

Locality versus Anti-locality Effects in Mandarin Sentence Comprehension

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Whether the distance between the filler and the gap increases or decreases the difficulty for comprehenders has always been subject to debate. Locality theory claims that the greater the distance between the filler and the gap, the more difficult it is. However, anti-locality theory predicts that the greater the distance, the easier it is. This study examined whether it was the position of the verbs that made the differences. Three kinds of structures, simple SVO, relative clauses, and BA constructions, were manipulated. If the locality theory is correct, increasing reading times at the critical words should be observed. If anti-locality theory is correct, decreasing reading times should be found. In both SVO and RCs, we observed increasing reading times at the critical nouns. In BA constructions, however, we observed decreasing reading times at the critical verbs. It is thus the critical word at the end that leads to differences.

1. Introduction

Whether the distance between the filler and the gap increases or decreases the difficulty for comprehenders have always been subject to debate in the field of sentence comprehension. According to locality theory, e.g., Gibson's Dependency Locality Theory (Gibson, 1998, 2000; Babyonyshev & Gibson, 1999), it attributes language processing difficulties to the distance between an argument and its head. Although a majority of studies have found evidence in support of the locality effect, there are some counterexamples (Konieczny, 2000; Vasishth & Lewis, 2006) from head-final languages such as German and Hindi. They found that the longer the distance, the more difficulty it is for comprehenders to interpret. The situation that the farther the argument from its head the faster the reading times has been called anti-locality effect.

Konieczny (2000) was among one of the first researchers to notice anti-locality effect. He compared two detailed metric calculation of processing difficulties, one being Dependency Locality Theory and the other, Hawkins' (1994) IC-to-Words calculation based on the concept of Early Immediate Constituent (EIC). According to Hawkins, "...words and constituents occur in the orders they do so that syntactic groupings and their immediate constituents (ICs) can be recognized (and produced) as rapidly and

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efficiently as possible in language performance” (p. 57). The ratio, IC-to-Words, was proposed to account for the processing difficulty by examining whether constituents that should be grouped together is immediately recognized or not. If the ratios are maximized, there will be efficient and faster recognition of the mother node and the examples are below:

- (1)
- a. I_{VP}[gave NP[the valuable book that was extremely difficult to find] PP[to Mary]]
 1 2 3 4 5 6 7 8 9 10 11
- b. I_{VP}[gave PP[to Mary] NP[the valuable book that was extremely difficult to find]]
 1 2 3 4

The verb “gave” in (1) is a dative verb, which requires three arguments. After processing “I” and “gave”, comprehenders would expect to see another two arguments. Take (1) for example, there are two possibilities to continue the sentence: one is to adjoin NP right after “gave” as in (1a). The other possibility is to adjoin the PP right after the verb “gave” as in (2b). Since three constituents (V, NP and PP) are required in this example, (1b) facilitates comprehenders’ understanding than (1a) because it only takes 4 words (at “the” position) to complete the requirement of searching for the other two arguments. On the other hand, construction of VP will be greatly delayed in (1a) since it not until the 11th word “to” that makes people realize the presence of NP and complete the search for arguments. Simply put, of all the twelve words, comprehenders need to scan 11 words for recognition in (1a) while only 4 words in (1b). Thus people should prefer (1b) over (1a). The metric IC-to-words calculation of the two sentences here are 3/11=27.3% for (1a) and 3/4=75% for (1b).

To further investigate locality versus antilocality issue, Konieczny (2000) examined the effect of relative clause position, relative clause length and extraposition distance In a 2 x 3 x 3 design. Examples are given below:

- (2)
- a. Er hat das Buch, *das Lisa gestern gekauft hatte*, **hingelegt**.
 he has the book that Lisa yesterday bought had laid_down
 (“He has laid down the book that Lisa had bought yesterday.”)
- b. Er hat das Buch **hingelegt**, *das Lisa gestern gekauft hatte*.
 he has the book laid_down that Lisa yesterday bought had
 (“He has laid down the book that Lisa had bought yesterday.”)

The italicized regions represent German relative clauses, which can be either directly adjoined to the main clause or extraposed to the right of the main clause. When the relative clause is extraposed, it crossed one word, three-four words, or five-six words, the latter two of which being prepositional phrases. The examples are again given below:

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(3)

a. One Word (no PP)

Er hat die Rose *hingelegt* + RC (extraposed)

He has the rose laid_down + RC

b. Three-four Words (short PP)

Er hat die Rose auf den Tisch *gelegt* + RC (extraposed)

