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# Putting Things in Context: Sentence Processing in Languages with Flexible Word Order

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## **1 Introduction**

A crucial issue in the study of sentence processing is understanding the strategies used to parse languages with flexible word order. Prior work on this issue has often approached it from a primarily syntactic perspective, appealing, for instance, to structural complexity to account for parsing difficulties with noncanonical word order. This paper presents an alternative approach which relies on discourse factors guiding the processing of noncanonical (scrambled) structures.

In this paper, we first review research showing that discourse-semantic factors motivate word order variation. It follows from the discourse-driven nature of scrambling that, in order to really test whether the structural complexity and/or infrequency of scrambled sentences necessarily lead to them being processed slower than canonical sentences, one needs to manipulate the contexts in which sentences occur. We argue that the majority of existing studies of scrambling, by not controlling for discourse factors, unwittingly leave open the question of what makes noncanonical structures harder to process than their canonical counterparts.

In order to determine how context affects the processing of canonical and noncanonical constructions in Finnish, we conducted a self-paced reading study and an eye-gaze study. The results of these two studies reveal that contextual information plays an important role in mitigating the processing load associated with noncanonical structures, and that the comprehension system uses discourse-status information, encoded in word order, to anticipate the referents of upcoming NPs.

## **2 What is Scrambling?**

Human languages differ in the amount of word order flexibility they permit. Some languages, including English, have fairly rigid word order. If the word order of an English sentence—e.g. *The bird ate a worm*—is changed, the meaning of the sentence also changes: *A worm ate the bird*. This is a consequence of English using word order to encode the grammatical relations between words, i.e. to indicate ‘who did what to whom.’ Many parsing theories emphasize the role that word order information plays. For

example, Bever (1970) suggested that a configuration consisting of an NP, followed by a verb, followed by a second NP (NVN) is parsed as 'actor-action-object'. Many other languages, however, encode information about 'who did what to whom' not by means of word order, but by case-marking on the NPs. As a result, in these languages, varying the word order does not alter the meaning of the sentence. Consider the following examples from Finnish, where changing the word order does not change the propositional content of the sentence.

- (1a) *Canonical SVO*      Lintu      söi madon.  
    *bird-NOM ate worm-ACC*<sup>d</sup>  
    'The/a bird ate the/a worm.'
- (1b) *Scrambled OVS*      Madon      söi lintu.  
    *worm-ACC ate bird-NOM*  
    'A bird ate the worm.'

Crucially, even though the propositional meaning is unchanged, the change from SVO to OVS does have an effect on the discourse-status of the arguments, as approximated by the use of the definite and indefinite articles in the English translations. This example illustrates an important property of word order flexibility: it is not random or arbitrary. It is usually driven by discourse-based factors, such as whether a certain entity has already been mentioned in the discourse or whether an entity is in a set relation with something else in the discourse (see e.g. Birner & Ward 1998, Givón 1984, Prince 1999, Rambow 1993, *inter alia*). It is often the case that, across languages, entities that have not yet been mentioned in the discourse (new information) tend to occur towards the end of the sentence, whereas entities that have already been mentioned (old/given information) tend to occur towards the beginning of the sentence.

For flexible word-order languages which lack articles, word order variation often plays an important role in encoding the discourse-status of referents. For example, in Finnish, noncanonical OVS order (ex. 1b) can be used when the object is old information and the subject is new. On the other hand, the canonical SVO order (ex. 1a) is used when the subject is old and the object is new. Thus, when the arguments of the verb have different information statuses, there is a preference to place old/known information before new information. When both arguments have the same information status (both old or both new), Finnish defaults to the canonical SVO order

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<sup>1</sup> Abbreviations used in this paper: NOM=nominative, ACC=accusative, GEN=genitive, INESS=inessive, ILL=illative, poss=possessive suffix.

