An Active Gap Strategy
in the Processing of Filler-Gap Dependencies in Chinese[1]

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This study investigates how filler-gap relations are processed on-line in Chinese, in constructions where the relation is driven by the gap rather than by the filler. The specific issue is whether there is an Active Gap Strategy analogous to the Active Filler Strategy that has been well-documented by data from English, Italian and other languages. Results of a self-paced word-by-word reading experiment on Mandarin Chinese indicate that when a gap is encountered first, and a possible filler then presents itself, the parser prefers to adopts that potential filler without waiting to see whether there are other or better alternatives later in the sentence. This is one of several on-line phenomena that would follow from an Active Gap Strategy.

Introduction

The Active Filler Strategy, first proposed by Frazier (1987), is well-established for the real-time processing of filler-gap dependencies (Crain and Fodor 1985; Frazier 1987; Frazier and Clifton 1989; Frazier and Flores D'Arcais 1989; Stowe 1986). It depicts a parser that, after identifying a filler (e.g., a *wh*-question word), will actively look for a gap position to assign the filler to. An active search process means that in processing subsequent words the parser ranks the option of a gap above the option of a lexical noun phrase. In other words, when a potential gap position appears, the parser will immediately associate it with the filler, which will require reanalysis if the next word it receives reveals that there was no gap in that position after all. Processing difficulty typically accompanies filler-gap revision.

The present study investigates the processing of filler-gap dependencies from another angle; it examines filler-gap associations that are initiated by the gap. The question of interest is: Is there an Active Gap Strategy analogous to the Active Filler Strategy? In other words, if a gap is detected before its filler is encountered, will the parser actively seek out its filler later in the sentence? The Minimal Chain Principle ("Avoid postulating unnecessary chain members at surface structure, but do not delay required chain members") of De Vincenzi (1991) is formulated in a symmetric fashion,

treating fillers and gaps alike and implying active parsing for both. While the filler-gap dependency studied here is a semantic relationship, not technically a chain in the sense of a syntactic binding, it is worthwhile to consider the broader hypothesis that *all* filler-gap associations follow the same imperative of completing the association as rapidly as possible in on-line processing.

Active search for a filler could manifest itself in several ways. The parser might show a preference for a filler in the left context (i.e., previously processed material in the discourse or sentence) if there is a candidate there, since that is already accessible and requires no waiting. If there is no prior filler, the parser might seek out a filler in the incoming material, adopting the first available candidate without waiting to see if there are other or better ones; that is, it would rank the option of a filler analysis above the option of a non-filler hypothesis on-line. Or the parser might locally assign a generic ('arbitrary') interpretation to the gap, which avoids the need to locate a filler at all. These 'active gap behaviors' are not mutually exclusive, of course. So in looking for evidence pertaining to the psychological reality of an Active Gap Strategy we should be on the watch for any and all of these signs. The experiment reported here focuses on the second of these indicators of active gap processing: the greedy acceptance of the first-found potential filler that follows the gap. In a self-paced reading experiment on Mandarin Chinese, the experimental sentences offered an early but incorrect filler – a 'decoy' filler – which, if adopted, would require revision of the filler-gap association later in the sentence.

Chinese has an abundance of constructions containing gaps. The focus of investigation in the present experiment is a construction with a clausal subject whose own subject is phonologically null (a gap). Its counterpart in English would be a sentence such as *To go on safari would be too risky for Tim*, where the point of interest is how the phonologically null subject of *To go on safari* is interpreted on-line. The usual word order of a Chinese sentence is SVO, as in English. Thus, the clausal subject precedes the main clause predicate, which may or may not contain a filler for the gap. Relevant to this experiment is that Chinese has a pre-nominal possessive construction which can create a temporary ambiguity as to which noun in the main clause predicate is the filler for the gap. For instance, in an English rendering of the Chinese sentence *To go on safari would be too risky for Tim*, the filler is *Tim* but in *To go on safari would be too risky for Tim's cousin* the filler is the cousin. An important difference from English is that the Chinese possessive marker *de* is a separate character, graphemically independent of the preceding word (even though phonologically it leans on that word).[2] Therefore, when *Tim* is

