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**The effects of local and global factors on the
comprehension of pronouns**

**Rosalind Anne Crawley
1985**

**A thesis in two volumes submitted for the degree of Doctor
of Philosophy in the University of Durham.**

Volume 1

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**Department of Psychology
University of Durham**



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The effects of local and global factors on the
comprehension of pronouns

R. Crawley

Abstract

The factors influencing the comprehension of pronouns at a local sentence level and at a global text level were examined with the purpose of satisfying six aims. The first and primary aim was to explicate the relationship between local and global influences on pronoun comprehension. At the sentence level, the subject of the sentence had an important effect (especially on the assignment of ambiguous pronouns), there was a strong influence of a gender cue and a general knowledge factor, gender bias, affected assignment even in the presence of a gender cue. When sentences were embedded within text, there was an additional effect of the discourse topic.

The second aim concerned the difference between the comprehension of single sentences and of texts. Results indicated that conclusions drawn from single sentence experiments should not be generalised to texts. The third aim investigated some of the factors which signal the discourse topic: Frequency of mention, initial mention in a passage and the title were all important and the effect of the topic on pronoun assignment was graded, depending on the number of factors signalling the topic. The fourth aim was to clarify whether the deep or surface subject was critical for pronoun comprehension. The deep subject was more important in passive sentences, but this result may not generalise to active sentences. The fifth aim was to investigate whether the effects of local subject and global topic were top-down or bottom-up. The effect of the topic appeared to be top-down, while the subject's effect showed elements of both types of processing. The final aim investigated the role of general knowledge in pronoun comprehension. The results suggested that inferences from general knowledge are always made during comprehension.

Some proposals are made on the basis of these results and further hypotheses arising from them are considered.

CHAPTER 1

INTRODUCTION

Aims of the research

The main aim of this thesis is to examine some of the processes involved in the comprehension of anaphoric pronouns. In the course of comprehension, a reader's task is to form an integrated and coherent representation of the text to be stored in memory. An important part of this process is the identification of an entity as either a new referent or a familiar one. Pronouns are frequently used to indicate that the intended referent is familiar. In written texts, a referent is usually familiar because it has been introduced earlier in the text. When a pronoun identifies a previously introduced antecedent, it is called an anaphoric pronoun.

The anaphoric pronoun and the antecedent are said to be coreferential but, to be more precise, the pronoun refers not to the antecedent, but to what the antecedent refers, that is, to the referent (Lyons, 1977) although, for ease, this distinction may not always be made explicit. The referent of a pronoun need not be explicitly mentioned in the preceding text (or spoken discourse); it may be implicitly evoked either by the text or by the situation. It can even follow the pronoun (cataphora). The experimental work in this thesis, however, is only concerned with the comprehension by skilled, adult readers of anaphoric pronouns in written text.

The reader's task on encountering such a pronoun is to find the antecedent from the set of entities mentioned earlier in the text. This is a complex process involving syntactic, semantic and pragmatic factors and yet it is usually achieved with surprising success, ease and speed. For example, in the following extract from 'What Maisie Knew' by Henry James, three antecedents for the pronoun 'she' are possible on the basis of gender cues.



1.1 Miss Overmore laughed, and Maisie could see that in spite of the irritation produced by Mrs Wix, she was in high spirits.

Even so, there is no difficulty in assigning 'she' to 'Miss Overmore'. Perhaps even more interesting are those cases where there is some difficulty or disagreement about assignment. For example in the extract from 'Titus Alone' by Mervyn Peake shown in 1.2 below, some readers assign 'him' to 'Titus' and others assign 'him' to 'the jailor' but, whichever assignment is made, readers have no difficulty in integrating the pronoun with the rest of the text.

1.2 As Titus stood there taking in the features of the room the jailor locked the door behind him, and he heard the key turn in the lock.

(There may also be some disagreement about the assignment of 'he' in this example.) The questions of interest to psychologists are: On what basis are such assignments made and what determines the ease of assignments?

As demonstrated by Garnham, Oakhill and Johnson-Laird (1982), the pattern of coreference between pronouns and their antecedents is very important for establishing the coherence of both spoken discourse and written text. And there is evidence to suggest that the use of pronouns rather than repeated noun phrases facilitates the integration of information in a text (for example, Lesgold, 1972). In addition, the ease or difficulty of coreference allows the investigation of the availability of different entities in the memory representation which results from reading the text. The understanding of pronominal reference is therefore crucial to the more general problems of text comprehension and memory.

In this chapter, the influence of four main kinds of factors on pronoun comprehension will be considered:

linguistic factors, heuristic strategies, textual factors and the influence of semantics and general knowledge. Before these are considered in detail, an impression of the type of explanations offered in terms of these factors will be offered by considering the assignment of 'she' to 'Miss Overmore' in 1.1.

Coreference between 'she' and 'Miss Overmore' is permissible according to two of the linguistic constraints governing the assignment of simple pronouns, namely lexical agreement (the pronoun agrees with the antecedent in terms of number, person and gender) and binding theory (roughly, this states that the antecedent is not in the same clause as the pronoun). However, these factors cannot account for the choice of 'Miss Overmore' as antecedent in preference to 'Maisie' and 'Miss Wix' since assignment to these characters would be equally permissible on these grounds. But such a choice can be explained by each of the three remaining factors under consideration.

One example of a heuristic strategy which would explain this assignment is the parallel function strategy (Sheldon, 1974) whereby a pronoun is assigned to a preceding NP with the same grammatical function as the pronoun. Since both 'she' and 'Miss Overmore' are in the subject position, it could be argued that assignment is determined in terms of this strategy. However, this is not a sufficient explanation since 'Maisie' is also in subject position and should also qualify as a likely antecedent. (And it should be noted that this strategy could not account for either of the two possible assignments for 'him' in 1.2.) A similar, but simpler, heuristic strategy, however, would account for the choice of 'Miss Overmore' as antecedent in preference to the other two candidates. This is the strategy of assigning a pronoun to the surface subject of the sentence (and it would also account for the assignment of 'him' to 'Titus' in 1.2). As these two examples of heuristic strategies illustrate, they tend to involve factors operating at the sentence level. But more global, textual factors may also account for this example

of assignment.

One textual factor which might be important in 1.1, despite the fact that it is a single sentence, is the topic of the sentence. It has been claimed that a pronoun tends to refer to the topic of a sentence (Caramazza and Gupta, 1979). The topic is a complex feature which can be identified at a number of different levels. But even at the sentence level it can be considered as a textual factor since it is the result of a dynamic, structural property of language in contrast to a fixed, syntactic function, for example. It is not easy to specify the features signalling the sentence topic but, assuming the commonly held view that the topic is frequently the first mentioned entity in a sentence (Halliday, 1970), assignment to the NP 'Miss Overmore' could be said to be due to its position at the beginning of the sentence and its accompanying thematic status. (A similar explanation would also account for the assignment of 'him' to 'Titus' in 1.2.)

An explanation based on the roles of semantics and general knowledge could also account for the assignment of 'she' to 'Miss Overmore' in 1.1. Such an explanation might argue that a reader would use the knowledge that 'she' was in high spirits together with the knowledge that 'Miss Overmore' was laughing to infer that the two were coreferential since laughing is a natural consequence of being in high spirits.

This is just one example of how these four factors might be used to explain the selection of a referent for a pronoun. It is not intended as an exhaustive account but as an illustration that there is frequently more than one way to explain a particular assignment. This is a problem when examining pronominal reference since the different factors which could account for assignment are often unavoidably confounded (Kieras, 1981a; Rubin, 1978). The aim of the experiments reported here is to examine the relative importance of a number of these factors both in a textual context and in single sentences. For example, the role of linguistic constraints is explored by manipulating

the gender of the pronominal referents. Most of the previous research in this area has concentrated either on the sentence level and exclusively local effects or, conversely, on the textual level and exclusively global effects. The aim of this research is to examine both local and global effects together to determine their relative importance for the understanding of pronouns. The use of these two contexts allows an assessment of the relative importance of the factors operating at these two levels, the primary aim of this thesis.

The four factors outlined above will now be considered in more detail.

Factors influencing assignment

1 Linguistic factors

Syntactic constraints on permissible antecedents for pronouns are currently described by Chomsky's (1981) binding theory. Binding theory consists of three conditions which can be (roughly) stated as follows:

- 1 A reflexive pronoun must have a c-commanding antecedent in the same local domain.
- 2 A personal pronoun cannot have a c-commanding antecedent in the same local domain.
- 3 A noun phrase cannot have a c-commanding antecedent at all.

(The local domain of a constituent is the smallest noun phrase (NP) or sentence containing it. A c-commanding antecedent is an NP which is (roughly) higher in the tree than the pronoun. More formally:

x c-commands y if the first branching node dominating x also dominates y.)

Conditions 2 and 3 replace earlier constraints on backwards pronominalisation. Thus, for example, backwards pronominalisation is blocked whenever the pronoun c-

commands the NP (condition 3), as in 1.3.

1.3 * He_i ate dinner before Chris_i walked into town.

Similarly, the clause-mate constraint on reflexives and the converse clause-mate constraint on personal pronouns (Lees and Klima, 1963) have been superseded by conditions 1 and 2 where the notion of 'clause' has been replaced by the notion of 'local domain'.

As far as personal pronouns are concerned (conditions 2 and 3), it should be noted that these conditions only rule out potential antecedents, they do not uniquely identify them.

One other linguistic factor appears superficially to provide a better means of identifying the antecedent. This is the factor of lexical agreement: a pronoun and its antecedent must agree in number, animateness, person and gender. However, even this is not foolproof (for example, generic 'he' may be used with feminine antecedents). Nevertheless, these are the most straightforward of the linguistic factors affecting pronoun assignment. Consequently, agreement in gender was chosen as the example of a linguistic constraint to be used in the experiments reported in this thesis.

2 Heuristic strategies

2.1 The role of the subject

The subject of a sentence or clause is important in a number of heuristic strategies as a factor influencing the selection of an antecedent. There have been many attempts to produce a universal definition of the subject of a sentence (for example, Fries, 1952; Givón, 1976; Hsieh, 1979; Keenan, 1976; Li and Thompson, 1976; Sridhar, 1979). It is typical to find that at least three types of subject are identified, the three most common being the surface (or grammatical) subject, the deep (or logical) subject and the

psychological (or thematic) subject (Halliday, 1970; Hornby, 1972; Lyons, 1977). In addition, there is a close correspondence between the subject and the agent in sentences containing agentive verbs. The subject, therefore, is frequently associated with the semantic role of agent. These four aspects of the subject usually coincide unless there is 'good reason' for them not to (Halliday, 1970; Reinhart, 1983).

The definition for the surface structure subject varies from one language to another, but in English it is usually identified as the noun with which the verb agrees (for example, Chafe, 1976) or as the left most NP immediately dominated by the sentence node in the surface structure (Chomsky, 1965).

The deep subject is the subject of the sentence in the underlying structure and, unlike the surface subject, is not altered by passivisation, for example. Thus, in the active sentence in 1.4 below, 'John' is both the surface and the deep subject whereas in the passive sentence in 1.5, the deep subject is still 'John' but 'Bill' has become the surface subject.

1.4 John hit Bill.

1.5 Bill was hit by John.

The deep subject is sometimes equated with the actor or agent of a sentence (for example, by Chafe, 1976; Halliday, 1970 and Hornby, 1972) but the two should be distinguished since, although every verb must have a deep subject, only agentive verbs have agents. So, for example, verbs which describe an experience (for example, 'fear') or a state (for example, 'expect') have no agent although they do have a deep subject. In other words, the semantic role of the deep subject may vary, so the semantic role of the subject should be considered separately.

The psychological subject is more difficult to define and is usually associated with the topic or theme of the sentence (for example, by Allerton, 1978). The effects of

this type of subject on pronoun assignment will therefore be examined in the section on textual factors. In this section, the evidence for the importance of the surface and deep subject on pronoun assignment will be examined. (One example of the importance of the subject is condition 1 of binding theory where the antecedent of a reflexive in direct object position is invariably the subject of the clause.) The semantic role of the subject will also be examined.

The different aspects of the subject are frequently confounded in experiments purporting to demonstrate the salience of the subject in pronoun comprehension. In many cases it is not clear which aspect of the subject is under investigation, and some of the studies which argue for the importance of one particular subject role do so without justification since the role in question is confounded with other roles. These problems will become clear as the evidence for the importance of the three roles is considered.

2.2 The surface subject

Claims for the importance of the surface subject have been made mainly in terms of two heuristic strategies; the parallel function strategy and the subject assignment strategy.

The parallel function hypothesis (PFH) was first proposed by Sheldon (1974) to account for children's understanding of relative clauses. She argued that in a complex sentence, if coreferential NPs have the same grammatical function in their respective clauses, then the sentence should be easier to understand than if they have different grammatical functions. The same hypothesis, she argued, may also account for adult's comprehension of unstressed pronouns. For example, in 1.6 the subject pronoun 'he' would be assigned to the subject of the first clause, 'John', and the object pronoun 'him' would be assigned to the object of the first clause, 'Bill', because

of their parallel function in the surface structure.

1.6 John hit Bill and then he kicked him.

However, she provided no evidence for this proposal, although this lack of evidence has been largely overlooked and her proposal has been accepted as the basis for a strategy according to which a pronoun is assigned to a preceding NP with the same grammatical function as the pronoun.

Since Sheldon only used active sentences in her study (thus confounding surface and deep structure roles) it is unclear whether she intended to implicate surface or deep grammatical roles in the PFH. It is normally assumed that surface rather than deep roles are involved (for example, by Caramazza and Gupta, 1979), although Cowan (1980) interpreted the parallel function strategy in terms of deep roles. So, according to this strategy, the surface subject is only important for the assignment of pronouns in surface subject position.

The putative importance of the surface roles of the pronoun and its antecedent was first tested by Grober, Beardsley and Caramazza (1978). They asked students to complete sentence fragments of the form:

1.7 NP1 modal verb NP2 because/but pronoun...

The pronoun always occurred as the subject of the subordinate clause and, where there were no gender cues to determine assignment, they predicted on the basis of the PFH, that the pronoun would be assigned as coreferential with the subject (NP1) of the main clause. In addition they varied a number of semantic and syntactic factors such as the implicit causality of the verb in the main clause, the modal auxiliary associated with that verb and the conjunction preceding the pronoun. Although some of these factors modulated the influence of the PFH, overall they found that the grammatical subject was chosen as the

antecedent for the subject pronoun in over 70% of all sentence fragments. They concluded that assignment according to parallel function is a basic perceptual strategy (similar to those proposed by Bever, 1970) underlying the comprehension of a potentially ambiguous pronoun in the subject position of a subordinate clause.

However, there are two problems with their conclusion. Firstly, the surface subject and the deep subject (and possibly the semantic subject) were confounded in their sentences so their conclusion that it was the surface subject which was important is unwarranted. Secondly, since they only considered pronouns in the subject position of the subordinate clause, the pattern of assignments obtained could be explained by a similar, but simpler, subject assignment strategy which states that a pronoun in any position will be assigned to the subject of a previous clause or sentence. The additional evidence cited by Grober et al (1978) in support of the PFH can also be explained by a subject assignment strategy. For example, they mention that Garvey, Caramazza and Yates (1976) found that various syntactic factors influenced the implicit causality of verbs in such a way that they produced a preference for assignment to the grammatical subject. They also claim that Halliday's (1967) distinction between theme and rheme strengthens the case for the PFH because the theme of a subordinate clause is likely to be interpreted as the theme of the main clause and the theme is usually the subject of the sentence. However, this could equally well support a simple subject assignment strategy.

The difficulty of distinguishing between the parallel function strategy and the subject assignment strategy was acknowledged by Wykes (1981) when interpreting the results of her study into young children's comprehension of anaphoric pronouns. She found that children made fewer errors when acting out active sentences in which a subject pronoun referred to the subject of a previous sentence than when a subject pronoun referred to a constituent of the previous object. As she pointed out, while these results

are consistent with an explanation based on the parallel function strategy, they could also be interpreted in terms of a subject assignment strategy.

However, there are two studies which are able to distinguish between these two strategies. The first examined the assignment of object pronouns in sentences where both subject and object NPs were available as potential antecedents in the way suggested above. This was the study by Maratsos (1973) which, ironically, has not been cited in favour of either of these strategies but in support of a strategy based on the semantic role of the subject. Nevertheless, the children in his study interpreted single, unstressed pronouns in both subject and object positions as coreferential with the preceding NP with the same grammatical, logical and semantic function as the pronoun, thus favouring the parallel function strategy in preference to a simple subject assignment strategy.

Conversely, however, a study in French by Rondal, Brédart, Leyen, Neuville and Péree (1983) found evidence to support the subject assignment strategy rather than the parallel function strategy. They also examined the assignment of pronouns in both subject and object positions but they found that pronouns in both positions were assigned to the subject of a previous sentence, a pattern of assignments which cannot be accounted for by the parallel function strategy.

So, the evidence which would allow a choice between the parallel function strategy and the subject assignment strategy is contradictory. But the most promising account seems to be the subject assignment strategy since, even though it cannot explain all the data (specifically, that of Maratsos, 1973), neither can the parallel function strategy (for example, Rondal et al, 1983) and the subject assignment strategy has the advantage of being a simple but surprisingly effective strategy. Its simplicity is a major advantage for a strategy of this kind which could not be expected to be a sufficient explanation for all assignments. And its effectiveness was illustrated by

Hobbs (1976) who found that it accounted for a very high proportion of assignments in the texts and dialogues he examined. Moreover, the evidence which favours the parallel function strategy (Maratsos, 1973) comes from work on young children and it has been suggested that the strategies used by young children may differ from those of adults (Wykes, 1981).

The ease with which a potentially ambiguous pronoun can be interpreted as coreferential with the subject NP of an active sentence (where deep and surface subject roles are confounded) has been frequently noted. For example, Broadbent (1973) found that most people interpret 'it' as coreferential with 'the feedpipe', rather than 'the chain' in the following sentence.

1.8 The feedpipe lubricates the chain, and it should be adjusted to leave a gap half an inch between itself and the sprocket.

Similarly, Purkiss (1978) demonstrated that a sentence was read more quickly when a subject pronoun was coreferential with the subject rather than the object of a previous sentence.

However, there is one aspect of the subject assignment strategy which is not specified precisely enough. This is whether the subject in question is the surface subject or the deep subject. In all the studies considered so far, the roles of the surface and the deep subject have been confounded. Thus, whether one accepts the parallel function strategy or the subject assignment strategy, it is not clear whether the important aspect of the subject is its surface role or its deep role.

Only three studies specifically examine this issue. These are Caramazza and Gupta (1979), Broadbent (1973) and Cowan (1980). In their second experiment, Caramazza and Gupta used passive sentences and hence separated the deep and surface roles of the subject. They found some evidence for a preference for the surface subject, but this effect

was modified by the causal bias of the verb in the passivised clause. Overall, Caramazza and Gupta argue that it is the topic of the sentence, rather than the surface subject, which influences pronoun assignment. However, any interpretation which emphasises the position of the NP is rather doubtful given the marked influence of the causal bias of the verb on the observed results. Hence, the results do not provide any clear cut evidence for either the topic of the sentence or the surface subject.

But there is other evidence to suggest that it is the surface role which is critical. Broadbent (1973) asked a number of people to rate the likelihood of 'John' being the referent for 'he' in the active and passive sentences shown below (where 1 = John and 5 = someone else).

	Mean rating
1.9 John told Tom that he had won the race.	2.86
1.10 Tom was told by John that he had won the race.	3.66

'John' is the deep subject in both sentences and if the parallel function strategy or subject assignment strategy were based on the deep roles of the pronoun and antecedent, then the ratings for the two sentences should be very similar. However, there was a significant difference in the ratings reflecting a preference for assignment to the first person mentioned, that is, the surface subject in both sentences ('John' in 1.9 and 'Tom' in 1.10). Nevertheless, it is difficult to draw any general conclusions on the basis of this one example.

Cowan (1980) favours the view that it is the deep subject which is critical for pronoun assignment. More specifically, he argues for the parallel function hypothesis based on deep grammatical roles. Cowan investigated pronoun assignment in a number of different sentence types and, in general, his results favoured the PFH based on deep roles: The pronoun in surface subject (and deep object) position of a passive clause was normally assigned to the deep object of the prior clause. For

example, in 1.11, 'it' was assigned to 'the catalyst'.

1.11 The catalyst is sent to the converter by the conveyor, so it is cleaned of all impurities.

However, in some of the sentences (including this example), the deep object was in surface subject position. Consequently, a surface subject assignment strategy cannot be ruled out. Furthermore, in sentences where the deep subject was also the surface subject, the pronouns were frequently assigned to the indirect object, a finding which is counter to deep parallel function; for example, in dative movement sentences such as the following:

1.12 The conveyor sends the converter the catalyst, so it is cleaned of all impurities.

This also reduces the evidence favouring the deep subject. More crucially, in these sentences, the deep subject seems to be ruled out as a possible antecedent on pragmatic grounds. (For example, in sentence 1.12 above, readers are unlikely to assume that 'it' refers to 'the conveyor'. The conveyor is carrying out the action in the first clause and so is unlikely to be the object of the second clause.) For this reason, therefore, Cowan's data rule out the possibility of observing a simpler subject assignment strategy based on the deep subject. Overall, then, the evidence is mixed concerning both parallel function versus subject assignment and deep versus surface roles of the subject.

