁴ The data of one participant was excluded due to a technical problem during the experiment. Statistical analyses were based on trials where the participants correctly answered the comprehension questions.

COMPREHENSION ACCURACY AND LATENCY. All participants were able to correctly answer at least 90% of the comprehension questions. The overall comprehension accuracy was 94%. Table 5 summarizes the comprehension accuracies and response latencies (in parentheses) as a function of the sentence types and word orders. Statistical results are given in Table 6.

SENTENCE TYPE	SVO ORDER	BA ORDER	BEI ORDER
Baseline 1	.98 (1,563)	.96 (1,665)	.98 (1,591)
Baseline 2	.98 (1,620)	.99 (1,555)	.98 (1,678)
Sentences with ARCs	.92 (1,643)	.93 (1,591)	.92 (1,725)
Sentences with PRCs	.90 (1,998)	.87 (1,906)	.89 (1,704)

TABLE 5. Proportion correct on the comprehension questions in experiment 2, with mean response times in milliseconds (in parentheses).

Regarding comprehension accuracy, baseline 1 and baseline 2 were both higher than PRCs. Regarding response latencies of the comprehension questions, sentences with animate patient NPs took longer than sentences with inanimate patient NPs. Several interactions between word order and sentence types were significant: while passives induced shorter response latencies than the SVO order in PRCs, they induced longer response latencies than the SVO order in all other sentence structures. The difference between passives and SVOs was significant (Coef. = -0.16 , $SE = 0.06$, $t = -2.76$) and interacted with the alienability of the dependent NP (Coef. = 0.17 , $SE = 0.08$, $t = 2.06$): passives induced shorter response times than the SVO variants in PRCs when the dependent NP was an inalienable noun.

PER-CHARACTER READING TIME. Per-character reading time of each sentence was based on the average time taken to read each region divided by the number of Chinese characters in that region, excluding punctuation. Figure 2 provides a bar chart for per-

¹⁴ For sentence types, a sum contrast was defined contrasting PRCs with ARCs (PRCs coded as +1, ARCs as -1). For word orders, two contrasts were defined, contrasting the passives with the SVO order (passive coded as +1, SVO as -1), and contrasting the passives with the *ba* order (passive coded as +1, *ba* as -1). For animacy of the NPs, animate NP was coded as +1, and inanimate NP as -1. For the effect of alienability, codings of contrasts were the same as those for the by-region reading times in ARCs and PRCs, with the alienability of the dependent NP included as an additional predictor (alienable NP coded as +1, inalienable NP as -1).

CONTRAST	COMPREHENSION ACCURACY				COMPREHENSION RT			PER-CHARACTER RT		
	COEF	SE	z	Pr(> z)	COEF	SE	t	COEF	SE	t
(intercept)	4.45	0.52	8.52	<0.001	7.23	0.07	108.64	5.45	0.05	101.04
sentence_type PRC-ARC	-0.82	0.52	-1.57	0.12	0.10	0.06	1.75	0.11	0.03	4.11
sentence_type PRC-Baseline 2	-2.26	0.64	-3.53	0.00	0.08	0.06	1.40	0.10	0.03	3.53
sentence_type PRC-Baseline 1	-1.78	0.62	-2.89	0.00	0.09	0.06	1.61	0.28	0.03	10.44
word_order bei-SVO	-0.04	0.29	-0.12	0.90	0.01	0.02	0.61	0.07	0.01	5.41
word_order bei-ba	0.16	0.29	0.57	0.57	0.02	0.02	1.35	-0.03	0.01	-2.26
animacy_Agent	-0.60	0.52	-1.15	0.25	0.06	0.05	1.06	0.06	0.02	2.57
animacy_Patient	-0.27	0.44	-0.62	0.53	0.09	0.04	2.16	0.09	0.02	4.27
sentence_type PRC-ARC × word_order bei-SVO	-0.08	0.56	-0.14	0.89	-0.12	0.05	-2.36	-0.29	0.04	-7.58
sentence_type PRC-Baseline 2 × word_order bei-SVO	-0.11	0.81	-0.14	0.89	-0.12	0.05	-2.46	-0.29	0.04	-7.67
sentence_type PRC-Baseline 1 × word_order bei-SVO	-0.05	0.81	-0.07	0.95	-0.12	0.05	-2.37	-0.31	0.04	-8.37
sentence_type PRC-ARC × word_order bei-ba	0.41	0.55	0.74	0.46	-0.06	0.05	-1.21	-0.23	0.04	-6.16
sentence_type PRC-Baseline 2 × word_order bei-ba	0.58	0.86	0.67	0.50	-0.07	0.05	-1.48	-0.25	0.04	-6.74
sentence_type PRC-Baseline 1 × word_order bei-ba	-0.62	0.71	-0.87	0.38	-0.04	0.05	-0.78	-0.17	0.04	-4.58

TABLE 6. Effects of sentence types, word orders, animacy, and interactions on the comprehension accuracy, comprehension-question response latency, and per-character reading time of whole sentences in experiment 2 (significance at $\alpha = 0.05$ indicated by boldface; model: sentence_type × word_order + animacy_Agent + animacy_Patient + (1|Subject) + (1|Item)).

character reading times as a function of the sentence types and word orders. Statistical results are given in Table 6 above.

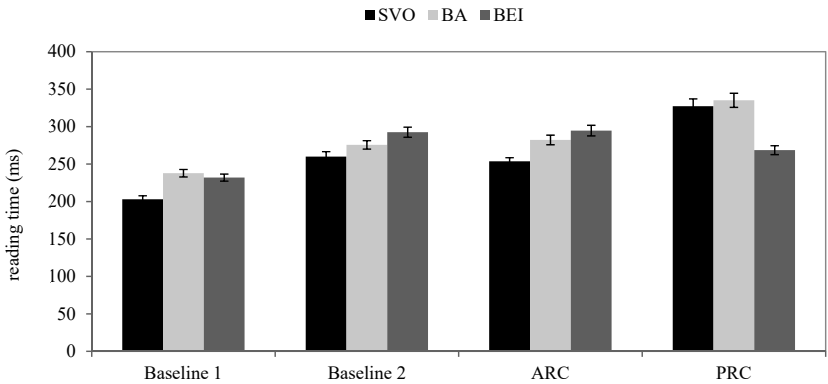


FIGURE 2. Per-character reading times in experiment 2 (error bar indicates one standard error).