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[2] Note that although *de* functions like the possessive marker *'s* in English, it occurs more broadly since it follows all kinds of pre-nominal modifiers including even relative clauses. Also, in the possessive *de* construction, animate and inanimate nouns are equally acceptable in the role of possessor, unlike in English which is less tolerant of inanimates. For example, *the charm of his smile* is acceptable in English but *his smile's charm* is much less acceptable, whereas the latter construction is perfectly fine in Chinese.

encountered in word-by-word reading, there is no indication yet that it is a possessor. In Chinese, the parser cannot know whether or not *Tim* is the filler until it receives the next word or a period (。 in Chinese) following *Tim*. If *Tim* is sentence-final, or is followed for instance by an adverb such as *tomorrow*, then *Tim* is clearly the filler. However, if the word following *Tim* is *de*, the marker of a nominal modifier, then *Tim de* is a possessive modifier, and the head noun (e.g., *cousin* in the English example above) that it modifies is the true filler for the gap.[3]

Previous studies on gap-driven processing of filler-gap dependencies

A gap may be identified before its filler is even if the gap does not precede the filler in linear word order. The category of gap-driven filler-gap dependencies includes situations in which a filler precedes its gap but is not immediately recognized <u>as</u> a filler when it is encountered but only later, often not until the gap is subsequently encountered. This is the case for passive, raising and control constructions in many languages, since the filler is just an ordinary nominal in subject position (e.g., *Sue was photographed by the journalist*, where *Sue* is the filler for the gap created after *photographed* by passivization). Sometimes the matrix verb offers a clue that this is a filler-gap construction, as in *Sue appeared to be fainting* or *Jill promised Sam to drive him home*, where *appear* is a typical raising verb and *promise* is a familiar control verb; but this is far from reliable in view of *Sue appeared in the mirror* or *Jill promised Sam a present*. Many previous studies have investigated constructions such as these, with a variety of processing questions in mind, including: the strategy used to select a preceding filler; the time course of gap resolution; and the time course of use of verb and plausibility information. For a recent review, see MacDonald and Seidenberg (2006), and Shapiro (2000). However, the possibility of an Active Gap Strategy for gap-first constructions has been explored, to my knowledge, only by Hsu and Bruening (2003).

In their investigation Hsu and Bruening employed Chinese sentences containing relative clauses. Chinese noun phrases are head-final; hence the relative clause precedes the head noun it modifies, which means that the gap in the relative clause also precedes the head noun, which is the gap's filler. Hsu and Bruening argued in favor of an 'Active Gap' hypothesis on the grounds that the parser can be shown to anticipate the head noun before encountering it, as evidenced by a 'surprise' effect when other words intervene. An example of the test sentences is shown in (1). (CL=classifier)

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[3] In certain cases it is possible for the modifier, rather than the head noun, to be the filler. See discussion below.

(1) a.　　Na-wei　lao-taitai zuotian　　bianzhi-le[4]　yi-jian maoyi　songgei　ta-erzi.
　　　　　That-CL old-lady　yesterday knit-PAST　one-CL sweater give-to　her-son
　　　　　'That old lady knitted a sweater to give to her son yesterday.'

　　 b.　　Na-wei [e_i zuotian　　bianzhi-le　yi-jian　maoyi　songgei ta-erzi]　de
　　　　　That-CL　 yesterday knit-PAST　one-CL sweater give-to　her-son　DE
　　　　　lao-taitai$_i$ shenbing-le.
　　　　　old-lady　get-sick-PAST
　　　　　'That old lady who knitted a sweater to give to her son yesterday got sick.'