Regarding the latter distinction, other work on passive sentences suggests that the surface subject role is the important one. Although some people claim that the active and passive mean the same in English (for example, Katz and Postal, 1964), others believe that they do not (Chomsky, 1957; Johnson-Laird, 1968a, 1968b and Ziff, 1966). For example, it has been claimed that the active and passive differ in terms of markedness (Anisfeld and

Klenbort, 1973; Klenbort and Anisfeld, 1974). The active voice can be thought of as the typical, unmarked voice or "the common voice" (Long, 1961) conveying information in a neutral manner. The passive, on the other hand, can be thought of as the marked voice enriching the basic message with additional nuances.

One of the main functions of the passive is to allow the omission of the deep subject in an agentless or short passive (for example, 'John was killed'). This construction is very common (Svartvik, 1966) and can be useful when the deep subject is unknown, difficult to specify or self evident. This in itself suggests that the surface subject role is the important one since the deep role may be omitted altogether in the passive. In addition, even when the deep subject is present, the most commonly held view is that the passive is used to emphasise the importance of the deep object by placing it at the beginning of the sentence and making it the surface subject (for example, Tannenbaum and Williams, 1968a, 1968b).

Johnson-Laird (1968a) obtained experimental support for the importance of the deep object in the passive by showing that when Subjects were asked to produce simple diagrams to represent one active and one passive sentence, the deep object was represented by a larger area in the passive than in the active. He concluded that the passive is chosen to emphasise the importance of the deep object and that the active implies either that there is little difference in the importance of the deep subject and the deep object or that the deep subject is slightly more important. In a later study, he asked Subjects to rank order normal and inverted active and passive sentences for their appropriateness in describing one diagram rather than another and found that it was word order which was the important determinant of where the emphasis lay (Johnson-Laird, 1968b). As this suggests, the deep object's position at the beginning of the sentence is often thought to be more important than its role as surface subject. The existence of stylistic inversions which allow the deep

object to come to the front of the sentence without changing its surface or grammatical status (for example, 'Him I really like') support this idea since they emphasise the deep object in the same way (Chomsky, 1965). This is linked to the idea that initial position in a sentence is important for topicalising an item. Nevertheless, when surface and deep subject roles are separated in the passive, many people emphasise the importance of the deep object (surface subject) rather than the deep subject.

2.3 The deep subject

It has already been shown that the evidence favouring the role of the deep subject in pronoun assignment is not clear cut. However, some of the work on passives suggests that the deep subject might be important in pronoun comprehension. Although one of the main functions of the passive is to allow the omission of the deep subject and, although many believe that the passive emphasises the importance of the deep object by placing it at the beginning of the sentence or phrase, the opposite view has also been proposed. The passive may also be considered as serving to direct attention to the deep subject as the focus of new information in the sentence.

For example, Huttenlocher, Eisenberg and Strauss (1968) found that the deep subject had prominence in the passive. The deep subject can be considered more important in two ways; firstly, in terms of the distinction between presupposed information and focal information and secondly, in terms of the distinction between theme and rheme (Hinds, 1975).

In passive sentences, the deep object is presupposed and the deep subject is focused. However, it is not only the logical relations which determine this (Hornby, 1971, 1972, 1974). The focused status of the deep subject is the result of a number of other features of the passive sentence. For example, Fillmore (1968) pointed out that the 'by' phrase in the passive marks its object (the deep

subject) as focal and Mihailović (1963) argued that the deep subject is emphasised because it receives heavy stress in the sentence. Smith (1971) also noted that, under normal intonation, the deep subject receives the heaviest stress in the passive. Since Chomsky (1971) defined the phrase receiving heaviest stress as the focus of the sentence, this would mark the deep subject as the focus of the sentence. A similar idea was proposed by Quirk, Greenbaum, Leech and Svartvik (1972). In this sense, then, the deep subject is the 'most important' part of the passive sentence. Additional evidence for this comes from an analysis of a discourse by Bertrand Russell by Smith (1971). She found that "the most important material" tended to occur at the end of the sentence. Another reason for supposing the deep subject to be marked as focal in full passives is that, if it were not important, it could be omitted altogether in a short, agentless passive. By including it, the speaker or writer draws attention to it, making it the focus of the sentence (Anisfeld and Klenbort, 1973). (However, it should be remembered that the existence of agentless passives has also been used to argue for the opposite conclusion, that is, for the importance of the deep object which is always present in the passive.)

There is evidence that, in general, focused information is perceived as more important than presupposed information. For example, Hornby (1974) showed that Subjects were more likely to notice when the focal rather than the presupposed information in a sentence was misrepresented in a briefly presented picture. And Zimmer and Engelkamp (1981) argued that the most informative part of the sentence must occur in the focused position of cleft sentences in German. Experimental evidence for this was provided by Jarvella and Nelson (1982).

In addition to these studies showing the general importance of the focal as opposed to the presupposed information, an experiment by Klenbort and Anisfeld (1974) demonstrated its importance in passive sentences, specifically. They concluded that the deep subject is the

focus of a passive sentence.

The passive is also used to indicate that the theme and rheme are not those items usually associated with theme and rheme under the usual word order of an active sentence (Hinds, 1975). Hinds interpreted theme and rheme in terms of the amount of information conveyed by the items in a sentence in the same way as the Prague school linguists. In his terms, the theme is that part of a sentence which is most easily predictable from the context and the rheme is that part of a sentence which is least predictable in context. The word order principle dictates that there is a progression from thematic to rhematic material in a sentence. Consequently, the passive is a means of altering the normal theme-rheme relationship in a sentence by moving elements out of the subject-verb-object progression. The deep subject is thus marked as the rheme of a passive sentence, the part containing the least predictable information and, in this sense, the most important part of the message conveyed by the sentence.

There is therefore good reason to suppose that the deep subject is important in the passive construction. But, as shown in the previous section, there is also reason to believe that the deep object is important; they are important in different ways (Anisfeld and Klenbort, 1973; Klenbort and Anisfeld, 1974). As a general rule, the deep object is important as the local topic of the sentence because of its position at the beginning of the sentence, and the deep subject is important as the focus of the sentential assertion and as the rheme. While the local topic determines what the sentence is about, the focus and rheme contains the new information in the sentence. The question is whether the local topic or the focus/rheme is more important during pronoun comprehension.

There are two main reasons for arguing that a pronoun would be assigned to the deep subject of a passive sentence. Firstly, the deep subject might be important in assignment as the new, focused information in a previous clause or sentence. Secondly, as already mentioned, the

parallel function strategy (Sheldon, 1974) could also be interpreted in terms of deep roles (for example, Cowan, 1980). Thus, a subject pronoun would be assigned to an antecedent in deep subject position. However, it should be noted that the role of the deep subject may be different in active and passive sentences.

2.4 The semantic role of the subject

Caramazza and Gupta (1979) claimed that a strategy implicating the semantic roles of a pronoun and its antecedent had been put forward by Maratsos (1973). They described this as the role-inertia strategy whereby pronouns are assigned to a preceding NP with the same semantic role. Thus, a pronoun occupying the role of agent would be assigned to the agent of a previous clause or sentence. However, although Maratsos did suggest that such a strategy might explain the assignments of unstressed pronouns by the children in his study, he was careful to point out that the evidence he presented was equally compatible with an explanation based on the surface or deep roles of the pronouns and antecedents. Indeed, he concluded that: "Questions do remain as to exactly what factors were most effective in this strategy, since the pronoun of the second clause filled a position that was parallel to an NP of the first clause in at least three ways: surface grammatical role, deep structure grammatical role, and semantic role" (p. 7). (Nevertheless, Caramazza and Gupta interpret their own findings in terms of the sentence topic rather than in terms of parallel function.)

Kail and Léveillé (1977) also suggested that children utilise the semantic roles of a pronoun and its antecedent during pronoun assignment. They found that young children (up to about eight years old) would rather transgress lexical rules (such as gender agreement) than change the 'functional' roles of the pronoun and antecedent. By 'functional' roles they appear to mean the semantic roles of agent and patient, although in the active sentences

which they used, these roles were confounded with the surface and deep roles of the subject and object.

The subject's role as agent was also emphasised by Hobbs (1979) in his examination of factors affecting pronoun assignment. However, like Maratsos, he only suggested that this might explain the assignments he observed. In a previous study in which he examined the assignment of pronouns in naturally occurring text and dialogue, Hobbs (1976) found a very high proportion of subject assignments. They accounted for 90% of assignments in the texts and 75% in the dialogues. His account of the problem of coreference assumes that assignment is determined as a by-product of discovering the coherence relations within a text. The coherence relations which he puts forward frequently involve close correspondences between the assertions of two sentences, so he suggested that a good strategy would be to try to match the agent of one clause or sentence with the agent of the preceding clause or sentence. Since the agent often appears as the subject, he claims this would explain the high proportion of assignments to subject NPs.

It should be noted that, according to the suggestion put forward by Maratsos (1973), the agent would only be expected to be chosen as an antecedent for a pronoun also occupying the role of agent. It is worth noting that Hobbs claimed that the subject assignment heuristic which he observed was especially effective for pronouns in the subject (and presumably agent) position.

So, even if one accepts the suggestion that the subject's role as agent is important in pronoun assignment, this influence seems to be restricted to pronouns occupying the role of agent. A more serious limitation (acknowledged by Maratsos) is that the evidence does not allow the conclusion that the agent is the most important aspect of the subject as far as assignment is concerned. Indeed, it is unlikely to be the only factor behind the strong subject assignment strategy observed by Hobbs (1976) and others since some verbs do not have agents.

2.5 Summary of the role of the subject

There is evidence that the subject is frequently chosen as an antecedent for a pronoun (for example, Hobbs, 1976, Clancy, 1980) but it is not clear which aspect of the subject is most important. While the semantic subject or agent may be important in some sentences, the fact that not all verbs take agents reduces the likelihood that this aspect of the subject can explain the observed preference for the subject as antecedent. There is some evidence to suggest that the surface subject may be more important than the deep subject (for example, from Broadbent, 1973 and Caramazza and Gupta, 1979) but there are problems with both these studies which makes further investigation desirable. The relative importance of the deep and surface subjects was therefore examined in this thesis.

Whichever aspect of the subject is important, there are two ways in which it could be incorporated into a strategy for pronoun assignment. Firstly, a pronoun may be assigned to an antecedent with the same surface or deep structure role (as in the parallel function strategy) so that only a subject pronoun would be assigned to a preceding NP in subject position. The second type of strategy (a subject assignment strategy) is more general, governing the assignment of pronouns in any surface or deep role; a pronoun in either subject or object position would be assigned to a preceding subject NP. Since there is only one study (by Maratsos, 1973) for which the second strategy does not explain the results as effectively as the first (and that was on children's comprehension), the subject assignment strategy seems to be the more promising account as it has the advantage of simplicity and a more widespread application since it can apply to any pronoun and not only to those in a position similar to that of the antecedent. This means there would be no need to check on the position of the pronoun, only the antecedent.

In any case, a subject assignment strategy is a strong

candidate for pronoun assignment. It may even temporarily override the role of general knowledge, as in this example from Jespersen (1954, p. 143).

1.13 If the baby does not thrive on raw milk, boil it.

Here, the tendency to assign 'it' to the subject of this sentence is disconcertingly strong. (It should be noted that since the pronoun is in the object position, this tendency could not be accounted for by the parallel function strategy.)

However, the demonstration of the importance of the subject (surface or deep) need not necessarily be interpreted in terms of a heuristic strategy of 'mechanical' assignment. For example, the subject may be important as a consequence of its close association with the topic of a sentence. Since the topic and the subject frequently coincide (Hockett, 1958), a strategy of assignment to the topic would often appear as one of assignment to the subject. Such a strategy need not assume mechanical assignment in accordance with some heuristic but may explain assignment in terms of differing degrees of salience associated with different entities in the memory representation. The PFH is reinterpreted in these terms, for example, by Garrod and Sanford (1982) who also argue for different retrieval strategies for subject and object pronouns. The topic is an example of a textual factor. The influence of such factors will be considered next.

3 Textual factors

Three textual factors will be considered; the recency of mention of the antecedent, the frequency of mention of the antecedent and topicalisation. All three have been interpreted in terms of the limitations of storage and processing within working memory (Baddeley, 1981; Baddeley and Hitch, 1974) under the assumption that assignment is easiest when the antecedent is within working memory. An antecedent which is topicalised, recently mentioned or frequently mentioned is assumed to be more likely to be within working memory when the pronoun is encountered, and therefore easier to retrieve as a referent. This notion underlies much of the experimental and linguistic work on recency, for example (Chafe, 1974; Clancy, 1980; Clark and Sengul, 1979; Daneman and Carpenter, 1980; Oakhill, 1981; Sanford and Garrod, 1981 and Whitehead, 1982).

3.1 The effect of recency of mention

The distance between a pronoun and its antecedent appears to influence the ease of pronoun assignment in text. The nearer the antecedent, the easier assignment is thought to be. In addition, where there is more than one plausible antecedent for a pronoun, recency is thought to influence the choice of antecedent. However, recency alone does not appear to be a major determining factor in the selection of an antecedent. Nevertheless, there are cases where the most recent candidate seems to have an advantage over a more distant one, as in the following example from Charniak (1972):

- 1.14 Bill threw Jack a green ball.
Jack was holding a red ball.
Jack threw it to Dick.

In the third sentence, 'it' appears to refer to the 'red ball' mentioned in the preceding sentence. However, if the

order of the first two sentences is reversed, then 'it' appears to refer to the 'green ball'. Recency is one source of information, although a relatively unimportant one, used by Charniak (1972) in his program for understanding children's stories. He makes use of it on the basis of the observation that a pronoun's antecedent usually occurs in the last two or three sentences of a story (although he acknowledges that there are exceptions to this).

There are two main types of evidence for the importance of recency in pronoun assignment; evidence derived from the examination of the distance between naturally occurring pronouns and their antecedents and experimental evidence.

Evidence from naturally occurring pronouns

Examples of naturally occurring pronouns have been examined in both written and spoken language.

Written language

Hobbs (1978) examined the distance between one hundred consecutive examples of pronouns and their antecedents in three very different types of written text and found that 98% of antecedents occurred in either the same sentence as the pronoun or in the preceding sentence. However, at the other extreme, he found one antecedent which occurred nine sentences before the pronoun. The number of sentences between a pronoun and its antecedent is also a rough measure of the number of NPs which may occur between them, another aspect of recency which may be important, as Allerton (1978) has pointed out. The nearer the antecedent is to a pronoun, the less likely it is that between them there will be NPs competing as antecedents. In technical writing in particular, there may be numerous plausible antecedents for the pronoun 'it', even in one sentence. For example, there were thirteen such antecedents in one of

the sentences examined by Hobbs (1978).

Spoken language

Recency might be expected to be even more important in determining assignment in spoken language since there is no permanent record of previous referents against which to verify or alter the selected antecedent. In a study of naturally occurring reference terms in a series of spoken narratives, Clancy (1980) found that at least 97% of all inexplicit references (pronouns and elliptical references) in English and Japanese occurred with no more than one intervening referent. This shows the importance of this aspect of recency. In addition, she found that over 80% of inexplicit references occurred after an interval of two clauses or less from the antecedent. The distribution of pronouns and other NPs in spontaneous speech was also examined by Marslen-Wilson, Levy and Tyler (1982) who asked subjects to retell a comic book story which centered on two main characters. They analysed the use of reference terms according to an hierarchical structure of events embedded within episodes of the story and found that the choice of anaphoric reference term was related to this structure. Pronouns were used on forty six of the fifty occasions on which the reference was within an utterance relating to the same story, episode or event as the one containing the antecedent.

Experimental evidence

The other main line of evidence relating recency to pronoun comprehension is experimental. Carpenter and Just (1978), for example, reported several experiments showing that the further back a referent was mentioned, the harder it was to identify. Clark and Sengul (1979) looked more closely at the question of whether there is a boundary beyond which anaphora becomes more difficult. They tested the notion that the entities mentioned in the last sentence

are in a privileged position as far as easy reference is concerned, an idea very similar to that proposed by Chafe (1974) and Lockman and Klappholz (1980). However, Clark and Sengul found that it was the last clause rather than the last sentence which was important. Sentences in which a pronoun or NP referred to an entity in the previous clause were read faster than those in which the antecedent occurred in the second clause back.

The general importance of the previous clause was also demonstrated by Chang (1980). Subjects were asked to read two clause sentences and were then presented with a probe word. The task was to decide whether this word had appeared in the sentence they had just read. Recognition was faster when the word had occurred in the second clause of the sentence than when it had occurred in the first clause even though the number of words between the target word and the end of the sentence was controlled. In this experiment, then, it was the clause boundary rather than the number of words separating the probe word and target word which was important. The relationship between the two clauses also appears to be important. For example, Ehrlich (1980) found that when the antecedent for a pronoun occurred in the main clause of a sentence, assignment was easier when the pronoun was in a dependent, subordinate clause than when it was in an independent clause.

Additional evidence for the importance of the distance between a pronoun and its antecedent was provided by Daneman and Carpenter (1980). They asked Subjects to read passages in which the distance between a pronoun and its antecedent was varied and then asked them to answer some questions, one of which asked for the identity of the antecedent. They found that it became more difficult to retrieve a pronoun's antecedent as the distance between them increased from two to seven sentences. However, Subjects differed in the ease with which the antecedents were retrieved. Some were able to correctly identify the antecedents at all distances, even when there were seven sentences (containing rival NPs) between the pronoun and

its antecedent. The Subjects' ability to retrieve a referent was found to be related to their performance on the reading span test, a test devised by Daneman and Carpenter to measure the capacity of working memory. In the test, Subjects read aloud a series of unrelated sentences and then had to recall the final word from each sentence in the order of presentation. There were three sets of two, three, four, five and six sentences and the reading span (which ranged from two to five) was defined as the highest level at which they were correct on two out of the three sets. Their results are therefore consistent with the notion that the influence of recency is a consequence of the limitations of working memory.

The experimental evidence for an influence of recency does not only depend on gross measures of reading comprehension, such as reading times and the ability to answer questions about a pronoun's antecedent. Experiments involving the measurement of eye movements also demonstrate an effect of recency. For example, Ehrlich (1983) measured eye movements as Subjects read stories in which the distance between a pronoun and its antecedent was varied. The locus of the longest fixation, where pronoun assignment was assumed to occur, varied with the distance. In other words, assignment did not appear to occur at a fixed point (for example, when the pronoun was encountered) but occurred increasingly later as the distance between the pronoun and its antecedent increased. These results suggest that some of the processing of a pronoun occurs after it is encountered and that this varies as a function of recency. Ehrlich and Rayner (1983) found similar results. As in Clark and Sengul's study, Ehrlich and Rayner found that the antecedents in the last clause were assigned faster than those further back, but there was no difference in the speed of assignment whether an antecedent occurred at the beginning or the end of the clause preceding the pronoun. This suggests that potential antecedents were evaluated clause by clause rather than candidate by candidate. This is important since an effect

of recency is often interpreted as evidence that antecedents are searched serially, starting with the nearest one (Springston, 1975) under the assumption that the farther back an antecedent occurs, the more candidates will have to be examined. Ehrlich and Rayner's data, however, argues against such a simple candidate by candidate search. It could be that the search is parallel, for example, but nearer antecedents are always retrieved faster than far ones. The explanation favoured by Ehrlich and Rayner is that further antecedents are less likely to be part of the current topic of the passage and are therefore less accessible.

Recency alone is unlikely to determine the contents of working memory and the ease of pronominal reference. For example, Charniak (1972) showed that detailed world knowledge was far more important than recency information. Kantor (1977) went further and claimed that recency only influenced pronoun assignment in cases where there was no topic to determine assignment. Sanford and Garrod (1981) also proposed that recency interacts with topicalisation, arguing that, together, these two factors determine the allocation of working memory space to different entities.

Whitehead (1982) also showed that distance alone was not responsible for the ease of assignment. For example, he found that there was no difference in the time taken to read a sentence containing a pronoun whose antecedent occurred in the previous sentence and one in which the antecedent occurred eight sentences back. The crucial variable appeared to be whether or not the antecedent had been kept in the 'foreground' in the intervening sentences (for example, through reference to related entities) rather than distance alone.

The notion of 'foregrounding' was put forward by Chafe (1972) and is similar to the notion of topicalisation. Its influence has been acknowledged by many people investigating the effects of recency (for example, Grosz, 1981 in AI and Clark and Sengul, 1979 and Daneman and Carpenter, 1980 in psychology).

However, it could be argued that foregrounding (or topicalisation) does not merely represent an additional factor affecting assignment alongside recency but that it may account for the influence of recency. The observation that assignment is easier when antecedents are nearer to the pronoun may be a by-product of the fact that recent NPs are more likely to be foregrounded than far ones and that these two factors are frequently confounded. Nevertheless, recency does seem to contribute in some way to the ease of assignment, perhaps through its influence on which entities are foregrounded or topicalised in the text.

3.2 The effect of frequency of mention

The frequency with which an entity is mentioned seems to influence pronoun assignment in a similar way to recency. That is, frequency itself is probably not crucial on its own, but may be a contributory factor in the selection of an antecedent.

This is illustrated by the fact that one of the heuristic rules used in AI text comprehension programs specifies that repeatedly referenced prior concepts are likely antecedents (Sanford and Garrod, 1981). In addition, in the programs devised by Norman, Rumelhart and LNR (1975) and Winograd (1972), if a referent has already been pronominalised, it is a likely candidate for further reference.

Allerton (1978) claimed that a frequently mentioned item may become so thoroughly "given" that it can be referred to pronominally with great ease. Similarly, Keenan (1974) suggested that repetition is important in establishing the topic in children's language. And Kintsch and van Dijk (1978) suggested that a frequently mentioned referent may become thematic at a textual level.

