Discourse context and word order preferences in Hindi*

Shravan Vasishth

Abstract

Discourse context has been argued to be the main factor responsible for increased processing difficulty in non-canonical order sentences: if appropriate discourse context is provided (the argument goes) both canonical and non-canonical order sentences are equally easy to process. This research suggests that this generalization may not be true across languages: the distance between arguments and verbs could affect the ease with which the former can be integrated with the latter, and sufficiently increasing this distance makes processing difficult, regardless of discourse context.

1 Introduction

Let us refer to any claim that increasing the distance between dependents and heads (e.g., arguments and verbs, respectively) results in increased processing

difficulty at the verb as the *distance hypothesis*; for ease of exposition, we can define distance as a linear function of the number of intervening words. Early Immediate Constituents (Hawkins, 1998) and Discourse Locality Theory (Gibson, 2000) propose variants of this distance hypothesis.

In order to understand the rationale behind this claim, first consider the Hindi single center embedding in (1).

(1) *Siitaa-ne Hari-ko kitaab khariid-nekaa aadesh-diyaa*
Sita-erg Hari-dat book buy-inf ordered
'Sita ordered Hari to buy a book.'

This is an instance of a control construction: as shown in Figure 1, the subject noun phrase (NP2) of the innermost verb *khariid-nekaa,* 'to buy' is the indirect object of the main verb (here *aadesh-diyaa*, 'ordered') which is one clause higher. As a result, this noun phrase is assigned the dative case marker *-ko* from the higher clause. Note also that this structure is a center embedding construction because the clause S2 is embedded within the main clause S1.

In this structure, the distance between the verb V2 and its two arguments NP2 and NP3 can be varied in several different ways. Consider the situation where the indirect object NP2 (2a) or the direct object NP3 is fronted (2b).

(2) a. *Hari-ko Siitaa-ne kitaab khariid-nekaa aadesh-diyaa*
Hari-dat Sita-erg book buy-inf ordered
'Sita ordered Hari to buy a book.'

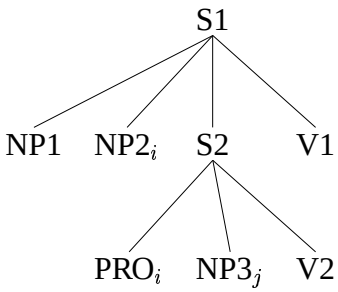

Figure 1: Schematic representation of the single center embedding in (1).

b. *Kitaab Siitaa-ne Hari-ko khariid-nekaa aadesh-diyaa*
book Sita-erg Hari-dat buy-inf ordered
'Sita ordered Hari to buy a book.'

Here, Early Immediate Constituents predicts that increasing distance (2b,c) between dependents and heads will result in increased processing difficulty at the inner verb: more words need to be processed before the head of the embedded clause is recognized. That is, processing difficulty at the innermost verb is predicted to be greater in the direct-object and indirect-object fronting cases compared to the canonical order sentence in (1), but no difference in processing difficulty is expected at the verb between the fronted indirect-object versus fronted direct-object cases.

Discourse Locality Theory makes similar predictions, but the reason here is different: the number of new discourse referents between the head and dependents increases in the noncanonical orders and, since new discourse referents consume memory resources, integrating the fronted element with the verb is difficult-

cult. Moreover, Discourse Locality Theory predicts that the processing cost at the innermost verb in the fronted direct-object sentence (2b) is higher than in the fronted indirect-object sentences (2a). In direct-object fronting, there are two new discourse referents between the fronted NP and the verb (as opposed to zero new discourse referents in the canonical case), whereas in indirect-object fronting there are two new discourse referents intervening between the fronted indirect object and the verb (as opposed to one new discourse referent in the canonical case). That is, Discourse Locality Theory predicts that processing difficulty at the innermost verb will be greater in the fronted cases compared to the canonical case, and greater in the fronted direct-object sentence compared to the fronted indirect-object sentence.