Sentence (1a) serves as the baseline; it does not contain a filler-gap dependency. The sentence in (1b) contains a relative clause with a subject gap. The fact that it is a relative clause is cued by the preceding demonstrative and classifier, both of which are typical components of a noun phrase; thus, if what follows them is not a noun that is compatible with the classifier, as *zuotian* 'yesterday' is in (1b), it signals the likely presence of a relative clause embedded in the noun phrase. (The classifier *wei* signifies a person.) If the parser actively tries to interpret the gap as rapidly as possible, it might anticipate the presence of *de* and the head noun as soon as it has processed *maoyi* 'sweater' because the relative clause could terminate there. In fact, the relative clause continues for two more words in (1b), where *songgei ta-erzi* is an optional adjunct clause inside the relative. Hsu and Bruening report a reading slowdown on those words, and attribute this to the unexpected delay in locating the filler for the gap. They call this the 'missing-filler effect', seeing it as analogous to the 'filled-gap effect' which is a major source of evidence for active filler parsing (Crain and Fodor 1985; Stowe 1986). They conclude that the human parser follows an Active Gap Strategy as well as an Active Filler Strategy.

　　　　This evidence is not decisive, however, because the reading time results are open to alternative interpretations. One very natural explanation would be an increase in memory cost due to the prolonged prenominal relative clause. The parser has to build the tree structure within the relative clause, and has to maintain the gap in working memory as it does so. In addition, a lengthy relative clause may not be very frequent in Chinese so there may be a reasonable expectation that it will terminate without including an additional clause inside of it. All this could significantly increase the processing load in the latter part of the relative clause, resulting in the observed reading slowdown.

　　　　In short: an Active Gap Strategy is only one possible reason for the finding of Hsu and Bruening, so the validity of that strategy is left uncertain by this evidence. No study to date, to the best of my knowledge, has provided unambiguous evidence either for or against active gap processing. The present study will employ a different Chinese gap-filler construction and other types of argument in order to address this issue. The

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[4] *Le* seems to be taken as a past tense marker in Hsu and Bruening. But it is more commonly considered to be a perfective aspect marker.

experiment explored whether the parser adopts the first potential filler it encounters after a gap is identified, or whether it waits to find out what alternatives there might be later in the sentence and then selects the strongest candidate.

Design and Methodology

One way to test for an 'active' gap energetically seeking out its filler is to create a 'decoy' filler that precedes the real filler. In Chinese, this can be achieved by exploiting the head-final property of the noun phrase: the decoy filler looks like a plausible filler but turns out to be a modifier of the subsequent head noun which is the real filler. The test sentences were designed based on this principle, as illustrated in (2). The regions for presentation and data analysis are shown in Table 1; the target regions of interest are regions 2-5. (CAU: causative marker)

(2) a.   **Plausible Decoy Filler**
$[e_i$ Nonghuile jige   wanju] bingweishi **xiaohaizi de baomu$_i$ gengxiaoxin**.
      broke   a-few toy   not-CAU   child   DE nanny   more-careful
'Having broken a few toys did not make the child's nanny more careful.'

b.   **Implausible Decoy Filler**
$[e_i$ Nonghuile jige   wanju] bingweishi **youeryuan   de baomu$_i$ gengxiaoxin**.
      broke   a-few toy   not-CAU   kindergarten DE nanny   more-careful
'Having broken a few toys did not make the kindergarten's nanny more careful.'

Table 1: Regions of target sentences for presentation and data analysis.

	N_1	de	N_2	N_2+1	
Region 1	2	3	4	5	6
All words prior to N_1	**xiaohaizi youeryuan**	**de**	**baomu**	**gengxiaoxin**	All words and period following N_2+1[5]

The clausal subject (the Chinese counterpart of English *Having broken a few toys*) in the sentences in (2) has a null subject; it is not overtly specified who broke the toys. On recognizing the gap at the beginning of the sentence, an active gap parser would take its referent to be *xiaohaizi* 'child' in (2a), which is the first candidate filler it encounters. By contrast, *youeryuan* 'kindergarten' in (2b) is not a plausible subject for the verb *break*, thus not a good filler for the gap. For an active gap parser that makes use of plausibility information on-line, this could be expected to increase the reading time for *youeryuan*, relative to *xiaohaizi* and also leave the parser seeking a better referent in the remainder of the sentence. When it encounters *baomu* 'nanny' in (2b) it would accept this as the