So, like recency, the frequency with which an item is mentioned is probably important for its role in foregrounding an item as the current topic of a discourse. However, like recency, frequency alone is not crucial in

this respect. Perfetti and Goldman (1974) showed that the frequency with which an item was mentioned in a passage was not the only factor responsible for its effectiveness as a recall prompt for the passage. The item which was the subject of the final sentence of the passage interacted with the effect of frequency.

3.3 The role of the topic

The possibility of an influence of the topic in pronoun assignment has already been suggested several times in previous sections, but the term has so far been used very loosely. The features of the topic will now be examined more closely and consideration given to why it should influence assignment.

It is very difficult to produce a definition of the 'topic' (and the related term 'comment'), partly because the term has been used to refer to a number of different concepts and partly because different terms have been used to refer to the same thing (for example, topic, theme, focus, psychological subject). The situation is complicated further by the fact that, although the role of the topic is included here as a discourse factor (under the general heading of 'textual factors'), it may also be important at a number of other levels (such as the clause, sentence, utterance, and paragraph). Two levels will be considered here; the sentence level and the discourse level. Consequently, two types of topic will be distinguished; the local topic and the global topic (following Garrod and Sanford, 1983 and Hirst, 1981). Another problem is that some of the definitions are very vague, especially at the discourse level, as Bever (1975), Bickerton (1975), Galambos (1980) and Morgan (1975) have pointed out. There is also little agreement on how far the notion of 'topic' is related to other factors, such as theme/rheme, given/new, presupposed/asserted, subject and foreground. (An account of some of these factors and their interpretations can be found in Chafe, 1976 and Jarvella and Engelkamp, 1983). In addition, different languages differ in the way in which the topic is marked which makes it difficult for linguists who want to produce a universal definition for such a notion.

An outline of the way in which the local, sentence topic has been defined is presented in Table 1.1 (with separate sections for those who argue for and against

certain definitions). Table 1.2 shows the definitions commonly used for the global, discourse topic. (Where the same definition is used at both levels, the definition is underlined.)

The terms 'topic' and 'theme' (and 'comment' and 'rheme') are used interchangeably throughout much of the linguistic and psychological literature (for example, by Allerton, 1978; Caramazza and Gupta, 1979 and Lyons, 1977), although some people have made a point of distinguishing between them (for example, Creider, 1978; Halliday, 1970; Kieras, 1982; Li and Thompson, 1976; Perfetti and Goldman, 1974, 1975). Those people who have distinguished the two are indicated on the tables by an asterisk (and the term used for a particular definition made clear). The term 'topic' will otherwise be used (here and in future discussions) for what has been variously termed the topic or theme.

Table 1.1 Definitions of local topic

Definition	FOR	AGAINST
<u>What the sentence is 'about'</u>	Bloom & Hays (1978), Clark & Card (1969), Fletcher (1984), Hinds (1975), Hornby (1971), Kantor (1977), Kuno (1972), also Creider (1978) and Galambos (1980) with qualifications	Chafe (1976) - argued that this definition applies to the <u>subject</u> of the sentence; Fillmore (1970); Sapir (1921)
Topic = surface subject	Clark & Card (1969), Fletcher (1984), Kieras (1979), Perfetti & Goldman (1975)* (topic), Smith (1971)	
Topic = psychological subject	Allerton (1978), Hornby (1971), Lyons (1977)	<u>Topic = usually same as subject but not exactly equivalent</u> Clark & Card, 1969; Hockett, 1958; Reinhart, 1983; Segal & Greenspan, 1982
<u>Starting point</u>	Allerton (1978), Grimes (1975)* (theme), Halliday (1970)* (theme), Hockett (1958), Lyons (1977), Trávníček (in Firbas, 1964)	Bloom & Hays (1978)* (theme) = summing up of sentence (not an acceptable starting point)

Table 1.1 continued

Definition	FOR	AGAINST
<u>Initial mention</u> (first content word in clause)	Caramazza & Gupta (1979), Clark (1965), Cole, Harbert, Hermon & Sridhar (1980), Fletcher (1984), Greenspan & Segal (1984), Grimes (1975)* (topic), Halliday (1970)* (theme), Trávníček (in Firbas, 1964)	Many people argue that although the topic often occurs in initial position in many languages (Li & Thompson, 1976; van Dijk, 1979), this is not a defining feature: Bloom & Hays (1978), Jarvella & Engelkamp (1983), Lyons (1977), Perfetti & Goldman (1975), Smith (1971) e.g. some sentences lack a topic (Creider, 1978), other linguistic markers (e.g. intonation) may designate a non-initial NP as topic (Creider, 1978; Hornby, 1971, 1972; Karmiloff-Smith, 1980) and a NP in initial position may be focus of contrast not topic (Chafe, 1976)
<u>Salient, focused, foregrounded</u>	Clark & Card (1969), James (1972), Perfetti & Goldman (1975)* (topic)	Galambos (1980): topic = backgrounded

Table 1.1 continued

Definition	FOR	AGAINST
Relation to given/new distinction	<u>Topic = given</u> : Halliday (1970)* (topic = theme + given), Hornby (1974), Vachek (1966)	<u>Topic = new</u> : this is never stated explicitly. But it has been argued that focus = new (Jackendoff, 1972; Yekovich, Walker & Blackman, 1979). And others argue that focus = topic (see above). <u>Topic = usually given but the two can be distinguished</u> Allerton (1978), Chafe (1974, 1976), Creider (1978), Firbas (1964), Galambos (1980), Hinds (1975, 1978), Jarvella & Engelkamp (1983), Kieras (1977), Kuno (1976), Lyons (1968, 1977), van Dijk (1977, 1979)
Lowest degree of communicative dynamism	Firbas (1964), Hinds (1975)	
Other features associated with the topic:		
1. Topic = definite	Galambos (1980), Givón (1976), Li & Thompson (1976)	

Table 1.1² continued

Definition	FOR	AGAINST
2. Associated definite article (van Dijk, 1977), pronoun with use of:	(Hinds, 1975; van Dijk, 1977), certain syntactic structures e.g. cleft (Hornby, 1972) and paralinguistic factors e.g. stress and intonation (Hornby, 1972) and in other languages with special syntactic or inflectional markings (Galambos, 1980 - popular spoken French; Grimes, 1975 - Phillipine languages; Tai, 1978 - Chinese)	
36 3. Hierarchy of entities likely to be topic	Givón (1976) e.g. human > nonhuman; Kuno (1972) - syntactic hierarchy, similar to the empathy hierarchy of Kuno & Kaburaki (1977); Lyons (1977) e.g. familiar > nonfamiliar	

* Distinction made between topic and theme

Table 1.2 Definitions of global topic

Definition

What the discourse is 'about'

Creider (1978), Garrod & Sanford (1983)

Salient, focused foregrounded

Clancy (1980), Kantor (1977) - topic determined by the 'activatedness' of concept (similar to notion of 'focus' - Grosz, 1977, 1978; Hirst, 1981; Sanford & Garrod, 1981), Karmiloff-Smith (1980) - thematic subject = main character, Kieras (1979)* (topic = main referent, a pointer in working memory similar to Carpenter & Just's, 1977, discourse pointer; theme = main idea), Li & Thompson (1976)* (topic = "centre of attention" announcing theme of discourse), Perfetti & Goldman (1974, 1975)* (theme = "central subject of discourse"), Perfetti & Lesgold (1977), van Dijk (1977, 1979)

Defined as most frequent or central proposition in terms of Kintsch & van Dijk's (1978) macrostructure theory

Kieras (1978)* (theme), Kozminsky (1977), Perfetti & Goldman (1974)* (theme), Perfetti & Lesgold (1977), van Dijk (1977, 1979) + similar ideas from de Villiers (1974), Pompei & Lachman (1967), Schultz & Kamil (1979), Sulin & Dooling (1974)

Table 1.2 continued

Definition

Defined in terms of
surface features of
text:

- | | |
|---------------------------|---|
| 1. <u>Initial mention</u> | Christensen (1965), Kieras (1979, 1980a), Sanford & Garrod (1981) |
| 2. Title | Dooling & Mullet (1973), Kieras (1979), Kozminsky (1977), Sanford & Garrod (1981) |
| 3. Uniqueness of referent | Kieras (1981b) |
| 4. Frequency of mention | Kieras (1979), Perfetti & Goldman (1974)* (theme), van Dijk (1979) |
| 5. Repetition | Givón (1976) - especially in child language |

Tables 1.1 and 1.2 show that a number of different factors are thought to contribute to the topicality of an entity at both the local and global levels. A number of definitions are common to both the local and the global topic; particularly, what the sentence/discourse is 'about', initial mention and salience or foregrounding. Although the local and global topics have been separated in these tables, it is likely that the designation of the topic at one level will influence that at the other level. For example, it has been found that the topic at the discourse level may influence the choice of topic at the sentence level (Perfetti and Goldman, 1975; Smith, 1971) and that topicalisation within the sentence may also help to determine the topic of the discourse, particularly if it is consistent over a number of sentences (Kieras, 1981b, 1982; Perfetti and Goldman, 1975; Sanford and Garrod, 1981).

The most striking feature of Tables 1.1 and 1.2 is that there appears to be more agreement about the features contributing to the global topic than there is for the local topic. However, this may be a reflection of the fact that there has been less attempt to adopt a universal and formal definition in the case of the global topic. It is generally agreed that the global topic is the foregrounded information, summing up what the text is 'about'. Thus, the topic typically appears at the beginning of the text, in a title and is frequently mentioned.

Some people, such as Kieras (1979) and Perfetti and Goldman (1974), have made a distinction between the topic and the theme. However, this may be done in rather different ways. For example, Kieras uses both terms at the discourse level (the topic is the main character and the theme is the main idea). But Perfetti and Goldman (and van Dijk, 1977) use the terms to distinguish between the sentence and discourse levels ('theme' at the discourse level and 'topic' at the sentence level). Perfetti and Goldman use Kintsch and van Dijk's (1978) model to determine the 'theme' of the discourse (the central

proposition in the text). This formulation of the global topic may be contrasted with the use of surface features of the text to signal the topic (see Table 1.2). In addition, it should be noted that, at the discourse level, the semantic content of the text is also important in determining the salience of an item (Kieras, 1980b; Kintsch and van Dijk, 1978).

At the sentence level, there is more disagreement about which features are most important in determining the local topic. It is difficult to find an easily applied, universal definition that is less vague than 'what the sentence is 'about''. And even this vague definition has been challenged; for example, Chafe (1976) argued that this definition applies to the subject of the sentence rather than the topic. Many people have pointed out the connection between the topic and the subject although it is usually acknowledged that the two are not exactly equivalent. For example, there is a distinction between subject-prominent languages, such as English, and topic-prominent languages (Givón, 1976; Li and Thompson, 1976). Similarly, the local topic has often been associated with the starting point of a sentence and with initial mention. These definitions are consistent with the notion that there is an association between the topic and the subject. However, as Table 1.1 shows, there is no universal agreement on these definitions. The general picture that emerges is that these different features frequently overlap but can, in principle, be distinguished.

A similar argument applies to the relation between the local topic and given information. The two are usually associated although it is recognised that they are distinguishable. 'Given' and 'new' are part of what Halliday (1970) called the information structure of a text. It is a point of contact with what the listener already knows. Chafe (1974) defined given information as that which the speaker assumes the listener has in consciousness (and new information as that which is not assumed to be in consciousness), characterising given items as those which

were 'on stage' or 'in the air'.

The association between the topic and given information is consistent with studies by Wright and Glucksberg (1976), in English, and Engelkamp (1982), in German, which have shown that readers prefer definite articles (associated with givenness) at the beginning of simple sentences (a position associated with the topic). However, this association seems to contradict the proposal that the local topic is salient, focused and foregrounded (although this has been disputed by Galambos, 1980). Since Jackendoff (1972) and Yekovich et al (1979) argued that the focused or salient information is equivalent to the new information in a sentence, there appears to be a contradiction between the association of the topic with salient information on the one hand, and with given information on the other.

A similar contradiction occurs between the notion of the local topic as the salient information in a sentence and the notion that it usually occurs towards the beginning of a sentence since the most informative part of the sentence is often considered to be the end of the sentence (Smith, 1971). Intonation, stress placement and word order are all considered to contribute to the placement of salient information towards the end of a sentence.

One problem seems to be whether the most salient, focused and foregrounded information is the same as the 'most informative' or new information. The paradox seems to be that while the local topic can be considered to be what the sentence is 'about' and thus salient in this sense, it may also be considered as given information and, in this sense, not as informative as other information in the sentence. At a more general level, the term 'focus' is sometimes used to mean 'salient' and foregrounded and refers to the topic (for example, Perfetti and Goldman, 1975). But it is also used to refer to the new, informative (and hence non-topic) part of the sentence (for example, Jackendoff, 1972; Yekovich et al, 1979).

This problem is very important when considering

pronoun assignment since one might expect an anaphoric term with little lexical content, like a pronoun, to refer to a salient referent. The problem is whether the local topic or new information is considered most salient in this respect. On the one hand, a pronoun might be expected to refer to what the sentence is 'about' (the topic), but on the other, it might be expected to refer to the new information in a sentence (not the topic). However, in either case, it is generally agreed that a pronoun's referent should be 'given' (for example, Allerton, 1978; Grimes, 1975; Haviland and Clark, 1974; Lyons, 1968). The sense in which a referent should be given is that it should be readily retrievable, usually as a result of an explicit mention in the preceding text.

At the discourse level, there seems little disagreement with the notion that the topic is the salient foregrounded information so, at this level, one might expect a pronoun to be assigned to the topic. In other words, the importance of the topic, like recency and frequency, appears to lie in the way it influences the construction of a memory representation during text comprehension. If certain parts of a text are signalled as more or less important than others (and labels like 'topic' are intended to convey such differences), then the resulting differential salience of entities may be important for the selection of antecedents and the ease of assignment.

The effect of the topic on pronoun assignment

When considering the effect of the local or global topic on the comprehension of pronouns, it is important to distinguish between the pronoun itself, its antecedent (an expression in the text) and its referent (the actual entity or concept referred to).

Global topic

It is usually as a referent or antecedent that the global topic is considered important.

Thus, the global topic is frequently implicated as the referent for a pronoun. A view commonly held by linguists is that a full NP is used to introduce a new topic but that subsequent reference is achieved using a pronoun (Bolinger, 1979; Clancy, 1980; Creider, 1978; Hinds, 1977, 1978). This seems true of a number of languages, for example, Korean (Chang, 1978), Palauan (Josephs, 1978), Mandarin Chinese (Tai, 1978) and Kalenjin (Creider, 1978). Indeed, a number of languages have a special set of pronouns for referring to the topic of a paragraph (Grimes, 1975). A similar view of a pronoun as a place holder for reference to the global topic is also found within psychology (for example, Garrod and Sanford, 1982; Olson, 1970; van Dijk, 1977).

The global topic has also been considered important as an antecedent, as opposed to a referent (for example, by Clancy, 1980; Cowan, 1980 and Givón, 1976). A variety of experimental evidence supports this view. Sanford and Garrod (1981), for example, claimed that pronoun assignment is easiest when the entity referred to is part of the "current topic of discussion" (p. 25). A similar view has been proposed for the understanding of pronouns in spoken language (Marlsen-Wilson et al, 1982); and for French children's use of sentence initial pronouns in spontaneous speech (Karmiloff-Smith, 1980). However, Tyler (1983) found that over the age of seven years, English children's

comprehension of pronouns in speech was more influenced by lexical and pragmatic factors than by whether or not the antecedent was the topic of the discourse.

Nevertheless, the global topic does seem to influence adult's comprehension of pronouns in written text. For example, Purkiss (1978) found that comprehension of a sentence containing a pronoun in subject position was fastest when its antecedent was the subject NP of the first sentence of the passage (marking it as the global topic) or when there was little intervening information between the pronoun and its antecedent. And when reference was to the subject of the first sentence, assignment was easier when reference was achieved via a pronoun rather than a NP, even when three sentences intervened between the pronoun and its antecedent. A similar effect of foregrounding was found by Carpenter and Just (1977, 1981) and by Whitehead (1982). Carpenter and Just found that a pronoun was more likely to be assigned to a NP foregrounded in a cleft construction than a non-foregrounded NP (although their measurement of assignment through eye movements was rather indirect).

Anderson, Garrod and Sanford (1983) also showed the importance of the global topic. They examined pronominal reference in passages containing one "main character" (the global topic, who was foregrounded by being mentioned at the beginning of the passage) and one "scenario-bound character". Pronominal reference to the global topic was faster than pronominal reference to the scenario-bound character even though the distance between the pronoun and the main character was greater than the distance between the pronoun and the scenario-bound character. (See also Henderson, 1982). Similarly, in a continuation task, Anderson et al found that Subjects were more likely to continue a story by referring to the global topic than the scenario-dependent character (particularly after a large time shift) and, more importantly, after such a time shift there was a greater likelihood of making that reference with a pronoun when reference was to the main character than when it was to the scenario-dependent character.

So, a variety of evidence suggests that pronoun assignment is easiest when the antecedent NP is the discourse topic.

The status of the pronoun itself is rarely considered when the effect of the global topic is discussed, but it may be important. Garrod and Sanford (1982) interpret the search for an anaphoric antecedent in terms of the specific areas of memory which are searched when different reference terms are encountered (Garrod and Sanford, 1983; Sanford and Garrod, 1981). The search domain for a pronoun is, in general terms, equivalent to the set of explicit entities in working memory (implicit entities are only included in the search domain for full definite NPs). But they also specify different search domains for pronouns in different syntactic positions. Pronouns in sentence-initial, subject position are thought to initiate a search for an antecedent which is the discourse topic while pronouns in any other position will not necessarily do so. Garrod and Sanford therefore claim that it is sentence-initial, subject pronouns specifically which serve to maintain reference to the thematic subject (which is also frequently found in sentence initial position) while the use of a full NP in that position signals a change in the thematic subject. A similar suggestion was made by Kieras (1981b). The notion that a sentence-initial pronoun may be important for maintaining reference to the global topic is reasonable if one accepts the view that such a pronoun is the local topic of a sentence (see Table 1.1) since then there would be a correspondence between the topics at the two levels.

Although Sanford and Garrod are mainly concerned with assignment across sentence boundaries, they also suggest that similar forces may operate within a single sentence. For example, they suggest that the frequency with which a pronoun in subject position of a coordinate or subordinate clause is observed to refer to the subject of its sentence may be a result of a similarly restricted search domain (but within the sentence) for a pronoun in such a subject position (Garrod and Sanford, 1982). Again, the subject of

the sentence may be important in such a search because of its role as local topic of the sentence.

Local topic

The effect of the local topic is usually considered in terms of the local topic as antecedent (and often for assignment within a single sentence). Two studies which suggest that the local topic is a preferred antecedent are those of Caramazza and Gupta (1979) and Fletcher (1984). Caramazza and Gupta defined the local topic as the initial content word of the main clause of the sentence. They found that altering the surface features of a sentence in a number of ways led to a preference for assignment to the surface subject of the sentence (their local topic). However, there are problems with this study, as noted earlier (p. 13). Fletcher defined the local topic as the initially mentioned surface subject and found that Subjects were more likely to interpret an inexplicit, linguistically ambiguous reference term (such as ellipsis or an unstressed pronoun) as coreferential with the local topic than an explicit term (such as a full definite NP). He interpreted his findings in terms of Givón's (1983) hypothesis that various syntactic constructions can be placed along a continuum which codes the degree of topic continuity in a discourse. The position of a construction on this continuum is said to depend upon its explicitness or markedness. Thus, an inexplicit reference term signals a previous topic whereas an explicit term indicates a shift in the topic. (This hypothesis was based on a series of cross linguistic studies.)

However, such studies do not unequivocally support an explanation based on the local topic. Although the subject and initial mention are frequently associated with the local topic, it is generally agreed that they are not equivalent (see Table 1.1) and the possibility that it is the subject or initial mention rather than the local topic which is important in these studies cannot be ruled out.

On the other hand, since the local topic and the subject do frequently coincide, it is also possible that many of the studies which have demonstrated the importance of the subject in pronoun assignment could be interpreted in terms of the local topic instead.

Arguments against the importance of the topic

Some people would argue that the topic is not very important in pronoun comprehension. For example, Ehrlich (1979) and Wilks (1975) argued that thematic factors are only used as a last resort. Ehrlich claimed that readers only use their knowledge of the topic when they are conscious that reference is indeterminate. Even then she does not believe that it is necessarily the topic status of an entity (rather than factors such as plausibility in the story or frequency of mention) which is important. Nevertheless, the evidence already considered would seem to indicate that the influence of the topic should be seriously considered. Even many of those who do not argue strongly for an assignment strategy based on textual factors (such as Charniak, 1972) acknowledge the potential influence of thematic factors in the selection of a pronominal antecedent.

Givenness and Saliency

Tables 1.1 and 1.2 indicate that both givenness and saliency are frequently associated with the topic (at both the local and global levels). Hence some consideration will now be given to these two notions in relation to pronoun assignment. The term 'saliency' is used in preference to the term 'focus' because of the ambiguity that has been noted of the latter term.