Consistent with the rating results of experiment 1, significant interactions were found between word orders and sentence types. The passive variant was read faster than the SVO order and the *ba* structure in the PRCs, but not in baseline 1, baseline 2, or ARCs. The animacy of the agent NP and of the patient NP also showed significant effects, with animate agents and animate patients being read longer. When the alienability of the dependent NP was included as a predictor for the PRCs, the same effects were replicated; neither the effect of alienability nor interactions with it were significant.

BY-REGION READING TIMES OF ARCS AND PRCs. Sentences with ARCs and sentences with PRCs have parallel regions as presented in Table 1, which allow region-by-

region comparisons. Figure 3 presents the by-region reading times of ARC and PRC sentences as a function of relative clause types and word orders. Table 7 presents the statistical results from the relativizer to the second region after the head noun.

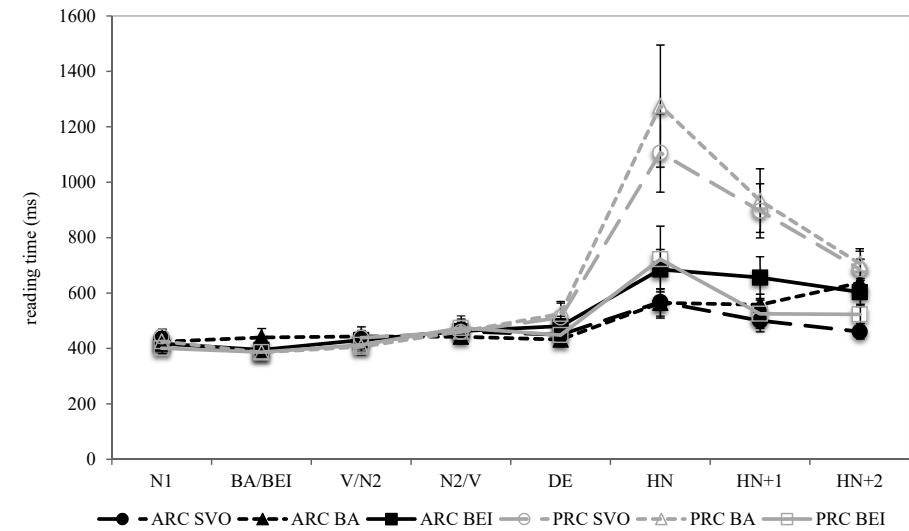


FIGURE 3. By-region reading times of sentences with ARCs and sentences with PRCs (error bar indicates one standard error).

CONTRAST	DE			HEAD NOUN		
	COEF	SE	t	COEF	SE	t
(intercept)	5.97	0.06	106.48	6.16	0.10	61.28
sentence_type PRC-ARC	0.07	0.03	2.03	0.34	0.05	6.31
word_order bei-SVO	-0.04	0.03	-1.58	-0.14	0.04	-3.43
word_order bei-ba	-0.03	0.03	-1.12	-0.15	0.04	-3.58
animacy_Agent	0.05	0.03	1.40	0.11	0.06	1.84
animacy_Patient	0.08	0.03	2.76	0.23	0.05	4.69
sentence_type PRC-ARC × word_order bei-SVO	-0.11	0.06	-2.02	-0.48	0.08	-5.80
sentence_type PRC-ARC × word_order bei-ba	-0.14	0.06	-2.53	-0.47	0.08	-5.62

CONTRAST	HEAD NOUN + 1			HEAD NOUN + 2		
	COEF	SE	t	COEF	SE	t
(intercept)	6.12	0.08	77.46	6.08	0.08	74.22
sentence_type PRC-ARC	0.20	0.07	2.96	0.15	0.08	1.82
word_order bei-SVO	-0.12	0.04	-3.19	-0.01	0.04	-0.16
word_order bei-ba	-0.15	0.04	-3.81	-0.09	0.04	-2.23
animacy_Agent	0.11	0.07	1.50	0.14	0.09	1.61
animacy_Patient	0.12	0.06	2.03	-0.01	0.07	-0.14
sentence_type PRC-ARC × word_order bei-SVO	-0.56	0.08	-7.27	-0.30	0.08	-3.93
sentence_type PRC-ARC × word_order bei-ba	-0.49	0.08	-6.40	-0.29	0.08	-3.85

TABLE 7. Effects of sentence type, word orders, animacy, and interactions on the reading times of four regions after the prenominal clauses of sentences with ARCs and sentences with PRCs in experiment 2 (significance at $\alpha = 0.05$ indicated by boldface; model: sentence_type \times word_order + animacy_Agent + animacy_Patient + (1|Subject) + (1|Item)).

Regarding the effect of sentence types, PRCs were read longer than ARCs from the relativizer to the first region after the head noun. The effects of word orders were significant in the head noun and the first region after the head noun. The interactions between sentence types and word orders were significant in all four regions. The passive

variant was read faster than both the SVO order and the *ba* order in PRCs but not in ARCs. Regarding the animacy effects, sentences with animate patient NPs were read longer than sentences with inanimate patient NPs from the relativizer to the first region after the head noun. The effect of alienability was not significant; the same word-order effects (i.e. passives being read faster than the SVO order and the *ba* order) were replicated on PRCs when the alienability of the dependent NP was included as a predictor.¹⁵

Experiments 1 and 2 both adopted a between-items design where ARCs and PRCs have different prenominal clauses. This design leaves open the possibility that PRCs with the passive *bei* structure may have been easier because these PRC sentences happened to be better fitted for the passive structure. To rule out this possibility, experiment 3 adopted a within-items design where ARCs and PRCs have identical lexical items in the prenominal regions.

