The relationship between anaphor features and antecedent retrieval: Comparing Mandarin *ziji* and *ta-ziji*

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Abstract

In the present study we report two self-paced reading experiments that investigate antecedent retrieval processes in sentence comprehension by contrasting the real-time processing behavior of two different reflexive anaphors in Mandarin Chinese. Previous work (Dillon et al., 2014; Gao et al., 2005; Liu, 2009; Li & Zhou, 2010; cf. Chen et al., 2012) has suggested that comprehenders initially evaluate the fit between the morphologically simple long-distance reflexive 'ziji' and the closest available subject position, only subsequently considering more structurally distant antecedents. In this paper, we test the hypothesis that this *locality bias* is the result of relatively poor cues to antecedent retrieval associated with the morphologically simple reflexive *ziji*. This predicts that the locality bias effect should be attenuated for anaphors with richer feature content that may serve as retrieval cues. In Experiment 1, we investigate the processing of *ziji* and show a strong locality bias for *ziji* in self-paced reading measures. In Experiment 2, we investigate the processing of the morphologically complex reflexive *ta-ziji* (lit. s/he-self) in the same structural configurations as Experiment 1. The results of Experiment 2 suggest that *ta-ziji* is not subject to the same locality bias effects in reading that *ziji* is. In light of these results, we hypothesize that the relatively impoverished feature content of *ziji* effectively forces comprehenders to adopt a search strategy to find an appropriate antecedent, resulting in locality bias effects in real-time processing measures. In contrast, relatively feature-rich anaphors like 'ta-ziji' show behavior more consistent with a direct-access antecedent retrieval mechanism, and relatively minimal locality bias effects in reading measures. Our conclusions are in line with other cross-linguistic research that suggests that the morphological features of an anaphoric expression influence how comprehenders retrieve an antecedent from working memory (Jäger et al, 2015).

Introduction

Anaphoric expressions such as pronouns (e.g. *him*, *he*), reflexives (e.g. *himself*), and anaphoric definite descriptions (e.g. *the boy*) have been widely studied in both linguistic and psycholinguistic traditions. Linguists have long been concerned with how the linguistic form of a referring expression determines its interpretation and syntactic distribution (Chomsky, 1981; Elbourne, 2008; Heim, 1982; *a.o.*). Psycholinguists have studied anaphoric expressions both as a window into how comprehenders organize a text, and as a window into the working memory mechanisms that support sentence-level and discourse-level language comprehension (Greene, McKoon & Ratcliff, 1992; Gernsbacher, 1989; Myers & O'Brien, 1998; Kintsch, 1975; Dillon, 2014; Foraker & McElree, 2011; Kush, 2013; *a.o*)

In the present work, we pursue a research question at the intersection of these two traditions. We ask how the form of a referring expression is related to the processing mechanisms that comprehenders use to assign it a referent. To this end, we contrast the processing of two closely related reflexive anaphors in Mandarin Chinese. Specifically, we compare the processing behavior of the morphologically simple reflexive *ziji* to that of the morphologically complex reflexive *ta-ziji*. We investigate the degree to which each anaphor exhibits a *locality bias*, a processing advantage (or preference) for syntactically local antecedents over more distant ones. Our empirical goal is to investigate whether the morphological complexity of an anaphor modulates the degree to which it will exhibit a locality bias in processing. To foreshadow our empirical and theoretical conclusions: our experimental findings suggest that morphologically complex anaphors in Mandarin Chinese show a diminished locality bias in comparison to morphologically simple ones, a finding that we attribute to how the processor makes use of the richer morphological feature content of morphologically complex anaphors.

Long distance reflexives and locality effects

In recent years, there have been a number of experimental investigations into the real-time processing behavior of the Mandarin Chinese long-distance reflexive *ziji*. *Ziji* is a morphologically simplex reflexive, literally meaning *self* (Huang, Li & Li, 2009). *Ziji* is a long-distance reflexive, unlike English reflexives which must be bound within their immediate tensed clause (their *binding domain*; Chomsky, 1981). Long-distance reflexives are so called because their binding domain is larger than their immediate tensed clause, although the exact size of their expanded domain varies across languages (see Büring, 2005). For Mandarin *ziji*, it appears that the binding domain is the entire root clause in which *ziji* is found (Büring, 2005, Huang, Cole & Hermon, 2006; Huang & Liu, 2001; Huang, Li & Li, 2009; Tang, 1989; Xue, Pollard & Sag, 1994). To take one example, in (1) *ziji* may be bound either by the subject of its immediate clause *Lisi*, or by the subject of the higher (root) clause *Zhangsan* (note that throughout, subscripts are used to indicate acceptable coindexation):

(1) *Zhangsan*$_j$ *shuo Lisi*$_i$ *nongshang-le ziji*$_{i/j}$
Zhangsan says Lisi harm-perf self
"Zhangsan says that Lisi harmed him/herself"

Ziji requires an animate antecedent (Huang & Liu, 2001; Tang, 1989; Xue, Pollard & Sag, 1994), and receives an interpretion analogous to English reflexive forms. *Ziji* does not bear any overt morphological features, however, and so may take antecedents regardless of their gender, number, or person features.

Given the possibility of long-distance binding, it is interesting to note that many experimental studies have shown that comprehenders show a locality bias when processing *ziji*, preferring or more easily processing antecedents in their local clause over antecedents found in more distant clauses. For example, Li and Zhou (2010) conducted an ERP experiment in Mandarin, measuring the electrophysiological response to *ziji* in examples like (2) (# indicates a pragmatically disfavored interpretation of *ziji*):

(2) a. *Xiaoli*$_{i}$ *rang Xiaozhang*$_{j}$ *buyao weizhuang ziji*.$_{i/\#j}$
Xiaoli asked Xiaozhang not disguise ziji.
"Xiaoli asked Xiaozhang not to disguise himself."

b. *Xiaoli*$_{i}$ *rang Xiaozhang*$_{j}$ *buyao qianlian ziji*.$_{\#i/j}$
Xiaoli asked Xiaozhang not embroil ziji.
"Xiaoli asked Xiaozhang not to embroil him."

Li and Zhou observed a larger P300/P600 at *ziji* when the semantics of the verb created a bias towards a long-distance reading of the reflexive, as in (2b), compared to when the meaning of the verb biased comprehenders towards to a local reading of the reflexive, as in (2a).

Cross-modal priming studies point to a similar advantage for local antecedents over long-distance antecedents. Gao, Liu & Huang (2005) and Liu (2009) auditorily presented participants with sentences of the form in (1). Upon reaching the sentence-final *ziji*, participants were presented with a visual probe word. At short SOAs, participants recognized probes that were semantic associates of a local antencedent more quickly than they did probes associated with long-distance antecedents; at longer SOAs, this locality advantage disappeared (Gao et al, 2005; Liu, 2009).