An anaphor or antecedent, may be 'given' in one of two ways. They may be informationally given or linguistically marked as given. Clark and Haviland (1977) proposed that a reader searches for linguistically given information in

order to match it to previous information in memory. According to them, pronouns and definite NPs are marked as given in this way. They found that the assignment of an anaphoric NP was easier when there was an explicit antecedent in the prior text than when a bridging inference was needed to make the assignment (Haviland and Clark, 1974), and Lesgold, Roth and Curtis (1979) found similar results. They were therefore concerned with the status of the anaphor as given. However, these results could also be interpreted in terms of the givenness of the antecedent. An explicit antecedent is informationally given, but there is no informationally given antecedent when a bridging inference is needed. Assignment may therefore have been easier when an explicit antecedent was present because then the information marked as linguistically given (the definite NP) could be matched to an item which was informationally given (the explicit antecedent). Such an interpretation is consistent with Lesgold et al's demonstration of a third condition affecting the ease of anaphoric NP mapping, intermediate between the 'given' condition and the inference matching condition. This involved 'reinstatement' and occurred when the antecedent NP had been mentioned previously, but was no longer foregrounded in "active memory" (that is, the antecedent was intermediate on a continuum of givenness; not completely new, but not as readily available as the 'given' condition). The reading time results were consistent with this ordering of givenness of the antecedent.

So, assignment seems to be easiest when the antecedent as well as the referent is informationally given. However, there is evidence to suggest that this may only be true for pronouns and not for anaphoric NPs. Garrod and Sanford (1983) showed that, given the right context, a sentence containing an anaphoric NP with no explicit antecedent need not take longer to read than one containing an anaphoric NP with an explicit antecedent. They showed that the title of a passage was sufficient to evoke an implicit antecedent which could be easily referred to by an anaphoric NP. It

seems that the anaphoric NP could be assigned with ease despite the lack of an explicit (informationally given) antecedent because the referent was informationally given. Pronouns, however, do appear to need antecedents which are informationally given. Garrod and Sanford (1982) found that although it is sometimes possible for pronouns to refer to inexplicit antecedents (as long as there is no other competing NP to which a pronoun might "bond"), such reference is judged to be infelicitous (Sanford, Garrod, Lucas and Henderson, 1983) and reading times increase accordingly. Thus, pronouns are usually only used to refer to explicit (informationally given) antecedents.

As with givenness, there is little disagreement that a pronoun's referent should be salient and foregrounded (for example, Bloom and Hays, 1978; Chafe, 1972; Grosz, 1977; Hinds, 1977; Hirst, 1981; Kantor, 1977; Sanford and Garrod, 1981). These notions arise from the need for a referent to be unambiguously retrievable (Chafe, 1974; Givón, 1976). Thus, the use of a pronoun indicates to a reader that the concept is known or can be easily computed (Carpenter and Just, 1977).

Similarly, many people argue that the antecedent for a pronoun should be salient and foregrounded. In particular, this view is widespread within AI (Grosz, 1977; Hirst, 1981; Levin, 1975; Lockman and Klappholz, 1980; Norman et al, 1975; Winograd, 1972).

The notion that a pronoun's antecedent should be salient and foregrounded would suggest that the topic should be an important candidate for assignment. At the global level, there is clear agreement that the topic can be defined in this way (see Table 1.2). There is also some support for the notion that the same is true at the local level (see Table 1.1). The evidence for the influence of the local and global topics on assignment will now be summarised.

Summary of the effect of the topic

It is clear that there is a good deal of evidence to suggest that both the local and global topics are likely antecedents for a pronoun. This evidence comes from studies which have specifically examined the role of the topic and from studies which have examined the related notions of givenness and salience or foregrounding. If anything, the evidence for a likely effect of the global topic is stronger than that for the local topic. The global topic was therefore chosen as an example of a textual factor likely to influence assignment at the discourse level and whose influence could be investigated in relation to that of local factors.

In addition, an attempt was made to discover which surface features of the text are important in determining the global topic of the discourse. A number of such features have been proposed, for example, the title, initial mention and frequent mention (for example, Kieras, 1979). These three were examined in this thesis. It is possible that the effects of some of these features are stronger than others. If this were so, it may explain why some people have failed to find an influence of the features normally associated with the global topic. For example, although the title and initial mention in a passage are usually regarded as strong indicators of the global topic, Moar (1982) found no tendency for faster reading times when a pronoun referred to the character mentioned first in a passage and no effect of title. And she found similar results in a sentence continuation task. This suggests that these may not be such strong indicators as previously supposed. Another possibility is that the influence of the global topic varies with the number of features used to signal it. As the number increases, so might its influence.

An attempt was also made to separate the influence of the global topic as a referent from that of a particular surface feature (such as initial mention) associated with

it. For example, if an effect of assignment to the global topic is found when the global topic as antecedent occurs as surface subject of the first sentence, then it is not clear whether such an effect would be found wherever the global topic occurred in the passage or whether its influence is confined to that position. In an attempt to discover whether the global topic's influence extends beyond certain surface features associated with it as antecedent (rather than as referent), the topic was set up as such in the first sentences of the passages but its influence as a potential antecedent was not tested until a later sentence in the passage.

The influence of the local topic was also investigated although, as in many previous studies (for example, Caramazza and Gupta, 1979), its influence could not be separated from an effect of the surface subject. This problem is essentially unavoidable since, even though the surface subject and local topic are not inextricably linked, at present there appears to be no other acceptable defining characteristic for the local topic which would allow the two to be distinguished (see Table 1.1). However, one set of experiments was designed to separate the influence of the local topic from that of the deep subject.

4 The effects of semantics and general knowledge

The assignment strategies considered so far are usually constrained by whether the resulting referential mapping is consistent with the overall meaning of the sentence or discourse being read. For example, Cowan (1980) showed that the parallel function strategy was overridden by the influence of the pragmatic plausibility of potential antecedents. Pronoun assignment will be affected both by the meaning derived from the text and by a reader's general knowledge (since general knowledge will determine whether or not certain assignments are acceptable given the information derived from the text so far). One of the main questions is whether this knowledge always exerts an influence before assignment takes place or whether it is only used to check the validity of assignments made on the basis of other factors, when these fail to make an assignment, or when the assignment is incompatible with other information in the sentence.

One aspect of the meaning derived from the text which appears to influence assignment at a local level is the meaning of individual words.

4.1 The influence of lexical meaning

Verbs, in particular, are thought to exert an important influence on pronoun assignment and it is claimed that they assign abstract features to either the subject or the object NP which then affects coreferential mapping. Two examples of such a view are the Experiencer Constraint and the effect of implicit causality. (It is arguable, however, whether these constraints are pragmatic rather than semantic.)

The Experiencer Constraint

This constraint applies to verbs which describe an introspective state (for example, 'like', 'envy') and is based on the fact that the person experiencing the state is in the best position to make statements about it. Thus, in a sentence in which such a state is being communicated, the experiencer (if present) is most likely to be the speaker (and cannot be the listener). For example, the pronoun in 1.15 would be assigned to Anne.

1.15 Anne_i told Fiona that she_i hated Peter.

The opposite argument applies to sentences containing these verbs with interrogatives. The experiencer (if present) has to be the object of the inquiry rather than the inquirer, as in 1.16.

1.16 Anne asked Fiona_i if she_i hated Peter.

Such considerations have been formalised into constraints which require retrieval of the detailed lexical characteristics of verbs (for example, Fillmore, 1970 and Postal, 1970). Springston (1975) has provided evidence to suggest that the speed of assignment is affected by the Experiencer constraint. Assignment was faster when the constraint was operating, even when gender cues alone were sufficient to determine assignment.

Springston (1975) also investigated the Shared Property constraint which involves matching a pronoun to an antecedent which has the same verb associated with it as the pronoun. But, unlike the Experiencer Constraint, he found no effect of this constraint when assignment could be determined unambiguously by gender.

Implicit Causality

Another feature associated with verbs which is thought to influence pronoun assignment is implicit causality. This factor is said to select either the subject or the object NP associated with the verb as "the probable instigator or causal source for a series of events" (Caramazza, Grober, Garvey and Yates, 1977, p. 601). Its influence was first suggested by Garvey and Caramazza (1974) who claimed that the causal agent suggested by the main verb was usually the antecedent for a following pronoun. Subjects were asked to complete sentence fragments of the form: NP verb NP because Pro ... (for example, 'The prisoner confessed to the guard because he...'). They found that for some verbs (such as 'confess', 'sell' and 'telephone'), the potentially ambiguous pronoun was consistently assigned to the first NP of the fragment; for others (such as 'kill', 'criticise' and 'fear'), Subjects assigned the pronoun to the second NP, and for a third group of verbs (including 'help', 'argue' and 'give'), there was no agreement. This pattern of results makes sense in terms of the plausibility of various outcomes given certain verbs. For example, part of what we know about confessing is that the motive for the confession usually arises from the person making the confession. Consequently, a sentence fragment of the form: NP confessed to NP because he ... is likely to be completed with reference to the first NP. Indeed, as already suggested, it could be argued that implicit causality is not a semantic feature, but a pragmatic feature since its effect does not just depend on the meaning of the verb itself but on how it interacts with other general knowledge.

Others have also investigated the effect of implicit causality on pronoun assignment. For example, Caramazza et al (1977) found that Subjects indicated the referent for a pronoun faster when the information following the pronoun was consistent with the proposed bias of the verb than when

it was inconsistent, even when assignment could be determined unambiguously by gender cues. But others have shown that its influence may be attenuated by a number of other factors. For example, Garvey et al (1976) found that its influence was affected by passivisation, negation and the status difference between the two characters involved. And Grober et al (1978) found that it only affects assignment in sentences which are unmodified by modal auxiliaries (such as 'may', 'ought' and 'should'). They also argued that when semantic factors, such as implicit causality, did not select one antecedent unambiguously, readers employed a parallel function strategy to determine assignment. The relative effects of parallel function and implicit causality were further studied by Caramazza and Gupta (1979). They found a strong effect of implicit causality in active sentences, but in passive sentences, its effect seemed to depend on whether the verb had NP1 or NP2 bias.

So it seems that, for a limited set of verbs, implicit causality may have an effect on pronoun assignment in some sentence constructions. Factors such as these which are associated with particular lexical items clearly contribute to the understanding of pronominal reference but are only of limited generality, especially if (as with implicit causality) their effects are attenuated by common linguistic variations such as passivisation.

Ehrlich (1979) also found that the verb occurring with the pronoun was important for influencing assignment. She argued that it was the underlying roles of the pronoun and antecedent which were important (by which she seems to mean the semantic roles). However, she has also pointed out that the events described in a sentence as a whole may override the influence of the main verb (Ehrlich, 1980). She found that when the relations between events described in a sentence were manipulated by altering the conjunction, this altered the assignments predicted on the basis of implicit causality. She concluded by interpreting implicit causality more generally in terms of the underlying

semantics of the verb and by suggesting that readers use both linguistic knowledge of the semantics of the verb together with knowledge of the overall event relations described by the sentence in order to select antecedents.

Cowan (1980) also reinterpreted the implicit causality feature, suggesting that it may be the result of more general properties associated with verbs (for example, whether they are obligatorily transitive). But he also argued that particular lexical items are less likely to be important than more general processing strategies such as parallel function. However, he provided no evidence for this view, merely assuming that the parallel function strategy can explain assignment preferences and attempting to determine the limits of its application.

Clearly, it is not only verbs which influence assignment. Other lexical items may also have an effect, for example, words such as "back" (as in 'Harry hit Chris and he punched him back') may influence assignment. Individual word meanings have been utilised in AI systems for reference assignment (for example, by Wilks, 1973, 1975), but clearly, a knowledge of word meanings alone is not always sufficient to determine anaphoric assignment; inferences from the text and from general knowledge are also frequently required (and these levels are also used by Wilks).

However, once one considers the influence of meaning beyond the word level, it is difficult to separate the effects of the meaning derived from the sentence or text itself from the pragmatic effects of inference and general knowledge since the two are intimately connected. Such effects can therefore operate at both local and global levels.

4.2 The effects of inference and general knowledge

There is a great deal of evidence to suggest that inferences from a text and from general knowledge are important for general understanding and recall. For

example, AI models which do not take account of general knowledge and the meaning of sentences are not as successful as those which do (Charniak, 1972; Hirst, 1981; Winograd, 1972).

A variety of experimental work has investigated the process of inference during both comprehension (for example, Clifton and Slowiaczek, 1981 and Thorndyke, 1976) and recall (for example, Fillenbaum, 1966 and Owens, Bower and Black, 1979). Much of this work has concentrated on when inferences are made and in particular whether they are made during reading or only when they are needed (for example, for answering questions). Garnham (1982) distinguished two types of inferences; those which are necessary for integrating the information from different sentences into an overall coherent representation of the text and elaborative inferences. He claimed that the former, including those needed for anaphoric reference, are made during reading whereas only those elaborative inferences which are improbable are stored in the representation of the text. A number of other studies also support the idea that inferences necessary for integrating sentences into a coherent representation of the text are made during reading (for example, Clark and Haviland, 1977; Garrod and Sanford, 1977, 1978). Sanford and Garrod argue for a context-driven process of inference making in terms of scenarios or frames. These may extend the domain of reference to include implied entities (Garrod and Sanford, 1978, 1983; Sanford and Garrod, 1981).

Inferences and general knowledge are clearly also important in certain cases of pronoun assignment. For example, in the following sentences (from Sidner, 1979) the assignment of the pronouns in the two alternative continuation sentences (1.18 and 1.19) have to be interpreted using general knowledge.

- 1.17 I took my dog to the vet yesterday.
- 1.18 He bit him on the shoulder.
- 1.19 He injected him in the shoulder.

But the question is whether such inferences are always necessary when resolving pronominal reference. There are two main views on this question. Some claim that general knowledge is always important and an integral part of the assignment process. Others, however, claim that these factors are only important if 'simpler' strategies fail. There is evidence to support both positions.

Evidence suggesting that semantics and general knowlege are always important

Marslen-Wilson and Tyler argue very strongly for the importance of pragmatic inferences as an integral part of anaphoric processing in the understanding of spoken language. (By pragmatic inference they mean the assessment of the plausibility of potential antecedents relative to the properties predicated of the pronoun.) However, as they point out, the understanding of spoken language is not necessarily the same as the understanding of written language. For example a reader, unlike a listener, has control over the speed of input of text (Tyler and Marslen-Wilson, 1982). Nevertheless, they present a variety of evidence to illustrate the importance of pragmatic inference when resolving pronoun reference in spoken language. For example, Subjects responded faster to a visual word probe which was an appropriate continuation of a sentence fragment beginning with an anaphor than to a probe which was an inappropriate continuation (Marslen-Wilson and Tyler, 1980). They found the same result whether the anaphor at the beginning of the fragment was a repetition of the character's name, an unambiguous pronoun or a zero anaphor. Since a zero anaphor could only be interpreted on the basis of inference, they argued that this demonstrated the importance of an early influence of pragmatic inference on pronoun assignment. (However, there are problems when interpreting results based on a finding of no difference.) Their finding was replicated and

extended by Tyler, Marslen-Wilson and Koster (1982) who contrasted three sources of information available for pronoun assignment; discourse focus, lexical constraints and pragmatic inference (based on properties of the verb). They found that lexical cues and pragmatic inference had approximately equal influence over assignment while discourse focus was less important.

So, although they do not claim that inferences are the only source of information used to resolve anaphora, they argue that "pragmatic checking" (Sidner, 1979) is a normal part of the resolution process.

Evidence for the use of inference as a normal part of the understanding of pronouns in written language usually rests on the demonstration of an effect of inference or semantic factors in the presence of simpler linguistic cues. The argument is that if general knowledge influences assignment when there is no need for it to be used because simpler cues are available, this suggests that it is always used during assignment. For example, Hirst and Brill (1980) examined the effect of the plausibility of different antecedents carrying out the actions predicated of a pronoun and found that plausibility influenced assignment even when syntax alone was sufficient to determine assignment. The syntactic cues they presented agreed with the assignment expected on the basis of plausibility and they argued that if integration followed assignment, then syntax alone should influence assignment time. They found that assignments were faster for highly plausible referents than for moderately plausible referents even with a syntactic cue, so they argued that both types of information were working together and that integration occurs during rather than after assignment. (However, their results do not reveal what would happen if the syntactic cues and plausibility had been contradictory). They concluded that a pronoun does not trigger a search for an antecedent, but instead acts as a signal to integrate the information in the pronominalised clause with preceding information. They suggest that, as a result, pronouns

probably facilitate integration, and there is evidence to suggest that this is the case (Lesgold, 1972). Further evidence to suggest that integration occurs during anaphoric assignment was provided by McKoon and Ratcliff (1980), although they used anaphoric NPs rather than pronouns.

Springston (1975) studied a number of factors affecting pronoun assignment and concluded that both structural and semantic cues are important, neither having precedence over the other. For example, he found that the Experiencer Constraint influenced assignment even when assignment could be determined by gender cues alone. On the other hand, he found that the Shared Property constraint had no effect when gender cues were present. He concluded that potential antecedents are evaluated serially, but that the criteria used for evaluating them (including syntactic and semantic cues) are applied in parallel. Thus, he claimed that semantic factors are always utilised during pronoun comprehension. Others have also found that semantic (or pragmatic) factors may influence assignment in the presence of linguistic cues (for example, Caramazza et al, 1977) and such evidence is used to argue that semantic or pragmatic factors are always evaluated during assignment.

But not all the experimental work on written language supports the view that semantic factors and inferences from general knowledge always influence assignment.

Evidence suggesting that semantics and general knowledge are not always important

Ehrlich (1980) claimed that general knowledge need not always influence pronoun assignment. She examined the relative importance of gender cues, implicit causality and inferences from general knowledge. The effect of general knowledge was manipulated by changing the conjunctions used in the target sentences, thus altering the relations between the events described in the sentence. There was

evidence to suggest that the general knowledge factor was more important than implicit causality, but she also claimed that she found no effect of general knowledge in the presence of a gender cue. Thus, she argued that general knowledge is not used to determine assignment if there are gender cues present. However, such a claim should have been reflected in an interaction between the general knowledge factor and the gender cue factor, yet she failed to find such an interaction (instead, there was a main effect of the general knowledge factor by Subjects). (It should also be noted that she only used single sentences in isolation, a rather unnatural reading situation in itself.) So, this is not very strong evidence for the claim that inferences from general knowledge are not always necessary for pronoun assignment.

Sanford and Garrod (1981) also argued that it is not always necessary to use inferences from general knowledge to resolve pronoun assignment. They cite the work of Springston (1975) and Caramazza et al (1977) in support of this claim but it is argued here that these studies indicate the opposite since they show clear effects of semantic factors (the Experiencer Constraint and implicit causality) even in the presence of linguistic cues. The different interpretation from Sanford and Garrod emerges because they concentrate on the fact that gender cues facilitate comprehension rather than the fact that other factors (such as the Experiencer Constraint and implicit causality) still influence comprehension even in the presence of gender cues.

Sanford and Garrod distinguish three sources of information which may be used to resolve assignment: information which influences assignment before the pronoun is encountered (including mainly textual factors such as recency and topicalisation), information which influences assignment when the pronoun is encountered (including lexical cues and syntactic factors) and information which influences assignment after the pronoun is encountered. It is this third type of information which includes inferences

from general knowledge. They argue that while the first two sources of information represent primary processing, the use of general knowledge requires secondary processing (Garrod and Sanford, 1983, p. 294) and only operates when primary processing fails to select a unique antecedent. So, although general knowledge may be used to determine the referent for a pronoun, they claim that it is not always necessary. Indeed, they claim that it should not be necessary and that the use of a pronoun in cases where it is needed represents inconsiderate discourse.

The experimental evidence for this claim includes an experiment by Sanford et al (1983) which examined the claim that pronouns must refer to explicit antecedents (Garrod and Sanford, 1982). They found that, although it is not always necessary for an explicit antecedent to be present in the preceding text, sentences containing such antecedentless pronouns (which must be assigned using inference), were judged to be infelicitous and took longer to read than those which contained an explicit antecedent. More importantly, they found that reading times increased if there was an unrelated NP which agreed in number and gender with the antecedentless pronoun, suggesting that the pronoun had "bonded" to this NP even though such bonding was semantically inappropriate. For example, in the sentences shown below (from Sanford et al, 1983, p. 306), the pronoun 'it' in 1.21 would bond to 'hair' in 1.20 even though this does not make sense.

1.20 Ronald parted his long hair.

1.21 It was twisted with many teeth missing.

This suggests that if other factors are present which can be used to determine pronoun assignment (in this case, an explicit, but inappropriate antecedent), then they are used before semantics and general knowledge are taken into account. Further evidence for this is provided by the fact that the initial interpretation usually given to the sentences shown in 1.13 and 1.22 (from Hirst, 1981, p. 56)

are strongly opposed to what one would expect on the basis of inferences from general knowledge.

1.22 If an incendiary bomb drops near you, don't lose your head. Put it in a bucket and cover it with sand.

This suggests that assignment occurs immediately the pronoun is encountered, before the information following the pronoun has been interpreted.

Summary of role of semantics and general knowledge

Thus, there is some evidence to suggest that general knowledge has an effect even in the presence of linguistic cues (for example, Caramazza et al, 1977; Hirst and Brill, 1980; Springston, 1975), yet there is other evidence to suggest that other factors operate before general knowledge has an effect (for example, Sanford et al, 1983). The precise role of general knowledge in the presence of linguistic cues therefore remains an open question and needs further investigation. The influence of a general knowledge factor in the presence of a gender cue was therefore investigated in Chapter 5.