5.3. EXPERIMENT 3: SELF-PACED READING B. As in experiment 2, dependent measures in experiment 3 included the accuracies of the responses to comprehension questions, the time taken to respond to the comprehension questions, and the reading times in each of the four regions after the prenominal clause. Fixed effects in experiment 3 included sentence types, word orders, alienability of the dependent NP, and their interactions. Three sentence types were compared in the model: ARCs following an adverbial phrase (ARC_adv), PRCs following an adverbial phrase (PRC_adv), and PRCs following a classifier-noun mismatch cue (PRC_dcl). Since the main comparison of interest regarding word orders is the difference between the passive and the nonpassive structures, the effect of word order was defined as the difference between passives and nonpassives.¹⁶ Seven participants (five female, two male) whose comprehension accuracies on the experimental trials were lower than 85% were excluded from the statistical analyses. The overall comprehension accuracy across all trials for the remaining participants was 95.68%. The reported analyses were based on trials where the participants correctly answered the comprehension questions.

COMPREHENSION ACCURACY AND LATENCY. Table 8 summarizes the descriptive statistics of comprehension accuracies and response latencies for comprehension questions as a function of the clause types, word orders, and alienability of the embedded NP. Table 9 presents the results of the model estimates. In terms of comprehension accuracy, none of the effects was significant. In terms of the time taken to respond to comprehension questions, the only significant effects were the three-way interactions between sentence types, word orders, and alienability. Since these interactions were observed based on response latencies to comprehension questions and none of the main effects was significant, they are less straightforward to interpret.

BY-REGION READING TIMES OF ARCS AND PRCs. No significant effects were found in the regions before the relativizer. Table 10 summarizes the model estimates of the four

¹⁵ Several additional variables suggested by the referees were checked to ensure that they do not contribute to the PRC/ARC asymmetry observed. These factors included the existence of aspect marker *le* in some of the PRCs, the misparsability of the *N de HN* sequence in the SVO variant of the PRCs, and the type of head noun in ARCs. Since none of these factors interacted with the effects observed, they are not included in the model estimates reported in the main text.

¹⁶ Sliding contrasts were defined for sentence types, contrasting ARCs following adverbs with PRCs following adverbs for the difference between ARCs and PRCs (ARC_adv coded as $-2/3$, PRC_adv as $+1/3$, PRC_dcl as $+1/3$), and contrasting PRCs following adverbs with PRCs following DCLs for the effect of classifier-noun mismatch (ARC_adv coded as $-1/3$, PRC_adv as $-1/3$, PRC_dcl as $+1/3$). For the effect of word orders, sum contrasts were defined, comparing passives with nonpassives (nonpassives coded as $+1$, passives as -1). For alienability of the dependent NP, alienable NP was coded as $+1$, and inalienable NP as -1 .

	INALIENABLE NP		ALIENABLE NP	
	NONPASSIVE	PASSIVE	NONPASSIVE	PASSIVE
ARC (following adverb)	.88 (1,413)	.88 (1,410)	.96 (1,481)	.93 (1,299)
PRC (following adverb)	.91 (1,564)	.98 (1,375)	.94 (1,372)	.96 (1,576)
PRC (following DCL)	.95 (1,542)	.87 (1,544)	.93 (1,435)	.98 (1,321)

TABLE 8. Proportion correct on the comprehension questions in experiment 3, with mean response times in milliseconds (in parentheses).

CONTRAST	COMPREHENSION ACCURACY				COMPREHENSION RT		
	COEF	SE	z	Pr(> z)	COEF	SE	t
(intercept)	3.24	0.61	5.29	0.00	7.19	0.10	71.92
sentence_type PRC_adv-ARC_adv	1.10	0.59	1.86	0.06	-0.02	0.04	-0.35
sentence_type PRC_dcl-PRC_adv	-0.58	0.65	-0.90	0.37	0.08	0.06	1.44
word_order nonpassive-passive	-0.13	0.45	-0.29	0.77	0.02	0.04	0.49
alienability 1	1.07	0.90	1.19	0.24	-0.03	0.14	-0.21
sentence_type PRC_adv-ARC_adv × word_order	-1.50	1.18	-1.27	0.20	0.12	0.08	1.38
sentence_type PRC_dcl-PRC_adv × word_order	2.53	1.30	1.95	0.05	-0.17	0.10	-1.76
sentence_type PRC_adv-ARC_adv × alienability	-1.09	0.81	-1.35	0.18	0.01	0.06	0.15
sentence_type PRC_dcl-PRC_adv × alienability	0.94	0.99	0.95	0.34	-0.06	0.07	-0.90
word_order × alienability	-0.22	0.70	-0.32	0.75	0.00	0.05	-0.09
sentence_type PRC_adv-ARC_adv × word_order × alienability	-0.07	1.62	-0.05	0.96	-0.28	0.12	-2.41
sentence_type PRC_dcl-PRC_adv × word_order × alienability	-2.76	1.98	-1.39	0.16	0.28	0.14	2.04

TABLE 9. Effects of sentence type, word order, alienability, and their interactions, on the comprehension accuracy and comprehension-question response latency in experiment 3 (significance at $\alpha = 0.05$ indicated by boldface; model: sentence_type × word_order × alienability + (1|Subject) + (1|Item)).

regions after the embedded clause—from the relativizer to the second region after the head noun. Reading times were longer for PRCs than for ARCs. The effect of word order was significant in the relativizer region, the head noun region, and the second region after the head noun, with nonpassives being read longer than passives. Crucial to our prediction, the interaction between clause type and word order was significant in the head noun region: the passive structure was read faster than the nonpassive structures in sentences with PRCs but not in sentences with ARCs.

The effect of alienability was itself not significant, though it interacted with word orders and the existence of mismatch cues in the relativizer region, and interacted with relative clause types in the two regions after the head noun. Figure 4 shows the average reading time for each region as a function of relative clause types (ARCs following adverbs vs. PRCs following adverbs) and the word order of the prenominal clause.