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[5] Region 6 contained just the period in some sentences, but other sentences had additional words following region 5. This variation is unimportant since the design of the experiment was such that region 6 played no role in the data analyses.

plausible filler it needs. In (2a), by contrast, when the parser encounters *baomu* 'nanny' it must recognize that its first hypothesis was wrong: *xiaohaizi* 'child' cannot be the filler after all, since it is only a modifier of the real filler *baomu*.[6] So for (2a) the parser must dissolve the link between the gap and the decoy filler *xiaohaizi*, and establish a new link between the gap and the real filler *baomu*. This would make *baomu* more difficult to process in (2a) than in (2b) where (we are assuming) no gap-filler link was previously established.

There were 16 target sentences, each in two conditions as illustrated in (2a,b). These were combined with 32 sentences of different construction related to another experimental hypothesis, and 48 distracter sentences of assorted structure but roughly comparable in complexity. A total of 56 native Mandarin speakers (age: 18-33; mean age: 22; 38 female) from Mainland China successfully participated in this experiment. After reading each sentence, participants were presented with a comprehension question with two answers offered. The question did not directly ask about the gap and its referent in the sentence; its purpose was to exclude inattentive participants. Two participants whose accuracy rates fell at or below 85% were excluded. The average accuracy rate of the remaining 56 participants on the comprehension questions was 95.3 %.

Results and Discussion
Reading times more than 3 standard deviation units away from the mean reading time of an individual participant for each region were discarded. This affected 2% of all the data points. The data analyses reported are all one-tailed *t*-tests performed on participant- and item-based reading time means. Summary values for the four relevant regions (regions 2 to 5) are presented in Table 2 and graphically in Figure 1.

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[6] In both Chinese and English, the modifier may be the real filler in some contexts (though not in the experimental materials), as noted above. For example, in an English sentence such as *Breaking a few toys was Jim's idea*, the filler is clearly not *idea* but is *Jim* (or some group with whom Jim is associated). The same is true for the Chinese counterpart of this sentence. But in both Chinese and English, if what follows the possessive marker is a plausible filler, the modifier cannot be the filler. For example, in the sentence *Breaking a few toys was Jim's sister's idea*, the filler can be *Jim's sister* but it cannot be *Jim* (though nothing excludes Jim from being among those who broke the toys). Because of this, the word *de* in (3a) could <u>alert</u> the parser to the likelihood that the real filler will be the noun that follows *de*, not *xiaohaizi* after all, but *de* is not a definitive predictor of this since the meaning of the noun could also matter. (Note that the variability and meaning-sensitivity of filler choice in this construction is part of the evidence that it does not constitute a true syntactic chain; see Hornstein 1999; Landau 2001.)

Table 2: Mean reading times (ms) for regions 2-5, as a function of Decoy Filler Type (plausible, implausible)

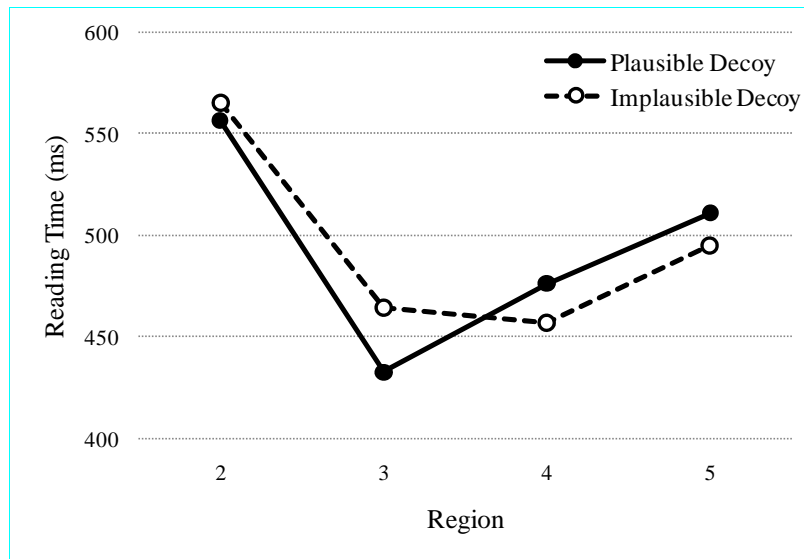|	Plausible Decoy Filler	Implausible Decoy Filler
Region 2	557	566
Region 3	433	465
Region 4	477	457
Region 5	512	495