Using a different experimental paradigm, Chen, Jäger and Vasishth (2012) show using self-paced reading that locally bound ziji is read more quickly than is long-distance bound *ziji*. These authors leveraged the observation that *ziji* requires an animate antecedent to create the pair of experimental sentences in (3) (brackets are used to indicate tensed clause boundaries):

(3)

a. *Fanduipai-lingxiu*$_{i}$ *biaoshi [zhe-ge shengming*$_{j}$ *[zai kangyi shikong de-shihou] gaojie-le ziji*$_{i/*j}$ *de dangyuan]*
opposition-leader said [this-CL announcement [at protest out.of.control time] warn-ASP ziji DE party.member]
"The opposition leader said that this announcement warned his party members when the protest was out of control"

b. *Zhe-ge shengming*$_{i}$ *biaoshi [fanduipai-lingxiu*$_{j}$ *[zai kangyi shikong de-shihou] gaojie-le ziji*$_{*i/j}$ *de dangyuan]*
this-CL announcement said [opposition-leader [at protest out.of.control time] warn-ASP ziji DE party.member]

> "The announcement said that the opposition leader warned his party members when the protest was out of control"

In (3a), the only animate, c-commanding antecedent is *fanduipai-lingxiu*, "opposition leader." Thus, in this example, *ziji* must take a long-distance antecedent in the immediately higher clause. In contrast, the embedded subject in (3b) is the only animate and c-commanding antecedent, and so *ziji* must take a syntactically local antecedent. In this paradigm, the difference in reading times between *ziji* in (3a) and (3b) is taken to indicate the difficulty of constructing a long-distance *ziji* interpretation in (3a). Chen and colleagues observed a small but reliable RT slow-down in reading times at the region following *ziji* (*de*) in (3a), suggesting difficulty in constructing a long-distance interpretation of *ziji*. This result was subsequently replicated in an eye-tracking while reading study, using direct object *ziji* in place of possessive *ziji*, and without an adverbial clause intervening between the subject and the verb (Jäger, Engelmann & Vasishth, 2015; Experiment 2).

The finding of a locality bias associated with *ziji* has broader implications for the processing mechanisms that support the retrieval of an anaphor's antecedent in comprehension. Dillon, Chow, Wagers, Guo, Liu & Phillips (2014) suggested that these effects reflect a difference in how quickly comprehenders can access long-distance or local antecedents in comprehension. To test this, Dillon and colleagues used the multiple-response speed-accuracy tradeoff (MR-SAT) technique to investigate sentences similar to those in (3). The (MR-)SAT technique involves eliciting behavioral responses at a series of pre-defined response deadlines. This allows the researchers to chart how accuracy on a response measure grows as a function of time, giving a full picture of the time-course of processing. The resulting SAT function may be separated into independent measures of processing speed and processing accuracy. Dillon et al's results indicated that the difference between local and long-distance binding in examples analogous to (3) was primarily reflected in the speed of processing. Put simply, comprehenders took longer to interpret *ziji* with long-distance antecedents than they did with local antecedents.

To account for this result, Dillon and colleagues offered an explanation for *ziji*'s locality bias in terms of a processing mechanism that identified a binder for *ziji* by implementing a serial search over structurally accessible antecedents. They proposed that *i*) comprehenders serially evaluate potential antecedent NPs for *ziji* and *ii*) this search process is initially biased towards antecedents in the local clause (their *Local Search Hypothesis*; Dillon et al, 2014). Due to the bias towards syntactically local antecedents, this model posits that comprehenders are likely to evaluate the local subject as a potential antecedent when processing *ziji* even if it is not semantically appropriate as an antecedent (i.e. if it is inanimate). If this occurs, then comprehenders will be forced to consider more distant antecedents to identify an appropriate antecedent. This simple model captures the full range of locality effects across the methodologies presented above. However, the search process hypothesized by Dillon and colleagues is unexpected when one considers a broader range of findings that address how comprehenders search through working memory to form syntactic and referential dependencies in comprehension. This raises the important question of how to reconcile their search model with existing theoretical proposals. With this goal in mind, we now turn to a brief review of this wider literature.

Search behavior and feature richness

For a wide range of linguistic dependencies, there is evidence that the processor makes use of a content-addressable retrieval mechanism to form syntactic and referential dependencies in comprehension (Foraker & McElree, 2011; Lewis & Vasishth, 2005; Lewis, Vasishth & Van Dyke, 2006; McElree, 2000, 2006, 2014; McElree, Foraker & Dyer, 2003; Van Dyke & McElree, 2006, 2011). A content-addressable retrievel mechanism accesses a representation in memory using the inherent features of the representation as cues to guide the memory retrieval process. These cues are said to provide *direct access* to the desired representation, obviating any need to search through irrelevant representations at retrieval. This mechanism has the benefit of granting extremely rapid access to information in memory, making this an attractive mechanism for memory access in the human sentence processor (Lewis et al., 2006). However, if multiple representations in memory match the retrieval cues used at retrieval, it may be more difficult to isolate a *target* representation in memory, a phenomenon known as *retrieval interference*. Retrieval interference has been shown to be a primary cause of difficulty in sentence comprehension (Lewis, 1996; Lewis & Vasishth, 2005; Lewis et al., 2006; Van Dyke, 2007; Van Dyke & Lewis, 2003; Van Dyke & McElree, 2006; see also Gordon, Hendrick & Levine, 2002; Gordon, Hendrick & Johnson, 2001, 2004; for a recent review, see Van Dyke & Johns, 2012). Importantly, it has been shown that retrieval interference arises as a function of the retrieval cues present at retrieval, rather than solely due to interference that may arise during the process of encoding a representation in working memory (see extended discussion in Van Dyke & McElree, 2006).

Models that posit a content-addressable retrieval mechanism predict that an increase in structural or linear distance between the retrieval site (e.g. the anaphor) and the target of retrieval (e.g. its antecedent) may lead to reduced retrieval accuracy, but it should not result in longer retrieval times. This prediction has been shown to hold true for subject-verb dependencies (Foraker & McElree, 2011; McElree et al., 2003; Van Dyke & McElree, 2011; Wagers & McElree, 2010), VP ellipsis (Martin & McElree, 2008, 2010), sluicing (Martin & McElree 2011), cross-discourse anaphoric dependencies (Foraker & McElree, 2007), and the processing of filler-gap dependencies in English (McElree, 2000; McElree et al, 2003). For each of these dependencies, SAT evidence suggests that retrieval speed is not modulated by linear or structural distance between the retrieval site and the target, supporting a content-addressable retrieval mechanism that directly accesses dependent elements when they are needed in processing.

Dillon et al. (2014)'s finding that the locality bias associated with *ziji* reflected slower retrieval times for distant antecedents contrasts with these findings. This contrast raises a theoretical question: of all the dependency types investigated to date, why does the distance between retrieval site and retrieval target modulate the speed of processing associated with *ziji*, but not for other dependencies investigated to date? Put in terms of the theoretical model advanced by Dillon and colleagues, why does *ziji* sample potential antecedents in a serial search, when the other dependencies studied with the SAT technique to date make use of a direct access mechanism?