Figure 5 presents the by-region reading times for the sentences with PRCs as a function of whether they were preceded by a classifier-noun mismatch cue and the different word orders of the prenominal clause. The same word-order effect is observed: the passive structure was read faster than the nonpassive structures on the head noun and the region following it. The effect of classifier-noun mismatch was not significant in any region, though the overall numerical trend shows that PRC sentences with classifier-noun mismatches (the DCL condition) were read faster than those without the mismatch (the adverb condition).¹⁷

¹⁷ To check whether instrument ARCs and noun-complement clauses in the ARC condition displayed the same word-order effects, a linear mixed-effects model was constructed where types of gapless clauses (instrument ARCs vs. noun-complement clauses) and word orders were included as fixed effects. None of the main effects or their interactions was significant, corroborating the homogeneity within ARC processing.

CONTRAST	DE			HEAD NOUN		
	COEF	SE	t	COEF	SE	t
(intercept)	6.05	0.04	171.00	6.09	0.05	135.16
sentence_type PRC_adv-ARC_adv	-0.01	0.03	-0.28	0.10	0.05	2.20
sentence_type PRC_dcl-PRC_adv	-0.01	0.04	-0.36	0.05	0.06	0.79
word_order nonpassive-passive	0.06	0.02	2.48	0.10	0.04	2.53
alienability 1	-0.01	0.02	-0.64	-0.04	0.03	-1.33
sentence_type PRC_adv-ARC_adv × word_order	0.10	0.06	1.66	0.18	0.09	2.04
sentence_type PRC_dcl-PRC_adv × word_order	-0.10	0.07	-1.46	-0.09	0.10	-0.89
sentence_type PRC_adv-ARC_adv × alienability	0.02	0.04	0.39	-0.06	0.06	-0.94
sentence_type PRC_dcl-PRC_adv × alienability	-0.05	0.05	-1.10	-0.06	0.07	-0.90
word-order × alienability	-0.07	0.03	-1.97	-0.10	0.05	-1.95
sentence_type PRC_adv-ARC_adv × word_order × alienability	-0.10	0.08	-1.23	-0.17	0.12	-1.34
sentence_type PRC_dcl-PRC_adv × word_order × alienability	0.22	0.09	2.32	0.08	0.14	0.53

CONTRAST	HEAD NOUN + 1			HEAD NOUN + 2		
	COEF	SE	t	COEF	SE	t
(intercept)	6.13	0.04	145.12	6.08	0.04	153.97
sentence_type PRC_adv-ARC_adv	0.20	0.05	4.31	0.14	0.04	3.94
sentence_type PRC_dcl-PRC_adv	-0.05	0.06	-0.81	-0.06	0.05	-1.21
word_order nonpassive-passive	0.05	0.04	1.43	0.06	0.03	2.14
alienability 1	-0.05	0.04	-1.37	-0.04	0.03	-1.35
sentence_type PRC_adv-ARC_adv × word_order	0.08	0.09	0.94	0.05	0.07	0.70
sentence_type PRC_dcl-PRC_adv × word_order	-0.09	0.10	-0.84	-0.09	0.08	-1.11
sentence_type PRC_adv-ARC_adv × alienability	-0.13	0.06	-2.17	-0.11	0.05	-2.23
sentence_type PRC_dcl-PRC_adv × alienability	0.09	0.07	1.26	0.04	0.06	0.78
word-order × alienability	-0.02	0.05	-0.43	-0.05	0.04	-1.15
sentence_type PRC_adv-ARC_adv × word_order × alienability	-0.12	0.12	-0.98	-0.07	0.10	-0.75
sentence_type PRC_dcl-PRC_adv × word_order × alienability	0.23	0.14	1.62	0.12	0.11	1.10

TABLE 10. Effects of sentence type, word order, alienability, and their interactions on the reading times of four regions after the prenominal clauses in ARCs and PRCs of experiment 3 (significance at $\alpha = 0.05$ indicated by boldface; model: sentence_type × word_order × alienability + (1|Subject) + (1|Item)).

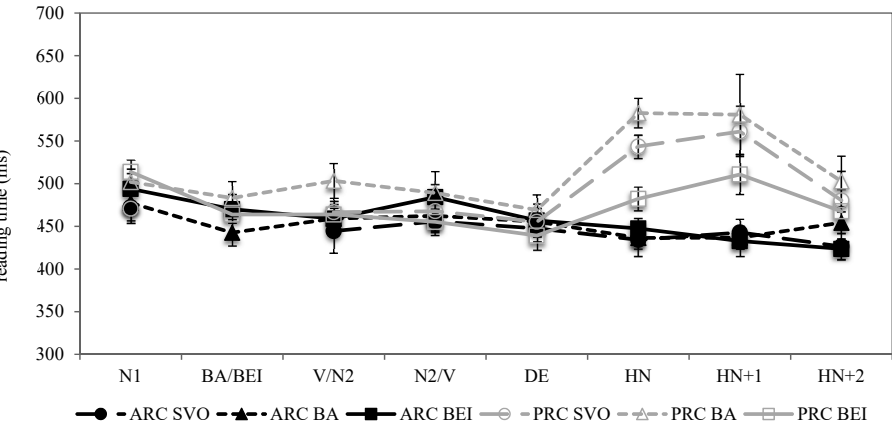


FIGURE 4. By-region reading times of sentences with ARCs and sentences with PRCs following adverbials in experiment 3 (error bar indicates one standard error).