However, the discussion above ignores the well-known fact (Altmann & Steedman, 1988; Steedman, 2000; Kaiser & Trueswell, 2002; Weber & Neu, 2003) that appropriate discourse context can neutralize any increase in processing difficulty resulting from non-default word order, differences in the number of presuppositions that must be computed or satisfied, etc. Also, it is well-known that sentences with non-canonical order presented out of context are less acceptable in languages like English, German, Finnish, and Hungarian (see (Hyönä & Hujanen, 1997) and references cited there). One should therefore not find the claim surprising that non-canonical order sentences involve more processing cost when no preceding context is provided. What would be surprising is if an increase in processing

difficulty occurs in spite of appropriate discourse context being present.

This research demonstrates that non-default word orders can sometimes lead to greater processing difficulty irrespective of whether sentences are presented with appropriate context or not. One plausible explanation for this increased difficulty with non-canonical orders is increased argument-head distance.

2 Previous work

Vasishth (2003b) conducted two experiments in order to test the distance hypothesis. As these motivate the set of experiments that form the focus of this paper, I briefly discuss them in this section.

The experiments used the non-cumulative self-paced moving window methodology (Just, Carpenter, & Woolley, 1982). A G3 laptop Macintosh running PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993) was used to present the materials to subjects. The task was to press the space bar in order to view each successive phrase; each time the space bar was pressed, the previous phrase would disappear and the next phrase would appear. Reading time (in milliseconds) was taken as a measure of relative momentary processing difficulty. A yes/no comprehension question was presented after each sentence; this was meant to ensure that subjects were attending to the sentences. Subjects with less than 70% correct responses were not included in the data analysis; typically this resulted in data from four or

five subjects being excluded in each experiment. The computer screen presentation was as described below with the aid of Figure 2.

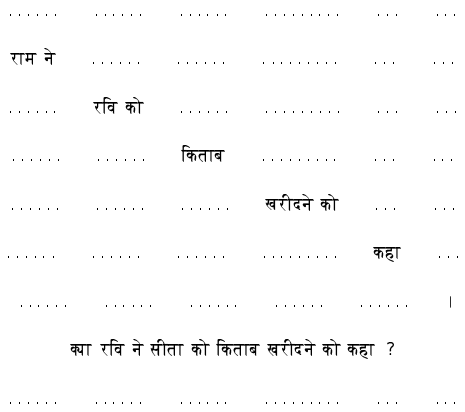

Figure 2: Schematic view of moving window design.

Each line in Figure 2 shows a particular stage during a trial. At the beginning of a trial (which could be a filler or stimulus sentence), the screen shows the uppermost line in Figure 2: a series of dotted lines separated by spaces, with each line corresponding to a phrase in the sentence that will eventually be seen in that trial. Then the subject presses the space bar. The screen now displays the second line in the figure; at this point, only the first phrase is visible. The subject then presses the space bar again, and the next phrase appears and the previous one disappears (see the third line in Figure 2). This procedure is repeated until the end of the sentence (marked by the period, a vertical line) is reached. After the entire

sentence has been seen, a yes/no question is shown, to which the subject responds by pressing the frontslash ("/") key for "yes", or the "z" key for "no". After the subject responds, the screen reverts to displaying the lines as in the uppermost line in Figure 2. This signals the start of a new sentence, and the procedure is repeated for the new sentence. The phrase segmentation of the stimuli is shown by the vertical bars between words/phrases in (3). The period was invariably presented as a separate segment.

One experiment in (Vasishth, 2003b) investigated reading time differences at the innermost verb resulting from increased distance between a verb (the innermost verb) and its dependents (its arguments) by fronting the indirect object; the stimuli were as in (3).

(3) a. *Riinaa-ne* | *Siitaa-ko* | *kitaab* | *khariid-neko* | *kahaa*
Rina-erg Sita-dat book buy-inf told
'Rina told Sita to buy a book.'

b. *Siitaa-ko* | *Riinaa-ne* | *kitaab* | *khariid-neko* | *kahaa*
Sita-dat Rina-erg book buy-inf told
'It was Sita who Rina told to buy a book.'

As shown in Figure 3, increasing distance resulted in a signifi cantly longer reading time (RT) at the innermost verb (V2) in the IO-fronted case compared to canonical order. This was as predicted by the distance hypothesis.

In the second experiment the contrasting pairs were fronted *direct* object versus canonical order, as shown in Examples (4) below.