A possible answer to this question lies in the nature of the retrieval cues that Dillon and colleagues attributed to *ziji*. Dillon et al. proposed that *ziji* initiated a retrieval

that relied in equal parts on locality cues and on animacy cues to the antecedent. On their account, animacy cues reflected grammatical restrictions on *ziji*'s antecedent, and the locality cues reflected a processing principle that prioritized retrieval of syntactically local dependents (their *Local Search Hypothesis*). In simulations of their MR-SAT data, this retrieval model yielded a good fit to the observed data.

Importantly, in long-distance binding configurations like (3a), this hypothesized combination of cues does not uniquely isolate the target antecedent. The local subject *zhe-ge shengming* 'this announcement' mismatches animacy cues, yet matches the locality cues. The long-distance subject *fanduipai-lingxiu* 'opposition leader' matches the animacy cues, but mismatches the locality cues. Thus in this configuration, *ziji* does not provide sufficiently diagnostic cues to isolate the appropriate, long-distance antecedent in working memory. In other words, Dillon and colleagues proposed that both subject positions in (3a) are only partial matches to *ziji*'s retrieval cues. Since the cues associated with *ziji* are not sufficiently diagnostic to isolate an appropriate antecedent in (3a), highly accurate, direct-access retrieval of the long-distance antecedent is not guaranteed.

The situation that arises when there are not sufficiently rich or diagnostic retrieval cues to isolate a single target memory at retrieval is known as *cue overload* (Martin & McElree, 2009, 2011; Nairne, 2002; Öztekin & McElree, 2007; Roediger & Guynn, 1996; Watkins & Watkins, 1975, 1976). By increasing the number of associations a given retrieval cue has, the amount of retrieval interference is increased. This leads to a decreased probability of accurately retrieving a desired representation when needed. Martin and McElree (2011) propose that cue overload contributes in part to retrieval interference in sentence processing (see also Van Dyke & McElree, 2006, 2011; Van Dyke & Johns, 2012).

Dillon and colleagues' (2014) search proposal relates fairly directly to the notion of cue overload. Cue overload obtains in sentences like (3a) because *ziji* does not have retrieval cues that uniquely isolate the long-distance antecedent. However, Dillon and colleagues suggested that cue overload in this context does not invariably result in a failure to recover the target antecedent (see discussion in Martin & McElree, 2011 of the ways in which cue overload may lead to interpretive failure). Instead, they suggested that the processor reacts to this cue overload by engaging in multiple resampling operations to recover the antecedent. That is, the hypothesized cue overload in (5a) causes the processor to execute a search, with comprehenders serially sampling antecedents for *ziji* until the correct antecedent was found. Note that in this model, the underlying memory architecture remains content-addressable, although it is put to use in sentence processing in a way that effectively implemented a search process.

An interesting consequence of this model is that it links the search behavior associated with *ziji* to its relatively impoverished retrieval cues. This model thus predicts that if an anaphor contained richer retrieval cues to long-distance antecedents, then cue overload would be lessened in configurations like (3a). In this situation, the processor would be more likely to have direct access to syntactically distant antecedents, and consequently, it should show a smaller locality bias effect. We are thus led to hypothesize that the richer the feature content of an anaphor, the less likely it is to show search behavior, and thus, the less susceptible it will be to locality bias effects in comprehension. We dub this the *Less Is More Hypothesis*: the less featural content an anaphor has, the more search is necessary to identify its antecedent in comprehension.

Ziji and Ta-ziji

Mandarin grammar provides one way in which the Less Is More hypothesis may be tested. Reflexive anaphors in Mandarin come in two forms: the morphologically simple,'bare' reflexive *ziji*, and morphologically complex anaphors. An example of a morphologically complex anaphor is *ta-ziji*, which consists of a third singular pronoun along with the bare reflexive (e.g. 'he-self'). Other morphologically complex reflexives may be formed by combining other pronouns with *ziji* (e.g. *wo-ziji*, myself; *ni-ziji*, yourself), although here we focus on the third person singular form *ta-ziji*. *Ta-ziji* has a distribution that partially overlaps with *ziji*. For instance, when the antecedent of the anaphor is in the local clause, *ta-ziji* and *ziji* are interchangeable:

(4) Lisi_i nongshang-le ziji_i/ta-ziji_i
Lisi harm-PERF self / 3sg-self
"Lisi harmed himself"

The morphological differences between *ziji* and *ta-ziji* provide one way of testing the Less Is More hypothesis. There is good reason to suspect that the addition of an overt pronoun to form a morphologically complex anaphor will yield richer retrieval cues for purposes of identifying an antecedent. First, the orthographic representation of the pronoun overtly provides animacy cues: 他 (tā) is used for animate male referents, 她 (tā) is used for animate female referents, and 它 (tā) is reserved for inanimate referents, despite the fact that these forms are not distinguished phonologically. Second, the use of an overt pronoun is statistically more likely for animate antecedents than for inanimate antecedents. A search of the Google Books corpus for simplified Chinese in the last 50 years reveals that animate uses of *ta* account for approximately 73-80% of tokens of the third person singular pronoun.

If this is correct, then the relatively more feature-rich *ta-ziji* should engender less cue overload when attempting to retrieve a long-distance antecedent than *ziji*, because the stronger animacy features associated with *ta-ziji* will resonate more strongly with animate long-distance antecedents. This should make it more likely that retrieval of an antecedent for *ta-ziji* will result in direct access to syntactically distant antecedents, and consequently, make it less likely that a protracted serial search for an antecedent is required. Because the relatively rich feature content of *ta-ziji* should promote direct access to long-distance antecedents, we predict that locality bias effects should be less pronounced for *ta-ziji* than for *ziji*.

However, a direct comparison of the locality effects for *ziji* and *ta-ziji* is complicated by the fact that they do not have identical syntactic distributions. In contrast to *ziji*, the size of *ta-ziji*'s binding domain is a matter of some controversy. Huang, Li and Li (2009) report that it must be bound within its immediate tensed clause, like English *himself*. However, Pan (1998, 2000) argues that the binding domain of *ta-ziji* is fixed by the closest accessible animate antecedent, such that *ta-zij* can be bound outside of its local clause if the local subject is inanimate. Because of this lack of clarity in the binding domains associated with these two reflexives, it is not ideal to compare these these

reflexives in the same embedding configurations used in previous studies (Chen et al, 2012; Dillon et al, 2014; Jäger et al, 2015).

Instead, we compare the behavior of *ziji* and *ta-ziji* in environments where they do have reliably overlapping distributions. For both *ziji* and *ta-ziji* the c-command relation that regulates binding in English (Chomsky 1981) appears to be too restrictive. Instead, antecedents that do not strictly c-command these anaphors are sometimes grammatically available, as in (5) (Tang 1989):

(5) Zhangsan$_i$ de jiao'ao hai-le ziji$_i$ / ta-ziji$_i$
Zhangsan DE arrogance harm-perf ziji / 3sg-ziji-i
"Zhangsan's arrogance harmed him."