In summary, experiment 3 controlled for the variance in the prenominal regions of ARCs and PRCs by using the same words in the prenominal clauses, and it replicated

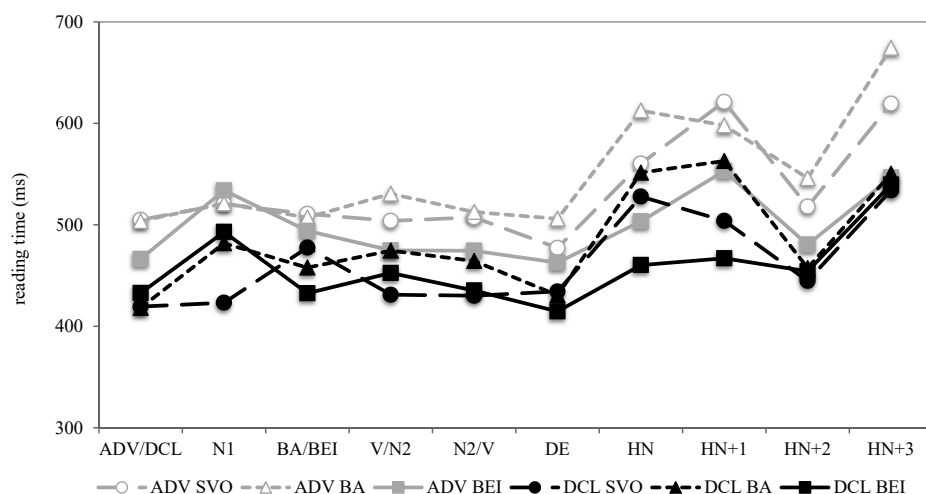


FIGURE 5. By-region reading times of sentences with PRCs as a function of word orders and existence of classifier-noun mismatch in experiment 3.

the interaction between relative clause types and word orders on the head noun. These results can be summarized as follows (where ‘<’ means ‘shorter reading time than’).

- (44) a. ARC: nonpassive < passive
 b. PRC: passive < nonpassive

The results of experiment 3 are consistent with the first two experiments. Within the PRCs but not the ARCs, the passive *bei* variant was read faster than the SVO and the *ba* variants. The same passive advantage was observed with regard to whether the PRC sentences were disambiguated by a classifier-noun mismatch and whether the embedded dependent NP was alienable. These results support the memory-based theory that relies on structural locality and subject prominence for the comprehension of dependencies in prenominal relative clauses. As predicted, a dependent NP located at the subject position is less costly to retrieve. These results are incompatible with the predictions of both memory-based accounts that rely on linear locality and the frequency-based account.

Regarding the differences between ARCs and PRCs, the reading times of PRCs were longer than those of ARCs starting from the head noun region to the end of the sentence. This effect may be due to the ARC head nouns being relational nouns with higher frequencies, and/or to the greater cost of searching for a dependent NP to complete a possessive dependency in a PRC.

6. GENERAL DISCUSSION. The goal of the present study was to investigate how gap-filler dependencies are established in prenominal relative clauses where the relativized gaps appear before the head nouns. Research on this topic has focused on whether different grammatical and linear positions of the gap would predict different processing costs for establishing dependencies. Relativizations involving extractions from subject and object positions have been compared in previous research because the gaps in SRs and ORs are located at different grammatical positions and hold different linear distances from the filler. This research tradition has been most interested in the memory mechanisms involved in representing and retrieving lexical items for establishing dependencies.

The present study points out critical inadequacies of such comparisons for studying dependency effects. While researchers are interested in whether dependencies that involve different grammatical and linear positions modulate processing difficulty, comparisons between SRs and ORs are additionally inflicted by factors unrelated to the dependency effect. In Standard Chinese, for example, SRs have higher frequencies than ORs, but ORs present a more canonical word order than SRs. These additional factors make observations of an SR/OR advantage difficult to interpret. The literature for SR/OR comparisons in Standard Chinese has presented a mixture of SR/OR preferences due to the array of factors involved.

The present research therefore investigated processing contrasts between ARCs and PRCs: while ARCs do not involve filler-gap dependencies, PRCs do. Given that the same clausal structures and lexical items can be used in the prenominal clauses of ARCs and PRCs, factors unrelated to filler-gap dependencies, such as structural frequencies and word orders, can be controlled for so that memory mechanisms related to the dependency effect can be revealed. Processing differences between ARCs and PRCs can thus be attributed to the existence of a dependency effect in PRCs in contrast to the nonexistence of such an effect in ARCs. In the present design, ARCs are expected to demonstrate baseline frequency effects, but PRCs are expected to additionally demonstrate dependency effects.

Three experiments were conducted. The naturalness rating patterns in experiment 1, the per-character reading patterns in experiment 2, and the reading patterns on the head nouns of ARCs and PRCs in experiments 2 and 3 are summarized in Table 11.

SENTENCE TYPE	EXPERIMENT 1 (NATURALNESS RATING) & EXPERIMENT 2 (PER-CHARACTER RT)	EXPERIMENTS 2 & 3 (HEAD NOUN RT)
Baseline 1	nonpassive < passive	N/A
Baseline 2	nonpassive < passive	N/A
ARCs	nonpassive < passive	nonpassive < passive
PRCs	passive < nonpassive	passive < nonpassive

TABLE 11. Summary of patterns in the three experiments (where ‘<’ means ‘less unnatural or shorter reading time than’).

The same trends for the baseline sentences and the sentences with ARCs were observed in experiments 1 and 2. The passive condition was rated as less natural and comprehended with longer reading times than the canonical and the *ba* conditions. These results confirmed the expectation-based frequency effect: the frequent structural variants have a processing advantage over the less frequent ones. As the trends in ARCs are consistent with those in the baseline sentences, the processing difficulty of ARCs can be understood as reflecting the structural frequency and canonicity of the prenominal clauses. This finding supports the analysis that the head nouns of ARCs are relational nouns that take the whole prenominal clauses as their complements.