(see Chesterman 1991, Vilkuna 1995 for further details on Finnish word order). Similarly, in other articleless scrambling languages such as Japanese and Russian, the discourse properties of constituents are related to their positions in the sentence (Ishihara 2001, Yokoyama 1986, *inter alia*). Even in German, a scrambling language that has articles, the position of the arguments of the verb reflects their connection to the preceding discourse (see e.g. Lenerz 1977 and others). In sum, then, crosslinguistic research shows that the word order flexibility exhibited by many of the world's languages is not random, and is in fact driven by discourse-related factors such as (but not limited to) the given-new distinction.

### 3 Existing Work on Processing of Scrambling Languages

In recent years, a number of studies have investigated the processing mechanisms for languages with flexible word order, including Finnish, Japanese, Serbo-Croatian, Russian, German and Dutch. The emerging consensus from this body of work is that sentences with noncanonical word order are harder to process than their canonical counterparts. However, since this research has tended to focus on determining how propositional content is recovered from utterances with a noncanonical structure, almost all experiments used sentences presented in isolation. Given that scrambling is driven by certain kinds of discourse-related factors, many of the existing results are hard to interpret, as they do not tell us whether it is syntactic complexity or infrequency, or pragmatic infelicity that is making scrambled sentences harder to process.

#### 3.1 Finnish

Hyönä & Hujanen (1997) conducted an eye-tracking experiment looking at the effects of case marking and word order on the processing of Finnish sentences. They used sentences with three word orders: (i) subject-verb-object (SVO), (ii) object-verb-subject (OVS) and (iii) adverbial-verb-subject-object (AVSO) or adverbial-subject-verb-object (ASVO), shown in (2a-c).<sup>2</sup>

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<sup>2</sup> In addition, they also tested sentences where the target word (S, O or A) was preceded by an adjective which, in Finnish, is marked with the same case as the head noun. For reasons of space, we will not consider these adjective conditions here.

**(2a)<sup>3</sup>First noun: Subject**

Lopulta **politiikka** tuhoaa joustavuuden päätöksenteossa.

*finally politics-NOM destroys flexibility-ACC decision-making-INESS*

'Finally the politics destroys the flexibility in decision-making.'

**(2b)First noun: Object**

Lopulta **politiikan** tuhoaa jatkuvasti kasvava nukkuvien puolue.

*finally politics-ACC destroys continuously growing sleepers party-NOM*

'Finally the politics are destroyed by the continuously growing body of non-voters.'<sup>4</sup>

**(2c) First noun: Adverbial**

Lopulta **politiikassa** tuhoaa moni poliitikko kansansuosionsa.

*finally politics-INESS destroys many politician-NOM popularity-poss*

'Finally in the politics many politicians destroy their popularity.'

In the experiment, participants were asked to read the sentences for comprehension, and they were occasionally asked to paraphrase a sentence they had just read.

On the basis of analyses of residual gaze duration (i.e. duration of initial looks at the noun, adjusted for word length) on the target noun ('politics' in the example above), Hyönä & Hujanen found a significant main effect of grammatical role and of case marking. Gaze duration was significantly longer for objects than subjects, and adverbials also had significantly longer gaze durations than subjects. Objects and adverbials did not differ significantly from each other. Analyses of regressive eye movements from the middle or the end of the sentence (i.e. looks back to the target noun) mirror these findings.

In sum, Hyönä & Hujanen found that, in Finnish, canonical word orders were easier to process than noncanonical orders. They attributed this finding to the relatively low frequency and structural complexity of OVS sentences. It is worth noting that, since Hyönä & Hujanen were focusing on the interplay of syntactic and morphological aspects of processing, the stimulus sentences were presented out of context. However, given the discourse properties of OVS order, we would thus like to know whether presenting OVS sentences in a pragmatically felicitous context makes them easier to process.

<sup>3</sup> Some word-for-word translations have been changed slightly for reasons of clarity.

<sup>4</sup> Finnish has no passive of the English type, so this should not be considered to be a literal translation. The Finnish sentence shown here has OVS order and an active verb.

### 3.2 Experiments in Other Languages

In this section, we briefly consider findings from other languages with flexible word order. For Japanese, Miyamoto & Takahashi (2001) found in a self-paced reading study that sentences with VP-internal scrambling take significantly longer to process than their canonical counterparts. Miyamoto & Takahashi attribute this slowdown with scrambled sentences to their greater structural complexity.