The work of Sanford and Garrod raises the question of whether the various factors influencing pronoun assignment have a 'top-down' or 'bottom-up' effect on assignment. They suggest that textual factors (such as recency and the topic) influence assignment before the pronoun is encountered (top-down) whereas general knowledge has an effect after the pronoun is encountered and gender cues affect assignment once the pronoun is encountered. If the topic has a top-down influence, then an expectation that the topic will be mentioned should produce more completions involving a topic character than any other character in a sentence completion task. There is evidence to suggest that this is the case (Anderson et al, 1983) but this issue was investigated further in this thesis (Chapter 7).

The present research

The experiments in this thesis were designed with the following aims in mind. The first aim was to examine the interrelationship between local and global factors affecting pronoun assignment. Although the importance of both local and global factors has been demonstrated in previous experiments, the different factors are often considered separately. Moreover, with a few exceptions (for example, Sanford and Garrod, 1981), local and global factors are rarely considered together; local factors are usually examined in single sentences (for example, Ehrlich, 1980 and Springston, 1975) where there is no possibility of an influence of global factors, and global factors are usually investigated at the discourse level with no account of local factors. Thus, in this study, passages of prose were used and manipulations were made at both the text level and at the sentence level. At the global (text) level, the effect of the discourse topic was investigated. At the local (sentence) level, three different features were investigated: the subject of the sentence, the presence or absence of gender cues, and the pragmatic constraints of particular verbs. Thus, an example of each of the four factors discussed above was investigated.

The way in which the influence of the subject was examined requires a little explanation. On the basis of the evidence produced so far, it is not clear whether the subject is a preferred antecedent as a result of a simple subject assignment strategy (in which case any pronoun would be assigned to the subject) or as a result of a parallel function strategy (in which case only subject pronouns would be assigned to the subject). In addition, the precise aspect of the subject which is important (surface, deep or semantic) is also unclear. However, it is not possible to resolve all these issues at once and these problems were considered secondary to that of determining the relative importance of local and global factors in pronoun comprehension. The experimental

materials were therefore constructed so that these controversial aspects of the subject effect were confounded. That is, a subject pronoun was included in the target sentences so that assignment to an antecedent in subject position would be expected on the basis of both a subject assignment strategy and parallel function. And active sentences were used so that the surface, deep and semantic roles of the subject were confounded. The intention was to ensure the maximum possibility of an influence of this factor whatever the precise details of its effect since this would enable it to be used as an example of a local factor to be compared with the influence of a global factor.

A second aim of these experiments was to examine pronoun assignment in the same sentences presented both in text and in isolation. The processes involved in understanding single, isolated sentences may differ from those involved in a more natural discourse context. For example, much of the evidence for an effect of the subject relies on data from experiments which have used single, isolated sentences. In these circumstances it could be that an influence of the subject is found simply because there is little else available to influence assignment. Consequently, sentences were presented not only in passages of text but also in isolation.

A third aim was to examine the surface features of the text which are important for determining the topic's influence on assignment.

The fourth aim was to determine whether the deep or surface subject role is more important for pronoun assignment.

Fifthly, given the existence of a topic effect and a subject effect, the question of whether these are top-down or bottom-up effects was investigated.

Sixthly, one set of experiments was designed to discover whether inferences from general knowledge invariably influence assignment or whether they are only used when there are no linguistic cues to assignment.

The first two aims (to examine the relative influence of local and global factors and to examine the same sentences in text and in isolation) are fulfilled by the series of experiments as a whole. The third aim (to elucidate the role of the features signalling the global topic) is addressed in the passage experiments of Chapters 2, 3, 4 and 6. The fourth aim (to discover whether the subject's deep or surface role is more important) is examined in Chapter 8, and Chapter 7 addresses the fifth aim (to determine whether the effects of the topic and subject are top-down or bottom-up). The sixth aim (to examine the influence of general knowledge factors) is pursued in Experiment 9 of Chapter 5.

CHAPTER 2

GLOBAL AND LOCAL FACTORS - CUMULATIVE PRESENTATION OF PASSAGES

Introduction

This experiment was designed to examine the effects of both local and global factors on assignment in a reading situation which was as natural as possible. Passages of text, rather than single sentences were presented, with the assignments of interest being made in one of the later sentences in the story.

If anaphora is a discourse level phenomenon, then one might expect a discourse level factor to override the influence of local factors. On the other hand, discourse level factors may only function to increase the ease of assignments made in accordance with sentence level factors so that unless the two coincide, sentence level factors are more important. Materials were constructed in which factors at both levels had the chance to operate in an attempt to determine which had the greater effect on the assignment of ambiguous and unambiguous pronouns.

The factors which were chosen to represent the two levels were those which were expected, on the basis of previous results, to exert a strong influence on pronoun assignment. At the discourse level, the factor chosen was the global topic and at the sentence level, the subject of the sentence and gender agreement.

If sentence level factors are important in pronoun assignment, then one would predict that the target sentences used in Experiment 1 would induce assignment of ambiguous pronouns to the subject of the sentence as a result of one (or more) of the strategies implicating the subject in assignment, for example, subject assignment, parallel function or local topic assignment. A failure to find such an assignment, especially if coupled with a tendency for assignments to be made to the global topic,

would be strong evidence for the control of assignment by discourse level factors rather than by sentence level factors.

The influence of gender agreement was also studied. In some of the target sentences of Experiment 1, the pronoun could be disambiguated by gender. If linguistic constraints are utilised at an early stage of anaphoric selection, then one might expect assignments to be made on the basis of gender cues alone, in which case there should be no effect of whether or not assignment was also constrained to the subject or to the global topic. On the other hand, if other sentence level and/or discourse level factors always influence assignment, then one would expect an influence of the subject and/or the global topic over and above an effect of gender cue on the ease of assignment as measured by reading times.

EXPERIMENT 1

Method

Subjects

One hundred and twenty students or staff from Durham University took part in this experiment. To avoid confusion with the grammatical sense of the word 'subject', they will be referred to as 'readers' (except in section headings).

Apparatus

Passages were presented on a 32K Commodore PET microcomputer (3032 series) with cassette and printer attachments. The same apparatus was used in all experiments except Experiments 6 to 9, 11 to 14, 19 and 20, in which the 8032 series of the PET was used with disk drive attachments, and Experiments 15 to 18 in which no PET was used.

Materials

There were twelve experimental and fifteen filler passages. All of the passages were six sentences long and three questions were asked about each passage. The story described by each passage revolved around two main characters.

In the experimental passages, an attempt was made to ensure that one of the two characters, the global topic, was more important than the other. This character was signalled as the topic in a number of ways. Most of the action and description centered on this character who was thus mentioned more frequently than any other character. This character's name was used as the title of the passage and the first sentence was about the topic character. In

addition to the topic, each passage referred to one or more less important characters, one of which was designated the nontopic. Different names were used for all characters.

The fifth sentence was the target sentence, containing the pronouns whose assignment was investigated. This sentence consisted of two clauses of interest. The first mentioned the topic and nontopic characters by name and the second referred to them using pronouns. These were not necessarily the only two clauses in the sentence but the others are not relevant here so, for ease of exposition, they will be referred to as the first and second clauses. In all but one of the target sentences the two clauses were joined by the conjunction 'and', the exception being Passage 1, Mary in which the conjunction was 'when'. The sentences were constructed so that it was possible for either the topic or the nontopic to be subject or object of a verb in the first clause while maintaining the sense of the passage. In the pronominal clause, the topic and nontopic were referred to using third person personal pronouns 'he', 'she', 'him' or 'her' as subject or object of another verb. Again it was possible for either the topic or the nontopic to take the subject or object position. There were two main types of target sentence, ambiguous (containing pronouns which were ambiguous by gender) and unambiguous, (containing pronouns which were unambiguous by gender). The passages containing these types of sentences will be referred to as ambiguous and unambiguous passages. There were six conditions in this experiment (two ambiguous and four unambiguous) and an example of a target sentence in each of these conditions is shown in Figure 2.1 below.

used in Experiment 1 are shown in Table A 2.1 in the Appendix.

Apart from ambiguity, the ambiguous and unambiguous passages were the same. Where the sex of one of the characters was changed to produce an unambiguous passage, the name of the character chosen was equal in length (in terms of letters and syllables) to that used in the ambiguous version (for example, Shaun and Clare). The number of words in the target sentence ranged from 9 to 29 with a mean of 17.7.

Like the experimental passages, the fillers were all six sentences long and were also mainly concerned with two characters. The name of one of them was used as the title of the passage, but no effort was made to make either character stand out as important. So there were no topic or nontopic characters. In six passages the two main characters were the same sex, in eight they were not and the remaining one referred to some boys and some trucks. Two of the filler passages were used as practice passages. An example of a filler passage is shown in Table A 2.2.

At the end of each passage (both experimental and filler) there were three questions. In the experimental passages one question, the 'critical question', was concerned with the assignment of the pronouns in the second clause of the target sentence. In the ambiguous passages, this allowed assignment of the pronouns to be determined and in the unambiguous passages, it made it possible to check that assignment had been made correctly (according to the gender constraints of the sentence). The questions were in the form of statements which the reader had to judge as 'true' or 'false'. The critical question was constructed by taking the second clause of the target sentence and replacing the pronouns with the names of the topic and nontopic characters. For example, for the ambiguous form of the target sentence illustrated in Figure 2.1 one version of the critical question was as follows.

Shaun called to Ben to be careful. (true or false?)

There were two versions of the critical question. In one, type (a), the topic was subject of the question (as shown above) and in the other, type (b), the nontopic was subject (for example, 'Ben called to Shaun to be careful'). The other two questions associated with the experimental passages were not important for determining pronoun comprehension but were included to make the true purpose of the questioning less apparent, and to check that readers were reaching a satisfactory level of comprehension. One was a question about the topic character and the other was a question about some general aspect of the passage (such as setting or time). Thus, readers could not always expect questions about the characters mentioned in the passages. The experimental questions are shown after each passage in Table A 2.1.

The filler passage questions were similar to the experimental ones. One was about the character whose name was used in the title, one was a general question and the third was about the two main characters in the passage (for example, see Table A 2.2). In the experimental passages, the number of 'true' and 'false' responses required for the correct answers to these different question types was roughly equal, as shown in Table A 2.3. (Originally the number of such responses was exactly equal for each question type, but one passage intended as an experimental passage was excluded from the analysis because it contained plural pronouns (Tony and Steve). It was therefore treated as a filler passage, upsetting the number of 'true'/'false' responses.)

Design

A reader saw only one version of each passage and the allocation of one of the six conditions to a passage was determined by a Latin square design. This design, illustrated in Table A 2.4, ensured that each reader saw two passages in each condition (that is, it was a Within

Subjects design). The order of presentation of the passages for each reader was randomised. Each passage was presented to two groups of ten readers in each condition. One group was presented with critical question type (a) associated with the condition and the other with critical question type (b). Similarly for the two occurrences of each condition seen by a reader, one was accompanied by critical question type (a) and the other with type (b). Critical question type was thus a control variable, counterbalanced across readers, passages and conditions and was not included in the analysis of results.

The presentation order for the questions about different aspects of the experimental passages was varied. Six different orders were used and these were counterbalanced across readers, passages and conditions.

Only one version of each filler passage was used throughout the experiment with the same order of questions.

Procedure

Each reader was tested individually in a self-paced reading task. Reading times were examined on the assumption that longer reading times reflect greater complexity in the comprehension process. Times were not measured for units smaller than a sentence in order to preserve as natural a reading situation as possible. The passages were presented on the screen of a PET microcomputer and were preceded by brief instructions which were an abbreviated version of the verbal instructions shown below.

"This is an experiment on comprehension. You will be shown simple stories which I want you to read to yourself. After each one there will be three questions to answer. They are not difficult so please read the stories as normally as possible, as you would read any piece of text, in a magazine for example. There are twenty five passages altogether and you will have a short break after every five.

Each sentence in the passage will come up separately when you press the space bar (here). Read the sentence to yourself and, as soon as you have understood it, press the bar again and the next one will appear. Try to keep your eyes on the point where the last sentence finished so that you are ready to read the next sentence which will follow on from the previous one, as in normal prose.

The first two passages are practice ones so you will have a chance to get used to this method of presentation. The questions are in the form of true-false statements. Read each one and if you think it is true, press the key marked 'true' with your left forefinger. If you think it is false, press the key marked 'false' with your right forefinger. If the statement is true then the information will have been stated explicitly in the passage. Keep your fingers in position over these keys throughout the experiment and you will be able to use your thumbs to press the space bar. Remember you have to press the space bar to bring up each sentence and the first question. You will know when to expect the questions because the message 'Questions' will appear in the middle of the screen. Press the space bar to get the first one, and then the key press indicating your answer will bring up the next one.

If, for any reason, nothing happens when you press the space bar or the 'true'/'false' keys, try again and if nothing happens then, wait a minute and it should start working again. While you are waiting, please write down the name of the passage and roughly whereabouts the screen went blank.

Any questions? Press the space bar when you are ready to start."

The passages were presented one sentence at a time in normal case (except for the title which was in upper case) and readers were asked to press the space bar each time they had read and understood a sentence. This key press caused the next sentence to appear. Care was taken to ensure that readers understood that they were to read the text to themselves, as normally as possible. Once a

sentence had appeared, it stayed on the screen until the end of the passage and each sentence followed on from the last, as in normal text, separated by one space. This type of presentation will be referred to as cumulative presentation and was used to make the appearance of the text as normal as possible in an attempt to encourage natural reading (without special emphasis on memorising, for example).

When the last sentence of the passage had been read, the key press caused the screen to clear and the message 'Questions' appeared in the middle of the screen. The reader was told to press the space bar to replace this message with the first question and to press either the key marked 'true' or the key marked 'false' in response to the question. As a result of the key press, the question disappeared and was replaced by the next one (after a 50 millisecond delay to prevent masking). Each question appeared on a single line in the centre of the screen.

When the third question had been answered, the screen cleared and the message 'Press space bar to proceed' appeared. Readers could then start the next passage when they were ready.

The first two filler passages served as practice passages, allowing the reader to become familiar with the method of presentation. During the practice trials the experimenter remained available to answer questions. The order of the remaining twenty five passages (twelve experimental and thirteen fillers) was randomised, a different order being used for each reader. These passages were presented in five blocks of five passages with a fifteen second break between each block of trials to give the reader a short rest. During the break between two blocks, the message 'Short pause now - please wait' appeared on the screen and after fifteen seconds was replaced by the message 'Press space bar to proceed'. When all five blocks had been completed, the message 'That's all thank you - you can go now' indicated that the experiment was over. An experimental session lasted for approximately

half an hour.

A slight problem was encountered as a result of the PET's garbage collection routine. Occasionally and unpredictably the screen went blank while the routine was in operation. Readers were warned that this may happen and it did not appear to disrupt the procedure except that one or two reading times had to be discarded.

The time taken to read each sentence was recorded by the PET, although only the reading time for the fifth, target sentence was used in the analysis. The verification time and response to each question was also recorded. The response to the critical question was used to determine the assignment of the pronouns in the target sentence. Times were recorded in jiffies (sixtieths of a second) from the presentation of a sentence or question to the depression of a response key.

Results

To evaluate the results statistically in an analysis of variance, both readers and items (in this experiment, passages) must be considered as random factors (Clark, 1973). So, two separate F ratios were computed; one (F_1) treating readers as a random factor and collapsing over items (passages) within treatments and the other (F_2) treating items (passages) as a random factor and collapsing over readers within treatments. From F_1 and F_2 the minimum value of F' (Min F') can be calculated using the formula

$$(1) \text{ Min } F'(i, j) = \frac{F_1 F_2}{(F_1 + F_2)} .$$

If F_1 has n and n_1 degrees of freedom (df) and F_2 has n and n_2 df, then $i = n$ and $j =$ the nearest integer given by the expression

$$(2) \quad j = \frac{(F_1 + F_2)^2}{F_1^2 + F_2^2} \cdot \frac{n_1 + n_2}{n_1 n_2}$$

Relying on Min F' alone may sometimes be too restricting since it is a very conservative measure of reliability. For this reason, throughout this thesis, both F_1 and F_2 will be reported and commented on when Min F' is not significant.

The first treatment of the data was to check the general level of comprehension of each reader to ensure that they had been reading the passages properly. The measure used was the number of errors and the criterion chosen was that anyone with 25% or fewer errors would be accepted as having achieved an adequate level of comprehension. The answers to all questions (about filler and experimental passages) were included in this check except for those concerning the assignment of the ambiguous pronouns since these did not have a strictly correct answer.

No reader exceeded the limit of 19 errors out of the 76 questions for which there was a correct or incorrect answer, so it was not necessary to exclude anyone on this basis. The number of errors ranged from 0 to 14, with a mean of 5.02. After this preliminary check on the level of comprehension, the results from the ambiguous and unambiguous passages were analysed separately.

Ambiguous passages

Assignments

Table 2.1 shows the total number of assignments made to the subject and object for Condition T = S and for Condition NT = S.

Table 2.1 Assignments to the subject and object by
condition - Experiment 1, ambiguous passages

	Assignment to	
	SUBJECT	OBJECT
T = S	194	46
NT = S	167	73
\bar{x}	181	60

These frequencies show that many more assignments were made to the subject than to the object, and suggest that this preference was even stronger when the topic, rather than the nontopic, was subject of the target sentence, (that is, when the topic rather than the nontopic was the antecedent of the subject pronoun). The data for each passage are shown in Table A 2.5. Sometimes a reader produced only subject assignments or only object assignments in a particular condition so there are a lot of zero entries in the F_1 data.

Analyses of variance were carried out on the frequency data. The two factors examined, assignment to the subject or object, and topic or nontopic as subject of the target sentence, were treated as repeated measures for both analyses, even though in the F_2 analysis the target sentence differed slightly between the two conditions.

The total number of assignments in the two conditions was necessarily equal since half the passages contained target sentences with topic as subject and half with nontopic as subject and an assignment was made after each passage.

The analysis showed that there was a reliable difference between the number of assignments to the subject and the number to the object, as suggested in Table 2.1., with many more assignments to the subject (Min F' = 52.21, $df = 1, 24, p < .01$). There was also a significant interaction between condition and assignment to the subject or object on the F_1 analysis ($F_1 = 8.31, df = 1, 119, p$

<.01), but it was only marginally significant on the F_2 analysis ($F_2 = 4.17$, $df = 1, 11$, $p = .064$), and hence $\text{Min } F'$ was not significant ($\text{Min } F' = 2.78$, $df = 1, 24$, $p > .05$). This interaction indicates that the tendency to assign the pronoun to the subject of the sentence was even stronger when the subject was also topic of the passage. (See Table A 2.6 for the summary tables.)

Overall, the assignment data reveals a strong effect of the subject on pronoun assignment, as well as a suggestion of an effect of topic on assignment.

Reading rates

Data based on times produce well known problems for analysis and there is therefore a strong case for considering transformations of data. It may be that the original data in the form of times are not compatible with the assumptions underlying analysis of variance whereas some transformed version of the data is. Many workers have unthinkingly carried out analysis of variance without considering the use of transformations and there are several problems with this.

An examination of the reading time data collected from ambiguous passages in Experiment 1 showed two main deviations from normality; firstly, the data were positively skewed and secondly, there were a number of very slow times producing a second peak at one end of the distribution and a smaller number of very fast times at the other end of the distribution.

The solution to the problem of the very slow times initially considered was to discard any times more than a certain number of standard deviations away from the overall mean. However, there is no consensus on the number of standard deviations to use as a cut-off point. There are variations between different investigators, for example, Tyler (1983) used two standard deviations while Greenspan and Segal (1984) used three, and also from the same investigator on different occasions, for example, Clark and

Sengul (1979) used two and a half standard deviations in their first experiment but three in their second and third experiments (as well as discarding any times exceeding ten seconds). But the main reason why this procedure was not adopted was that the times identified as more than two standard deviations away from the overall mean in Experiment 1 were not distributed randomly across conditions or passages as one would expect if these were truly 'wild' scores. This cut-off point also failed to eliminate any of the very fast times since two standard deviations below the overall mean invariably fell below zero.

Similarly, the elimination of times falling above a certain criterion time (as used for example by Cirilo and Foss, 1980 and McKoon and Ratcliff, 1980) or truncation (as used by Walker and Yekovich, 1984) did not seem to be viable solutions. Again it is difficult to decide upon a suitable cut-off point, and there is the same problem that the times determined by such a criterion were not randomly distributed.

At the lower end of the distribution, for times which were very fast, however, the elimination of times falling below a certain criterion did seem to be useful. While it is difficult to decide whether a very long reading time reflects a real difficulty with comprehension or some artifact (such as sneezing), it is reasonable to claim that at a certain point a reading time becomes too fast to reflect reading with comprehension. The criterion chosen was 1200 words per minute. Since reading times were divided by the number of words in the sentence, this criterion was converted into milliseconds (ms) per word (50 ms per word). Any time faster than this was excluded from analyses as too fast to reflect reading with understanding. Although it is difficult to determine an average reading time for the average adult reader, estimates usually vary from about two hundred to three hundred words a minute (for example, from Tinker, 1965). Fast readers can read about 1000 words per minute, so the criterion of 1200 words

per minute is reasonable in relation to these estimates. More importantly, it appeared reasonable in relation to the reading times obtained in this experiment. There were few reading times as fast as this (0.8%) and those which did occur were clearly outliers reflecting extraordinary 'wild' scores rather than very fast comprehension.

In order to overcome the problems of skewness and very slow reading times, the times were transformed to rates by a reciprocal transformation. This made it unnecessary to decide whether a slow time was caused by a difficulty in comprehension or something unrelated to the understanding of the sentences since the transformation brought these times within the normal distribution. The transformation made the elimination of the very fast times even more crucial since these would yield very large, outlying rates which would have had a disproportionate effect on the calculation of means.