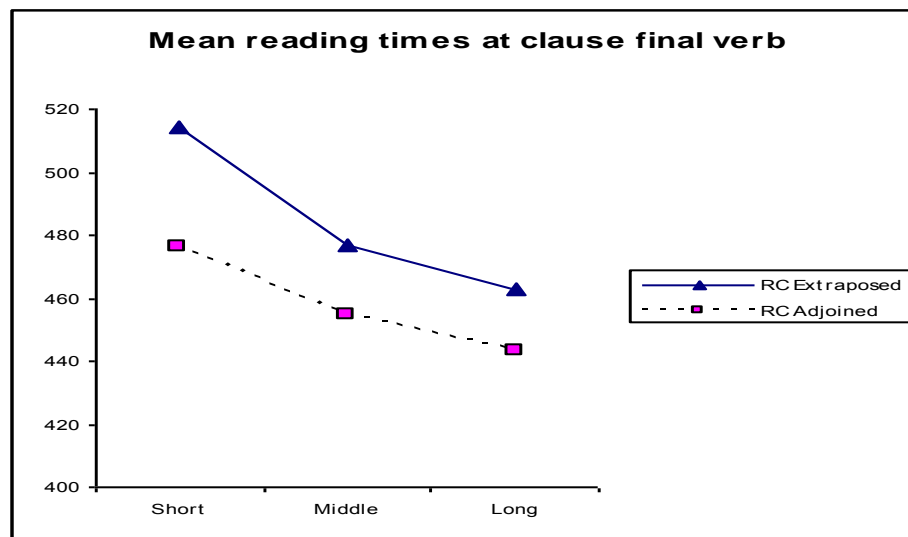
He has the rose on the table laid + RC

c. Five-six Words (long PP)

Er hat die Rose auf den Kleinen runden Tisch *gelegt* + RC (extraposed)

He has the rose on the small round table laid + RC

In terms of the RC length, it varied from three-five words, six-eight words to nine-eleven words. According to DLT and other locality-based theories, reaction times should increase at the position of “hingelegt” since it is computationally more costly when this verb has to be integrated with a farther previous structure. However, IC-to-Word has different predictions. When the relative clause is extraposed across a longer prepositional phrase, the percentage of IC-to-Word ration should drop sharply. This is because with the same number of constituents have to be divided by a larger number of total words. However, when the relative clause is adjoined to the main clause, the percentages remain similar across all 9 conditions. The actual mean reading times at the clause final verb by levels of RC is also reconstructed as follows:



The figure above shows that for regardless of the position where the relative clause

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is attached, reading times drop sharply when the relative clause is long. Basically, this result goes against the prediction of locality theory. Furthermore, in spite of the fact that Hawkins' EIC predicts that when RC is short, people should prefer it to be extraposed, the reading times shows faster reading times for the relative clause to be adjoined. However, except for this position, when RCs are of middle and long length, the results conform to Hawkins' predictions. Konieczny concluded that their results do not support the locality theory. Instead, it conforms more to the so-called "anticipation hypothesis, which states that the verb can be anticipated through preceding arguments" (p. 643).

Another piece of evidence came from Hindi, Vasishth and Lewis' (2006) example, which also found the anti-locality effect in Hindi, another head-final language, with facilitation at the inner most verb, *buy*, when different intervening phrases, including adverbs, prepositional phrase and relative clauses, were interposed. In addition, they also found facilitation in processing at the inner most verb with intervening phrases when compared with no intervening items.

Studies which found faster reading times at the verb position seem to be based in head final languages like German and Hindi, but not in head-initial languages like English. However, there is one exception. Jaeger et al. (2005) inserted one, two and three prepositional phrases in the English relative clause region to investigate the processing speed at the main clause verb "bought", which is getting farther and farther away from the main clause subject. Their examples are also given below:

(4)

- a. The player [that the coach met *at 6 o'clock*] **bought** the house..
- b. The player [that the coach met *by the river at 6 o'clock*] **bought** the house..
- c. The player [that the coach met *near the gym by the river at 6 o'clock*] **bought** the house...

If the locality effect is correct, longer reading times could be observed at the bought position. If the anti-locality effect is true, faster reading times could be observed. In this experiment, they argued to have found facilitation effect at the verb "bought" when more prepositional phrases were used in the relative clause region.

Even though most of the above-mentioned studies have claimed to found anti-locality effect, concerns arise regarding whether comprehenders need to process these adverbial or prepositional phrases at all when they process these stimuli sentences. For example, the comprehension question for (6) could be "Did the coach buy the house?" which does not require comprehenders to process the prepositional phrases at all. If subjects do not need to process the prepositional phrases, it will not be too surprising that people might speed up more and more just to get rid of the prepositional phrases. Thus the faster reading times at the inner most verb could be a spill over effect from the speed up of the prepositional phrases.

Since most anti-locality effect was found in head-final languages like German and

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Hindi, we decide to examine whether this effect appears in another head-final language like Mandarin. We also plan to embed one, two and three prepositional phrases into the stimuli sentences. Because of some similarities between prepositional phrase and relative clause, we need to illustrate the prepositional phrase first.

In Mandarin, if we need to use a prepositional phrase to modify a noun, we need to include DE in between, as the following example shows.

- (5)
攤位旁的女孩
Standnext DE girl
(the girl next to the stand)

When we embed the above structure into a simple SVO structure, we will get a stimuli sentence as in (8a). Note that this structure looks a lot like our relative clause since it includes a typical DE. If the ant-locality effect is correct, we should be able to observe faster reading times at the final main clause object, girl, as more and more prepositional phrases are included in the structure.