Research on Serbo-Croatian by Stojanović (1999) also found a processing cost related to scrambling. She measured word-by-word reading times for SVO (canonical), OVS, OSV and SOV (noncanonical) sentences with ambiguous case-marking. Overall, Stojanović found that SVO orders were read faster than SOV orders, and OVS orders were read faster than OSV orders. According to her, these findings can be explained if we assume that the parser tends to analyze the initial NP as a subject, and (i) in OVS order, reanalyzes it as an object upon encountering the disambiguating verb, and (ii) in OSV and SOV, delays further parsing upon encountering the second NP and waits for the disambiguating verb.

Additional evidence for the claim that scrambled sentences are harder to process comes from a self-paced reading study of Russian (Sekerina 2003) which investigated the differences between movement by scrambling and wh-movement (which is optional in questions in Russian). For the non-wh conditions, Sekerina used canonical sentences and compared them with sentences with non-canonical word order where the object has been preposed to a position in front of the subject. The results show that in Russian, the overall reading times for scrambled sentences are longer than the total reading times for sentences with canonical word order.

### 3.3 Why are Noncanonical Orders Harder to Process?

Overall, empirical evidence suggests that scrambling is associated with a higher processing cost than the processing of sentences with canonical word order. Several explanations for this finding have been proposed. First, it has been suggested that the increased processing load is due to scrambled sentences being structurally more complex than their canonical counterparts (e.g. De Vincenzi 1991, Miyamoto & Takahashi 2001, *inter alia*). It has been suggested that the human sentence parser finds canonical orders easier to process because their structures are computationally less costly (e.g. Frazier (1987)'s Active-Filler strategy, De Vincenzi (1991)'s Minimal Chain Principle) and because they impose a lighter memory load than noncanonical structures (e.g. Gibson 1998, see also Miyamoto & Takahashi 2001).



An alternative explanation within the spirit of the constraint- and frequency-based theories (MacDonald, Pearlmutter & Seidenberg 1994, Trueswell & Tanenhaus 1994, Mitchell & Cuetos 1991) argues that the low frequency of scrambled word orders contributes to making them harder to process (see Hyönä & Hujanen 1997:854). This approach argues that a low-frequency structure is harder to process than a high-frequency structure. Since scrambled orders are often significantly less frequent than their canonical counterparts, this approach—like the structural complexity accounts—predicts that scrambled sentences will be harder to process.

However, the scrambling studies discussed so far used sentences presented in isolation, without any context—even though, as we saw above, noncanonical word orders only occur in certain discourse contexts, i.e. they need the right kind of contextual support. As far as we know, so far only three published studies have addressed the importance of context when investigating the processing of scrambling: Bader & Meng (1999), Kaan (2001) and Sekerina (2003).

In addition to the study comparing scrambling and wh-movement discussed above, Sekerina also conducted another, very similar experiment, but this time the test sentences were preceded by a “single-sentence context that generated discourse-appropriate conditions for using scrambled sentence[s]” (Sekerina 2003:317). However, Sekerina does not specifically discuss what kinds of discourse factors motivate the use of scrambled sentences of the type she used.

Sekerina predicted that, when presented without a context, scrambled sentences would be processed more slowly than canonical sentences, and that the presence of a context would decrease this difference, but not eliminate it. And she did indeed find an effect of context for *all* sentence types (scrambled, canonical, questions). Presenting sentences with a context lead to total reading times that were, on average, 250 ms faster overall than total reading times for sentences out of context. However, scrambled sentences still took longer to process than sentences with canonical word order, even when a context was present. These findings show that the presence of a context can facilitate the processing of scrambled sentences, canonical sentences and sentences with wh-movement, but that context cannot eliminate the increased processing load induced by scrambling. Her study provides further support for the generally accepted idea that sentences in general are read faster when preceded by a context than in isolation. It leaves open the question of whether a scrambled sentence could become as easy to process as a canonical sentence—or even easier—when located in a context that supports the scrambled word order but doesn't support the



canonical order. In other words, how powerful an influence can discourse context have on the processing of scrambled sentences?