The reciprocal transformation was chosen for two main reasons. Firstly, the reciprocal of a time gives a meaningful unit for analysis, namely a rate. Since the measurement of time in psychology experiments is arbitrary, there being no psychological significance behind the unit of time (Box, Hunter and Hunter, 1978), the analysis of rates is just as legitimate. And since there is no good reason for the use of one measure rather than the other, the most appropriate unit was chosen for statistical reasons. Analysis of variance by condition was performed on the mean reading times (by readers) for the ambiguous passages used in Experiment 1 using a number of different transformations following the procedure recommended by Box and Cox (1964) and Box et al (1978). This procedure finds the best power transformation of the data that simultaneously optimises the normality and homogeneity of variance of the data, in addition to providing the simplest additive model. It effectively involved analysing the raw data raised to a particular power (λ) and selecting the optimal value of λ (see Box et al for details). A value of λ of 1 corresponds to the original times and

a value of -1 to rates. The optimal value of λ was -0.65 with 95% confidence intervals of -0.3 and -1.1 . Thus the transformation to rates (-1.00) fell within the confidence interval for the optimal value of λ . The original unit of time (1.00), however, did not and rates were therefore considered preferable to the original times. The rates transformation was chosen in preference to the optimal value of -0.65 because, unlike the optimal value, it yields a meaningful unit of analysis, as recommended by Box and Cox.

This analysis suggests that others who have used untransformed times in similar studies may have been violating assumptions in using analysis of variance. This can be a particular problem in interpreting interactions as it can happen that an analysis of times may lead to different conclusions about the presence or absence of interactions from an analysis of rates (see, for example, Hettmansperger, 1984, example 5.4.2). Because the Box and Cox approach to the choice of transformation finds that transform that gets closest to satisfying the normality and homogeneity of variance assumptions and, at the same time, produces the simplest model, it would seem wisest to base conclusions about the existence of interactions on the analysis of rates.

The conversion from jiffies to rates was achieved in a number of stages. Firstly, the times in jiffies were divided by 0.06 to convert them to times in ms. Then, because the range of the number of words in the target sentences was so large (9 to 29 words) and because others (for example, Clark and Sengul, 1979) have found that reading times increase with the number of words in a sentence, the times were divided by the number of words in the appropriate sentence to give times in ms per word. The number of words in each target sentence is shown in Table A 2.7.

The next stage of the conversion was to eliminate very fast times from the data. Four very fast times were excluded on the basis of the criterion of 50 ms per word.

The remaining times (in ms per word) were divided by 1,000 to give times in seconds per word, and finally the reciprocal of these times were taken to produce reading rates in words per second.

Where the very fast times were excluded, the sample size on which the means were based was reduced. In the analysis by readers, there were only two rates per condition to start with, so where a fast time had been eliminated, the remaining rate was used in the analysis. Unfortunately, two of the four excluded rates happened to occur in the data for the same reader in the same condition, so there was no rate left to put into the analysis. In this case, the missing mean was calculated using Winer's formula for replacing missing scores (Winer, 1970, p. 281).

Generally, in this thesis, the convention of replacing scores using Winer's formula was adopted only when 5% or less of the data was missing. Others have replaced similar percentages (for example, Caramazza et al, 1977 replaced up to 3.3%; Ehrlich and Rayner, 1983 up to 4% and Clark and Sengul, 1979 up to 4.4%), although some have replaced much higher percentages (for example, Tyler, 1983 replaced up to 12% and Caramazza and Gupta, 1979 up to 15%). When the percentage of missing scores exceeded 5%, it was considered too unreliable to replace them with means calculated from the rest of the data using Winer's formula and analyses where this would have been necessary were either not performed at all or were adapted in other ways, for example, by collapsing over the reader's data.

The resulting overall mean reading rates are shown below in Table 2.2. The means shown in this table (and all such tables in this thesis) are taken from the F_1 analysis by readers. (The means for each passage are shown in Table A 2.8.)

Table 2.2 Mean reading rates (words per second) by condition - Experiment 1, ambiguous passages

T = S	NT = S
4.25	3.65

Analyses of variance were carried out on the mean reading rates. There was a reliable effect of condition (Min $F' = 4.86$, $df = 1, 19$, $p < .05$). Reading rates were faster when the topic was subject of the target sentence. (The summary tables for the F_1 and F_2 analyses are shown in Table A 2.9.)

The data were then separated into those where assignment had been to the subject and those where assignment had been to the object. These data are shown in Table 2.3.

Table 2.3 Mean reading rates (words per second) by condition and assignment - Experiment 1, ambiguous passages

Assignment to	T = S	NT = S	\bar{x}
SUBJECT	4.24	3.74	3.99
OBJECT	3.88	3.51	3.70
\bar{x}	4.06	3.63	

Analyses of variance on these data indicated that, as before, there was a main effect of condition ($F_1 = 6.82$, $df = 1, 11$, $p < .05$; $F_2 = 6.80$, $df = 1, 11$, $p < .05$; Min $F' = 3.41$, $df = 1, 22$, $.05 < p < .1$). However, there was no difference in the reading rates for sentences where assignments were made to the subject and those where assignments were made to the object; nor was there any interaction between condition and assignment. (See Table A 2.11 for the summary tables and Table A 2.10 for the

passage means. The F_1 data were collapsed over groups of ten readers to overcome problems with missing scores^{and} in the F_2 data, (one score was replaced using Winer's, 1970, formula.)

Verification rates

Before the verification times were analysed, they were transformed to verification rates (for the same reasons that reading times were converted to reading rates). Firstly, verification times were converted from jiffies to ms. Unlike reading times, no account was taken of the number of words in the questions. The reason for this was that the verification times include not only the time taken to read the question (which may be legitimately divided by the number of words), but also the time taken to answer the question which is unlikely to be related to the number of words in the question.

Secondly, very fast times were eliminated from the analysis. It is slightly more difficult to determine a criterion for very fast verification times than it is for very fast reading times, but a criterion of 100 ms was chosen. This is a conservative choice considering that the criterion for reading times was 50 ms per word and the shortest question contained three words, particularly in light of the fact that verification times include a decision time as well as reading time. So, any times faster than 100 ms could be confidently assumed to be outliers. In fact no times had to^{be} eliminated from the verification data of this experiment on this criterion.

Three scores were excluded from the data on other grounds. In one case there had been an interruption during the experiment while the question was being answered, and in the other two cases, the screen went blank during question presentation.

The remaining times were transformed from ms to rates by dividing them into 10,000. The measure 10,000 / verification time was used rather than merely taking the

reciprocal of the time so that the resulting figures would be more manageable.

Analyses of variance on true versus false responses (over all conditions) indicated that true responses tended to be faster than false responses, although only on the F_2 analysis ($F_2 = 18.78$, $df = 1, 11$, $p < .01$). The mean verification rate for true responses was 3.61 and for false responses 3.38. (See Table A 2.13 for the summary tables and Table A 2.12 for the passage means. The times from nine readers were excluded from both analyses because their responses were either all true or all false.) Because of this tendency, the verification rates for true and false responses were analysed separately.

However, the two major factors of interest were the difference in rates in the two conditions of the target sentence (topic or nontopic as subject) and the difference when assignment is made to the subject of the target sentence rather than the object.

Mean verification rates were calculated for each reader and each passage for the two conditions of the target sentence, for assignments to the subject and object and for 'true' and 'false' responses. A problem with missing scores in the analysis by readers was overcome by calculating the means over blocks of ten readers. This still left three missing means and these were replaced using Winer's (1970) formula. There were also three missing means in the data arranged by passages and these were replaced in the same way. The mean rates for each condition are shown in Table 2.4. (The data for each passage are shown in Table A 2.14.)

Table 2.4 Mean verification rates by condition,
assignment and response - Experiment 1, ambiguous passages

T = S

Assignment to	Response		\bar{x}
	TRUE	FALSE	
SUBJECT (Topic)	3.74	3.39	3.57
OBJECT (Nontopic)	2.89	3.36	3.13
\bar{x}	3.32	3.38	

NT = S

Assignment to	Response		\bar{x}
	TRUE	FALSE	
SUBJECT (Nontopic)	3.53	3.30	3.41
OBJECT (Topic)	3.46	2.90	3.18
\bar{x}	3.50	3.10	

Analyses of variance were performed on the means but there were no significant effects except for a marginally significant effect of assignment to the subject or object on the F_1 analysis ($F_1 = 4.04$, $df = 1, 11$, $p = .067$) indicating faster assignments to the subject than object. (See Table A 2.15 for the summary tables.)

Unambiguous passages

Reading rates

Reading times were converted from jiffies to ms and then divided by the number of words in the target sentence (see Table A 2.7) to give times in ms per word. Two very fast times (less than 50 ms per word) were excluded from the data at this stage. The remaining times were then divided by 1000 to give times in seconds per word, and the reciprocals of these times were taken to produce reading rates in words per second.

The mean rates in each condition are shown in Table 2.5. (The means for each passage are shown in Table A 2.16).

Table 2.5 Mean reading rates (words per second) by condition - Experiment 1, unambiguous passages

Pronoun referent	TOPIC	NONTOPIC	\bar{x}
SUBJECT	4.37	4.05	4.21
OBJECT	4.14	3.87	4.01
\bar{x}	4.26	3.96	

Analyses of variance indicated that reading rates were faster when the pronoun referred to the topic rather than the nontopic (Min $F' = 5.39$, $df = 1, 31$, $p < .05$). There was also a tendency for those sentences where the pronoun referred to the subject to be read faster than those where it referred to the object, but this difference was only reliable by readers ($F_1 = 4.23$, $df = 1, 119$, $p < .05$) and not by passages ($F_2 = 1.46$, $df = 1, 11$, $p = .25$). There was no interaction between the two factors. (See Table A 2.17 for the summary tables.)

The reading rates for those sentences whose questions were later answered correctly were separated from those

whose questions were later answered incorrectly. Analysis of variance indicated no difference between these two sets of data; the mean reading rate for correct responses was 4.11 and for incorrect responses, 4.03. (See Table A 2.19 for summary tables and Table A 2.18 for passage means.)

Verification rates

Only if a critical question was answered correctly was the verification rate for that question included in the analysis. This is because verification rates were analysed in order to reveal the ease of retrieval of different referents for the subject pronoun, so it was vital to know who the referent was. Clearly, if the question was not answered correctly then the referent was not clear.

Verification times were converted from jiffies to ms. One very fast time was eliminated and the remaining times (in ms) were transformed to rates by dividing them into 10,000.

Apart from errors (93 out of a possible 960), three other scores were also missing from the data (one in each of conditions TS, NTS and NTO) because the screen had gone blank as the question was displayed.

Analyses of variance of true versus false responses (over conditions) indicated that false responses took reliably longer than true responses ($F_1 = 12.41$, $df = 1, 118$, $p < .001$; $F_2 = 5.52$, $df = 1, 11$, $p < .05$; $\text{Min } F' = 3.82$, $df = 1, 23$, $.05 < p < .1$). The mean verification rate for true responses was 4.33 and for false responses 3.98. (See Table A 2.21 for the summary tables and Table A 2.20 for the passage means. The data from one reader was excluded from both analyses because all answers given by that reader were true.) Because of the significant difference between the two sets of responses, the verification rates for true and false responses were analysed separately.

Mean verification rates were calculated for each reader and each passage as a function of the four conditions and the two responses (true and false).

However, the elimination of all incorrect rates, and the need to include response type as a factor, produced a serious problem with missing scores. This problem was particularly acute in the F_1 analysis where about half the readers had a score missing in one category or another. As a result, analysis of variance was carried out by passages (F_2) only.

The overall means from the F_2 analysis are shown below in Table 2.6 along with the number of errors (in parentheses) made in each condition. (The means for each passage are shown in Table A 2.22. The overall means calculated across readers were very similar and are also shown in Table A 2.22.)

Table 2.6 Mean verification rates and errors by condition and response - Experiment 1, unambiguous passages

<u>'True' responses</u>					
Pronoun referent	TOPIC (Errors)		NONTOPIC (Errors)		\bar{x}
SUBJECT	4.55	(3)	4.38	(6)	4.47
OBJECT	4.37	(21)	3.84	(8)	4.11
\bar{x}	4.46		4.11		
<u>'False' responses</u>					
Pronoun referent	TOPIC (Errors)		NONTOPIC (Errors)		\bar{x}
SUBJECT	4.00	(10)	4.13	(8)	4.07
OBJECT	3.80	(17)	3.76	(20)	3.78
\bar{x}	3.90		3.95		

The analysis of variance showed a reliable difference between 'true' and 'false' responses, as before ($F_2 = 5.69$, $df = 1, 11$, $p < .05$) with 'false' responses taking longer than 'true' ones. Verification rates were reliably faster when the referent was the subject rather than the object of

the target sentence ($F_2 = 9.93$, $df = 1, 11$, $p < .01$). This difference was also apparent in the means calculated across readers (see Table A 2.22). There was no main effect of topic assignments but there was an interaction between topic and response type ($F_2 = 5.84$, $df = 1, 11$, $p < .05$). The topic was retrieved more easily than the nontopic but only when the response required was true. No other interactions were significant. (See Table A 2.23 for the summary table.) Observation of Table 2.6 also indicates that errors were more likely when the referent to be retrieved was the object rather than the subject.

Discussion

Overall, the results of Experiment 1 indicate that there was a strong tendency to assign an ambiguous pronoun to the subject of a sentence. This tendency was even stronger when the subject was also the topic of the passage. Ambiguous sentences in which the topic was subject were also read faster than those in which the nontopic was subject. The unambiguous target sentences were read faster when the pronoun referred to the topic rather than the nontopic and when it referred to the subject rather than the object. In the unambiguous passages, verification rates were faster for those questions requiring retrieval of the subject rather than the object and there was an interaction between the topic and response type.

Thus the subject, whose influence on assignment has often been demonstrated in single sentence experiments, is also important when sentences are presented within passages of text. But its influence differed depending on whether or not the assignment of the pronouns was constrained by gender.

The influence of the grammatical role of the referent was more important in sentences where pronoun assignment was not constrained by gender than in those where it was so constrained. In the ambiguous passages of Experiment 1, there was a very strong tendency for assignment to be made to the subject rather than the object of the sentence. This finding is consistent with many other experiments which have shown the importance of the subject but the exact nature of its influence is not clear from Experiment 1. The structure of the target sentences does not allow a conclusion to be made about whether this was more likely to be the result of a simple subject assignment strategy or a parallel function strategy.

Other aspects of a sentence can be crucial for determining assignment. For example, gender cues may constrain assignment, or the meaning of the sentence may do

so, as the following two sentences from Hirst (1981, p. 41) illustrate.

2.1 When Sue went to Nadia's home for dinner, she served sukiyaki au gratin.

2.2 When Sue went to Nadia's home for dinner, she ate sukiyaki au gratin.

However, this is not to say that strategies, such as the subject assignment strategy, have no influence when assignment is constrained either by meaning or by linguistic constraints. If they are general strategies used to make comprehension easier, as is being suggested here, then these strategies would be expected to have some influence on comprehension, although this is much more likely to be evident in the ease, and therefore speed, of reading than in actual assignments. In this sense the influence of subject and topic would be expected to be weaker in unambiguous passages than in ambiguous passages (where they may affect assignment itself), and this is what was found in Experiment 1.

Unambiguous target sentences were read more quickly when the pronoun referred to the subject rather than the object, but this effect was only reliable by readers, suggesting that only some sentences were read more easily when the referent was the subject. This might suggest that the subject effect is not a result of a general strategy of subject assignment, but may be an artifact of the particular sentences used. This would be the case, for example, if it was the meaning of the particular sentences used which led to subject assignments being made. However, an independent check on the materials used in Experiment 1 suggested that this was not the case. Five judges were presented with the ambiguous target sentences as far as the second verb and asked to indicate the referent of the pronoun. Although there was a strong tendency for assignment to the subject in most of the sentences, this

pattern was consistent over all five judges for only four out of the twelve target sentences. (See Table A 2.24 for the assignments.) Thus the target sentences did allow assignment to either the subject or the object as intended. And an examination of the reading rates for sentences which produced consistent subject assignments compared to those which did not showed that the advantage in reading rates when the pronoun referred to the subject was evident in both sets of sentences (not just consistent subject assignment sentences as might be expected if the results were due to the meaning of the particular sentences used). (See Table A 2.25.)

These considerations raise the issue of how far the results of experiments like this are constrained by the way the materials are written in the first place. The aim in this experiment was to strike a balance between making the sentences so ambiguous that assignment could not be resolved, and so unambiguous that assignment was constrained by the experimenter. In other words, there has to be room for strategies like the subject assignment strategy to manifest themselves without biasing the results through under or over constraining the assignments. This seemed to be achieved in this experiment. Readers found no difficulty in understanding the target sentences, showing that they were able to resolve pronoun assignment satisfactorily. And assignments were made to both subject and object (even though there was a preference for the subject), showing that assignment was not totally constrained by the meaning of the sentences.

While the influence of the subject of the sentence was on assignment in ambiguous sentences, in unambiguous ones, it was on the ease, and therefore speed, of assignment. In the ambiguous sentences, on the other hand, there was no effect of assignment on reading rates. Although the subject had a strong influence on assignment, those sentences in which a subject assignment was made were not read faster than those in which an object assignment was made. Similarly, the subject had no effect on verification

rates in the ambiguous sentences; the subject and object were retrieved at similar rates.

However, in the unambiguous passages, there was a main effect of the subject on verification rates. It might be useful to clarify what such a difference in verification rates means since the conditions examined in the analysis of verification rates (TS, TO, NTS, NTO) refer to the way the target sentences rather than the questions were arranged. The different conditions of the target sentences reflect differences in the referent of the subject pronoun. Correct verification of a question therefore means that the referent of the pronoun in the target sentence has been retrieved. Consequently, an analysis of verification rates by condition should reflect any differences that exist in the ease (and rate) of retrieval of different referents.

Verification rates were reliably faster when the referent was the subject rather than the object of the target sentence. This difference is rather surprising since previous research has indicated that surface, syntactic information (such as who was the subject or object of the sentence) is not stored unless there are specific memory instructions (Johnson-Laird and Stevenson, 1970). However, the results could be explained by assuming that the subject is exerting its influence as local topic of the sentence rather than as grammatical subject of the sentence. This idea is explored more fully in Experiments 19 and 20 where target sentences are passivised, thus separating the subject's deep role from first mention and local topic role.

The error data also suggest that the subject was in some way more salient. There were more errors when the pronoun referred to the object than when it referred to the subject, possibly because the referent was mistakenly remembered as the subject.

The possibility that errors were due to a problem in the initial comprehension of the target sentences was investigated by analysing the reading rates for sentences whose questions were later answered correctly or

incorrectly. There was no difference between these two sets of reading rates suggesting that errors were due to problems of retrieval rather than comprehension. It was thus considered justified to include all the sentences in the analysis of reading rates whether the questions associated with them were later answered correctly or not.

In the ambiguous passages, the strong subject assignment strategy, discussed above, was modified by an influence of the global topic of the passage. There were more assignments to the subject when it was the topic of the passages rather than the nontopic showing a preference for assigning the pronoun to the topic character. This finding is consistent with previous work which has suggested that a pronoun is likely to be assigned to the global topic (for example, Anderson et al, 1983; Sanford and Garrod, 1981). However, the preference for the topic was not a very strong effect (since it was not a main effect and only reliable by readers). An examination of the particular passages used in this experiment revealed a possible reason for this. Although the topic was more important than the nontopic in a number of ways, (for example, the topic's name was used as the title of the passage, the topic was mentioned first and much more frequently than the nontopic), in the majority of passages, by chance, the nontopic was mentioned just before the target sentence. This may have led to the temporary foregrounding of the nontopic character and therefore reduced the effect of the topic in some passages. This possibility was investigated in the next experiments (Experiments 2 and 3).

In addition to influencing assignment in the ambiguous passages, the topic also affected the reading rate of the target sentences. They were read faster when the topic rather than the nontopic was subject of the sentence. The exact locus of this effect, however, is not clear. It could be that the topic influenced the ease of reading the first part of the sentence so that the sentence was faster to read simply because the topic was the subject. If, as

many people argue, the subject of a sentence is also the local topic, it is possible that the sentence was easier to read in Condition T = S because the local topic of the sentence was then in agreement with the global topic of the passage. Alternatively, the locus of the topic's influence may be the second part of the sentence; it could have been influencing the ease of pronoun assignment. (The strong subject assignment strategy means that the pronoun was usually assigned to the topic in the T = S condition and to the nontopic in the NT = S condition.) It may even have been important in both these locations.

An attempt was made to discover whether the topic was important for its effect in the first or second part of the sentence by analysing reading rates by condition and assignment. If the topic were influencing assignment, then an interaction should have been found between condition (T = S, NT = S) and assignment to the subject or object. Reading rates should have been faster when assignment was to the topic regardless of its grammatical function. However, there was no such interaction, so it seems that the topic's effect was due to its influence on the first part of the sentence, making it easier to read when it was mentioned first. The reason for this may be that the frequency with which the topic was mentioned before the target sentence may have led to an expectation that the topic would be mentioned again. Consequently, those target sentences which began by mentioning the topic would be understood and integrated faster than those which mentioned the nontopic first. However, this is not to say that the topic had no influence in the second part of the sentence, on assignment. Indeed, the assignment data show that the topic is also important here.