- (6)
a. SVO One Prepositional Phrase
同學 喜歡 攤位旁 的 女孩
Classmate like stand-near DE girl...
(*"The classmate likes the girl who is next to the stand."*)
b. SVO Two Prepositional Phrases
同學 喜歡 市場內 攤位旁 的 女孩
Classmate like market-inside stand-near DE girl
(*"The classmate likes the girl who is next to the stand inside the market."*)
c. SVO Three Prepositional Phrases
同學 喜歡 公園邊 市場內 攤位旁 的 女孩
Classmate like park-next market-inside stand-near DE girl
(*"The classmate likes the girl who is next to the stand inside the market next to the park."*)

Since the previous studies all include relative clauses as their stimuli sentence, we would like to include relative clauses with different numbers of prepositional phrases. If we want to turn (8) into relative clauses, we need to insert another DE after the verb. The stimuli sentences are like the following:

- (7)
a. RC One Prepositional Phrase
同學 喜歡 的 攤位旁 的 女孩

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Classmate like DE stand-near DE girl
(*“The classmate likes the girl who is next to the stand.”*)

b. RC Two Prepositional Phrases

同學 喜歡 的 市場內 攤位旁 的 女孩
Classmate like DE market-inside stand-near DE girl
(*“The classmate likes the girl who is next to the stand inside the market.”*)

c. RC Three Prepositional Phrases

同學 喜歡 的 公園邊 市場內 攤位旁 的 女孩
Classmate like DE park-next market-inside stand-near DE girl
(*“The classmate likes the girl who is next to the stand inside the market next to the park.”*)

(7) shows two DEs in the same sentence. The first DE represents relative clause while the second DE goes with the prepositional phrase. Therefore, the only difference between (8) and (9) lies in the first DE only. Again, if the locality theory or DLT is correct, the reading times for the final noun “girl” would be longer as more prepositional phrases are inserted into the stimuli. However, if anti-locality theory is correct, we should observe faster reading times for the final noun in (8c).

Even though we have constructed stimuli sentences with different numbers of prepositional phrases inserted, there is an important difference between our stimuli and those in the previous stimuli. All of the anti-locality effect was found in head-final languages where the verb appears after the arguments. Even though Mandarin has this head-final property, this property is mostly confined to relative clause constructions, where it is the head noun that appears at the end of the clause. We suspected that one of the reasons for the anti-locality effect to occur might be due to the verb, which appear at the final position. Verbs can be used to denote a large variety of events (McKoon & Ratcliff, 2003) and its importance has been found in many studies (Stowe, 1986; Garnsey, Tanenhaus & Chapman, 1989). In a simple Noun1 Verb Noun2 structure, we know that someone or something (Noun1) engages in some activity that affects someone or something else. The verb links together two entities and let people realize the relationship between these two entities. Boland, Tanenhaus, Garnsey and Carlson (1995) used stop-making sense paradigm to investigate wh-questions with respect to verb argument structure. For an implausible wh-phrases, there is a clear verb argument effect at the verb position. However, if the wh-question is plausible to be temporarily interpreted as the argument of the verb, the effect went away. These examples suggested that when arguments precede the verb, there is a tendency for the subjects to search for the verb as soon as possible so that the argument structure assignment or filler-gap assignment can be fulfilled.

Given the above findings, we have reason to believe that the reason for the antilocality effect to appear may be due to the fact the arguments all occur prior to the verb in German and Hindi. Speakers of these languages need to get to the verb as soon as

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possible to fulfill the assignment of verb argument structure. If it is the verb that facilitates the sentence comprehension, such facilitation will not appear in the head-final relative clause in Mandarin since the final word is a noun. In this situation, Mandarin is particularly suited for studying this locality versus anti-locality effect because of its flexibility in word order. By using BA constructions, it is possible to place nouns or arguments before the verb, as (8) shows. In these examples, the verb, hit, appears at the final position and is modified by one, two or three adverbial phrases.

(8)

a. BA One Adverbial Phrase

同學 把 壞人 狠狠地 打了 一頓

Classmate BA bad guy seriously beat once

(*"The classmate beat the bad guy seriously."*)

b. BA Two Adverbial Phrases

同學 把 壞人 狠狠地 結實地 打了 一頓

Classmate BA bad guy seriously fully beat once

(*"The classmate beat the bad guy fully and seriously."*)

c. BA Three Adverbial Phrases

同學 把 壞人 好好地 狠狠地 結實地 打了 一頓

Classmate BA bad guy completely seriously fully beat once

(*"The classmate beat the bad guy fully and seriously."*)

If it is the verb that facilitate the processing, we would be able to observe faster reading times at the verb in (8) but not in the noun in (7). However, if it is not the verb that leads to faster reading times, or locality theories are correct, we would expect to observe elevated reading times at both the verb and the noun position.

2. Materials, design and procedure

The experiment was conducted using a self-paced moving-window reading paradigm, like the one that we have used previously. Thirty native speakers of Mandarin, recruited from University of Illinois at Urbana-Champaign, participated in the experiment. Of the thirty subjects, 28 of them were graduate students while 2 of them were undergraduate students.