Kaan (2001) and Bader & Meng (1999) took steps to incorporate the discourse-driven nature of scrambling into experimental design by using sentences with pronouns. Kaan (2001) investigated the strength of the ‘subject-first’ preference, i.e. the bias, when faced with two NPs whose case marking doesn’t disambiguate their syntactic roles, to interpret the first as the subject and the second as the object. Kaan conducted a self-paced reading study with locally-ambiguous NP-NP-V sequences in Dutch relative clauses, and varied the type of the second NP: it was either a case-ambiguous definite NP or a case-ambiguous pronoun. In NP-NP-V sequences where the second noun is a pronoun, one might expect readers to be sensitive to a correlation that exists between pronouns and subjecthood (see e.g. Prince 1992) and thus to no longer show a default subject-object order preference.

Kaan found that (i) when both of the NP’s are full definite NPs, a clear subject-object preference arises, but (ii) when the second NP is a pronoun, “this preference was much weaker or even absent” (Kaan 2001:542). She concludes that the ‘subject-first’ preference can be influenced by NP type, which is related to the discourse status of the referent of the NP. Her results show that people’s preference to interpret an ambiguous NP-NP sequence as having subject-object order can be weakened by discourse information—but since the sentences were presented out of context, we cannot tell if this effect would be even stronger in contexts that bias an object-subject interpretation.

A related experiment by Bader & Meng (1999) using a speeded-grammaticality judgment task compared different kinds of subject-object ambiguities in German, including sentences with two full noun phrases and sentences with a pronoun and a full noun phrase. According to Bader & Meng, temporally ambiguous sentences with noun-noun sequences where the *first* noun (subject or object) is a pronoun are more flexible in terms of their discourse properties than sentences with a noun-noun sequence where both are full NPs. Bader & Meng found a significant effect of noun phrase type (pronoun-NP sequence vs. NP-NP sequence) on the accuracy of grammaticality judgments, with NP-NP sequences showing a stronger preference for canonical subject-object order than pronoun-NP sequences. Following a serial model of parsing, they interpret these results as evidence that the garden-path is stronger with NP-NP sequences that are disambiguated as object-subject structures than pronoun-NP sequences that are disambiguated as object-subject structures, because the former also require that the information structure of the sentence be revised. In other words, they suggest that the revision of the information structure of the sentence that is necessary with NP-NP sequences that turn out to have

object-subject order increases processing cost. Like Kaan's results, these findings indicate that discourse information plays an important role in on-line parsing, and again raise the question of whether a scrambled sentence could become as easy to process as a canonical sentence when located in a supportive context.

## 4 Experiments

In this section we report the results of two experiments using Finnish which investigate the processing of canonical and noncanonical word orders in context. The first experiment used a self-paced reading task to investigate how felicitous and infelicitous discourse contexts influence the processing load induced by scrambled sentences. The second study, an eye-gaze experiment, tested whether people use the discourse-status information encoded in word order to anticipate the discourse-status of upcoming referents.

### 5.1 Self-paced Reading Experiment

We explored the hypothesis that context has an effect on the ease of processing scrambled sentences in a self-paced reading study by manipulating the given/new status of the subject and object in SVO and OVS sentences. Our expectation was that, if the processing slowdown that previous studies observed for scrambling sentences was a result of the lack of contextual support, then placing scrambled sentences in supportive contexts should decrease the processing load.

In this experiment, we used short stories to establish the subject or object as old information. The other argument was introduced in the target sentence. This resulted in four conditions: [ $S_{old}VO_{new}$ ], [ $S_{new}VO_{old}$ ], [ $O_{old}VS_{new}$ ] and [ $O_{new}VS_{old}$ ], summarized in (3). Target sentences introduced the subject, verb and object in the first three words.<sup>5</sup> A sample item is given in (4). All fillers and critical items were followed by yes/no comprehension questions.