It might have been expected that, since the topic was clearly the most important person in the passage, the retrieval of information about the topic necessary to answer the questions, would be easier, and therefore faster, than retrieval of information about the nontopic. However, the analysis of verification rates showed that

this was not the case in the ambiguous passages, and in the unambiguous passages, the topic was only retrieved more easily when the response required was true. The reason for this interaction with response type is not clear.

The topic also influenced the reading rates for the unambiguous target sentences. Unambiguous target sentences were read faster when the pronoun referred to the topic rather than the nontopic. So, in the unambiguous sentences the topic's influence appears to be on the ease of assignment and this is further evidence that the global topic is a likely candidate for pronoun assignment.

Thus, both local and global factors together influenced assignment whether or not there was a gender cue available. It was not the case that no other factors affected assignment in the presence of a gender cue. When there were no gender constraints on pronoun assignment, there was a strong tendency to assign the pronoun to the subject of the sentence, especially if it was also topic of the passage. In other words, a local strategy involving the subject of the sentence was most important for determining assignment, but it was modified by the influence of the discourse feature, the global topic. In addition, comprehension of ambiguous sentences was easier and faster when the topic was subject of the target sentence. This seemed to be because of the topic's position at the beginning of the sentence rather than an influence on assignment. This suggests that readers were expecting a further reference to the topic character (and this effect may have been enhanced by the fact that, in subject position, the global topic could also be said to be the local topic of the sentence).

Similarly, both the local subject and the global topic influenced assignment of pronouns constrained by gender. Since assignment could have been determined by gender alone, these effects could be considered superfluous and therefore might have been expected to disappear altogether. The fact that comprehension was faster when the assignments determined by the gender constraints were

in agreement with those prompted by these strategies suggests that these strategies always affect assignment, not only when there are no other cues to assignment. Verification rates showed that the subject was retrieved faster than the object as the referent in answer to the critical question. Whether this advantage was due to the subject's grammatical role, or whether it was because of the subject's position making it local topic of the sentence is not clear, but this is examined in a later experiment.

The results of Experiment 1 revealed an influence of the global topic on the comprehension of both ambiguous and unambiguous pronouns. However, it is not clear exactly which features of the topic were important for producing these effects. In Experiment 1, the topic was characterised by several features, so any one or a combination of them could have been important. For example, it could be that the topic was important as the person who was mentioned most frequently, or it could be something more subtle, like first mention in the passage, which was important. These questions were pursued in Experiments 2 and 3.

It was suggested that the influence of the topic may have been reduced in Experiment 1 by the mention of the nontopic immediately before some of the target sentences. The possibility of an influence of such a recency factor was examined in Experiments 2 and 3. In addition, several other aspects of the materials used in Experiment 1 were modified or controlled in an attempt to eliminate confounding variables. These are discussed in the Introduction to Experiments 2 and 3. Other issues, such as the exact role of the subject which was important, were examined in later experiments.

CHAPTER 3

FURTHER INVESTIGATION OF GLOBAL AND LOCAL FACTORS - CUMULATIVE PRESENTATION OF PASSAGES

Introduction

In Experiment 1, the topic was characterised by a number of features. The topic's name was used as the title of the passage, the first sentence was about the topic, the topic was mentioned more frequently than the nontopic and the action of the passage revolved around the topic. Consequently any one or a combination of these features could have been responsible for the topic effect. Experiments 2 and 3 reduced the features characterising the topic in an attempt to isolate those features which are important in pronoun assignment.

In contrast, another aspect of the passages used in Experiment 1 may have biased pronoun assignment to the nontopic character. Although the topic was mentioned most frequently and was generally the most important character, the nontopic was often mentioned just before the target sentence. In ten of the twelve passages the nontopic was the most recently mentioned character when the target sentence was encountered, (the exceptions being Passage 1, Mary and Passage 3, Jane). This may have led to the local foregrounding of the nontopic character and therefore a reversal of who seemed the most important character. As a result, there may have been an expectation that the nontopic would be the most likely referent of a pronoun and a consequent lessening of the effect of the global topic of the text on assignment.

Experiments 2 and 3 were designed to examine these factors in some detail with, in addition, more careful control over a number of other factors which may have influenced the results of Experiment 1.

Another consideration arising from the results of



Experiment 1 was that, since the strategies of pronoun assignment in ambiguous and unambiguous passages differed, they should be treated separately in future experiments. Hence Experiment 2 investigated ambiguous pronouns and Experiment 3 unambiguous pronouns.

The effect of topic

In order to discover the particular features of the topic which influence pronoun assignment, Experiments 2 and 3 reduced the features characterising the topic to two. The topic's name was used as the title of the passage and the topic was subject of the first sentence (a factor which Clancy, 1980 and others have found to be important for the designation of the global topic). One of the chief characteristics of the topic in Experiment 1 was the greater frequency of mention of the topic compared with the nontopic. While frequency of mention has been suggested as a factor signalling the global topic, it does not appear to be a necessary feature (see Table 1.2). In Experiments 2 and 3 an effort was made to equalise the amount of information about the two characters. An effect of topic found in these two experiments could not then be attributed to simple frequency of mention, but must be a consequence of the topic's importance signalled by the title and initial mention.

Recency of mention

In Experiment 1, by chance, the nontopic was usually the most recently mentioned character when the target sentence was encountered. It is possible that this aspect of the structure of the passages may have influenced pronoun assignment in Experiment 1. This factor was therefore systematically varied in Experiments 2 and 3. As in Experiment 1, there were six sentences in each passage and the target sentence was always the fifth sentence. Each sentence was concerned with either the topic or the

nontopic and the most recently mentioned character was varied by altering the order of sentences three and four. Obviously the order of the information presented in the passage was not crucial to the sense of the passage.

As part of the effort to equalise the amount of information about the two characters, two of the sentences before the target were about the topic and two were about the nontopic. Since one of the features of the topic was that it should be mentioned first in the passage, the first sentence was always about the topic. The second sentence was always about the nontopic. The order of sentences 3 and 4 were varied, giving the following two orders of sentences before the target.

Figure 3.1 Orders of sentences used in Experiments 2 and

3

Order X	Order Y
Sentence about topic	Sentence about topic
Sentence about nontopic	Sentence about nontopic
Sentence about topic	Sentence about nontopic
Sentence about nontopic	Sentence about topic

In Order X it is the nontopic who is the most recently mentioned character before the target sentence and in Order Y, it is the topic.

It was felt necessary to have roughly equal amounts of 'recently mentioned' information about the topic or nontopic before the target sentence, in this case one sentence of information. So sentences three and four had to be about different characters. This constraint, together with the need to have two sentences about each character before the target, made it necessary for the second sentence to be about the nontopic. The amount of 'recently mentioned' information before the target was only roughly equal because, although the total amount of information about the topic and nontopic was equal over the

first four sentences, it was not equalised by sentences. Consequently the amount of 'recently mentioned' information about the topic and the nontopic in sentence four was not necessarily equal.

Equalising the amount of information about the topic and the nontopic

The new experimental passages for Experiments 2 and 3 were based on the experimental passages used in Experiment 1. The main reason for this was that, since these experiments were designed to investigate the topic effect found in Experiment 1 in detail, it was necessary to use passages for which this effect had been demonstrated.

A propositional analysis based on Kintsch (1974) was initially used in the attempt to equalise the amount of information about the two characters. But this method presented a number of problems and was eventually abandoned. The most serious problem was that it was possible to produce different propositional analyses for the same sentence. For example, the first sentence of Passage 1, Mary, from Experiment 1 begins:

Mary usually got on very well with her younger sister Jenny...

The analysis for this, (excluding 'younger sister'), could be any one of the following:

- 3.1 ((GOT ON, MARY, JENNY)= α) & (USUALLY, α) & (VERY WELL, α)
- 3.2 ((GOT ON, MARY, JENNY, VERY WELL)= α) & (USUALLY, α)
- 3.3 ((GOT ON, MARY, JENNY)= α) & (USUALLY, α) & ((WELL, α)= β) & (VERY, β)

The problem is that there seem to be no criteria for choosing between them, a serious problem if one wants to equalise the amount of information about two people by

counting the number of propositions involving each of them. In fact a simple count of the number sentences about each character, or the number of times each one is mentioned, seems equally justified (and far easier).

Another problem with propositional analysis is that it is not clear how one should analyse such things as comparatives and adverbs. And Kintsch seems inconsistent about the level of analysis he uses, sometimes staying very close to the surface form of the text and at other times introducing new predicators, especially if these simplify the information conveyed in the text and yet still capture its meaning. But it is not clear how or why he chooses his specific predicators, e.g. CAUSE, TIME, LOCATION, NUMBER, SIZE. Moreover it is not clear whether a propositional analysis has 'psychological reality' (Sanford and Garrod, 1981).

It therefore seemed better to set up a model of the surface form of each passage indicating the syntactic category of each word or phrase and to equalise those categories which seemed important for conveying information about the characters. The eight syntactic features considered were subject, agent (the test for agent was whether the act was intended, Cruse, 1973), object, adverb, adjective, transitive verb (where 'transitive' meant a strictly transitive verb where the verb is agentive and can be converted to the passive voice, a verb which can take a direct object, a verb followed by an infinitive or a verb followed by a complement), intransitive verb (where 'intransitive' meant all those verbs not included as 'transitive', such as those followed by a prepositional phrase) and possessive.

The passages used in Experiment 1 were first analysed according to these categories and the number of times the topic, the nontopic, both or other characters were associated with each of these categories was noted. For transitive and intransitive verbs this meant that the number of times each character was an argument of one of these verbs was recorded. For adverbs and adjectives, the

number of times each character was subject of a verb qualified by an adverb or described by an adjective was recorded. From this analysis, it was clear that the topic was mentioned much more frequently than the nontopic. The passages were then rewritten so that the number of these categories associated with the topic and nontopic in the first four sentences was equal. The rewritten passages were used in Experiments 2 and 3. Only the first four sentences were analysed and equalised according to their syntactic categories since it was only necessary to equalise the amount of information about the two characters before the target sentence.

Table A 3.1 shows the results of the analysis for the experimental passages used in Experiments 2 and 3 in terms of the number of syntactic categories associated with the topic, the nontopic, both the topic and nontopic together and other characters over the first four sentences of each passage (that is, before the target sentence). The number of categories involving both the topic and nontopic and other characters was simply noted and not manipulated in any way. Table A 3.2 shows a detailed model of the syntax of the first four sentences of one of the passages from which the count displayed in Table A 3.1 was derived.

Other controls over materials

The length of most of the target sentences was reduced so that extra information, other than that involved in pronoun assignment, was discarded. Five of the twelve target sentences, (in Passages 1, 3, 5, 11 and 12) were exactly the same as those used in Experiment 1. The remaining seven were changed so that only the clause mentioning the topic and nontopic by name and the pronominal clause remained. For example, the target sentence from Passage 8 was changed from 3.4 to 3.5.

3.4 Diane liked Nicola straight away and after they had been talking for a while she asked her if she enjoyed sailing.

3.5 Diane liked Nicola straight away and she asked her if she enjoyed sailing.

The sixth and final sentence was also changed in the majority of passages to make it as short as possible without sounding abrupt. This was to minimise any memory difficulties readers may have had when answering the critical question as a result of information in sentence six intervening between the target sentence and the question. The number of words in this final sentence was reduced to between six and twelve.

A number of other features which may have influenced reference assignment in Experiment 1 were also considered. These were controlled or eliminated as far as possible. For example, it was considered important that there should be no breaks in the continuity of time or situation within a passage because such breaks are often associated with a shift, or expectation of a shift, in topic (Henderson, 1982). This would have the unfortunate consequence of upsetting the designation of topic and nontopic characters so all such breaks were avoided.

Ambiguities of reference (other than those intended in the ambiguous passages) were also avoided. An independent judge checked the experimental passages to ensure that there were no ambiguities and no time or situation breaks.

The constraints described above naturally only applied to the experimental passages. The filler passages were similar to the experimental passages in length and style. They were the same passages as those used as fillers in Experiment 1 (see example in Table A 2.2), except that fourteen instead of fifteen passages were used.

The questions used in Experiments 2 and 3 were based on those used in Experiment 1, but certain changes were made. Some changes had to be made to make the questions

consistent with the content of the new passages, but in addition more fundamental changes concerned which aspects of the passage were questioned. The critical question remained the same as in Experiment 1, probing the assignment of the pronouns in the second clause of the target sentence. In Experiment 3, this question always required the response 'true' (to avoid the necessity of separating true and false responses in the analysis of verification rates). The second question was about the topic. But the third question was no longer a general one, instead it was about the nontopic. This was partly to preserve the equality of treatment of the two characters, so that readers did not become aware, for instance, that questions were always concerned with the character whose name was used in the title. And it was partly because it was easier and more natural to ask questions about the nontopic when half the passage was about that character.

In Experiments 2 and 3 the first two questions for the filler passages consisted of one about the 'topic' (whose name was used as the title) and one general question, as in Experiment 1. (The actual questions used differed in some passages.) However, in Experiment 2 the third question was about the nontopic. In Experiment 3, the third question was about both the topic and the nontopic and required the answer 'false'. This was to counterbalance the numbers of true and false responses to questions involving the topic and nontopic.

EXPERIMENT 2 - Ambiguous passages

Method

Subjects

Twenty four students from Durham University volunteered to take part in Experiment 2.

Summary of materials

A detailed description of the construction of the materials for this experiment has been presented in the Introduction. In all other respects, the materials were the same as the ambiguous passages in Experiment 1. The experimental passages and associated questions can be seen in Table A 3.3.

Design

Two factors were varied in this experiment; order of sentences before the target sentence, and whether the topic or nontopic was subject of the target sentence. Both were within subjects factors. A Latin square design was used to determine the allocation of condition to a particular passage. This ensured that each reader saw three passages in each condition. Six readers were presented with the passages in the conditions indicated by each row of the Latin square. The order of experimental questions and question type were counterbalanced across conditions, readers and passages. For each condition, half the critical questions were type (a) and half were type (b). The order of presentation of passages to each reader was randomised.

The critical question probing the assignments made in the target sentence had no right or wrong answer, but for the rest of the questions, half required the answer 'true' and half 'false'.

There was only one version of each filler passage, and the question order 1 (see Table A 2.4) was used throughout. The number of 'true' and 'false' answers required for correct answers was equalised across passages. Each filler passage required either two 'true' and one 'false' answer, or one 'true' and two 'false' answers.

Procedure

As in Experiment 1, a self-paced reading task was used, and the procedure was essentially the same as in that experiment with cumulative presentation of the sentences in the passage. However, a few minor changes were made. For example, reading and verification times were measured in ms rather than jiffies. Timing in ms (accurate to within 0.04 ms in every 100ms) was achieved using a machine language routine (Stevenson, Thompson and Kleinman, 1981) incorporated into the programme running the experiment.

The instructions were changed slightly in an effort to make them clearer but they were essentially the same as in Experiment 1.

Since there were fourteen instead of fifteen filler passages, after the practice passages, the remaining passages were presented in four blocks of six passages.

In all other respects the procedure was identical to that of Experiment 1.

Results

The number of errors made on both experimental and filler questions (excluding the critical questions for which there was no right or wrong answer) ranged from 1 to 10 with a mean of 4.04.

Assignments

The number of assignments made to the subject and object of the target sentence was examined by condition. The total number of assignments can be seen in Table 3.1 below. (The number of assignments in each passage can be seen in Table A 3.4.)

Table 3.1 Assignments to the subject and object by condition - Experiment 2

	<u>Topic most recently mentioned</u>		
Assignment to	T = S	NT = S	\bar{x}
SUBJECT	55	53	54
OBJECT	16	19	18

	<u>Nontopic most recently mentioned</u>		
Assignment to	T = S	NT = S	\bar{x}
SUBJECT	59	56	58
OBJECT	12	14	13

Analyses of variance indicated that there were many more assignments to the subject than to the object in all four conditions (Min $F' = 32.05$, $df = 1, 17$, $p < .01$). But there was no difference in the pattern of assignments as a function of whether topic or nontopic was subject of the target sentence or the most recently mentioned character and no significant interactions. (The summary tables for these analyses can be seen in Table A 3.5.)

Reading rates

Reading times (in ms) were divided by the number of words in the target sentence, and then divided into 1,000 to produce reading rates in words per second. (The number of words in each sentence is shown in Table A 3.6.) One very fast time was eliminated from the data at this stage.

The mean reading rate for each condition is shown in Table 3.2 below. (The means for each passage are shown in Table A 3.7.)

Table 3.2 Mean reading rates (words per second) by
condition - Experiment 2

	Most recently mentioned TOPIC (Order Y)	NONTOPIC (Order X)	\bar{x}
T = S	4.01	4.04	4.03
NT = S	3.66	3.60	3.63
\bar{x}	3.84	3.82	

Analyses of variance indicated that the only reliable difference was between sentences where the topic was subject and those where the nontopic was subject, and this was only reliable by readers ($F_1 = 6.78$, $df = 1, 23$, $p < .05$; $F_2 = 3.06$, $df = 1, 11$, $p > .1$). This difference was due to faster reading rates when the topic rather than the nontopic was subject of the sentence. But the reading rates were not affected by whether the topic or nontopic was the most recently mentioned character and there was no interaction. (See Table A 3.8 for the summary tables.)

The data were then separated into those in which subject assignments had been made and those in which object assignments had been made (see Table A 3.9 for passage means). Problems with missing scores meant that analyses were only carried out on those sentences where subject

assignments had occurred. The resulting means are shown in Table 3.3. (The data were collapsed over order since this had no effect in the previous analysis.)

Table 3.3 Mean reading rates (words per second) by condition, subject assignments only - Experiment 2

T = S	NT = S
4.08	3.54

Analysis of variance indicated that reading rates were reliably faster when the topic was subject than when the nontopic was subject (Min $F' = 4.24$, $df = 1, 29$, $p < .05$). (See Table A 3.10 for the summary tables.)

Verification rates

The verification data were converted from times (in ms) to rates by dividing the times into 10,000. Four rates were missing from the data because the PET screen had gone blank just as the question appeared. One score from one reader was missing because all responses in one condition were 'true'. This score was replaced using Winer's formula for missing scores (Winer, 1970).

Of the two factors varied in Experiment 2, only topic or nontopic as subject of the target sentence was included in the analysis of verification rates since the consideration of recency of mention as well would have caused problems with missing scores.

The mean verification rates are shown in Table 3.4. (The means for each passage are shown in Table A 3.11.)

Table 3.4 Mean verification rates by condition and response - Experiment 2

Response	T = S	NT = S	\bar{x}
TRUE	4.22	3.86	4.04
FALSE	3.38	3.49	3.44
\bar{x}	3.80	3.68	

As expected from the previous experiment, 'true' responses were reliably faster than 'false' ones (Min F' = 5.74, df = 1, 32, p <.05). But the only other reliable difference was in the F₂ analysis where the questions about sentences where the topic was subject were verified faster than those where the nontopic was subject, (F₂ = 6.13, df = 1, 11, p <.05). This difference was not significant by readers (F₁ <.1) and there was no significant interaction. (See Table A 3.12 for the summary tables.)

EXPERIMENT 3 - Unambiguous passages

Method

Subjects

Forty eight readers were used in this experiment. All were schoolchildren aged over fifteen or teachers.

Summary of materials

The materials are described in the Introduction. The experimental passages were the unambiguous counterparts of those used in Experiment 2 (see Table A 3.3). In all other respects the materials were the same as the unambiguous passages in Experiment 1.

Design and Procedure

Three factors were varied in this experiment. Factor one was whether the pronoun referred to the topic or the nontopic, factor two was whether the pronoun referred to the subject or the object and factor three was the order of sentences (X or Y). Factors one and two were within subjects factors and factor three was a between subjects factor. As in Experiments 1 and 2, a Latin square was used to determine the allocation of a condition to a particular passage. Six readers were presented with the passages in the conditions indicated by each row of the Latin square. Separate Latin squares were used to determine allocation within Order X and Order Y. The order of presentation of passages was randomised for each reader.

As in Experiment 2, the order of experimental questions was varied across readers, passages and condition. The version of the critical question used was purposely confounded with condition so that the correct answer to the critical question always required a 'true'

response.

There was only one version of each filler passage, as in Experiment 2, but the order of filler questions was varied in this experiment. This was considered desirable so that the question about the topic and nontopic did not always occur last (as it would if the filler questions always occurred in order 1). But, unlike the experimental questions, the order of filler questions was varied across passages only (not across readers, conditions and passages). The order of questions used with each filler passage is shown in Table A 3.13. The total number of 'true' and 'false' responses required for correct answers was equalised for each type of question. In all other respects, the design and procedure were the same as for Experiment 2.

Results

The number of errors made on all questions ranged from 0 to 17 with a mean of 6.75.

Reading rates

There were three scores missing from the data, and another had to be eliminated because it was less than the criterion of 50 ms per word. Rates were calculated as before.

The mean reading rates by condition are shown below in Table 3.5. (The means for each passage are shown in Table A 3.14.)

Table 3.5 Mean reading rates (words per second) by condition - Experiment 3

<u>Topic most recently mentioned (ORDER Y)</u>			
<u>Pronoun referent</u>	<u>TOPIC</u>	<u>NONTOPIC</u>	<u>\bar{x}</u>
SUBJECT	3.76	3.72	3.74
OBJECT	3.51	3.66	3.59
\bar{x}	3.64	3.69	

<u>Nontopic most recently mentioned (ORDER X)</u>			
<u>Pronoun referent</u>	<u>TOPIC</u>	<u>NONTOPIC</u>	<u>\bar{x}</u>
SUBJECT	3.96	3.54	3.75
OBJECT	3.56	3.71	3.64
\bar{x}	3.76	3.63	

Analyses of variance indicated no significant effects. (The summary tables are shown in Tables A 3.15.)