Three different kinds of structures in Mandarin were used as the stimuli: simple SVO, relative clauses and BA construction. A complete list of stimuli is given as follows:

(9)

a. SVO One Prepositional Phrase

同學 喜歡 攤位旁 的 女孩 。

Classmate like stand-near DE girl Period

(*"The classmate likes the girl who is next to the stand."*)

b. SVO Two Prepositional Phrase

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同學 喜歡 市場內 攤位旁 的 女孩 。

Classmate like market-inside stand-near DE girl Period

(*"The classmate likes the girl who is next to the stand inside the market."*)

c. SVO Three Prepositional Phrase

同學 喜歡 公園邊 市場內 攤位旁 的 女孩 。

Classmate like park-next market-inside stand-near DE girl Period

(*"The classmate likes the girl who is next to the stand inside the market next to the park."*)

d. RC One Prepositional Phrase

同學 喜歡 的 攤位旁 的 女孩 已經 來了 。

Classmate like DE stand-near DE girl already come Period

(*"The classmate likes the girl who is next to the stand."*)

e. RC Two Prepositional Phrase

同學 喜歡 的 市場內 攤位旁 的 女孩 已經 來了 。

Classmate like DE market-inside stand-near DE girl already come Period

(*"The classmate likes the girl who is next to the stand inside the market."*)

f. RC Three Prepositional Phrase

同學 喜歡 的 公園邊 市場內 攤位旁 的 女孩 已經 來了 。

Classmate like DE park-next market-inside stand-near DE girl already come Period

(*"The classmate likes the girl who is next to the stand inside the market next to the park."*)

g. BA Construction with One Adverbial Phrase

同學 把 壞人 狠狠地 打了 一頓 。

Classmate BA bad guy seriously beat once Period

(*"The classmate beat the bad guy seriously."*)

h. BA Construction with Two Adverbial Phrases

同學 把 壞人 狠狠地 結實地 打了 一頓 。

Classmate BA bad guy seriously fully beat once Period

(*"The classmate beat the bad guy seriously."*)

i. BA Construction with Three Adverbial Phrases

同學 把 壞人 好好地 狠狠地 結實地 打了 一頓 。

Classmate BA bad guy completely seriously fully beat once Period

(*"The classmate beat the bad guy seriously."*)

Seventy-two sets of stimuli were created and were separated into three lists by using Latin Square design. Each of the subjects saw one of the lists which contained 216 stimuli sentences and 84 fillers. The whole experiments took around 40 minutes to complete. In addition, comprehension questions were created in a way to make sure that subjects had to process the prepositional and adverbial phrases.

3. Results

The results of the comprehension questions are presented below:

	One Phrase	Two Phrases	Three Phrases
Simple SVO	94%	91%	86%
Relative	86%	81%	75%
Clauses			
BA	85%	84%	81%

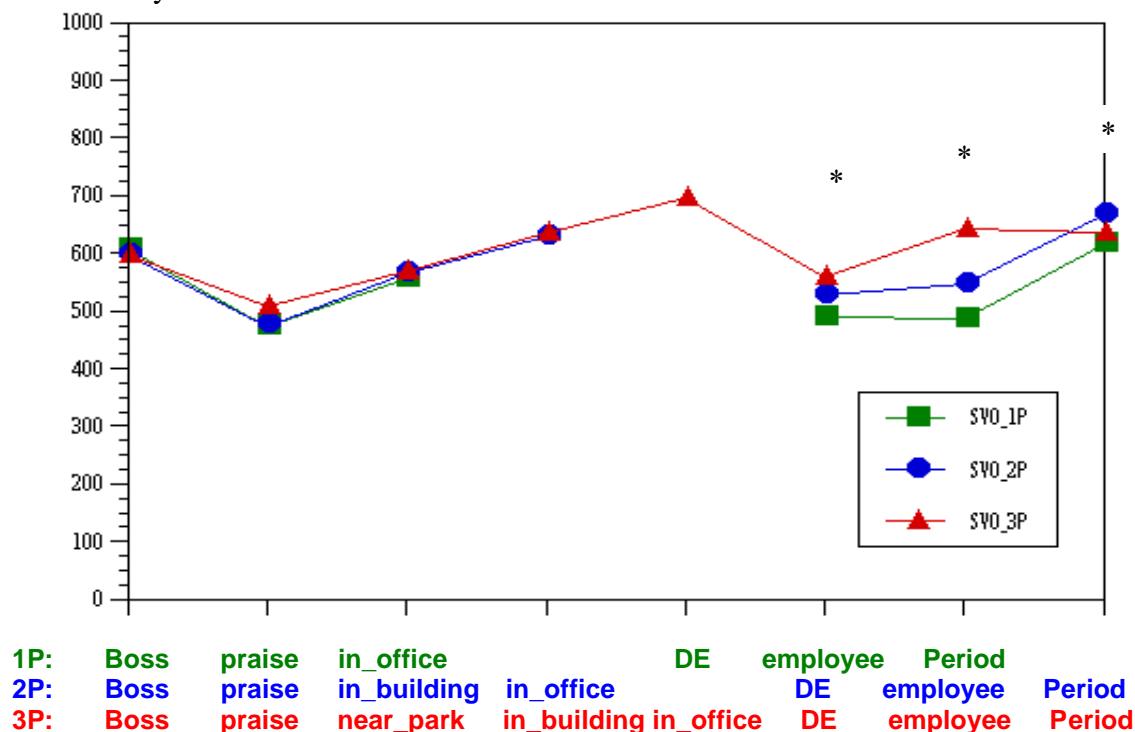
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construction			
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Table 1: Correct Rate of Comprehension Questions