Figure 1: Mean reading times (ms) for regions 2-5, as a function of Decoy Filler Type (plausible, implausible)

Before examining the data in detail, it will be useful to consider the phenomenon of 'spillover' in self-paced reading studies. It is commonplace to find that an effect predicted for one region is observed instead at the following region, especially if each region is just one word long as in this experiment (see Mitchell 2004). It has not been clearly documented whether this is so for all levels of processing, though it is usually integrative processing that is cited as giving rise to spillover phenomena. In this experiment and others that I have conducted in Chinese using the same experimental paradigm as here (Ng and Fodor, in press), I have found that lexical differences are registered in reading times for the region where the stimuli were actually presented, without spillover, while syntactic and semantic integration difficulties typically show up one word later. The results of the experiment reported here are more intelligible if the likelihood of this systematic one-region delay is borne in mind. For readers' convenience, I include here a

brief tabulation of which predicted effects are expected to manifest themselves in which regions.

Table 3: Summary by region of where processing events are expected to contribute to reading times, due to one-word 'spillover' of integration costs

	Word presented		Processes contributing to reading times
Region 2	plausible decoy noun	implausible decoy noun	Lexical processing of decoy nouns. Integration of last word of region 1, which makes the transition from subordinate to main clause.
Region 3	*de*		Lexical processing of *de*. Integration of decoy nouns into sentence meaning.
Region 4	head noun		Lexical processing of head noun. Integration of *de*, which marks a complex NP that will contain another noun.
Region 5	first word following the complex noun phrase (unrestricted category, but matched across sentence versions)		Lexical processing of first word following the complex noun phrase. Integration of head noun. Filler-gap assignment for implausible decoy filler sentence. Reanalysis of filler-gap assignment for plausible decoy filler sentence.

Region 2 (2-4 characters, mean: 3): This region follows the verb or causative marker at the onset of the main clause predicate. It is the first structural position that provides a filler for the gap. Plausibility dictates whether a nominal that occurs in this region is a good filler. The plausible and implausible decoy fillers, though distinct words, were matched in length, that is, in number of characters in Chinese orthography. They differed both lexically and in their plausibility in context. Any difference between them with respect to the difficulty of lexical processing should be apparent at this region (without spillover). In fact, the two decoy types elicited reading times (561 ms on average) that were not reliably different from each other ($t_1(55) = -0.68$, p > .20, $t_2(31) = -0.47$, p > .30). It can be concluded that the plausible and implausible decoy fillers were well matched, such that their lexical differences did not deflect reading times. A difference in the integration difficulty for these two nouns was predicted, with an advantage for the plausible filler, but it was expected that this would not emerge here but only in the following region, due to spillover.

Region 3 (1 character): This region contains only *de*, whose lexical processing is expected to be minimal, since it is a short (one character) function word. Its integration into the on-going sentence is likely to be more complex. *De* indicates that the noun in region 2 is a modifier, and that the head noun that it modifies will occur next. This has consequences for the identity of the filler. Although the modifier may remain as the filler in some cases (see footnote 6), the head noun is by far the most likely filler for the gap. The appearance of *de* would therefore be a strong hint to the parser that the previous noun (in region 2) was not the true filler. This would be easier for the parser to adjust to following the implausible decoy filler than following the plausible decoy filler, on the assumption that the parser had already rejected the implausible filler as not the true filler. Thus the integration of *de* is predicted to be more costly in plausible decoy sentences than in implausible decoy sentences. Once again, however, the integrative cost of *de* is expected to be manifested only in the following region.

