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Parallelism in pronoun comprehension

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Abstract

The aim of this study was to distinguish between two heuristic strategies proposed to account for the assignment of ambiguous pronouns: a subject assignment strategy and a parallel function strategy. According to the subject assignment strategy a pronoun is assigned to a preceding subject noun phrase, whereas according to the parallel function strategy a pronoun is assigned to a previous noun phrase with the same grammatical function. These two strategies were tested by examining the interpretation of ambiguous subject and non-subject pronouns. There was a strong preference for assigning both types of pronouns to preceding subject noun phrases which supported the subject assignment strategy. However the preference was reduced for non-subject pronouns compared to subject pronouns which we interpreted as evidence for grammatical parallelism. A subsidiary aim of the study was to investigate text-level effects of order-of-mention where a pronoun is assigned to a noun phrase which has been mentioned in the same sequential position. We did not observe any strong effects although we did observe a possible topic assignment strategy where topic-hood depended on order-of-mention. A *post hoc* inspection of the materials revealed possible effects of intra-sentential order-of-mention parallelism. We conclude that a subject assignment strategy, a parallel grammatical function strategy, a topic assignment strategy and a parallel order-of-mention strategy may all constrain the interpretation of ambiguous subject and non-subject pronouns.

Introduction

The comprehension of pronouns is made up of many processes operating at many different levels (syntactic, semantic and nonlinguistic). One such

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set of processes involves heuristic strategies: mechanical rules of thumb operating over a particular level of representation. Two strategies for pronoun comprehension concern us here: subject assignment and parallel function. The subject assignment strategy (*e.g.*, Broadbent, 1973; Clancy, 1980) proposes that ambiguous pronouns will be assigned to antecedents which function as subjects and the parallel function assignment strategy (Sheldon, 1974) proposes that pronouns will be assigned to antecedents with parallel (identical) grammatical functions.

Sheldon (1974) proposed that parallel function was used in pronoun resolution and noted that (1a) is easier than (1b).

- (1) a. Mary hugged John and Betty kissed him.
- b. Mary hugged John and he kissed Betty.

Several investigators have studied parallel function in pronoun comprehension and various factors which interact with it (*e.g.*, Caramazza and Gupta, 1979; Cowan, 1980). The general conclusion of such studies is that parallel function does influence the comprehension of ambiguous pronouns. However, Crawley, Stevenson and Kleinman (1990) observed that very few studies of parallel function have used non-subject pronouns and so the results cannot distinguish between a parallel function strategy and a subject assignment strategy because both strategies predict that ambiguous pronouns will be assigned to the subject antecedent. By contrast, the two strategies predict different outcomes when non-subject pronouns are used; the subject assignment strategy predicting subject assignment and the parallel function strategy predicting non-subject assignment. Using three sentence texts, Crawley, Stevenson and Kleinman (1990) found a clear subject assignment bias with non-subject pronouns, from which they concluded that parallel function was not being used.

Unfortunately they only used non-subject pronouns which will only distinguish between subject work was part of the ESRC funded Human Communication Research Centre (HCRC)

assignment and parallel function if either strategy is used in isolation. However, it is possible that both strategies are involved in comprehension, so that subject pronouns may show a more marked subject assignment bias than do non-subject pronouns. That is, the subject assignment bias observed by Crawley, Stevenson and Kleinman (1990) for non-subject pronouns might have been attenuated by a concurrent but conflicting parallel function strategy. The main aim of the present paper, therefore, is to test this possibility by investigating both subject and non-subject pronouns.

Stenning (1991) has found effects of order-of-mention in text processing. Given these effects and the possibility that order-of-mention is related to grammatical function because subjects usually come before non-subjects in English, a subsidiary aim was to investigate the existence of order-of-mention in pronoun comprehension. Cowan (1980) investigated order of mention effects in single sentence materials and concluded that there was no effect although there is a slight trend in his data which suggests that such effects might exist. Given Cowan's conclusions and Stenning's findings that order-of-mention operates over sentences, this experiment manipulated order-of-mention over sentences also. This was done by changing the order in which the pronoun's potential antecedents were introduced in the text. Either the order was the same as the order in the target or it was different (the order of antecedents in the target sentence were kept constant).