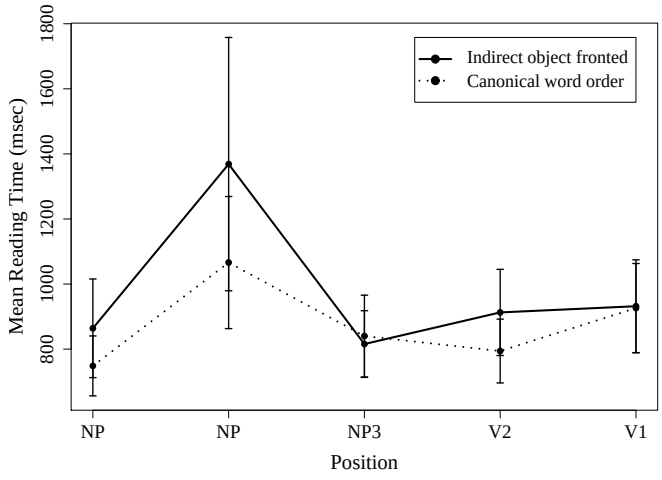

Figure 3: Canonical versus IO-fronted order; raw RTs, with 95% confidence intervals.

(4) a. *Riinaa-ne* | *Siitaa-ko* | *kitaab* | *khariid-neko* | *kahaa*
Rina-erg Sita-dat book buy-inf told
'Rina told Sita to buy a book.'

b. *Kitaab* | *Riinaa-ne* | *Siitaa-ko* | *khariid-neko* | *kahii*
book Rina-erg Sita-dat buy-inf told
'It was the book that Rina told Sita to buy.'

As illustrated in Figure 4, here too a longer reading time was observed at the innermost verb, V2, in the DO-fronted case.

Recall that Discourse Locality Theory predicts that fronting direct objects should result in greater processing difficulty at the innermost verb compared to fronted indirect objects. Although the difference was in the predicted direction, a t-test for reading times at V2 gave an inconclusive null result.

These experiments ignored the fact that in Hindi non-canonical word order

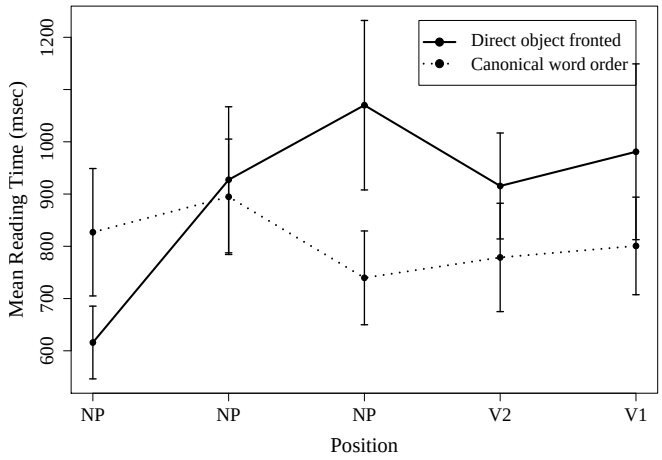

Figure 4: Canonical versus fronted DO; raw RTs with 95% confidence intervals

typically occurs due to an appropriate discourse context demanding it (Gambhir, 1981); even though Hindi is often described as a "free word order" language, there is always a discourse reason for word order variation, such as altered topic and/or focus, emphasis, discourse salience etc. For this reason, two self-paced reading studies were carried out to investigate the effect of discourse context on processing difficulty of canonical and non-canonical order sentences. These are discussed next. The same stimuli were chosen as in the original experiments, although different filler sentences were used.

3 Discourse context and noncanonical word order

3.1 Experiment 1

A self-paced reading experiment was carried out in order to test the effect of discourse context on fronted-IO sentences. The stimuli were as shown in (5). Before each stimulus sentence, subjects saw a question whose focus was either (i) the innermost VP (e.g., *What did Mary tell John?*, where the appropriate answer would be *Mary told John X*, *X* a VP like *to buy a book*), or (ii) the entire sentence (*What happened?*). The questions were presented in their entirety (not word-by-word). In the VP-focus sentences, the word order of the first and second NP was identical to that in the target sentence: canonical order sentences were preceded by questions with NP1 and NP2 in canonical order, and IO-fronted sentences (NP2 followed by NP1) had the word order NP2 NP1. I will refer to the VP-focus question type as SALIENT CONTEXT and the S-focus question as the NON-SALIENT CONTEXT.