PRCs, however, showed a different pattern: passive PRCs were rated as more natural and were read faster than nonpassive PRCs. This trend stood out as being distinctive from the baseline sentences and the sentences with ARCs. Because of the need to retrieve a dependent element from the prenominal clause, the head noun of a PRC shows reading-time differences that are sensitive to where the dependent element is located. Retrieving a dependent NP at the subject position, as in the passive variant of the PRCs, was less costly than retrieving dependent NPs at lower syntactic positions, such as the object position in the canonical variant and the specifier-of-VP position of the *ba* variant. This ANTILOCALITY EFFECT showed that dependent NPs at earlier/farther positions

turned out to be easier to retrieve. These results are not compatible with memory-based theories of linear locality (Gibson 1998) or recency effects on free recall of words in a list (i.e. operating on push-down automata; Bjork & Whitten 1974), which would predict easier retrieval of more recently encountered lexical items and hence an advantage for the SVO variant.

The retrieval advantage of the subject NP can be understood as a subject-prominence effect, which is compatible with several theories about the special status of grammatical subjects in sentence processing. First, the greater accessibility of subject NPs is compatible with the AH. The subject position, being the highest grammatical function on the AH, is structurally more accessible than any other grammatical position. This syntactic account bears on language users' structural knowledge in parsing long-distance dependencies (Friederici et al. 2011; for Mandarin see Jiang & Zhou 2009). The structural proximity between the head noun and the subject position can account for the accessibility advantage that a subject NP has over NPs at lower structural positions (Hawkins 2004, Lin 2006, O'Grady 1997).

Second, the subject position can also be understood as the information-prominent position, which receives more attention in discourse formation (Carreiras et al. 2010, Givón 1983, 1984, Kuno 1976, MacWhinney 2005, Schachter 1973, Tomlin 1983). Dependent NPs located at subject positions bear greater discourse prominence in the working memory and are therefore easier to retrieve. The effect of subject prominence is consistent with the greater prominence of subject NPs in anaphor resolution. Previous studies of pronoun resolution in Mandarin Chinese (Yang et al. 2003) reported a similar subject-prominence effect: independently of the different syntactic structures (e.g. Yang et al. 2003 also used canonical SVO, *ba*, and *bei* structures) and thematic roles, the subject NP of a sentence is the most favored referent of a pronoun in the following sentence. Similar findings have been reported in Finnish (Järvikivi et al. 2005, Kaiser & Trueswell 2008).

Finally, the current study presented a long-distance dependency effect in a prenominal relative clause where the embedded clause appears before the head.¹⁸ As most previous research on prenominal relative clauses has focused on the SR/OR asymmetry in gapped relative clauses, it has remained unclear whether the SR/OR difference should be attributed to establishing dependencies between the head noun and the embedded verb/gap or to expectation-related factors such as word order, structural uncertainty, and structural frequency. Comparing PRCs and ARCs, which have identical word orders and structures in the prenominal clauses but differ on the type of semantic composition associated with the head nouns, allows us to tease apart effects that are related to integrating head nouns with the whole clauses and those that are related to retrieving a particular lexical item in the prenominal clause.

7. CONCLUSION. The current study compared the comprehension of possessive relative clauses and that of adjunct relative clauses, which involve different types of dependencies. In an ARC, the head noun takes the whole prenominal clause as its complement (Tsai 1997, Zhang 2008); in a PRC, the head noun is associated with a particular dependent word in the prenominal clause. The findings in three experiments consistently showed distinctive processing patterns for ARCs and PRCs. The processing of ARCs was similar to that of the baseline sentences, reflecting expectation-based

¹⁸ In a previous study, Aoshima and colleagues (2004) examined filler-gap dependencies regarding WH-phrases in Japanese (a head-final language). However, the structures they investigated had the fillers (WH-phrases) preceding the gaps.

frequency effects. For PRCs, easier comprehension was observed on the passive variant where the dependent NP was located at the subject position of the prenominal clause. These results are compatible with memory-based sentence-processing accounts that focus on STRUCTURAL PROXIMITY (Hawkins 2004, Lin 2006, O'Grady 1997) and grammaticality prominence accounts that associate grammatical functions with different degrees of prominence in memory retrieval (e.g. the accessibility hierarchy of Keenan & Comrie 1977). Together with comprehension studies of prenominal relative clauses in Japanese (Ueno & Garnsey 2008) and Korean (Kwon et al. 2010), the current study suggests that subject prominence and structural locality better account for the processing of long-distance dependencies in prenominal relative clauses.

APPENDIX: EXPERIMENTAL MATERIALS

The canonical SVO version is provided below. The *ba* version and the passive *bei* version can be constructed using the following format:

Canonical SVO version:	N1 V N2
<i>Ba</i> version:	N1 <i>ba</i> N2 V
<i>Bei</i> version:	N2 <i>bei</i> N1 V

EXPERIMENTS 1 AND 2

BASELINE SENTENCES 1: SIMPLE SENTENCES

N1	V	N2	ENGLISH TRANSLATION
汪先生	吃光了	冰箱裡的藍莓。	'Mr. Wang finished the blueberries in the fridge.'
師傅	烤焦了	一個蛋糕。	'The cook burned a cake.'
老張	弄皺了	新的地毯。	'Mr. Zhang wrinkled a new rug.'
小華	搞砸了	這項研究計畫。	'Xiaohua messed up this project.'
陳老師	哭濕了	一整條手帕。	'Prof. Chen cried the handkerchief wet.'
小美	搞丟了	辦公室的鑰匙。	'Xiaomei lost the key to the office.'
老王	穿反了	那件花襯衫。	'Mr. Wang wore the colorful shirt inside out.'
仲介	賣掉了	那棟房子。	'The agent sold that house.'
車行	修好了	你的古董車。	'The repair shop fixed your antique car.'
一陣強風	吹熄了	桌上的蠟燭。	'A strong wind blew off the candles on the table.'
大雨	困住了	十多位旅客。	'The big storm trapped more than ten tourists.'
小黑狗	咬傷了	那個陌生人。	'The black puppy bit that stranger.'
潘小姐	淡忘了	舊情人。	'Miss Pan forgot the old lover.'
會員們	學會了	基本的防身術。	'Members learned basic self-defense.'
科學家	解決了	許多謎題。	'Scientists solved many puzzles.'
冒險家	克服了	各式各樣的挑戰。	'The explorer overcame different challenges.'
那位初學者	完成了	這項不可能的任務。	'That novice completed the impossible mission.'
醫師	拔掉了	植物人的管子。	'The doctor removed the life support tube of the patient in a coma.'
糊塗的學子	玩掉了	大學四年。	'The silly student goofed away the four years of college.'
士兵	拔除了	營區的雜草。	'The soldier got rid of the weeds on the base.'
負責任的班長	收齊了	寒假作業。	'The responsible class leader collected winter assignments.'
部長	看輕了	事情的嚴重性。	'The minister misjudged the severity of the matter.'
來賓	洩漏了	主持人的秘密。	'The guest revealed the secret of the host.'
委員會	調低了	今年的入學標準。	'The committee lowered this year's admission standards.'