- (3) ☺  $S_{old}VO_{new}; S=old$  (*felicitous*)  
 ☹  $S_{new}VO_{old}; S=new$  (*not felicitous*)

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<sup>5</sup> The words used as subjects and objects in the critical items had a minimum token frequency of at least 40 per million, following the criteria used by Hyönä & Hujanen (based on the frequencies reported in Saukkonen, Haipus, Niemikorpi & Sulkala 1979). The nouns were matched in terms of frequency and animacy.

- ☺  $O_{old}VS_{new}; O=old$  (*felicitous*)  
 ☹  $O_{new}VS_{old}; O=new$  (*not felicitous*)

(4a) *Context sentences...*

Lotta etsi eilen sienä metsässä.

*Lotta-NOM looked-for yesterday mushrooms-PART forest-INESS.*

Hän huomasi heinikossa hiiren/jäniksen joka liikkui

*S/he-NOM noticed grass-INESS mouse-ACC/hare-ACC that was-moving*

*varovasti eteenpäin.*

*carefully forward.*

(4b) ...*Target sentence (SVO)*

Hiiri seurasi jänistä ja linnut lauloivat.

*Mouse-NOM followed hare-PART and birds were-singing.*

*'Lotta looked for mushrooms yesterday in the forest. In the grass, she*

*noticed a mouse/hare that was moving carefully forwards. Mouse-SUBJECT*

*was following hare-OBJECT and birds were singing.'*

(4b') ...*Target sentence (OVS)*

Jänistä seurasi hiiri ja linnut lauloivat.

*Hare-PART followed mouse-NOM and birds were-singing.*

*'Lotta looked for mushrooms yesterday in the forest. In the grass, she*

*noticed a mouse/hare that was moving carefully forwards. Hare-OBJECT*

*was following mouse-SUBJECT and birds were singing.'*

Forty-four native Finnish speakers, mainly students at the Helsinki University of Technology, participated in the experiment, which contained 20 critical items and 35 fillers. The experiment was run on a PC laptop using DMASTR software (K. Forster & J. Forster, Monash University and the University of Arizona) and a button box. The target sentence of each critical item was presented in word-by-word fashion using a 'moving window' set-up. In other words, subjects first only saw the first word of the target sentence. Then, when they pressed a button, that word disappeared and the next word appeared. Another press of the button made that word disappear and revealed the next word, and so on. We recorded the reading times for the first five words of the target sentence: word 1: subject/object, word 2: verb, word 3: object/subject, word 4: filler, word 5: filler (these 'filler words' were the first words of the following clause and were identical across conditions).

### 5.3 Results and Discussion

Analyses of the overall reading times (Fig. 1) reveal significant effects of both structure and context ( $p$ 's < 0.05). Thus, overall, SVO order is read

faster than OVS order, and contextually felicitous items are read faster than items in infelicitous contexts. However, paired comparisons of the four conditions reveal that only OVS order in an infelicitous context differs significantly from the other three conditions.