In (5), the antecedent *Zhangsan* is embedded inside the subject, and hence does not c-command the anaphor. The structural relationship between Zhangsan and *(ta-)ziji* in (5) is referred to as *subcommand* (Huang & Tang, 1991; Tang, 1989). An NP is said to subcommand the anaphor if it is contained within an NP in subject position that c-commands or subcommands the anaphor (Tang 1989). Note, however, that subcommanding antecedents are not freely available. Instead, a subcommanding antecedent is only available when no possible c-commanding or subcommanding antecedent is structurally closer to ziji. Thus when the subject head noun is animate, subcommanding antecedents are blocked as in (6):

(6) Zhangsan$_i$ de xiaohai$_j$ hai-le ziji$_{*i/j}$/*ta-ziji*$_{*i/j}$
Zhangsan DE son harm-perf ziji / 3sg-ziji
"Zhangsan's son harmed himself/*him."

As *ziji* and *ta-ziji* distribute similarly in these environments, in the present studies we compare the processing of *ziji* and *ta-ziji* in configurations like (7):

(7)

a. *[Zhang$_i$ taitai jingchang guanggu de] na-ge shizhuangdian$_j$ shang-ge-zingqi ba ziji$_{i/*j}$ / ta-ziji$_{i/*j}$ bu xiaoxin nongshang-le.*
Mrs. Zhang often visit DE that-CL boutique last-week BA self / 3sg-self not careful harm-PERF.
"The boutique that Mrs. Zhang often visits carelessly harmed her last week."

b. *[Meiti$_i$ baodao de] na-ge nü-caifeng$_j$ shang-ge-zingqi ba ziji$_{*i/j}$ / ta-ziji$_{*i/j}$ bu xiaoxin nongshang-le.*
Media reports-on DE that-CL seamstress last-week BA self / 3sg-self not careful harm-PERF.
"The seamstress that the media reported on carelessly harmed herself last week."

Given the licensing constraints on *ziji* and *ta-ziji* proposed in the theoretical literature, we expect that both the local subject *na-ge nü-caifeng* 'that seamstress' in (7b) and the long-distance subject *Zhang taitai* 'Mrs Zhang' in (7b) should be grammatically accessible antecedents (see Tang (1989) and Huang and Tang's (1991) definition of

subcommand). The subcommanding antecedent *Zhang taitai* in (7a) is a long-distance antecedent because it is linearly and structurally more distant from the anaphor than the local antecedent *na-ge nü-caifeng* in (7b). For this pair of conditions, then, a locality bias effect should present as increased reading times on the anaphor in (7a) compared to (7b).

Given the Less Is More hypothesis, we predict that search will be necessary to recover the long-distance antecedent for *ziji* in (7b), creating a locality bias that will result slower reading times in a reading task. The critical test for the Less Is More hypothesis is whether the same locality effect obtains for *ta-ziji* in identical configurations. The Less Is More hypothesis predicts a diminished locality bias for *ta-ziji* compared to *ziji* in examples like (7). We now turn to providing two online self-paced reading experiments on examples like (7) that test this prediction for *ziji* (Experiment 1) and *ta-ziji* (Experiment 2).

Experiment 1

Participants

41 students from the University of Maryland community participated in the experiment. One participant was removed prior to analysis due to low comprehension question accuracy (see below). All participants were native Mandarin Chinese speakers from mainland China, and all had normal or corrected-to-normal vision. They were paid $10 for their participation in the experiment. Experimental sessions lasted approximately 45 minutes. Participants gave informed consent under an experimental protocol approved by the University of Maryland Institutional Review Board.

Stimuli

We created stimuli with the sentence structure in (7). We orthogonally manipulated the animacy of the local subject position and the embedded subject position, yielding four experimental conditions. These conditions are summarized in (8).

(8)

a. *LOCAL MATCH*:
Meiti/ baogao de/ na-ge/ nücaifeng/ shang-ge-xingqi/ ba/ ziji/ bu xiaoxin/ nongshang-le.
Media/ report-on DE/ that-CL/ seamstress/ last-week/ BA/ self/ not careful/ harm-PERF.
"The seamtress that the media reported on carelessly harmed herself last week."

b. *DISTANT MATCH*:
Zhang taitai/ jingchang guanggu de/ na-ge/ shizhuangdian/ shang-ge-zingqi/ ba/ ziji/ bu xiaoxin/ nongshang-le.
Mrs. Zhang/ often visit DE/ that-CL/ boutique/ last-week/ BA/ self/ not careful/ harm-PERF.
"The boutique that Mrs. Zhang often visits carelessly harmed her last week."

c. *MULTIPLE MATCH*:
Zhang taitai/ jingchang guanggu de/ na-ge/ nücaifeng/ shang-ge-zingqi/ ba/ ziji/ bu xiaoxin/ nongshang-le.

Mrs. Zhang/ often visit DE/ that-CL/ seamstress/ last-week/ BA/ self/ not careful/ harm-PERF.
"The seamstress that Mrs. Zhang often visits carelessly harmed her/herself last week."

d. *NO MATCH*:
Meiti/ baogao de/ na-ge/ shizhuangdian/ shang-ge-zingqi/ ba/ ziji/ bu xiaoxin/ nongshang-le.
Media/ report-on DE/ that-CL/ boutique/ last-week/ BA/ self/ not careful/ harm-PERF.
"The boutique that the media reported on carelessly harmed her last week."

The paradigm employed here thus followed Chen et al (2012), Dillon et al (2014), and Jäger et al (2015) in using animacy to manipulate the binding possibilities for *ziji*. The primary comparison of interest for the present purposes is the difference in reading times between the *local match* and *distant match* conditions at the anaphor. The *multiple match* and *no match* conditions were included for two reasons. First, the factorial manipulation of the animacy of the two subject positions allows us to dissociate effects of interest from simple effects of local subject animacy, a factor that may effect reading times for reasons unrelated to anaphoric processing (see discussion in Jäger et al, 2015). Second, the inclusion of the *multiple match* and *no match* conditions allows us to estimate any reading time effects associated with multiple appropriate antecedents, as well as the effect of having no sentence-internal antecedent. These contrasts provide another dimension on which we may compare the processing of *ziji* with *ta-ziji*.

The distant (sub-commanding) antecedent position was always the subject of an object relative clause that modified the main clause subject. This antecedent position was always the first word in the sentence, owing to the head-final order of Mandarin relative clauses. The local antecedent always followed the relative clause verb and the relativizing particle *de*. In order to construct plausible and natural sentences, the predicate inside the relative clause was different for animate and inanimate subjects. The matrix clause predicate was constant across all four experimental conditions.

In order to avoid wrap-up effects at the critical anaphor, the *ba* construction was used. In this construction the particle *ba* is used to mark the direct object, which is then moved to preverbal position to yield an SOV word order. So that the two arguments of the main clause were not linearly adjacent, a temporal adverbial was placed between the local subject and the *ba*-marked *ziji*. A manner adverbial was placed between *ziji* and the final verb in order to provide an extra spillover region.