BASELINE SENTENCES 2: SENTENCES WITH COMPLEX NPs

N1	V	N2	ENGLISH TRANSLATION
收養孤兒的有錢人	賣掉了	工廠。	'The rich man that adopted the orphan shut down the factory.'
修理馬路的工人	清除了	路障。	'The worker repairing the road cleaned up the road barriers.'
打掃廚房的工讀生	扔掉了	一大包垃圾。	'The part-time student worker cleaning the kitchen threw away a big bag of garbage.'

N1	V	N2	ENGLISH TRANSLATION
教物理的老師	搞錯了	學生的名字。	'The teacher who teaches physics remembered the students' names wrong.'
管理許多基金的經理人	忽略了	一個重要的訊息。	'The manager who manages many mutual funds ignored an important message.'
處理帳務的會計師	糾正了	許多錯誤。	'The accountant who was in charge of the funds corrected many errors.'
教練喜愛的投手	敲碎了	玻璃杯。	'The pitcher that the coach likes the best broke a glass.'
編劇欣賞的演員	點燃了	蠟燭。	'The actor that the playwright liked lit the candle.'
明星們害怕的小報	公佈了	名人整型前的照片。	'The newspaper that the stars are afraid of posted photos of celebrities before their plastic surgeries.'
里長請來的壯丁	剷平了	整塊草坪。	'The guy that the manager of the local district hired removed the lawn.'
雜誌社選用的攝影師	花光了	所有預算。	'The photographer that the magazine picked spent all the budget.'
節目聘請的專家	誇大了	塔羅牌的魔力。	'The expert that the show hired exaggerated the magical power of Tarot.'
交通警察	攔下了	違反規則的車輛。	'The traffic police officer stopped the car that violated the law.'
組長	告誡了	散佈謠言的同事。	'The group leader warned the colleague who spread rumors.'
軍官	嚇走了	闖入商店的流氓。	'The military officer scared away the scoundrel who entered the shop.'
男主角	演活了	作盡壞事的反派角色。	'The main actor played very well the antagonist who did all sorts of bad things.'
總經理	取消了	慶祝退休的派對。	'The general manager called off the party that celebrates retirements.'
大力士	撞開了	囚禁野狗的牢籠。	'The big guy pushed open the cage that locked up stray dogs.'
小朋友	清乾淨了	路人丟棄的垃圾。	'The kids cleaned away the garbage that pedestrians threw away.'
遊客	摘下了	果農種的草莓。	'The tourist picked the strawberries that the fruit farmers grew.'
男童	玩壞了	姑姑借來的錄音機。	'The boy broke the voice recorder that his aunt borrowed.'
賭徒	趕走了	老和尚救濟的流浪漢。	'The gambler kicked out the homeless guy that the old monk helped.'
店員	倒掉了	顧客吃剩的食物。	'The shop keeper threw away the food that the customers did not finish.'
那寡婦	獨自養大了	被害人留下的三個孩子。	'That widow raised the three kids that the victim left behind by herself.'

SENTENCES WITH ADJUNCT RELATIVE CLAUSES (ARCs)

N1	V	N2	DE	HN	POST HN
罪犯	綁架	小開	的	第一現場	在飯店停車場。
'The initial scene where the criminal kidnapped the rich man was at the hotel garage.'					
清潔工	洗掉	污垢	的	方法	是從書上學來的。
'The method by which the cleaner washed away the stain was learned from a book.'					
李老闆	買下	三間店面	的	地段	房價不斷飆漲。
'The street section where Mr. Li bought three stores has rising housing prices.'					
老王	弄丟	鑰匙	的	時間	大約是下午五點鐘。
'The time when Old Mr. Wang lost his key was around 5 pm.'					
洪老師	難倒	學生	的	題目	連大學教授都不會做。
'The questions that Prof. Hong failed the students with could not even be solved by college professors.'					
阿福	毒死	老鼠	的	砒霜	是美國製的。
'The poison with which A-Fu poisoned the mice was made in the USA.'					
小張	打敗	老王	的	運動項目	都和球類有關。
'The sports with which Xiaozhang defeated Old Mr. Wang with all had to do with balls.'					