As can be seen from the table above, the proportion correct for comprehension questions drops in all three structures when more phrases are inserted. Relative clauses with three prepositional phrases dropped the most. This should not be too surprising since the more prepositional phrases there are, the more information people have to remember so as to answer the comprehension questions correctly. With respect to BA construction, there is no reliable difference between BA_1 AP and BA_2 AP ($\chi^2(1)=0.67, p>.05$). However, there are marginally reliable differences between BA_2P and BA_3P ($\chi^2(1)=3.48, p=0.062$) and reliable differences between BA_1P and BA_3P ($\chi^2(1)=6, p<.05$). With respect to SVO constructions, there are marginally reliable differences between SVO_1P and SVO_2P ($\chi^2(1)=3.27, p=0.0707$) and between SVO_2P and SVO_3P, ($\chi^2(1)=4.72, p<.05$) and between SVO_1P and SVO_3P ($\chi^2(1)=15.81, p<.01$). In relative clause comprehension questions, there are reliable differences across all three pairs (RC_1P vs RC_2P: $\chi^2(1)=4.48, p<.05$; RC_2P vs RC_3P: $\chi^2(1)=9.67, p<.01$; RC_1P vs RC_3P: $\chi^2(1)=15.72, p<.01$).

The results of the reading times of SVO, RC and BA constructions are presented consecutively as follows:



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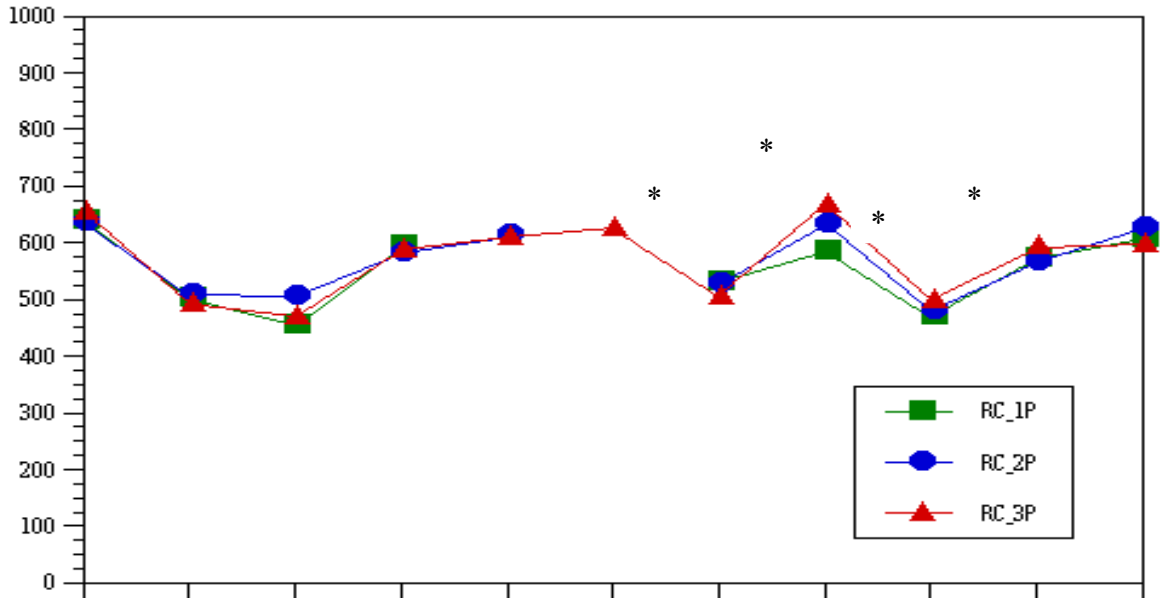
Figure 1: SVO with one, two and three prepositional phrase

The figure above presents the result from SVO with one prepositional phrase (green line), two prepositional phrases (blue line) and three prepositional phrases (red line). In order to align the final three positions since they are all the same *DE*, *head noun* and the *period*, the two lines, SVO with one and two prepositional phrases, actually contain a break. A closer look at the figure reveals that the more the prepositional phrases, the more elevated the reading times. Basically, the reading times for the first the second prepositional phrases almost lie on top of one another. Afterwards, there is a sharp drop in reading times at the DE position for all three lines. Despite the drop in reading times across three conditions, there were reliable differences for the pairwise comparisons (SVO_1P vs SVO_3P: $f(2128)=23.18$, $p<.01$; SVO_2P vs SVO_3P: $f(2128)=4.56$, $p<.05$); and SVO_1P vs SVO_2P: $f(2128)=7.23$, $p<.01$). This effect has got carried over to the next position, the main clause object position, where there were also reliable differences for the pairwise comparisons (SVO_1P vs SVO_3P: $f(2128)=26.65$, $p<.01$; SVO_2P vs SVO_3P: $f(2128)=78.30$, $p<.01$); and SVO_1P vs SVO_2P: $f(2128)=13.87$, $p<.01$).