18 sets of these four conditions were produced, and distributed into four lists in a pseudo-Latin square fashion. They were combined with 77 fillers, including materials from an unrelated experiment, for a total of 95 sentences. The ratio of acceptable-to-unacceptable sentences varied slightly from list to list due to the pseudo- Latin square procedure, but remained between 83 and 85 % acceptable. The fillers included 10 sentences that contained *ba* followed by non-anaphoric NPs in order to prevent participants from associating *ba* with *ziji* within the experiment.

Procedure

Sentences were presented using a moving-window self-paced reading paradigm, using the Linger software (Rohde, 2003). Each sentence was presented in black characters on a white screen, and no sentence was more than one line long. All sentences were presented using simplified Chinese characters. The sentences were segmented into 9 regions according to native speaker intuitions about where best to insert boundaries (regions are indicted by slashes in (8)). This procedure resulted in regions that ranged from one character (e.g. *ba*) to at most 6 characters (e.g. *yishuticaoguanjun*, "gymnastics champion").

Sentences initially appeared as a series of dashes that obscured the entire sentence. Participants pressed the space bar to present the first region, and each subsequent space bar press after that masked the current region and triggered presentation of the subsequent region. Reaction times between button presses were recorded. After approximately 50% of the filler sentences, a comprehension question was presented presented in its entirety on the screen, and participants were instructed to press *f* for yes, and *j* for no. Feedback was given for incorrect responses. The critical *ziji* sentences never were followed by comprehension questions.

In the analyses below we refer to the region containing *ziji* as the *critical region*, and the region that follows (e.g. *bu xiaoxin*) as the *spillover region*.

Analysis

Log-transformed reaction time data were analyzed using linear mixed effects models with the fixed-effects factors *local* and *distant*, as well as their interaction. Analysis was performed using the *lme4* package in the R statistical computing environment (R Core team, 2015; Bates, Maechler, Bolker & Walker, 2014). We adopted a 'maximal' random effects structure, including random intercepts and random slopes for all fixed effect parameters within both subject and item grouping factors (Barr et al 2013). If the full model failed to converge, we removed random correlations but retained random slopes for all fixed effects. Simple difference coding was used (-*Animate* = 0.5; +*Animate* = -0.5). We adopt the convention that a *t* value of absolute value greater than 2 presents a significant effect (Gelman & Hill, 2007).

If the initial analysis revealed significant effects above and beyond a main effect of local subject animacy, we tested three planned comparisons of interest. Taking the *local match* condition as the baseline, we define the *locality contrast* as the difference between the *distant match* condition and the *local match* condition. As in previous studies (Chen et al, 2012; Dillon et al, 2014; Jäger et al, 2015), this contrast is interpreted as the penalty associated with long-distance binding of the anaphor. We further define the *multiple match contrast* as the difference between the *multiple match* condition and the *local match* condition; this contrast is interpreted as the penalty associated with having multiple candidate antecedents. Lastly, we define the *no match contrast* as the difference between the *local match* condition and the *no match* condition; this is interpreted as the penalty associated with having no licit antecedent in the sentence. We used the *lmerTest* package to extract these comparisons from the fitted model objects (Kuznetsova, Bruun Brockhoff & Haubo Bojesen Christensen, 2015). In the calculation of the 95% CIs associated with each contrast, the Satterthwaite approximation to the degrees of freedom was adopted.

Because of our pseuo-Latin square procedure, the number of sentences within each condition was not balanced within subjects. To test for any effects this imbalance may have had, we performed log-likelihood ratio tests of models with and without a fixed effect for experimental list. If log-likelihood tests indicated an effect of *list*, we performed further model comparisons to determine if the effect of *list* interacted with our experimental fixed effects.

Analysis was performed for two regions of the experimental sentences: the critical region *ziji* and the spillover region (e.g. *bu xiaoxin* in (8)).

Results

Offline Judgments

Prior to Experiment 1, we gathered offline acceptability judgments of all experimental materials. All experimental stimuli, including fillers, were entered into the online experimental platform IbexFarm (Drummond, 2011.). 22 native Mandarin speakers were recruited from Beijing Normal University. Participants were directed to a web address that hosted the offline acceptability judgment questionnaire. Participants were asked to rate each experimental stimulus on a scale from 1 (not natural) to 7 (very natural).

	Distant:Mismatch	*Distant*:Match
Local:Mismatch	3.5 (0.3)	4.4 (0.3)
Local:Match	5.2 (0.3)	4.8 (0.3)

Table 1: Mean acceptability ratings in Experiment 1. Parentheses represent standard error by participants, corrected for between-participant variance (Bakeman & McArthur, 1996)

The results of this offline judgment study are presented in Table 1. Linear mixed effects modeling revealed a main effect of local NP animacy (Est = -1.09$\pm$ 0.25, t = -4.3), and an interaction of local and distant NP animacy (Est = -1.29$\pm$ 0.38, t = -3.45). There were lower acceptability ratings for both conditions with a local inanimate subject. However, a post-hoc comparison of the acceptability of the two local inanimate conditions revealed that they were significantly different from each other ($\overline{x}$ = -0.9, 95%CI: [-1.4,-0.4]).

Comprehension

Accuracy on the comprehension questions in Experiment 1 averaged 87% across participants, indicating that the participant attended to the linguistic stimuli. Across participants, accuracy ranged from 66% to 98%. One participant was removed from further analysis due to low accuracy (less than 70% accurate).

Reading Times

	1	2	3	4	5	6	7	8	9
Multiple Match	681	706	546	780	767	642	467	603	695
	(38)	(66)	(24)	(58)	(37)	(81)	(25)	(35)	(57)
Local Match	762	731	638	849	703	564	448	522	615
	(45)	(35)	(40)	(80)	(35)	(30)	(28)	(26)	(35)

Distant Match	728	644	599	914	715	525	489	737	847
	(74)	(24)	(27)	(90)	(29)	(28)	(25)	(35)	(81)
No Match	825	803	614	669	784	592	541	606	766
	(71)	(44)	(53)	(44)	(43)	(31)	(60)	(30)	(51)

Table 2: Mean reading times per region Experiment 1. Parentheses represent standard error by participants, corrected for between-participant variance (Bakeman & McArthur, 1996). Region labels are as follows: 1:*Zhang taitai* 2:*jingchang guanggu de* 3:*na-ge* 4:*shizhuangdian* 5:*shang-ge-zingqi* 6:*ba* 7:*ziji* 8:*bu xiaoxin* 9:*nongshang-le.*

	Est.	*t*
Local	-0.06 (0.03)	-2.27
Distant	0.01 (0.03)	0.35
Local × *Distant*	-0.01 (0.06)	-0.22

Table 3: Results of linear mixed effects modeling of critical region *ziji* in Experiment 1.

	Est.	*t*
Local	-0.18 (0.04)	-4.45
Distant	0.1 (0.04)	2.60
Local × *Distant*	-0.11 (0.07)	-1.49

Table 4: Results of linear mixed effects modeling of spillover region *bu xiaoxin* in Experiment 1.