N1	V	N2	DE	HN	POST HN
黃小姐	擊昏	小偷	的	棒子	是鋁製的。
'The bat with which Miss Huang beat the thief was made of aluminum.'					
小陳	敗光	家產	的	速度	令人驚訝。
'The speed at which Xiaochen lost all the family property was astonishing.'					
學校	寄丟	成績單	的	原因	還在調查當中。
'The reason why the school mailed and lost track of the transcript is still being investigated.'					
張三	記錯	電話	的	可能性	很高。
'The likelihood that Zhangsan remembered the phone number wrong is very high.'					
列強	瓜分	中國	的	手段	令人慘不忍睹。
'The way by which the strong countries attacked China was too cruel too witness.'					
立委	刪除	預算	的	理由	很難讓人接受。
'The reason why the legislators cut the budget was difficult to accept.'					
警衛	逮到	嫌犯	的	地點	在大樓地下室。
'The place where the guard caught the suspect was at the basement of a tall building.'					
老闆娘	找到	首飾	的	過程	十分曲折。
'The process by which the female owner found her jewelry was rather complicated.'					
經理	罵哭	服務生	的	言詞	十分苛刻。
'The words with which the manager scolded the server to tears were very harsh.'					
海關	扣留	貨物	的	機會	並不大。
'The possibility that the customs agents would withhold the goods is not great.'					
槍手	暗殺	總統	的	地方	竟然在熱鬧的大街上。
'The place where the gunman shot the president turned out to be on a busy street.'					
主播	誤導	觀眾	的	新聞報導	已經引起新聞局的關切。
'The news story by which the anchorperson misled the audience has caused the concern of the authorities.'					
清潔婦	曬乾	衣服	的	方式	十分傳統。
'The way that the cleaning lady dried the clothes was very traditional.'					
高僧	擺平	強盜	的	武器	只是一把短刀。
'The weapon by which the monk took down the bandit was merely a short blade.'					
王老闆	賣掉	車子	的	價格	並不划算。
'The price at which Mr. Wang sold the car was not worth it.'					
情婦	出賣	導演	的	信件	刊登在報紙上。
'The letter with which the mistress betrayed the director was published in the newspaper.'					
董事長	開除	秘書	的	名義	並不正當。
'The reason why the chairperson fired the secretary was not justifiable.'					

SENTENCES WITH POSSESSOR RELATIVE CLAUSES (PRCs)

N1	V	N2	DE	HN	POST HN
歹徒	殺害了	女兒	的	媽媽	哭得很傷心。
'The mother whose daughter the gangster killed was in tears.'					
流氓	打傷	妹妹	的	國中生	準備明天要報復。
'The middle school student whose sister the scoundrel hurt plans to take revenge tomorrow.'					
警察	抓走	學生	的	教授	馬上通知校方處理。
'The professor whose student the police took away informed the university right away.'					
朋友	弄哭	孫子	的	婦人	趕緊拿出一根棒棒糖。
'The lady whose grandchild her friend made cry took out a lollipop.'					
壞人	綁架了	老婆	的	總裁	正在調度贖金。
'The chairperson whose wife the bad guys kidnapped is preparing the ransom.'					
父母	錯怪了	女朋友	的	男子	急著澄清事實。
'The man whose girlfriend his parents misunderstood is eager to clarify.'					
鄰居	侵佔了	土地	的	地主	正開始蒐集證據。
'The landlord whose land the neighbor occupied is starting to collect evidence.'					
班上同學	扯破	制服	的	小朋友	哭了出來。
'The child whose uniform classmates ripped is in tears.'					
受訪者	敲壞了	攝影機	的	記者	只好決定停止錄影。
'The reporter whose video camera the interviewee broke decided to stop recording.'					
敵軍	炸毀	基地	的	官兵們	紛紛躲進了防空洞。
'The soldiers whose base the enemy bombed hid in the air-raid shelter.'					
金光黨	騙光	家產	的	富翁	晚景十分淒涼。
'The rich man whose property the swindlers swindled had bleak later years.'					

Adv/DCL	N1	V	N2	DE	HN	POST HN
昨天/那位	海關	扣留	行李	的	旅客	至今仍在等待。
'The traveler whose luggage the customs agents withheld (yesterday) is still waiting.'						狀況 至今仍未解決。
'The situation where the customs agents withheld the luggage yesterday is still not resolved.'						
上週/那位	電線	絆倒	祖父	的	男孩	馬上大聲呼救。
'The boy whose grandfather the electrical cord tripped (last week) called out for help right away.'						地點 位於大樓出口。
'The location where the electrical cord tripped the grandfather last week was around the main entrance of the building.'						
昨天/那位	太陽	曬紅	鼻子	的	園丁	實在讓人敬佩。
'The gardener whose nose the sun burned (yesterday) is really admirable.'						速度 實在讓人驚訝。
'The speed at which the sun burned the nose yesterday really surprised people.'						
去年/那位	法院	查封	房子	的	小開	我們並不認識。
'The rich guy whose house the court confiscated (last year), we did not know him.'						時候, 我們還沒認識。
'[The time] when the court confiscated the house last year, we did not know [each other].'						
那天/那位	滾水	燙傷	皮膚	的	影星	必須接受治療。
'The movie star whose skin the boiling water burned (the other day) has to receive treatment.'						時間 必須記錄下來。
'The time when the boiling water burned the skin the other day has to be noted down.'						
上個月/那位	颱風	吹垮	茅屋	的	農夫	完全感到絕望。
'The farmer whose hut the typhoon blew down (last month) feels completely desperate.'						速度 完全超出預期。
'The speed at which the typhoon blew down the hut last month was completely beyond expectation.'						
上週/那位	大火	燒光	作物	的	佃農	已經引起關注。
'The farmer whose produce the big fire burned up (last week) received much attention.'						意外 已經引起關注。
'The accident in which the big fire burned up the produce last week received much attention.'						
上週/那位	暴風雨	吹走	船隻	的	漁民	已經申請補助。
'The fisherman whose boat the big storm blew away (last week) has applied for funding.'						事件 已經造成恐慌。
'The incident where the big storm blew away the boats last week has caused much fear.'						
昨天/那位	油漆	弄髒	衣服	的	校工	在清洗衣物。
'The janitor whose clothes the paint stained (yesterday) is washing his clothes.'						位置 在口袋上方。
'The place where the paint stained the clothes yesterday was above the pocket.'						
前天/那位	媒體	逼哭	父母	的	官員	已經決定辭職。
'The official whose parents the media forced into tears (the day before yesterday) has decided to resign.'						新聞 已經引起公憤。
'The news that the media forced the parents into tears the day before yesterday has caused uproar.'						
昨天/那位	公司	開除	祕書	的	主管	其實早有準備。
'The manager whose secretary the company fired (yesterday) was actually prepared.'						名義 其實並不合理。
'The reason why the company fired the secretary yesterday was actually not reasonable.'						

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