Reading times in region 3 were expected to exhibit the difference in integration difficulty of the two nouns presented in region 2. Results showed an average 433 ms reading time for plausible decoy filler sentences, significantly faster than the average 465 ms for implausible decoy filler sentences ($t_1(55) = -3.25$, p $< .001$, $t_2(31) = -1.92$, p $< .05$). In support of the decision to construe this as a spillover effect from processing the nouns, rather than a local effect of *de*, there are several considerations. One is that the reading times in this region are high for a function word like *de;* per character, they are the highest in the whole experiment. As a reflection of integration of the preceding noun, however, these times are understandable. Also, the reading time difference between versions observed here in region 3 is in precisely the direction predicted given the plausibility difference between the nouns in region 2: it is the plausible decoy filler that is easier to process. This is explicable as a reflection of the parser's active search for a filler for the gap: a plausible noun could be readily adopted as filler, while an implausible noun (apparently in just the location in the sentence where the parser could expect the filler to be) would cause surprise and frustration. It is reasonable to conclude, then, that the reading slowdown in region 3 for the implausible decoy filler sentences does indeed reflect the predicted integration difficulty for the implausible noun.

Region 4 (2-3 characters, mean: 2.1): This region contains the head noun, which the parser must recognize as the real filler for the gap. If the parser previously associated the plausible decoy filler with the gap, it has to dissolve that link and co-index the gap with this new noun. This would be expected to increase reading time. Such reanalysis is not needed for the implausible decoy filler sentences, assuming that no filler-gap dependency was established before. Anticipating spillover, this predicted difference between the sentence types would be expected to manifest itself one word later, in region 5. Any contrast observed in region 4 would be due instead to integration of the *de* presented in region 3. (It could not be due to local differences in lexical processing, since the head noun was identical in the two sentence versions.)

While no fully reliable difference was observed in the data at region 4, there is a trend in the expected direction ($t_1(55) = 1.50$, $.05 < p < .10$, $t_2(31) = 1.11$, $p > .10$) with slower reading in the plausible decoy filler sentences than in the implausible decoy filler sentences. If this trend does signify a disadvantage for the plausible decoy filler, it is of interest because the contrast is in the reverse direction compared with the preceding region; the plausible filler that was easy to process at first is now making the sentence harder to process. This is as predicted at the point at which *de* is integrated. The occurrence of *de* as a harbinger of another noun to follow could have been anticipated by the parser in the implausible decoy filler sentences, where a good filler has yet to be found, but it would be unanticipated in the plausible decoy filler sentences. It could also be unwelcome in the latter case, as noted earlier, if the parser is sensitive to the fact that the new noun that will inevitably follow *de* could disrupt its current filler-gap association.

Region 5 (1-4 characters, mean: 2.3): In the experimental sentences this region always contained the first word following the end of the complex noun phrase, confirming the noun in region 4 as the head noun and hence the filler of the gap. Lexical content was identical across sentence versions, so no lexical processing differences could show up here. Instead, the reading times in this region are expected to reflect the integration of the head noun presented in region 4. The results show a trend in the same direction as in region 4 ($t_1(55) = 1.38$, $.05 < p < .10$, $t_2(31) = 1.11$, $p > .10$), with plausible decoy filler sentences once again eliciting longer reading times than implausible decoy filler sentences. If this is indicative of a genuine difference in processing cost, it is as predicted as a reflection of the cost of filler-gap reanalysis, as the parser now rejects the plausible decoy filler and adopts the head noun as filler instead.

General discussion

The pattern of data observed was fully consistent with predictions, though delayed by one word due to spillover. The major prediction had been that there would be a reading time disadvantage for the plausible decoy filler sentences later in the sentence, when *de* was encountered unexpectedly, and/or when reanalysis of the filler-gap relation, foreshadowed by *de*, was undertaken on receipt of the correct filler noun following *de*. This plausible filler disadvantage was predicted to be detectable in regions 4 and 5. A difference in the predicted direction was indeed observed there, in both regions, though it was not statistically robust (marginally significant by participants, but unreliable by items).