Raw mean reading times in Experiment 1 are presented in Table 2. Tables 3 and 4 present statistical analyses of the critical and spillover regions. There were no significant effects of counterbalancing list. In the critical region, there was a significant effect of local noun animacy: RTs were significantly longer when the local noun was inanimate. This effect persisted into the spillover region. In addition, there was a significant effect of distant noun animacy on the RTs in the spillover region: reading times were significantly longer when the distant noun was animate.

Further analyzing the pattern of reading times in the spillover region, modeling reveals a sizeable *locality contrast* ($\overline{x}$ = 0.28, 95%CI: [0.17,0.39]). In addition, there was a large *no match contrast* ($\overline{x}$ = 0.13, 95%CI: [0.02,0.24]). However, the *multiple match* contrast did not reach statistical significance ($\overline{x}$ = 0.05, 95%CI: [-0.06,0.15]).

Discussion

The results of the offline judgment experiment revealed that raters assign lower ratings to sentences where there is not a local antecedent for *ziji*. The lowest ratings were given to the *no match* condition, reflecting the difficulty that results from the lack of an intrasential antecedent. Interestingly, the *distant match* condition was rated lower than the *local match* and *multiple match* conditions. This penalty is consistent with the presence of a locality effect. This conclusion is supported by independent evidence that the acceptability of grammatical sentences is reliably modulated by the length of a binding dependency (Sprouse, Fukuda & Kluender, 2011). Importantly, the *distant match* condition was rated as more acceptable than the *no match* condition, consistent with the

claim that the distant binder is grammatically accessible as a binder for *ziji* (Huang & Tang, 1991; Tang, 1989).

The results of the online reading experiment indicate a substantial locality effect in the reading times, extending the findings of previous experiments to the subcommanding configuration tested here (Chen et al., 2012; Dillon et al, 2014; Jäger et al, 2015). The finding of the locality effect in the SOV configurations tested here is an important extension of previous findings. Importantly, it suggests that the locality effect is truly driven by processes initiated at the anaphor, rather than a reflection of a poor match between an inanimate subject and the verb (a possibility raised in Jäger et al, 2015).

In addition to the locality effect, the data reveal two other notable findings. First, there was a significant slowdown for *no match* conditions. Second, there were numerically longer reading times on the *multiple match* condition than in the *local match* condition, although this comparison did not reach significance. Nonetheless, this pattern weakly suggests a *multiple match* effect (Badecker & Straub, 1994, 2002; see also Rigalleau, Caplan & Baudiffier, 2004; Stewart, Holler & Kidd, 2007), an effect that refers to the processing difficulty engendered by the presence of multiple appropriate candidate antecedents. Chen and colleagues report a multiple match effect in their experiment: reading times on the anaphor were slowed in the presence of a grammatically illicit, but semantically appropriate antecedent for ziji (see also Jäger et al, 2015). The failure to see a significant multiple match effect in this experiment may reflect a lack of statistical power. Alternatively, it may reflect the relatively shallow task demands placed on readers in our experiment: it has been shown that in shallow depth-of-processing conditions, readers do not show a penalty for processing pronouns with multiple matching antecedents (Garnham et al., 1992; Rigalleau et al., 2004; Stewart et al., 2007).

Lastly, and somewhat surprisingly, we note that the reading times on the *no match* condition were in fact shorter than the *distant match* condition. We can only speculate as the source of this effect. It is possible that readers were able to terminate their search for an antecedent early in this condition, essentially 'giving up' on a protracted search for an antecedent if there was no animate entity at all in the immediate discourse or situation model. This possibility does not follow from the search model proposed in Dillon et al (2014), but we do not see it as incompatible with the model. Because of the speculative nature of this proposal, however, we refrain from further interpreting this effect, and set it aside an interesting puzzle for future research.

Before further interpreting the effects in Experiment 1, we present the results of Experiment 2.

Experiment 2

Experiment 2 was identical to Experiment 1 in all major respects, except that Experiment 2 investigates the processing of the complex anaphor *ta-ziji*.

Participants

70 students from the University of Maryland community participated in the experiment. All participants were native Mandarin Chinese speakers from mainland China, and all

had normal or corrected-to-normal vision. They were paid $10 per hour for their participation in the experiment. Participants gave informed consent under an experimental protocol approved by the University of Maryland Institutional Review Board.

Stimuli

The materials were largely identical to those from Experiment 1. Two important changes were made to these materials. First, all instances of *ziji* were replaced with *ta-ziji*. The materials were additionally modified so that within an experimental item set, the animate nouns in each position were of the same gender. This was done to preserve the ambiguity of the multiple match condition, and was necessary because *ta* orthographically marks gender (see Introduction). Half of the revised materials had male nouns, and the other half had female nouns.

All other aspects of the stimuli, including the fillers and comprehension questions, were identical to Experiment 1.

Procedure

The experimental procedure was identical to Experiment 1.

Analysis

The data analysis procedure was identical to Experiment 1.

Offline Judgments

As in Experiment 1, we gathered offline acceptability judgments of all experimental materials prior to running Experiment 2. Collection of judgments and recruitment of participants proceeded in the same fashion as the offline pre-test for Experiment 1. 26 native Mandarin speakers were recruited from Beijing Normal University.

	Distant:Mismatch	*Distant*:Match
Local:Mismatch	4 (0.3)	5 (0.3)
Local:Match	5.1 (0.3)	4.1 (0.3)

Table 5: Mean acceptability ratings in Experiment 2. Parentheses represent standard error by participants, corrected for between-participant variance (Bakeman & McArthur, 1996)

The results of the offline judgment study are presented in Table 5. Linear mixed effects modeling revealed only an interaction of local and distant NP animacy (Est = -1.88± 0.38, t = -4.15). This interaction was driven by low ratings in the *no match* condition, and low ratings in the *multiple match* condition. There was no appreciable difference between the ratings of the *local match* and *distant match* conditions.

Comprehension

Accuracy on the comprehension questions averaged 83% across participants, indicating that the participant attended to the linguistic stimuli. Across participants, accuracy ranged from 71% to 95%. As in Experiment 1, one participant was removed from further analysis due to low accuracy (less than 70% accurate).

Reading Times

	1	2	3	4	5	6	7	8	9
Multiple Match	781	803	643	829	810	640	600	619	685
	(34)	(29)	(23)	(32)	(28)	(29)	(19)	(22)	(36)
Local Match	852	879	658	817	787	594	590	569	656
	(30)	(31)	(31)	(35)	(37)	(31)	(20)	(25)	(40)
Distant Match	794	771	720	788	764	636	647	622	736
	(29)	(19)	(57)	(33)	(36)	(32)	(24)	(18)	(32)
No Match	860	916	699	774	799	620	699	717	751
	(36)	(54)	(26)	(32)	(32)	(20)	(28)	(24)	(30)

Table 6: Mean reading times per region Experiment 2. Parentheses represent standard error by participants, corrected for between-participant variance (Bakeman & McArthur, 1996). Region labels are as follows: 1:*Zhang taitai* 2:*jingchang guanggu de* 3:*na-ge* 4:*shizhuangdian* 5:*shang-ge-zingqi* 6:*ba* 7:*ta-ziji* 8:*bu xiaoxin* 9:*nongshang-le*.