Crawley, Stevenson and Kleinman's (1990) materials varied in the construction which was used to introduce the potential antecedents. Sometimes they were conjoined subjects and sometimes they were introduced in the subject and predicate of the first sentence. There was some hint in the data that these differences affected the resolution process so the manner of introduction was also included as a design factor.

In summary, this experiment investigated the use of a parallel function assignment strategy in simple three sentence texts, following Crawley, Stevenson and Kleinman (1990). By using both subject and non-subject pronouns a subject assignment strategy could be distinguished from a parallel function assignment strategy. Order of mention effects and the manner of introduction of the potential antecedents were also manipulated.

Experiment

Subjects

The subjects were 192 volunteer students from Durham University.

Example passage
Conjoined antecedents
John and Sammy were playing in the garden. Ellen watched their game with interest. John pushed Sammy and Ellen kicked him.
Antecedents in subject predicate form
John was playing with Sammy in the garden. Ellen watched their game with interest. John pushed Sammy and Ellen kicked him.
Antecedents in separate sentences
John and Ellen were playing in the garden. Sammy watched their game with interest. John pushed Sammy and Ellen kicked him.

Table 1: The same target sentence with three different context sentence pairs. (Same Order conditions. The order in which the two antecedents were introduced into the text was reversed in the Different Order conditions.)

Materials and Design

Each subject read 48 passages consisting of two context sentences followed by a target sentence. Each text described three individuals who were introduced in the two context sentences and repeated in the target sentence. The target sentence was made up of two conjoined clauses: the first mentioned two of the participants and the second mentioned the third participant and a pronoun which referred to one of the two individuals mentioned in the first clause.

The design factors were Text type (conjoined antecedents, subject-predicate antecedents, separate antecedents and target sentence only), Participant order (same order *vs.* different order), and Pronoun position in target (subject *vs.* non-subject). Half the targets contained 3 or 4 words after the *and* and half the targets contained 5 to 7 words after the *and* making a between materials variable of length with two levels. Table 1 shows a reduced text set illustrating three of the levels of the text type variable: conjoined antecedents, subject predicate antecedents and separate antecedents. The target shows the Non-subject pronoun level and the corresponding Subject pronoun level would be "John pushed Sammy and he kicked Ellen". The first two Text conditions are comparable to the materials used by Crawley, Stevenson and Kleinman (1990).

Forty-eight three-sentence texts were constructed (available from the authors on request). Twenty four texts had long targets and twenty four had short targets. Each set of three sentences was used to make 16 versions of itself (four levels of the Text variable, two levels of the Order variable and two levels of the Pronoun variable). These versions were used to produce sixteen lists of materials, four in

each of the four text conditions. In each text condition the four lists contained both levels of the Order variable and both levels of the Pronoun variable. Across the four lists, each text occurred in all of its four versions.

Each text was followed by a question derived from the crucial part of the second clause in the target sentence by repeating the second clause with the pronoun replaced by one of the potential antecedents (e.g., Ellen kicked Sammy? or Ellen kicked John?). The question was used to determine the assignment of the pronoun in the preceding text. The number of times each potential antecedent was substituted was balanced across materials.

Procedure

The task was a self-paced reading task, followed by a question about the target sentence. The context sentences of the passages were presented one sentence at a time and the target sentence was presented clause by clause. Subjects were asked to press the space bar as soon as they had read and understood the sentence/clause. When they did so the screen was cleared and the next sentence displayed. Once the final clause had been read, the screen cleared and then the question appeared. After answering the question by pressing one of two keys marked *true* and *false*, subjects were prompted to start the next trial.

The time taken to read the last clause of each target sentence was measured in milliseconds and the answer to each question was recorded. In this paper, we focus primarily on the answers to the questions which were used to infer the assignment of the pronouns.

Results

Comparison over Conjoined, Subject-Predicate, Separate and Single levels of Text: Assignment data Because the Single (target only) level of Text applies to single sentences the Order factor (Same and Different) does not apply, so to make a comparison over Text the Order variable has been collapsed over. The assignment data was prepared for analysis of variance by subtracting the number of non-subject assignments from the number of subject assignments by condition and by subject. This meant that for each subject, each condition was assigned a number between 12 and -12 which represented the assignment bias: a positive number indicated a subject assignment bias and a negative number a non-subject assignment bias.