Supposing that the experimental hypothesis of Active Gap processing were correct, is there any explanation for why the disadvantage of the plausible decoy filler sentences is not fully reliable in regions 4 and 5? A natural explanation would be that the predicted effect was weakened by being divided between these two regions, with variability between trials and between participants as to whether the reanalysis process is initiated by *de* (showing up in region 4 reading times) or only on encounter with the head

noun (showing up in region 5 reading times). Recall that *de* is a strong but not decisive cue that the noun that will follow will be a better filler than the one already in hand. It may be that in some cases, the process of breaking the earlier filler-gap association with the plausible filler began at *de*, thereby reducing the workload at the next region where the revised filler-gap association would be formed. A test of this speculation must await further experimental investigation.

However, the persistent one-word spillover effect provides an unexpected bonus for the present experiment, concerning the interpretation of the strong difference at region 3 in which the implausible decoy filler sentences are at a disadvantage. This had not been the focus of a planned prediction, because the two decoy nouns necessarily differed lexically as well as in their plausibility as fillers. However, the spillover phenomenon has the effect of separating out the lexical and integrative costs of these words. The nouns were presented in region 2. On the basis of past findings, any difference in lexical processing cost should be evident in that same region, while the cost of integrating the implausible decoy filler would be evident in region 3. We noted earlier that the clear lack of difference between sentence versions in the region 2 data indicates that the nouns in the two versions were quite well-matched in their lexical processing costs. But it can also be inferred that the strong difference evident in the region 3 data was not due to any purely lexical processing cost difference between the nouns – both because region 2 indicates that there was no such difference, and because even if there had been it would not have spilled over into region 3. In consequence, the difference in region 3 can be attributed to the cost of integrating the plausible/implausible noun into the meaning of the sentence. This reliable difference thus becomes legitimate evidence in favor of the parser's preference for the plausible filler, prior to its demotion when the developing sentence provided a rival, just as would be expected in active gap parsing.

With this in place, the experimental outcomes exactly mirror the predictions of the Active Gap Strategy, though statistically less than robust in some respects. An active-gap parser would seek out a filler to provide an interpretation for the gap and would adopt the first acceptable candidate without waiting to check for any alternatives. It would thus succumb to the lure of the plausible decoy filler, finding processing easy at that stage but paying the price later in the need for reassignment of the gap interpretation.

Of additional interest is that this active-gap processing is observed even in the absence of a syntactic chain. The construction tested in this study (commonly referred to as non-obligatory control; see Landau 2001) involves no chain relation. The filler and gap are linked through inference and co-indexation, depending to a large extent on the meanings of the particular words and phrases in the sentence (see examples in footnote 6). The results nevertheless show that the parser actively seeks out a filler for this kind of gap. It is possible that this broad applicability is also the case for the Active Filler Strategy, though additional research would be needed to establish that. In general, it may be found that the linguistic mechanism underpinning a filler-gap relation is less important

than the basic fact that there are two elements in a sentence whose interpretations are interdependent.

Finally, we may raise the question of what motivates an active-gap parser. For an active-filler parser there is the need to assign a thematic role to a fronted phrase, which is determined by whatever thematic role is assigned at the position of its associated gap (see discussion in Aoshima, Phillips and Weinberg 2004). But when a gap is identified before its filler is, its syntactic position and also its thematic role are perfectly evident to the parser, just as much so as in the case of a phonologically overt item. What it lacks is simply a semantic or referential interpretation, and a filler-assignment satisfies this requirement. Thus, even though active-filler processing and active-gap processing appear to have a great deal in common, they may differ in their driving force.

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APPENDIX: EXPERIMENTAL SENTENCES

Items are shown in Chinese as presented in the experiment, with English translations here for convenience. (The bolded part is the target regions 2 - 5.) (NOM: nominalizer)

课后进修是**这个学生 / 这个学校的老师应该**做的 。
class-after study was **this student / this school DE teacher should** do NOM
'To study after class was what the student's / the school's teacher should do.'