	Est.	*t*
Local	-0.06 (0.04)	-1.48
Distant	-0.01 (0.02)	-0.61
Local × *Distant*	0.07 (0.06)	1.14

Table 7: Results of linear mixed effects modeling of critical region *ta-ziji* in Experiment 2.

	Est.	t
Local	-0.08 (0.03)	-3.10
Distant	-0.02 (0.03)	-0.82
Local × *Distant*	0.15 (0.06)	2.78

Table 8: Results of linear mixed effects modeling of spillover region *bu xiaoxin* in Experiment 2.

Raw mean reading times are presented in Table 6, and statistical analyses of the critical and spillover regions are presented in Tables 7 and 8. As in Experiment 1, there were no significant effects of counterbalancing list. In the critical region, there were no significant fixed effects, although there was a near-significant effect of local noun animacy. Numerically, this effect was similar to the effect in Experiment 1, reflecting a reading time slowdown in the presence of an inanimate local noun.

In the spillover region, we observed a significant effect of local noun animacy, which was qualified by an interaction of local and distant noun animacy. Inspection of the means suggests that this pattern was driven by long reading times in the *no match* condition, compared to relatively flat reading times for all three other conditions.

Planned comparisons revealed a relatively small, marginally significant *locality contrast* ($\overline{x}$ = 0.06, 95%CI: [-0.02,0.13]). As in Experiment 1, there was a large *no match contrast* ($\overline{x}$ = 0.16, 95%CI: [0.08,0.23]). The magnitude of the *multiple match contrast* was comparable to Experiment 1, although it reached marginal signifigance in this experiment. ($\overline{x}$ = 0.05, 95%CI: [-0.03,0.13]).

Discussion

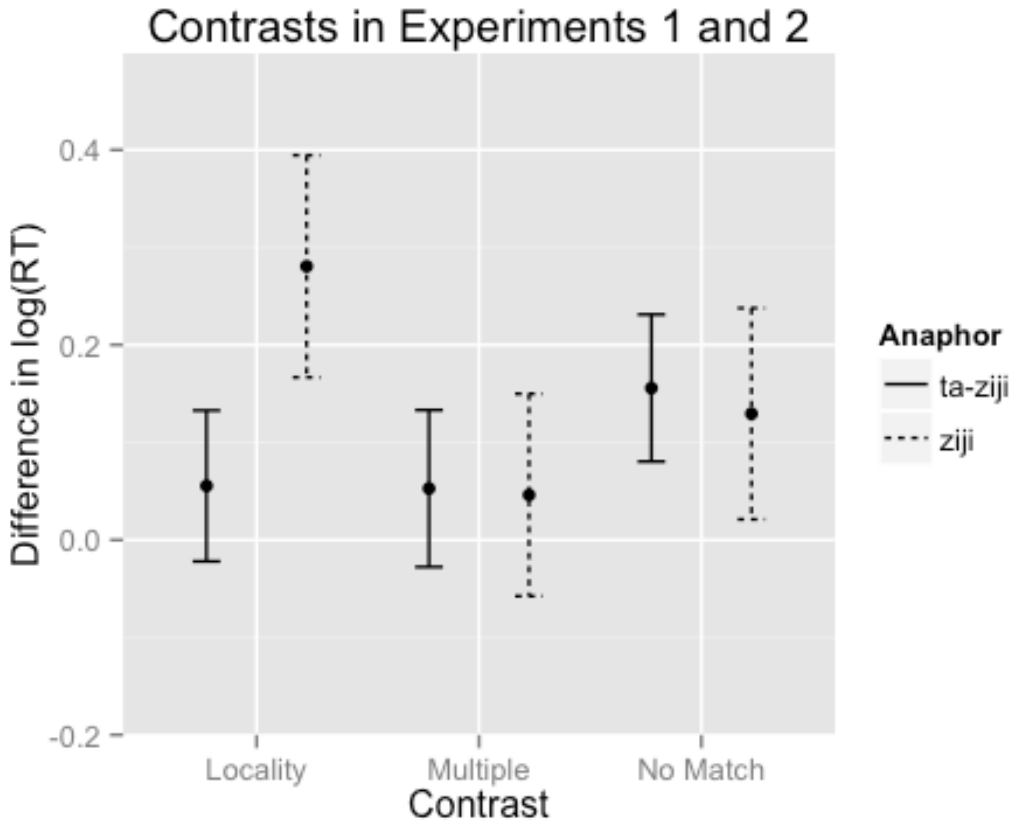

Figure 1: Planned contrasts in the spillover region in both Experiment 1 (*ziji*) and Experiment 2 (*ta-ziji*). Error bars indicate 95%CIs; see text for details on how confidence intervals were obtained.

The offline judgments for sentences containing *ta-ziji* reveal that *distant match* conditions were as acceptable as *local match* conditions for *ta-ziji*, and both configurations were more acceptable than *no match* conditions. There was no indication of a locality bias in the offline judgments for Experiment 2.

As in Experiment 1, in Experiment 2 we observed an interaction of local and distant subject animacy in the reading times at the spillover region. However, this interaction was driven by a different pattern of mean reading times in Experiment 2 than in Experiment 1. In Experiment 2, only the *no match* contrast was fully significant; the *multiple match* contrast and the *locality* contrast both reached only marginal significance. There were no significant effects on the critical region itself.

Of crucial interest is the comparison of the reading times in Experiments 1 and 2. This comparison reveals one major difference in the results of Experiments 1 and 2: the *locality* contrast associated with *ziji* in the spillover region of Experiment 1 was substantially larger than for it was for *ta-ziji* at the same region in Experiment 2. This is depicted visually in Figure 1, which plots the planned contrasts for each anaphor at the spillover region. From this figure it can also be seen that the two anaphors are otherwise very similar. The magnitude of the *no match contrast* was comparable across experiments, suggesting the penalty associated with a lack of a sentence-internal antecedent was comparable for the two anaphors. Likewise, the magnitude of the *multiple match contrast* was similar across the two experiments, although it reached marginal significance in Experiment 2. This pattern suggests that the failure to find a significant multiple match effect for either anaphor may reflect a lack of statistical power.

General Discussion

In two self-paced reading experiments, we evaluted the processing of two reflexive anaphors in Mandarin: the bare monomorphemic reflexive *ziji*, and the morphologically complex reflexive *ta-ziji*. In both offline acceptability rating and online reading time results, we observed that *ziji* was associated with a robust locality bias effect in Experiment 1. In contrast, Experiment 2 revealed a weaker locality effect for *ta-ziji* in reading times, and no locality effect in offline acceptability judgments. For online reading time measures, the difference in the magnitude of the locality contrast was the only point of appreciable difference between the two anaphors. For both *ziji* and *ta-ziji*, we observed reliable reading time slowdowns when there was no licit antecedent in the sentence, and the size of this *no match* penalty was not reliably different between anaphors. Likewise, for both anaphors we observed a trend towards a multiple match penalty. This effect did not reach statistical significance, although the consistency of the effect across experiments raises the possibility that this reflects a lack of statistical power.