At the period position, there is a main effect of the number of prepositional phrases ($f(2118)=5.01$, $p<.01$). In the pairwise comparisons, there is a reliable difference for the pair: SVO_1P vs SVO_3P ($f(2118)=7.03$, $p<.01$) and SVO_1P vs SVO_2P ($f(2118)=7.93$, $p<.01$). However, there is no difference between SVO_2P and SVO_3P ($p>.05$).

The results from both DE and main clause object suggest that the more intervening prepositional phrases there are, the more time it took people to process. The results from the SVO sentences support the predictions of locality theory, which predicts that more prepositional phrases actually lengthen the processing time.

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1P: Boss dislike DE in_office DE employee already go_home Period
2P: Boss dislike DE in_office in_building DE employee already go_home Period
3P: Boss dislike DE near_park in_office in_building DE employee already go_home Period

Figure 2: Relative Clauses with one, two and three prepositional phrases

The figure above presents relative clauses with one, two and three prepositional phrases. Again, there are gaps in RCs with one and two prepositional phrases since we aligned word positions after the second DE. As shown in the graph, reading times kept going up when more prepositional phrases were added into the structure. Then there is a drop at the DE position. The reading times at the DE position is not reliable different between the RC_1P vs RC_2P ($f(2128)=2.22, p>.05$). However, there were reliable differences between RC_1P vs RC_3P ($f(2128)=4.67, p<.05$) and RC_2P vs RC_3P ($f(2128)=13.28, p<.05$).

Even though the reading times were a little faster at the DE position for the RC with three prepositional phrases, reading times were most elevated for the relative clauses with three prepositional phrases at the head noun position. Relative clauses with two prepositional phrases at the head noun position also took longer for people to respond than the relative clause with one prepositional phrase. There is a reliable difference for the main effect of length of prepositions ($f(2128)=6.71, p<.01$). The pairwise comparisons all have shown reliable differences (RC_1P vs RC_3P: $f(2128)=26.12, p<.01$; RC_2P vs RC_3P: $f(2128)=5.54, p<.05$; RC_1P vs RC_2P: $f(2128)=7.72, p<.01$).

In the position following head noun, even though the three dots look to lie on top of each other, there is still main effect of prepositional phrases ($f(2128)=3.99, p<.05$). The pairwise comparisons reveals that there is reliable difference between RC_1P vs RC_3P ($f(2128)=6.18, p<.05$) and between RC_2P vs RC_3P ($f(2128)=5.79, p<.05$). However,

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there is no reliable difference between RC_1P vs RC_2P ($f(2128)=0.01, p>.05$). In the position before the period, there is no reliable difference of the main effect of the number of prepositional phrases ($f(2118)=2.18, p>.05$). However, in the pairwise comparisons, reliable difference only occurs in RC_2P vs RC_3P ($f(2118)=4.27, p<.05$). For the other two sets of comparisons, there is no reliable difference ($p>.05$). At the Period position, there is no main effect and the pairwise comparisons did not reach significance at all. It shows that the effect of prepositional phrases did not last to the final word.

The results from both the SVO and relative clauses supported the locality theory since our findings are in line with its predictions that more intervening phrases will lead to more reading times at the critical words.

The figure below presents BA construction with one, two and three adverbial phrases. Unlike the previous results where we found longer reading times when more prepositional phrases were inserted into the structure, we found reversed pattern in BA construction when more adverbial phrases were inserted into the structure. Decreasing reading times were observed across the three phrases. At the verb position, we found a main effect ($f(2128)=10.2, p<.01$). The pairwise comparisons also showed reliable difference across three pairs of comparisons: BA_1P vs BA_3P ($f(2128)=20.34, p<.01$), BA_2P vs BA_3P ($f(2128)=4.21, p<.05$) and BA_1P vs BA_2P ($f(2128)=6.05, p<.05$).