(5) a. *Rita-ne Ravi-ko kyaa kahaa? Rita-ne Ravi-ko kitaab*
Rita-erg Ravi-dat what said? Rita-erg Ravi-dat book
khariid-neko kahaa
buy-inf told
'What did Rita say to Ravi? Rita told Ravi to buy a book.'

b. *Ravi-ko Rita-ne kyaa kahaa*? *Ravi-ko Rita-ne kitaab*
Ravi-dat Rita-erg what said? Ravi-dat Rita-erg book
khariid-neko kahaa
buy-inf told

'What did Rita say to Ravi? Rita told Ravi to buy a book.'

c. *Kyaa hua*? *Rita-ne Ravi-ko kitaab khariid-neko kahaa*
What happened? Rita-erg Ravi-dat book buy-inf told
'What happened? Rita told Ravi to buy a book.'

d. *Kyaa hua*? *Ravi-ko Rita-ne kitaab khariid-neko kahaa*
What happened? Ravi-dat Rita-erg book buy-inf told
'What happened? Rita told Ravi to buy a book.'

As shown in Figure 5, a contrast analysis showed that when a salient context is provided in canonical versus non-canonical order sentences, a significant increase is not observed at V2 or in the spillover region V1 (although this is an inconclusive null result, it does contrast with Vasishth's first experiment, where such an increase was observed). Table 1 shows the reading times in milliseconds at V2 and the spillover region V1 for conditions (a) and (b).

Table 1: Experiment 1, reading times (msecs) at V2 and V1, conditions (a) versus (b) in example (5)

RTs at verb	(5a)	(5b)	F(1,47)	p-value
V2	709	759	1.69	0.1998
V1	836	886	0.66	0.4219

Moreover, as shown in Figure 6, in IO-fronted sentences, reading time in the spillover region V1 is significantly longer when no salient discourse context is present. This shows that discourse context indeed determines processing difficulty in fronted IO sentences, as predicted by existing research such as (Kaiser &

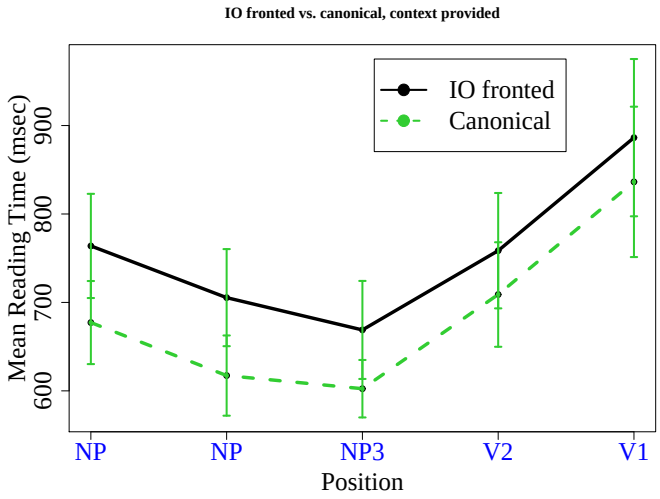

Figure 5: Experiment 1, conditions (a) versus (b) in example (5), with 95% confi - dence intervals.

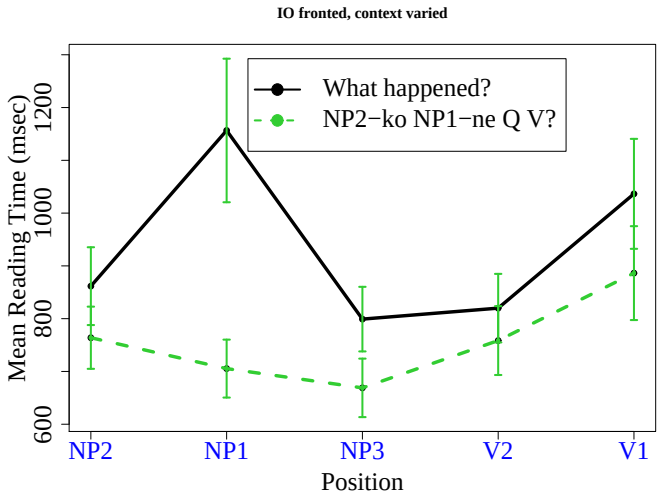

Figure 6: Experiment 1, conditions (b) versus (d) in example (5), with 95% confi - dence intervals.