The finding that the morphologically simple reflexive *ziji* exhibits a greater locality bias effect in reading measures than does the morphologically complex anaphor *ta-ziji* confirms the predictions of the Less Is More hypothesis. On our hypothesis, the slowdown for *ziji* reflects a search process that results from its relatively impoverished retrieval cues. While we believe this interpretation of our findings is plausible in light of the full range of existing evidence on processing *ziji*—notably the MR-SAT results presented in Dillon et al. (2014)—we stress that caution is required in drawing this conclusion from our reading time measures alone. Reading time measures conflate processing accuracy and processing speed (see discussion in McElree 2006), making it impossible to determine whether the locality effects observed in Experiments 1 and 2 reflect a difference in processing speed or processing accuray between local and long-distance binding configurations. In the absence of more direct time course evidence in the form of e.g. speed-accuracy tradeoff curves, we acknowledge that it is possible that the locality bias observed in Experiment 1 may simply be the result of a decrease in the quality of the memory representation of the more distant subject, rather than the result of a search process of the sort described in the introduction. Regardless of the specific theoretical interpretation of the locality bias effect we observed in our experiments, however, we note the finding that the locality effect was significantly smaller for the

morphologically complex anaphor *ta-ziji* supports the Less Is More hypothesis: the addition of the pronoun to the anaphor supports more reliable, or faster, access to the syntactically distant antecedent.

The Less Is More hypothesis, as we present it here, links morphological richness to richness in the cues used to recover an antecedent. However, the precise relationship between overt form and the retrieval cues remains unclear. Indeed, the problem of specifying the precise nature of the retrieval cues that support language processing is pervasive for cue-based approaches, and remains an area where much further work is needed (Van Dyke & McElree, 2011). Previous research suggests that the link between overt morphological feature content and retrieval cues may be less direct than implied by the Less Is More hypothesis. For example, Dillon, Mishler, Sloggett and Phillips (2013) present a series of studies that investigate the processing of English *himself*. On the basis of a comparison between retrieval models and online reading data, they suggest that *himself* does not use rich morphological feature cues to its antecedent, instead relying on a mixture of structural and locality cues (Dillon, 2014; Dillon et al, 2013; but see Jäger et al, 2015, for a critical view of this conclusion and an alternative analysis of these findings). Put differently, Dillon et al (2013) claim that the morphologically complex English reflexive *himself* deploys a cue set that is fundamentally similar to the cue set proposed for Mandarin *ziji*, despite the fact that *himself* is morphologically more similar to Mandarin *ta-ziji*.

Resolving this tension is beyond the scope of this paper, but there are several possibilities that suggest themselves. It may be that the empirical link between morphology and retrieval cues implied by the Less Is More hypothesis is misguided, and some other difference between *ziji* and *ta-ziji* is responsible for the difference in processing behavior. Unlike *ziji, ta-ziji* is associated with discourse contrast and intensification (Tang, 1989). It is possible that this feature, rather than its morphological complexity per se, is what leads to the difference in processing behaviors. Jäger, Engelmann and Vasishth (2015) provide another possibility that may account for cross-anaphor differences in retrieval behavior. Jäger et al. propose that cues that co-occur in similar retrieval contexts undergo a process of *cue confusion*, a learning process that causes multiple distinct cues to collapse into a single, merged cue when they reliably co-occur. On their hypothesis, *ziji* may come to be associated with single complex cue that jointly selects for semantic and syntactic features, because it is the only anaphor in its paradigm (see discussion in Jäger et al., 2015). In contrast, the diversity of person, number, and gender features associated with morphologically complex anaphors in Mandarin may prevent cue confusion of this sort, promoting the maintenance of a rich, articulated retrieval cue set for anaphors like *ta-ziji* that find themselves in a complex morphological paradigm. It remains possible that the apparent difference in the cue content of simple and complex Mandarin reflexives is the result of a learning process like that advocated by Jäger et al. (2015).

We note that in addition to supporting the Less Is More hypothesis, the observation of locality bias effects for *ziji* in Experiment 1 rules out several plausible alternative hypotheses for the source of the locality bias effect for *ziji*. First, and perhaps most importantly, the contrast between *ziji* and *ta-ziji* rules out the simple hypothesis that the locality effects reflect mere recency effects, or differences in the baseline availability of the two antecedent positions. Such a hypothesis predicts that the locality bias effects

should be uniform across anaphor type, which we failed to observe in our experiments. Another hypothesis that has been put forward to account for previous locality bias effects links these effects to the SVO word order used in other studies. If the local subject is reactivated at the verbal head (e.g. for thematic processing), then it may receive a boost in availability that causes it to be more accessible or available for anaphors in direct object position (King, Andrews & Phillips, 2012; Kush, Lidz & Phillips, 2014; see also Dillon et al, 2014). Since we observe locality effects in SOV configurations, however, we conclude that the position of the verb vis-a-vis the anaphor is not the sole source of the locality bias effect for *ziji*.

Lastly, we have attributed *ziji*'s locality penalty in reading to a processing mechanism that executes a search for an antecedent, making recovery of the long-distance antecedent more difficult. However, we did observe that there was a reliable offline acceptability penalty for long-distance *ziji* in Experiment 1. This raises the possibility that the locality effect in Experiment 1 reflects not a processing mechanism, but instead an as-yet undescribed grammatical constraint that penalizes antecedents for *ziji* in the configurations we tested. While we cannot firmly exclude this possibility, we find it unlikely for several reasons. First, we note that we did not observe a straightforward relationship between offline judgments and online reading times in Experiment 1. The *no match* condition was rated as least acceptable offline, yet was read more quickly than the *distant match* condition in our reading experiment. This pattern suggests that the *distant match* condition involves additional processing difficulty that is not present in other conditions, and which is present only in the reading measures. Second, it is plausible that the difference between the *local match* and *distant match* conditions in the offline acceptable is itself a reflection of the processing difficulty between the two. Offline acceptability judgments are reliably influenced by processing difficulty (Fanselow & Frisch, 2004; Schütze, 1996; Sprouse, 2008). Critically for present purposes, previous research has shown that locality effects in binding dependencies reliably influence offline judgments of acceptability (Sprouse et al., 2011). Thus there is independent evidence to believe that processing difficulty associated with antecedent locality should show up in the offline judgments.

Conclusion

In our Experiment 1, we observed that the morphologically simple long-distance reflexive *ziji* shows a robust locality bias in reading time measures. Experiment 2 revealed that the morphologically complex, local reflexive *ta-ziji* shows a much reduced locality bias in processing. This empirical contrast was predicted by the Less Is More hypothesis, which relates the feature richness of an anaphor to search behavior in the identification of an antecedent. Because morphologically simple anaphors lack robust retrieval cues, they may require a search process to identify their antecedent, leading to locality effects in comprehension. In contrast, morphologically complex anaphors may make use of a richer cue set, obviating the need for a search process and thereby minimizing locality effects in comprehension.

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