Figure 1 shows the mean assignment scores for the two types of pronoun in the four text conditions. An analysis of variance was then done on the data using three fixed factors: Text (Conjoined, Subject-Predicate, Separate, Single),

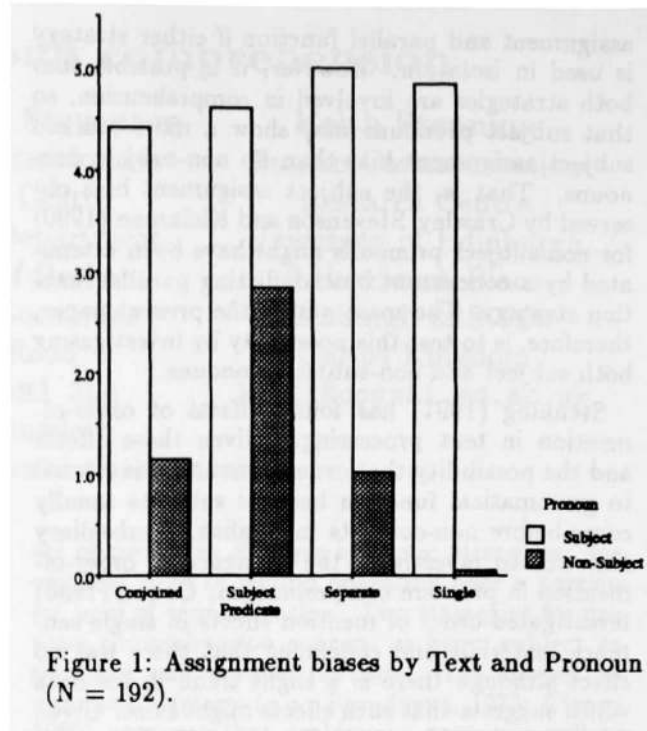


Figure 1: Assignment biases by Text and Pronoun (N = 192).

Length (Short, Long), Pronoun (Subject, Non-Subject). The analysis revealed two reliable effects. Subject pronouns received more assignments to the subject antecedent than to the non-subject antecedent ($\min F'(1, 83) = 32.32, p < 0.01$, Subject=4.7, SD=4.5 and Non-Subject=1.2, SD=1.2). There was also an interaction between Pronoun and Text, $\min F'(3, 203) = 2.89, p < 0.05$.

Analysis of simple effects shows that Text has no effect on subject pronouns (F_1 and $F_2 < 1$) but does have a reliable effect on non-subject pronouns ($\min F'(3, 187) = 4.36, p < 0.01$). Thus subject pronouns are largely unaffected by the preceding sentences whereas the subject assignment bias for non-subject pronouns is affected. The bias is largest when the two potential antecedents are introduced in a subject predicate form, is attenuated if the antecedents are conjoined subjects or subjects introduced in separate sentences, and is smallest for target sentences presented without any context.

A *post hoc* inspection of the materials showed that the structure of the target sentences varied across texts. In most of the targets the structure of the clauses was grammatically parallel, as in the example in Table 1. But in the rest they were not: only the subject pronoun was grammatically parallel to the subject antecedent. The non-subject pronouns and their antecedents occupied different grammatical roles, as in the example in Table 2. These differences could affect the way in which parallel function was operating over the materials because parallel function may operate over strict grammatical categories or over order-of-mention parallelism.