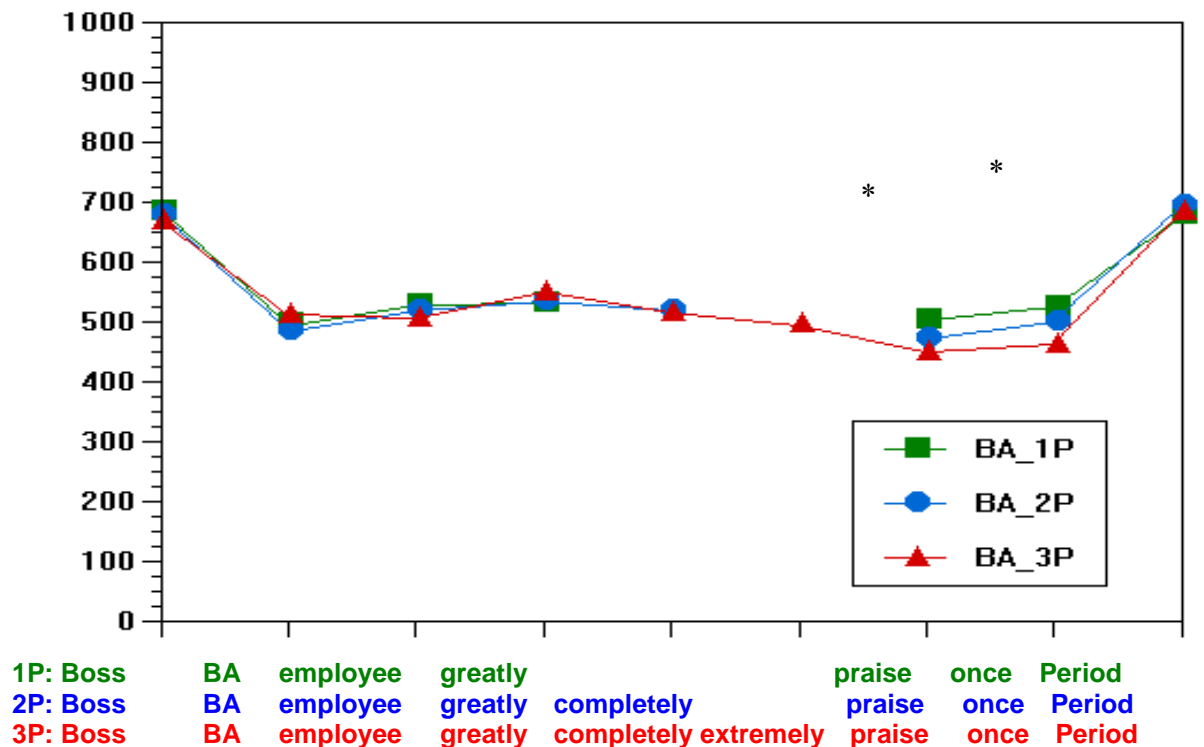


Figure 3: BA with one, two and three prepositions

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In the next position, we also found reliable difference for the main effect ($f(2128)=10.67$, $p<.01$). However, the pairwise comparisons revealed reliable differences only for two pairs: BA_1P vs BA_3P ($f(2128)=20.69$, $p<.01$) and BA_2P vs BA_3P ($f(2128)=8.85$, $p<.01$). There is no reliable difference for the third comparison: BA_1P vs BA_2P ($f(2128)=2.5$, $p>.05$). At the period position, we found no reliable difference for either the main effect. The results of the BA constructions actually supported the anti-locality theory, which claims that more intervening phrases will lead to more expectation, causing less reading times for the critical word.

4. Discussion

In this experiment, we set out to examine locality versus anti-locality theories. According to the locality theory, it claims that the greater the distance between the filler and the gap, the more difficult it is and it's possibly due to limitation of working memory. However, anti-locality theory actually claims the opposite. It predicts that the greater the distance between the filler and the gap, the easier it is and it's possibly due to increasing anticipation. Previous studies (Konieczny, 2000; Vasisht and Lewis, 2006; Jaeger et al., 2005) that have found support for anti-locality theory are mostly head-final languages like Hindi and German and have used structures with verbs as the critical words. They embedded one, two or three phrases into different kinds of syntactic structures to lengthen the distance between the verb and its preceding element. They found decreasing reading times for the critical word when more phrases are embedded in the structure. However, not many studies in the literature have found support for the anti-locality theory.

One thing to be noted in studies that have found support for antilocality theory is that their critical words were all verbs with the nouns occurring in advance as in Hindi and German. We suspected that it is the nature of the verb that made people wanted to speed up since they might be eager to know the relationship between these nouns that have occurred earlier. Adding more prepositional phrases or other kinds of phrases might just increase their anticipation to know what is going on with these nouns. However, if the final critical word is a noun, people know the relationship of at least one noun and the verb. All they need to find is another noun to complete the relationship. In other words, they would have less anticipation when the critical word is a noun.

In order to further look into the nature of locality versus antilocality theories, we decided to use Mandarin to find out why some studies support locality theory while others don't. At this juncture, Mandarin provides a great test ground for teasing apart these two theories. Given many different kinds of structures are allowed in Mandarin, we decided to make use of these structures to see if we can find out what contributes to the different claims between the two theories.

In our experiment, we used three kinds of structures, namely, simple SVO sentences, relative clauses, and BA constructions. The reason for us to use these structures is that the

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critical words for these structures differ. For simple SVO and relative clauses, the critical words are nouns. For simple SVO, the critical word is the object of the sentence while for the relative clauses, we were looking at the head noun which occur at the end of the clauses. For BA constructions, since they have N BA N V word order, the critical word is a verb. All together, we have nouns as critical word for SVO and RCs, and verbs as critical words for BA constructions. Of these three structures, we inserted one, two and three prepositional phrases into SVO and RCs and adverbial phrases into BA constructions, just like what previous studies have done.