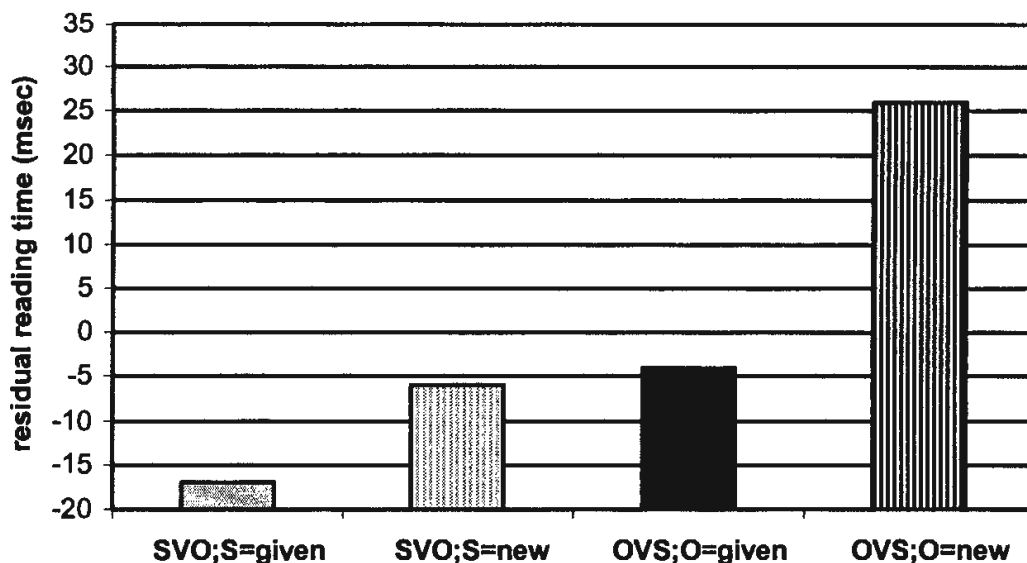


Figure 1. Average reading times (collapsed across positions)

The word-by-word reading times reveal that there is a certain time-dependent pattern over which the effects unfold. It seems that, in the initial stages of processing, contextual factors play a key role. Old NPs are read faster than new NPs at the first position (word 1: preverbal NP), and this effect persists at word 2 (verb).<sup>6</sup> Then, at the verb, structure also plays a key role. Verbs that were preceded by a subject (SV...) are read faster than those preceded by an object (OV...). This effect is also present at word 3 (postverbal NP): at this position, objects (SVO sentences) are read faster than subjects (OVS sentences). It is important to note that if we compare the felicitous conditions only, we see that felicitous SVO and felicitous OVS differ significantly only at the verb. In other words, for scrambled OVS

<sup>6</sup> The initial processing advantage for felicitous contexts could be due to some kind of repetition priming, since the felicitous orders all start with an NP that was mentioned earlier in the story. However, the structure-context interaction that emerges later cannot be attributed to repetition priming since it appears towards the end of the sentence, after the main effect of context has disappeared.

sentences in felicitous contexts, the effect of structure is very localized (see Kaiser & Trueswell (submitted) for details).

The finding that there is no effect of structure at the first word (the preverbal NP) suggests that structural factors may not become relevant until more than one constituent has been encountered, i.e. until there is a need to start 'building' a syntactic tree (also, see Kaiser & Trueswell (submitted) for discussion of the effects of morphological ambiguity).

Let us now turn to the two final positions. An interaction arises between context and structure in these positions (word 4 and word 5, both filler words)—more specifically, by this point, OVS order in an infelicitous context is significantly slower than the other three conditions. Importantly, OVS sentences in a *felicitous* context do not differ significantly from canonical SVO sentences. The lateness of the structure-context interaction suggests that it takes some time for the parser to fully integrate contextual and structural information. It is worth noting that since the last two words are filler words which are identical across all four conditions, one might expect there to be no differences at those positions. The presence of a context-structure interaction at this late stage is probably a kind of spill-over effect, which reveals that the parser requires time to combine different sources of information.

In sum, these results show that, when scrambled and canonical sentences are presented in felicitous contexts, the processing load difference becomes much smaller and highly localized. In other words, contextual factors can significantly decrease the processing load induced by noncanonical orders (see also Kaiser 2003, Kaiser & Trueswell (submitted) for further discussion).

#### 5.4 Eye-gaze study

The second experiment, an eye-gaze study, addresses an important related issue, namely the question of referential interpretation—i.e. how does the context in which a sentence occurs guide the referential interpretations assigned to its arguments? A self-paced reading study cannot tell us much about the on-line referential interpretation of the NPs in SVO/OVS sentences. Recall that OVS order is used in Finnish when the object is old and the subject new, whereas SVO is used when the subject is old and the object is old *or* new. Thus, the OV... configuration predicts that the postverbal subject will be new information, whereas the SV... configuration has no such predictive power. In the current study, we wanted to see if this information is used during on-line processing. Work by Kako & Trueswell (2000) and Altmann & Kamide (1999, 2002) shows that the semantic and

syntactic restrictions of verbs can create anticipatory effects, and so we wanted to test whether the discourse information encoded in word order can also trigger anticipation. To do this, we conducted an eye-gaze experiment that investigated whether listeners make use of the predictive power of OVS order in on-line processing of Finnish.