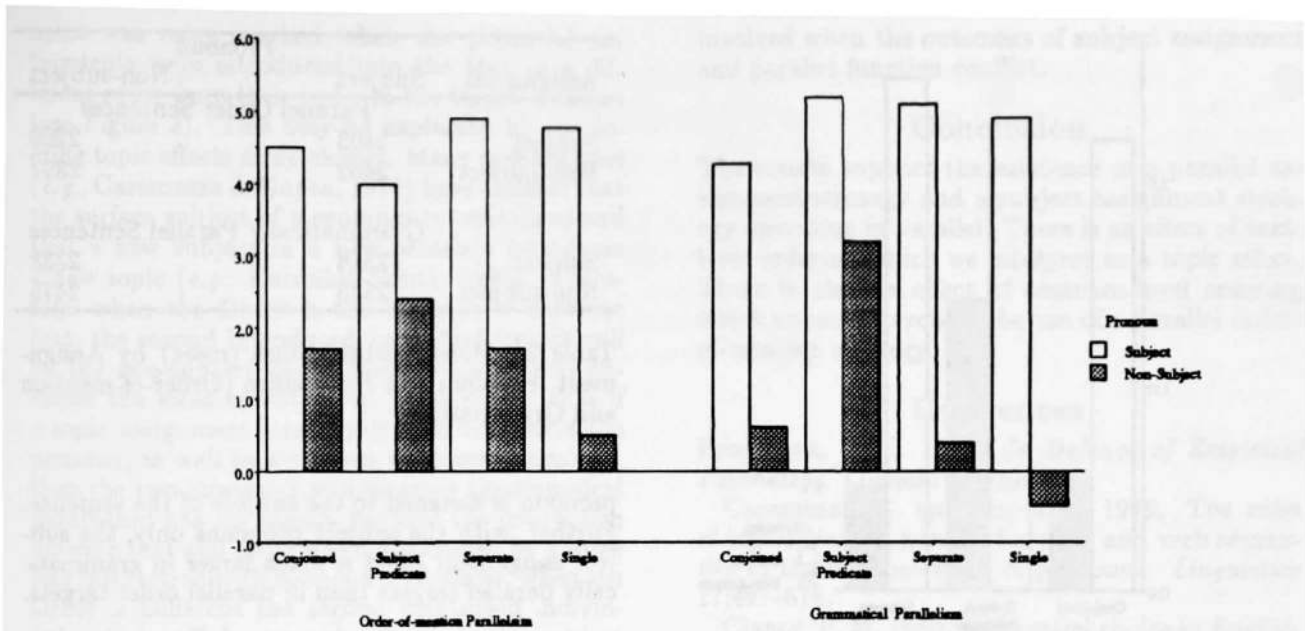


Figure 2: Assignment biases by Text and Pronoun for the Grammatical Parallelism and Order-of-mention Parallelism groups of materials (N = 46 for Order-of-mention parallelism and N = 50 for Grammatical Parallel).

Terry was going to meet Hector at the cricket match.
 Their friend Brenda came along to watch as well.
 Terry took Hector to the pavilion
 and he waved to Brenda.

Table 2: An example of a text with non parallel clauses in the target sentence.

Figure 2 shows the interaction between Text and Pronoun broken down by structure in the target sentence of the materials: those with grammatical parallelism and those with order-of-mention parallelism. Inspection of Figure 2 indicates that the subject bias is reduced in the non-subject pronouns when the targets are grammatically parallel. (We note that Subject-Predicate texts are an exception to this.)

Comparison over Conjoined, Subject-Predicate and Separate levels of Text: Assignment data In order to examine the order effects, the three Text conditions were analysed without the Single Sentence condition. As before, the assignment data was prepared for analysis by subtracting the number of non-subject assignments from the number of subject assignments by condition for each subject. Analysis of variance (with Pronoun, Order, Length and Text as fixed factors) showed that there was one reliable effect of Pronoun where the subject assignment bias was greater for subject pronouns ($\min F'(1,163) = 27.3, p < 0.01$, Subject=2.3,

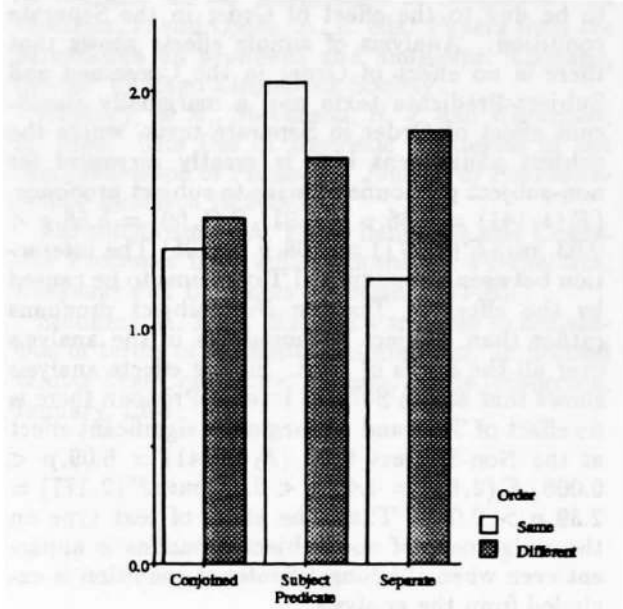


Figure 3: Pronoun assignment bias by Order and Text (N=192).