If the locality theory is correct, we would observe increasing reading times at the critical words when more phrases are intervening regardless of whether the critical word is a noun or a verb. If anti-locality theory is correct, we could observe decreasing reading times at the critical words when more phrases are inserted. However, if our hypothesis is correct that it is due to whether the critical word is a noun or a verb that lead to difference in expectation, we would observe increasing reading times for the critical nouns in both SVO and RCs and decreasing reading times for the critical verbs in BA constructions. This may be due to the fact that in BA construction two nouns are presented in a row and it creates expectations in comprehenders to want to know what happened between the two nouns. In SVO and RCs, since a noun and a verb have been presented, all is left is the noun to complete the action. Our findings support our hypothesis. In both SVO and RCs, we observed increasing reading times at the critical nouns. In BA constructions, however, we observed decreasing reading times at the critical verbs. We thus have some evidence that it is the critical word at the end that lead to differences in reading times.

Despite the fact that our findings support our hypothesis, we need to point out one concern: the use of prepositional phrases and adverbial phrases in front of the critical words. Prepositional phrases are used in simple SVO and RCs while adverbial phrases are used in BA constructions. Since it is not possible for us to use adverbial phrases to modify the head noun or to use prepositional phrases to modify the verb, we did not have a counterbalance condition to rule out the possibility that results in our experiments are entirely due to the critical words. There is a possibility that the difference is due to the phrases used. However, since previous studies have found similar results using different kinds of phrases in front of the critical verbs, including adverbial and prepositional phrases and they still found decreasing reading times at the critical verb, we have reasons to believe that our results are due to verbs and nouns as the critical words, instead of due to prepositional or adverbial phrases.

REFERENCES

BABYONYSHEV, MARIA. AND GIBSON EDWARD. 1999. The complexity of nested structures in Japanese. *Language*, 75: 423-450.

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- CARLSON, GREG, AND TANENHAUS, MICHAEL. 1988. Thematic roles and language comprehension. In W. Wilkens (ed.). *Syntax and semantics* (Vol. 21). New York: Academic Press, Inc.
- FRAZIER, LYN. 1987. Sentence processing: A tutorial review. In M. Coltheart (ed.), *The Psychology of reading. Attention and performance XII* (pp. 559-586). Hove, London: Erlbaum.
- GARNSEY, SUSAN., PEARLMUTTER, NEAL., MYERS, ELIZABETH., AND LOTOCKY, MELANIE. 1997. The contribution of verb bias and plausibility to the comprehension of temporarily ambiguous sentences. *Journal of Memory and Language*, 37: 58-93.
- GARNSEY, SUSAN. AND TANENHAUS, MICHAEL, AND CHAPMAN, R. M. 1989. Evoked potentials and the study of sentence comprehension. *Journal of Psycholinguistic Research*. 18: 51-60.
- GIBSON, EDWARD. 1998. Linguistic complexity: Locality of syntactic dependencies. *Cognition*, 68: 1-76.
- GIBSON, EDWARD. 2000. The dependency locality theory: a distance-based theory of linguistic complexity. In Y. Miyashita, A. Marantz, and W. O'Neil, (eds.), *Image, language, brain* (pp. 95-126). Cambridge, MA: MIT Press.
- GORDON, PETER, HENDRICK, RENDALL. AND JOHNSON, MARCUS. 2004. Effects of noun phrase type on sentence complexity. *Language AND Cognitive Processes*, 51: 97-114.
- GORDON, PETER. HENDRICK, RENDALL. JOHNSON, MARCUS. AND LEE, YOONHYOUNG. 2006. Similarity-based interference during language comprehension: Evidence from eye tracking during reading. *Journal of Experimental Psychology: Learning, Memory AND Cognition*, 32: 1304-1321.
- HAWKINS, JOHN. 1994. A performance theory of order and constituency. Cambridge: Cambridge University Press.
- HAWKINS, JOHN. 2004. *Efficiency and complexity in grammar*. Oxford: Oxford University Press.
- LIN, YOWYU. 2005. Word order, animacy, and agreement cues in sentence processing by L1 Mandarin EFL learners. Presented at the *Midwestern Conference on Culture, Language, and Cognition*, Northwestern University, IL.
- LIN, YOWYU. AND GARNSEY, SUSAN. 2009. The contributions of classifiers and pronouns to Mandarin relative clause comprehension. Presented at the 22nd *Annual CUNY Conference on Human Sentence Processing*, Davis, CA.
- O'GRADY, WILLIAM. 1997. *Syntactic development: The acquisition of English*. Chicago: University of Chicago Press.
- TANENHAUS, MICHAEL, CARLSON, GREG, AND TRUESWELL, JOHN. 1989. The role fo thematic structures in interpretation and parsing. *Language and Cognitive Processes*, 4: 211-234.