打错了一份文件使**我妹妹 / 我公司的秘书很担心** 。
typed-wrong one document CAU **my sister / my company DE secretary worried**
'Having made a typo in a document worried my sister's / my company's secretary.'

常常出国访问令**这个皇帝 / 这个国家的 大公主很疲倦** 。
often go-overseas visit CAU **this emperor / this nation DE first-princess tired**
'To often pay official visits overseas tired out the emperor's / the nation's first princess.'

加入公司的新部门给**副经理 / 财政部的翻译更多**工作 。
join company DE new department gave **assistant-manager / finance-department DE translator more** work
'Having joined the new department of the company increased the workload of the assistant manager's / the finance department's translator.'

收到裁员的消息教**他们 / 美国的同事无法**集中精神 工作 。
received layoff DE notice CAU **they / America DE colleagues unable** focus-on work
'Having received the layoff notice made their / America's colleagues unable to focus on their work.'

看护这些孩子把**那个朋友 / 那个灾区的医生累坏** 。
look-after these children BA **that-friend / that-disaster-area DE doctor exhausted**
'Looking after the children exhausted that friend's / that disaster area's doctor.

习惯新的教学法要求**留学生 / 文学院的教授很大**的耐心 。
get-used-to new DE teaching-method demanded **foreign-student / Arts-Faculty DE professor much** DE patience
'To get used to the new teaching method demanded a lot of patience from the foreign student's / Arts Faculty's professor.'

经常忘记了入帐是**这个朋友 / 这个公司的老板应该**改掉的坏习惯 。
often forgot enter-transaction was **this-friend / this-company DE boss should** change DE bad-habit
'To often forget to enter the transactions into the ledger was the bad habit this friend's / this company's boss should change.'

喜欢邻居的小狗并未使**这个大狗 / 这个房子的主人喜欢**她的邻居。
adore neighbor DE puppy not-CAU **this-big-dog / this-house DE owner liked** her neighbor
'Adoring the neighbor's puppy did not make the big dog's / this house's owner like her neighbor.'

买了旁边的单位令**这个业主 / 这个公寓的租客终于**拥有自己的地方。
bought neighboring DE unit CAU **this-landlord / this-apartment DE tenant finally** own self DE place
'Having bought the neighboring unit allowed the landlord's / the apartment's tenant to finally own a place of his own.'

工作至深夜往往令**富豪 / 房车的司机失去**与家人欢聚的时间。
work till late-night often CAU **tycoon / limousine DE chauffeur lose** with family happy-gather DE time
'To often work until late night made the tycoon's / the limousine's chauffeur sacrifice valuable time he could spend with his family.'

收到政府的收地通知令**这些村民／这个渔村的领导很愤怒**。
received government DE land-use-change notice CAU **these-villages / this-fishing-village DE leader angry**
'Having received the government's notice for a change in land use angered the villagers' / the fishing village's leader.'

执行这个危险的工作要求**政府官员／公家银行的护卫接受**更多的训练。
implement this dangerous DE job required **government-official / public-bank DE security-guard receive** more DE training
'To implement this dangerous job required the government officials' / the public banks' security guards to receive more training.'

学习用这个电脑程式弄得**我爸爸／我们系的学生头昏脑胀**。
learn use this computer program CAU **my-father / our-department DE student flummoxed**
'Learning this new computer program flummoxed my father's / our department's students.'

拥有出众的口才增加**这个原告人／这个律师行的律师对**赢得这个案件的信心。
own outstanding DE eloquence increased **this-plaintiff / this-law-firm DE attorney to** win this case DE confidence
'Owning outstanding eloquence increased the confidence of the plaintiff's / the law firm's attorney to win this case.'

弄坏了几个玩具并未使**小孩子／幼儿园的保姆更小心**。
broke a-few toy not-CAU **child / kindergarten DE nanny more-careful**
'Having broken a few toys did not make the child / the kindergarten's nanny more careful.'