In this experiment, people viewed pictures as they listened to stories about them. All pictures were in color, and they were designed with Photoshop using clipart images. The sound files accompanying the pictures were recorded by a native female Finnish speaker using the Syntrillium CoolEdit 2002 program. There were 16 critical items and 24 filler items.

Target trials contained a picture with three characters (e.g., a doctor and a nurse near a desk, and another nurse elsewhere in the scene). Prior to hearing the critical sentence, only two of the characters had been introduced (in this example, the doctor and the nurse near the desk), leaving the other character discourse-new. Participants then heard either an SVO (doctor-subject glanced-at nurse-object) or OVS (doctor-object glanced-at nurse-subject) sentence (see example 5). These ‘ambiguous-referent’ conditions were compared with ‘unambiguous-referents’ (e.g. man-subject greeted patient-object), where the discourse-new nurse was replaced in the picture by a patient.

(5a) *Context:*

Sairaalan vastaanottotiskiini nojailevat lääkäri ja  
*hospital-GEN reception-desk-ILL lean doctor-NOM and*  
 sairaanhoitaja  
*nurse-NOM*  
 ja kello on jo melkein kaksi.  
*and clock is already almost two.*

(5b) *SVO target sentence*

Hetken päästä lääkäri katsahtaa  
*moment-GEN after doctor-NOM glances*  
 sairaanhoitajaan / potilaaseen  
*nurse-ILL / patient-ILL*

(5b') *OVS target sentence*

Hetken päästä lääkäriin katsahtaa sairaanhoitaja / potilas.  
*moment-GEN after doctor-ILL glances nurse-NOM / patient-NOM*

(5c) *Concluding sentence*

Tämä sairaanhoitaja/potilas pitää kädessään saksia.  
*This-NOM nurse-NOM/patient-NOM holding hand-poss-INESS scissors*

‘On the hospital reception desk are leaning a doctor and a nurse, and it

is almost two o'clock. After a moment,  
 doctor-SUBJ glances-at nurse-OBJ / patient-OBJ. [SVO target]  
 doctor-OBJ glances-at nurse-SUBJ / patient-SUBJ. [OVS target]  
 This nurse / patient is holding a pair of scissors.'

In both the ambiguous and unambiguous conditions, we predict that the OV... configuration should trigger anticipatory looks to the discourse-new referent. Furthermore, we predict that, in ambiguous-referent conditions, SVO should show little consideration of the discourse-new nurse as the referent of the second NP, as compared to OVS.

Sixteen native Finnish speaking students participated in this experiment. Their task was to look at the pictures and listen to the stories to determine whether the stories contained any mistakes, and if so, to correct them. Their answers were recorded auditorily.

#### 5.4.1 Results and Discussion

Overall, the results show that listeners use word order patterns to predict upcoming referents on the basis of discourse status. The analysis of the eye-movements shows that both ambiguous and unambiguous OVS sentences, in contrast to SVO sentences, trigger anticipatory eye-movements to the discourse-new referent at very the onset of the postverbal NP. More specifically, OVS order is significantly more likely than SVO order to prompt looks to the discourse-new referent during the first 200 ms of the postverbal NP. Given that it takes about 150 ms to program an eye-movement (Matin, Shao & Boff 1993), the early looks to the new referent that occur in the OVS condition reveal that people are using the discourse-information encoded in OVS order to make predictions about the upcoming referent before they hear it. In contrast, SVO sentences do not induce anticipatory looks, which makes sense since they lack the discourse-based predictive power of OVS order. Listeners in the SVO-unambiguous condition don't look to the new referent (the new patient) until well after the word-onset, i.e. after they have heard enough to recognize the word (see Kaiser 2003 for further details).