Table 2: Experiment 1, reading times (msecs) at V2 and V1, conditions (b) versus (d) in example (5)

RT at verb	(5b)	(5d)	F(1,47)	p-value
V2	759	820	3.95	0.0531
V1	886	1036	5.39	0.0250

Trueswell, 2002), (Weber & Neu, 2003). Table 2 shows the reading times at V2 and V1 for conditions (b) and (d). Here, the RT difference approaches significance in the region V2, but is significantly different in the spillover region V1.

In sum, the present results, taken together with Vasishth's first experiment, suggest that providing appropriate discourse context can neutralize processing difficulty that occurs due to non-canonical order.

3.2 Experiment 2

In this self-paced reading study, the effect of discourse context on canonical versus *direct*-object fronted sentences was compared. The preceding salient and non-salient contexts had essentially the same structure as in Experiment 1, with one important difference: When the direct object was to be presented as a fronted element in the target sentence, it was fronted in the context question as well. This was done in order to topicalize the fronted direct object in the context question, so that its appearance in the target sentence as a fronted element would be felicitous. The stimulus examples are shown below.

(6) a. *Rita-ne Ravi-ko kyaa kahaa*? *Rita-ne Ravi-ko kitaab*
Rita-erg Ravi-dat what said? Rita-erg Ravi-dat book
khariid-neko kahaa
buy-inf told
'What did Rita say to Ravi? Rita told Ravi to buy a book.'

b. *Kitaab ka Rita-ne kyaa kiyaa*? *kitaab Rita-ne Ravi-ko*
book gen Rita-erg what did? book Rita-erg Ravi-dat
khariid-neko kahii
buy-inf told
'What did Rita do about the book? Rita told Ravi to buy the book.'

c. *Kyaa hua*? *Rita-ne Ravi-ko kitaab khariid-neko kahaa*
what happened? Rita-erg Ravi-dat book buy-inf told
'What happened? Rita told Ravi to buy a book.'

d. *Kyaa hua*? *kitaab Rita-ne Ravi-ko khariid-neko kahii*
what happened? book Rita-erg Ravi-dat buy-inf told
'What happened? Rita told Ravi to buy a book.'

As Figure 7 shows, even when appropriate context is provided, the mean RT at the verb V2 is signifi cantly longer in the DO-fronted case than in the canonical order sentence. This result is interesting because it goes against the assumption in the literature that processing diffi culty in non-canonical order sentences is due to the absence of discourse context (Kaiser & Trueswell, 2002). Table 3 shows the reading times at V2 and the spillover region V1 for conditions (a) and (b).

Furthermore, in DO-fronted sentences, RTs are signifi cantly faster if appropriate discourse context is present (Figure 8), but only in the spillover region V1. Table 4 shows the reading times at V2 and V1 for conditions (b) and (d).

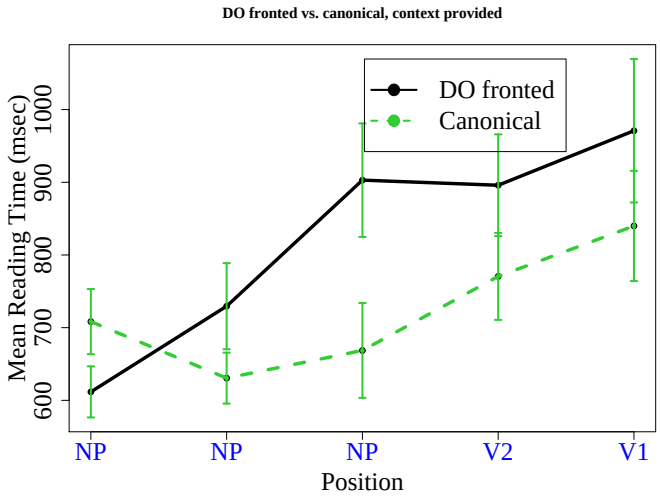

Figure 7: Experiment 2, conditions (a) versus (b) in example (6), with 95% confi - dence intervals.