SD=2.76, Non-Subject=0.8, SD=2.61). Two interactions approached significance: Order by Text, $F_1(2,141) = 3.95, p < 0.03, F_2(2,69) = 4.33, p < 0.02$ and Pronoun by Text $F_1(2,141) = 3.09, p < 0.05, F_2(2,69) = 5.04, p < 0.01$. Figure 3 and Figure 4 show the means for the two interactions respectively.

The interaction between Order and Text appears

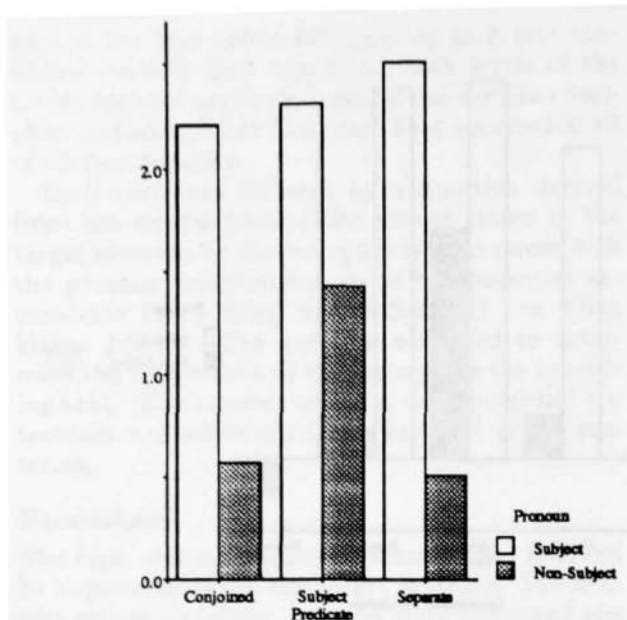


Figure 4: Pronoun assignment bias by Pronoun and Text (N=192).

to be due to the effect of Order in the Separate condition. Analysis of simple effects shows that there is no effect of Order in the Conjoined and Subject-Predicate texts and a marginally significant effect of Order in Separate texts, where the subject assignment bias is greatly increased for non-subject pronouns relative to subject pronouns. ($F_1(1, 141) = 6.86, p < 0.01, F_2(1, 69) = 5.58, p < 0.03, \text{min}F'(1, 171) = 3.08, p > 0.05$) The interaction between Pronoun and Text seems to be caused by the effect of Text on Non-Subject pronouns rather than Subject pronouns, as in the analysis over all the levels of Text. Simple effects analysis shows that at the Subject level of Pronoun there is no effect of Text and a marginally significant effect at the Non-Subject level ($F_1(2, 141) = 5.09, p < 0.008, F_2(2, 69) = 4.49, p < 0.02, \text{min}F'(2, 177) = 2.39, p > 0.05$). Thus, the effect of text type on the assignment of non-subject pronouns is apparent even when the Single Sentence condition is excluded from the analysis.

Reading times The reading time data were not amenable to ANOVA because the cell frequencies were unbalanced and many cells were empty. However, the overall mean reading times for subject and non-subject pronouns when assigned to subject and non-subject antecedents are shown in Table 3. The means are presented separately for parallel order sentences and grammatically parallel sentences as was done for the assignment data in Figure 2. (The pattern of results was similar in the four Text conditions.) Inspection of the Table reveals a clear subject assignment effect: both subject and non-subject pronouns are read most rapidly when the

Assignment	Pronoun	
	Subject	Non-subject
Parallel Order Sentences		
Subject	2403	2269
Non-subject	2462	2397
Grammatically Parallel Sentences		
Subject	2314	2338
Non-subject	2545	2475

Table 3: Mean reading times (msec) by Assignment, Pronoun and Parallelism (Order-of-mention and Grammatical).

pronoun is assigned to the subject of the sentence. Further, with the subject pronouns only, the subject assignment effect is much larger in grammatically parallel targets than in parallel order targets.