Interestingly, at the postverbal NP, listeners in the SVO-ambiguous condition show a clear preference for the discourse-old nurse over the discourse-new nurse—even though, lexically, the word 'nurse' is ambiguous. This preference for the old referent suggests that people avoid adding new referents to the discourse-model unless they have very clear evidence that they should do so. In contrast to SVO, the OVS-ambiguous condition *does* show substantial looks to the discourse-new nurse, but also



later competition with the discourse-old nurse, due to the ambiguous lexical cue. The difference between ambiguous OVS and unambiguous OVS—namely the proportion of looks to the new referent—may be due to cue strength. When listeners have both a word order cue and a lexical cue, as with unambiguous OVS order, the percentage of looks to the new referent of the postverbal subject is very high. When listeners only have a word order cue, as with ambiguous OVS order, the portion of looks to the new referent decreases. In addition, participants may very well be behaving in a Gricean fashion, reasoning that the speaker would have most likely said ‘another nurse’ had she meant to refer to the discourse-new nurse (see Kaiser 2003, Kaiser & Trueswell (submitted) for a more detailed discussion of the eye-gaze results).

Off-line referential judgments matched the eye gaze patterns (see Kaiser 2003, Kaiser & Trueswell (submitted) for details). As a whole, our results show that comprehenders use discourse-status, encoded in object-verb order, to predict that the upcoming postverbal subject is a new, previously unmentioned entity. This is indicated by the anticipatory looks; the participants start launching looks to the previously unmentioned referent even before they have heard enough of the noun to be able to recognize it. It is interesting to note that OVS order, which has often been claimed to be significantly harder to process than SVO order, is in this sense more helpful to the processor than SVO order.

## **6 Conclusions and Implications**

Taken as a whole, the results of the studies discussed here show that, when studying sentence processing in a language with flexible word order, it is important to consider contextual factors. The self-paced reading experiment shows that the greater processing load that many previous studies found for noncanonical structures cannot be attributed solely to syntactic or structural factors. Our results show that at least part of the slowdown that many previous studies observed is due to the scrambled sentences having been presented without the appropriate contextual support. The second study, the eye-gaze experiment, reveals that the comprehension system uses discourse-status, encoded in object-verb order, to predict that the upcoming postverbal subject is a new, previously-unmentioned entity. In other words, anticipation arises on the basis of discourse-status information, as encoded by word order—even when this order is argued to be structurally complex. Thus, even though OVS order is hard to process in isolation, in the appropriate context it is more informative from the perspective of the processor than SVO order. In fact, the predictive power of the OV... sequence raises

interesting questions as to what the slowdown at the verb that was observed in the self-paced reading study for OVS sentences really means: One could hypothesize that the slower reading time is at least partially due to the fact that the processor is computing the predictive information provided by the OV... sequence. This is an interesting issue for future work.

In addition to highlighting the importance of the inclusion of discourse-contextual factors, these findings have important implications for other areas of research in human sentence processing. Given that contextual factors can influence syntactic ambiguity resolution (Altmann & Steedman 1988, Crain & Steedman 1985) and the processing of scrambled sentences, we are faced with the question: What about the processing of other kinds of complex structures, such as filler-gap dependencies? A lot of research has shown that in filler-gap sentences, the parser prefers to fill the gap as soon as possible (see e.g. Clifton & Frazier 1986, De Vincenzi 1991). Thus, in a sentence such as (6), the parser posits a gap at the earliest possible location, and then has to revise its parse later.

(6) Who did John see <gap> Mary kiss <gap>?

However, the question we can now ask is whether the presence of the right kind of context could weaken this 'instant gap positing' preference. It would not be surprising if context could delay the gap, given that wh-questions are highly context-bound (see Sussman & Sedivy 2001 for related work looking at the effects of verb transitivity information in the processing of wh-questions).

In light of the results presented in this paper, we conclude that taking into account the discourse functions of different syntactic structures is likely to lead to new insights in the field of sentence processing, since it appears that hypotheses regarding an utterance's discourse function are made in tandem with hypotheses regarding the utterance's propositional content.

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