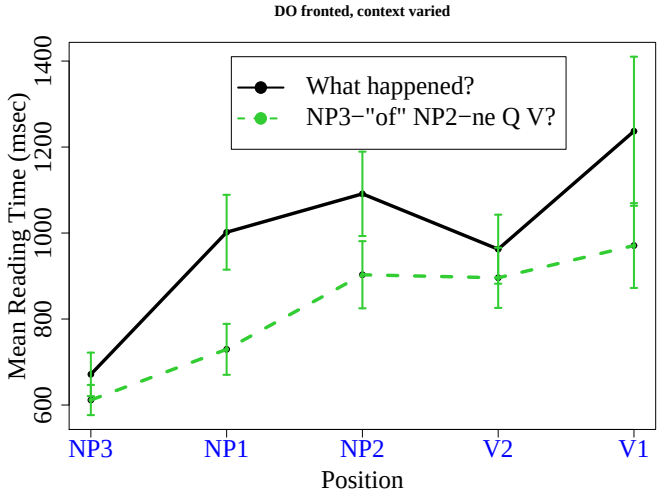

Figure 8: Experiment 2, conditions (b) versus (d) in example (6), with 95% confi - dence intervals.

Table 3: Experiment 2, reading times (msecs) at V2 and V1, conditions (a) versus (b) in example (6)

RT at verb	(6a)	(6b)	F2(1,43)	p-value
V2	709	759	10.19	0.0027
V1	836	886	1.05	0.3120

Table 4: Experiment 2, reading times (msecs) at V2 and V1, conditions (b) versus (d) in example (6)

RT at verb	(6b)	(6d)	F2(1,43)	p-value
V2	759	820	1.88	0.178
V1	886	1036	4.51	0.03

4 A summing up

The two experiments suggest that although discourse context does affect the processing of non-canonical order sentences, the extent to which it does so depends on the distance between arguments and heads: if this distance is relatively small (as in Experiment 1) the absence/presence of appropriate discourse context is the deciding factor in determining processing difficulty; however, if the distance is increased (Experiment 2), discourse context cannot neutralize the effect of this increased distance.

However, there is a problem with this conclusion. Previous research (Hakes, 1972; Konieczny, 2000; Vasishth, 2003b, 2003a) has shown that increasing argument-head distance can in fact facilitate processing. This appears to be true for a variety

of constructions in English, German, Hindi, and, it appears (Gibson, personal communication), Japanese as well. To illustrate the phenomenon, consider the Hindi sentences in (7).

(7) a. *vo-kaagaz jisko us-laṛke-ne dekhaa bahut-puraanaa thaa*
that-paper which that-boy-erg saw very-old was
'That paper which that boy saw was very old.'

b. *vo-laṛkaa jisne us-kaagaz-ko dekhaa bahut-jigyaasu thaa*
that-boy who that-paper-acc saw very-inquisitive was
'That boy who saw that (piece of) paper was very inquisitive.'

c. *vo-kaagaz jisko us-laṛke-ne mez ke-piiche gire-hue dekhaa bahut-puraanaa thaa*
that-paper which that-boy-erg table behind fallen saw very-old was
'That paper which that boy saw fallen behind a/the table was very old.'

d. *vo-laṛkaa jisne us-kaagaz-ko mez ke-piiche gire-hue dekhaa bahut-jigyaasu thaa*
that-boy who that-paper-acc table behind fallen saw very-inquisitive was
'That boy who saw that (piece of) paper fallen behind a/the table was very inquisitive.'

Sentences (7a) and (7c) are object relative clause constructions with the contrast that the verb *dekhaa*, 'saw', and its arguments *laṛkaa*, 'boy', *kaagaz*, 'paper', are adjacent in (7a) but in (7c) are separated by intervening material (*mez ke piiche gire hue*, 'fallen behind the table'). Sentences (7b) and (7d) are subject relative clauses with the same contrast.

These pairs of sentence types were investigated in a self-paced reading study; the research question was whether increasing argument-head distance renders processing harder. Distance was defined as in Gibson's theory, i.e., as the number of discourse referents intervening; note that the intervening material had a noun phrase and a finite verb, which also introduces a discourse referent in Gibson's theory. Thus the intervening material introduced two discourse referents.

The reading time at the verb (*dekhaa* in the examples above) that immediately followed the intervening material was the region of interest: if increasing distance adversely affects processing, reading time at this region would be longer. The results, however, show that increased distance facilitates processing; compare the reading times for the two conditions (zero versus two discourse referents intervening) at verb V2 in Figures 9 and 10.