Discussion

The results show a large subject assignment bias in both subject and non-subject pronouns when preceded by a text, but negligible bias in non-subject pronouns when presented in isolated sentences. The result that both types of pronouns show a subject assignment bias when preceded by a text is consistent with Crawley, Stevenson and Kleinman's (1990) result.

However, in all the Text conditions, the subject assignment bias was reliably greater with subject than with non-subject pronouns. We propose therefore that two strategies are operating: a subject assignment strategy and a grammatical parallelism strategy, and that the consequences of the operation of these two strategies are different for subject and non-subject pronouns. For subject pronouns the two strategies produce the same outcome, hence the marked subject assignment bias. For non-subject pronouns, the two strategies conflict, hence the reduced subject assignment bias.

Textual factors appear to influence the likelihood that a subject assignment will be made with non-subject pronouns, since there was negligible assignment bias when the target sentences were presented in isolation. This presumably reflects the fact that the two strategies have comparable weightings in isolated sentences and so either strategy may be used. However, when the target is preceded by text then other factors, such as topicalisation, may increase the weighting of the subject assignment strategy, since the subject of the sentence is also likely to be the topic of the text. Such an account is compatible with Crawley, Stevenson and Kleinman's (1990) results. Because they used only non-subject pronouns they were unable to distinguish between subject assignment effects and effects due to grammatical parallelism.

In the Separate Text conditions, subject assign-

ment was more marked when the potential antecedents were introduced into the text in a different order from their order in the target sentence (see Figure 3). This may be explained by considering topic effects more closely. Many investigators (e.g., Caramazza & Gupta, 1979) have claimed that the surface subject of a sentence is topicalised and that a new subject in a new sentence introduces a new topic (e.g., Karmiloff-Smith, 1985). Therefore, when the Order is the Same in a Separate text, the second introduced individual (which will be the non-subject antecedent in the target) becomes the most recent topic. This means that if a topic assignment strategy is used to resolve the pronoun, as well as a subject assignment strategy, then the two strategies will disagree (grammatical parallelism has no impact because the interaction between text and order was not modified by a three way interaction with pronoun). However, when the Order is Different the second mentioned individual, which will become the topic, is the subject antecedent in the target. Therefore the two strategies (topic assignment and subject assignment) will agree. The presence or absence of congruence between the two strategies, therefore, may account for the order effect in the Separate Text condition.

This argument does not apply to the other two Text conditions because in those two conditions the individual introduced in the second context sentence is a third individual who is never a potential antecedent of the pronoun. Thus, the effects of the most recent topic that were observed in the Separate condition, are not apparent here and in addition an effect of the initial topic is presumably attenuated.

A subsidiary aim was to investigate text-level order-of-mention parallelism by manipulating Order. However, we have seen that the interaction that was observed between Text and Order is most likely due to topic effect. Thus we have no strong evidence for a text-level order-of-mention parallelism. On the other hand, there does seem to be evidence of order-of-mention parallelism within a single sentence. Figure 2 shows that there is a parallelism effect in both the grammatically parallel targets and the parallel order targets. In the parallel order targets grammatical parallelism cannot be used. Therefore we conclude that the parallel effects in these cases must be due to a parallel order-of-mention strategy. Indeed, the parallelism effect appears to be greater in the grammatically parallel targets, which is what would be expected since the two strategies coincide in these sentences. The reading time data are consistent with these notions. The reading time advantage for subject pronouns is greatest when both order and grammatical parallelism are present. The absence of a similar advantage for non-subject pronouns is presumably due to the precise nature of the processes

involved when the outcomes of subject assignment and parallel function conflict.

Conclusion

The results support the existence of a parallel assignment strategy and a subject assignment strategy operating in parallel. There is an effect of text-level ordering which we interpret as a topic effect. There is also an effect of sentence-level ordering which appears to reflect the use of a parallel order-of-mention strategy.

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