Given the above results, it is difficult to argue that increased argument-head distance is the reason for increased difficulty with DO-fronting as opposed to IO-fronting. A plausible interpretation for Experiments 1 and 2 is that the preceding discourse context actually primes the syntactic structure of the target sentence in the IO-fronting case but not in DO-fronting. An interesting difference between the two experiments was that the IO-fronted context question focused a constituent: to the context question *What did A say to B*, the answer was *A told B to X*, where *X* was a constituent. By contrast, the DO-fronted context question did not focus a constituent: to the context question *What did A do with C?* the answer formed

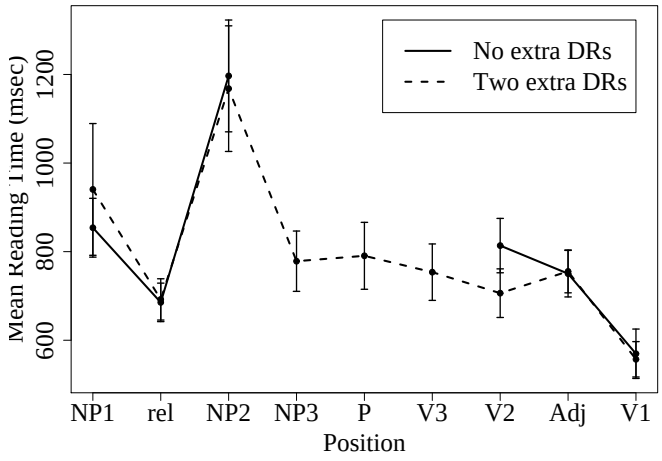

Figure 9: Object relatives (with 95% CIs)

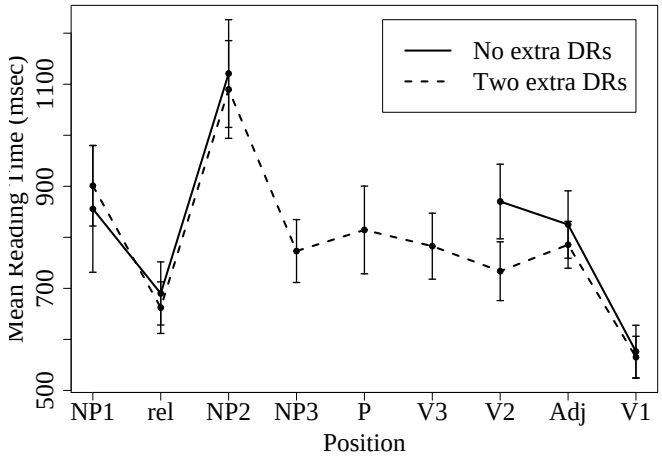

Figure 10: Subject relatives (with 95% CIs)

the pattern *A told B to buy C*, where the new material *told B to buy* did not form a constituent (of course, the actual verbs etc. were varied in the stimuli sentences). The canonical order sentences were, of course, primed by the context question.

Thus, in IO-fronted sentences the syntactic structure could have been primed by the context in both canonical and non-canonical orders, resulting in no difference in processing difficulty in canonical versus IO-fronted orders. By contrast, in DO-fronted sentences there would have been no structural priming, so that these would be harder to process than canonical order sentences, which were primed by the context.

Further experiments are being planned to explore the validity of the above explanation. If correct, this would suggest that in Experiment 2 it is not increased distance per se that is overriding any facilitation due to discourse context, but an asymmetry in syntactic priming. This would in turn imply that the present results are in fact consistent with the existing cross-linguistic results on the effect of discourse context on the processing of non-canonical word order.

In sum, an asymmetry in structural priming could in principle be responsible for the results of Experiment 2, and this would be consistent with the existing discourse processing literature and the other evidence against the distance hypothesis. On the other hand, there is extensive cross-linguistic evidence in favor of the distance hypothesis (Hawkins, 1994; Gibson, 2000) that cannot be ignored; therefore, until further experiments clarify the issue, a plausible conclusion from

Experiment 2 is that increased distance can dominate over any processing facilitation due to discourse context in non-canonical order sentences.

Notes

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