As in Experiment 1, reading rates for sentences whose questions were later answered correctly were compared with those for sentences whose questions were later answered incorrectly. Analysis of variance indicated that reading rates were faster for incorrect sentences than correct ones, but this difference was only reliable by readers ($F_1 = 5.43$, $df = 1, 39$, $p < .05$) and not by passages ($F_2 < 1$) nor on the Min F' test (Min F' < 1). (See Table A 3.17 for the summary tables and Table A 3.16 for the passage means.)

Verification rates

All correct verification times were converted from ms to rates by dividing them into 10,000. None had to be excluded for being too fast. But there were 91 scores missing from the data as a result of the exclusion of incorrect responses. An additional eight were missing

questions where the referent retrieved was the subject and those where it was the object, the subject being retrieved more quickly. The difference was marginally reliable by readers ($F_1 = 3.46$, $df = 1, 46$, $p = .066$) and by passages ($F_2 = 3.53$, $df = 1, 11$, $p = .084$). (See Table A 3.19 for the summary tables.) The distribution of errors across conditions suggests that there were more errors when the referent was the object rather than the subject. Recency of mention and whether the pronoun referred to the topic or the nontopic seemed to have little effect on the number of errors.

Discussion

Overall, these two experiments showed that, in ambiguous passages, subject assignments were more frequent than object assignments and reading rates were faster when the topic was subject than when the nontopic was subject (particularly when only subject assignments were considered). There was also a suggestion of an effect of the topic on verification rates in the ambiguous passages. In the unambiguous passages, there were no reliable effects of either the topic of the passage or the subject of the sentence (except for a suggestion of an influence of the subject on verification rates). Recency of mention showed no reliable effects in either type of passage.

In comparison to Experiment 1, the effect of the topic appears to be reduced as a result of the manipulations of the materials. Its effect was reduced in both Experiment 2 and Experiment 3 but the reduction was most marked in Experiment 3 where the effect disappeared altogether. The question then arises of how far the topic can still be regarded as such, that is, whether the topic was still the most important character in the text, as has been assumed.

In order to answer this, an independent check on the materials was carried out where judges were asked to read each passage in the different versions used in Experiments 2 and 3 and to indicate whether one person appeared more important than the others in each passage. At the same time the judges were asked to rate the target sentence for its importance to the passage as a whole. This was to find out whether this sentence stood out from the rest in any way.

Considering the ambiguous passages first, twenty sixth-form judges were asked to rate the importance of each target sentence on a scale from one to five (where one meant unimportant and five very important). They were also asked to write the name of the person (if any) who seemed most important at the end of each passage. Most of the target sentence importance ratings were around the middle

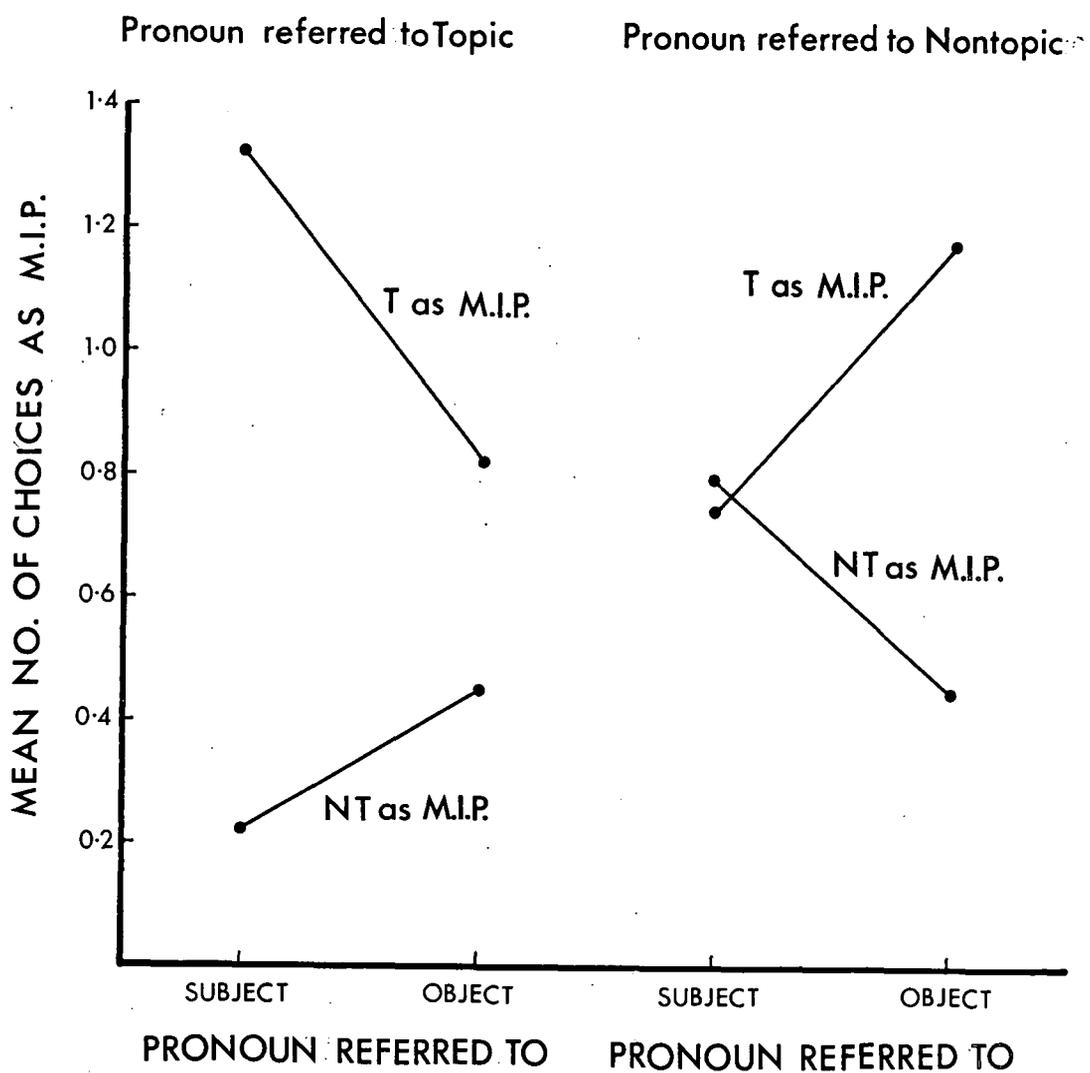
of the scale and they showed little variation with condition. (See Table A 3.20 for the individual passage results and Table A 3.21 for the mean ratings by condition. Analysis of ratings where T = S and where NT = S showed no significant difference - see Table A 3.22 for the passage means and Table A 3.23 for the summary tables.) However, analyses of variance of the choices of most important person showed that the topic character was more likely to be chosen than the nontopic ($F_1 = 5.86$, $df = 1, 19$, $p < .05$; $F_2 = 4.66$, $df = 1, 11$, $p = .052$; $\text{Min } F' = 2.60$, $df = 1, 26$, $p > .1$). However, there were also many choices of neither character (see Table A 3.24 for the full passage results). There was no effect of condition (the order variable was not included) and no interaction. (See Table A 3.25 for the passage data and Table A 3.26 for the summary tables.) The reliable preference for the topic suggests that the topic is justifiably considered the most important person in the ambiguous passages used in Experiment 2, or at least more important than the nontopic.

Forty sixth-form judges were asked to rate the importance of each target sentence and to judge who was the most important person in the unambiguous passages. Again, there was little variation in the target sentence importance ratings by condition (see Table A 3.27 for the individual passage results and Table A 3.28 for the overall mean ratings by condition) and the ratings were mostly around the middle of the range. (Analysis showed no significant difference by condition - see Table A 3.29 for the passage means and Table A 3.30 for the summary tables.) Thus, in neither the ambiguous nor the unambiguous passages did the target sentence appear to stand out as especially important in the passage and its importance did not seem to vary with condition.

The topic was chosen as the most important person more often than the nontopic in the unambiguous passages as well as in the ambiguous ones (see Table A 3.31 for the full passage results). Analysis of the number of times the topic or nontopic was chosen as the most important

character revealed a reliably greater number of choices of the topic (Min $F' = 11.70$, $df = 1, 22$, $p < .01$) and a two way interaction between the pronoun referring to the topic or nontopic and the choice of the topic or nontopic as the most important person, although this was only significant by readers ($F_1 = 6.15$, $df = 1, 39$, $p < .05$). However, there was also a three way interaction between the pronoun referring to the subject or object, the pronoun referring to the topic or nontopic and the choice of the topic or nontopic as the most important person (Min $F' = 6.49$, $df = 1, 37$, $p < .05$). This interaction is illustrated in Figure 3.2. (See Table A 3.32 for the passage data and Table A 3.33 for the summary tables.)

Figure 3.2 Frequency with which the topic and nontopic
were chosen as the most important person by condition -
materials from Experiment 3



Thus, the original designation of characters as topic and nontopic in Experiments 2 and 3 seems justifiable since the topic was chosen more frequently than the nontopic as the most important person. The only exception was in the unambiguous passages where the nontopic was just as likely as the topic (not more likely) to be chosen as the most important person in Condition NTS where the pronoun referred to the nontopic and subject of the sentence (see Figure 3.2). This may have been because in this condition an extra sentence, namely the target sentence, appeared to be 'about' the nontopic (since the nontopic was subject and the pronoun in the second clause referred to the nontopic).

Thus, although the effect of the topic was reduced in Experiments 2 and 3 to the extent of disappearing altogether in Experiment 3, the judgement study showed that the topic was perceived as more important than the nontopic in the passages used in these experiments.

However, the topic still affected reading rates in the ambiguous passages of Experiment 2, even though its effect was diminished in comparison to Experiment 1. The strong subject assignment strategy identified in Experiment 1 was also evident in Experiment 2, but it was no longer modified by a topic effect. Evidently the topic must be very obviously more important than the other characters in a passage before it is preferred as the referent for an ambiguous pronoun. When the only features defining it as more important are the use of its name in the title and first mention in the passage, as in Experiment 2, then this does not appear to be enough to warrant the expectation that this character is most likely to be the referent of a pronoun. Nevertheless, while the topic defined in this way does not seem important enough to influence assignment itself, there still seems to be an expectation that this character is more likely than others to be a referent. This is evident from the reading rates of Experiment 2.

As in Experiment 1, the question arises of where the topic's influence is occurring in Experiment 2. It could be that the sentence is easier to understand when the topic

is subject because it then becomes a sentence about the topic, and this is what is expected on the basis of the preceding passage. (If the subject is considered to be the local topic of the sentence, then faster reading rates may reflect the fact that the local topic matches the global topic of the passage.) On the other hand, it could be that the topic is important in the second part of the sentence and faster reading rates when the topic is subject is the result of the fact that assignment is then to the topic rather than the nontopic. (Assignment was not constrained so that the topic was always referent when it was the subject of the sentence, but the strong subject assignment strategy observed makes this a reasonable assumption.) The fact that the topic did not receive more assignments than the nontopic makes it more likely that the the first explanation is true, that is, that the topic's influence on reading rates was the result of its position at the beginning of the sentence. This seemed to be the explanation in Experiment 1. However, the analysis of subject assignments alone, (where assignment was known to be to the topic when the topic was subject, and to the nontopic when the nontopic was subject), showed a stronger effect of the topic than the analysis of reading rates by condition alone, where both subject and object assignments were combined. While this does not preclude the first interpretation, it seems to support the idea that the topic is influencing the ease of assignment. Ideally, an analysis of the object assignment data would clarify this discussion. Unfortunately there was not enough data to allow such an analysis. But, when reading rates for those passages which produced consistent subject assignments and those which did not in an independent check on materials were separately examined (see Table A 3.34), the difference between $T = S$ and $NT = S$ appeared confined to those which produced consistent subject assignments (see Table A 3.35). This also suggests an effect of the topic on the second part of the sentence, that is, on assignment.

Overall then, the evidence seems to point towards an

influence of the topic on assignment in Experiment 2, that is, on the second part of the sentence. This is in contrast to the conclusion drawn in Experiment 1 that the topic was exerting its influence on the first part of the sentence. However, the effect of the topic on reading rates in Experiment 2 was not a strong one and the alternative interpretation, which seemed most likely in Experiment 1, cannot be completely ruled out. This issue is pursued further in later experiments (see Chapter 6) where the target sentences were split in two so that the two halves could be timed separately.

In addition to its effect on reading rates, the topic also seemed to influence verification rates in Experiment 2. The retrieval of the topic as referent in answer to the critical question appeared easier and faster than retrieval of the nontopic. But this effect on verification rates, like that on reading rates, was not very strong, being reliable by passages only. However, it seems for some readers at least, the retrieval of the referent they chose was easier when the topic rather than the nontopic was subject of the target sentence. Since there were many more subject assignments than object assignments, this implies that verification was easier when the referent was the topic rather than the nontopic.

Overall then, although the topic does influence the ease of comprehension in Experiment 2, the strength of this influence is diminished in comparison to Experiment 1. There are a number of possible reasons for this. The most obvious is that in Experiment 2 the topic is no longer mentioned more frequently than the nontopic. In addition, the number of sentences about the topic near the beginning of the passage is reduced from two or three in the majority of passages in Experiment 1, to only one in Experiment 2. With so much information about the topic near the beginning of the passage, as well as the topic's name as title, this character would have been clearly established as the most important person by the time the target sentence was encountered in Experiment 1. In Experiment 2, however, the

topic's name was used as the title, but only the first sentence served to introduce this character as the one whom the passage was about. The nontopic was introduced in the second sentence and this may have reduced the perceived importance of the topic character. Sanford and Garrod (1981) claim that both the topic and repeatedly referenced prior concepts are likely to be chosen as pronoun antecedents. The topic in Experiment 1 satisfied both these criteria whereas the topic in these experiments only the first. Another difference between the two experiments which may have been important is the amount of extra information, irrelevant to assignment, contained in the target sentences of Experiment 1, but not Experiment 2. While this change may have been expected to draw attention to the ambiguity of assignment, and therefore increase the influence of the topic, this was obviously not the case in terms of the number of assignments made to the topic character. However, it may explain why the topic was retrieved faster than the nontopic in Experiment 2, but not Experiment 1, if memory for assignment was improved by the simplification of the sentence.

As already mentioned, the topic appeared to have no effect in the unambiguous passages of Experiment 3, either in terms of reading or verification rates. There was an effect of topic on the reading rates for unambiguous passages in Experiment 1, so it seems that the reduction in the number of features characterising the topic removed its influence in Experiment 3. Consequently, it appears that when assignment is constrained by gender, discourse features like topic have to be very obviously important in order for them to be effective. The independent topic ratings showed that the topic was perceived as more important than the other characters in the passages, but it seems that it was not important enough to create an expectation that it would be the referent of a pronoun. It makes sense that these features are less important when there are gender cues (as in Experiment 3) than when there are no such cues (as in Experiment 2), but they might still

have been expected to surface in some way if they are general strategies employed to aid comprehension. Either the measures taken were not sensitive enough, or these strategies only operate when the cues indicating that features such as topic will be useful, are very strong. Since the measures taken in this experiment have been shown to be sensitive in Experiment 1, the latter seems the most likely explanation.

The topic did influence the ease of assignment for unambiguous pronouns in Experiment 1, and the possible reasons for the reduction of the topic's influence in Experiment 3 are much the same as those discussed in relation to Experiment 2. Firstly, the topic was mentioned much more frequently than the nontopic in Experiment 1, but not in Experiment 3. Secondly, the majority of passages in Experiment 1 referred to only the topic character in the first two or three sentences, while in Experiment 3 the nontopic was always introduced in the second sentence. And thirdly, the target sentences were simpler in Experiment 3 than in Experiment 1. This may have made it easier to rely on gender cues for assignment without activating other strategies.

There is, however, a suggestion of an effect of grammatical function on verification rates in Experiment 3. There were more errors when the referent to be retrieved was the object rather than the subject and verification rates were faster when the critical question required the retrieval of the subject rather than the object as the referent. This effect was also found in Experiment 1 and, as mentioned in the discussion of that experiment, it is not clear whether the subject's advantage was due to its grammatical function or its position at the beginning of the sentence, making it local topic of the sentence. The separation of the subject's grammatical role from its role as the first person mentioned in the sentence is necessary to resolve this question. This is examined in later experiments (see Chapter 8). There is a third possibility in Experiment 3. Because it was necessary to make the

response to all correct answers 'true', it is possible that verification rates were faster when the subject was the referent because then the order of names in the question matched the order in the target sentence whereas when the referent required was the object, the order of names in the question was opposite to that in the target sentence. However, this explanation is unlikely since the effect was also found (and was stronger) in Experiment 1 where such an interpretation was impossible.

Overall, then, the reduction in the number of features characterising the topic seems to have reduced its influence on pronoun assignment. If there was any one feature that produced its influence in Experiment 1, it was not the use of its name as the title of the passage, or its first mention in the passage. Since there was still some effect of topic in Experiment 2, it also makes it unlikely that one of those features eliminated from Experiments 2 and 3 (such as frequency of mention) was wholly responsible. Instead, it seems more likely that it was a combination of the features, all increasing the perceived importance of this character, which was responsible for the topic's effect in Experiment 1. The reduction in the topic's influence was much greater in the unambiguous passages of Experiment 3 than in the ambiguous passages of Experiment 2. It seems that where there are strong local cues to assignment, such as gender cues, the effect of this global factor is reduced. It is also not clear whether the topic had any influence over assignment in the ambiguous passages. Although there was an effect of topic on reading and verification rates, these could have been due to its effect on the first part of the sentence rather than on assignment, although the evidence suggests that assignment to the topic was easier than assignment to the nontopic. The question of the locus of the topic's effect is pursued in later experiments (see Chapter 6).

The subject assignment strategy identified in Experiment 1, was not affected by the changes made to the ambiguous passages in Experiment 2. However, the subject's

effect was reduced in the unambiguous passages of Experiment 3. There was no longer an advantage in reading rates when the pronoun referred to the subject. In fact, this effect was not very strong in Experiment 1, being reliable by readers only. The effect of grammatical function on verification rates was also reduced, possibly because of the simplification of the target sentences, although this is by no means clear.

It was suggested in the discussion of Experiment 1, that the topic's influence on assignment of ambiguous pronouns (which was only significant by readers) may have been stronger if it were not for the fact that, by chance, the nontopic happened to be mentioned just before the target sentence in the majority of passages. However, this seems unlikely in view of the fact that that the manipulation of the most recently mentioned character had no effect on assignments, reading rates or verification rates in either Experiment 2 or Experiment 3. The ease of pronoun assignment in the target sentences seemed to depend entirely on local factors within the sentence itself and overall features of the passage as a whole, and not on local shifts in the characters mentioned in the previous sentence.

The reduction of the effect of topic on assignments and reading rates in Experiment 2 prompted a consideration of the procedure employed in the first three experiments. In all three experiments, the sentences were presented cumulatively; once a sentence had appeared on the screen, it stayed there until the end of the passage. Consequently, there was no way of ensuring that the reading time for the target sentence represented the reading time for that sentence alone. It is possible that readers were looking back over previous sentences and that this time was being incorporated into the reading time for the target sentence. This would have been particularly tempting in the ambiguous passages where pronoun assignment was not constrained by gender cues. In addition, it may have been a particular problem in Experiment 2 where the target

sentences were simplified in comparison to Experiment 1, since this may have drawn attention to the ambiguity of the pronouns. If it was the case that looking back over previous sentences occurred more often in Experiment 2 than in Experiment 1, then this might explain the reduction of the reading time effects in this experiment since the accuracy of the timing, necessary to reveal these effects, would be reduced. It could also explain the absence of the impact of the global topic on assignments if the ambiguity of the assignments were more obvious in Experiment 2, although this explanation seems less likely than one based on the reduction of the number of features characterising the topic. Nevertheless, these possibilities were examined in the next experiments (Experiments 4 and 5). These were direct replications of Experiments 2 and 3, except that the procedure was changed so that once a sentence had been read and understood, the sentence disappeared before the next one was presented. This is referred to as overlaid presentation of sentences. This allowed more accurate measurement of reading times for individual sentences, although it also introduced a new dimension to the task in the form of a memory load.

CHAPTER 4

GLOBAL AND LOCAL FACTORS - OVERLAID PRESENTATION OF PASSAGES

Introduction

The cumulative method of presentation used in the first three experiments involved presenting the sentences of a passage one at a time, but once a sentence had appeared on the screen, it stayed there until the end of the passage. This method of presentation created a problem which may have interfered with the results of the previous experiments: It was not possible to guarantee that the reading time measured was for one sentence only. There was nothing to prevent readers from looking back over previous sentences and, if they did, this time would be included in the reading time for the last sentence presented. If readers happened to ask whether such looking back was permissible they were discouraged from doing so. Otherwise nothing was said about it on the grounds that if it was mentioned, readers might be tempted to do something which otherwise would not have occurred to them.

Observation of reading times for successive sentences in the passages showed a tendency for reading times to increase as the passages progressed. It is possible that this is a reflection of the fact that readers were looking back over previous sentences. Sentences towards the end of the passage may take longer to read since there is more information to check back over. However, there is evidence to suggest that reading times increase in this way in any case (Carpenter and Just, 1977). In order to investigate whether the reading times for the target sentences in the first three experiments were inaccurate because of scanning back over previous text, an alternative procedure was employed which allowed accurate measurement of the reading

times. This involved an overlaid presentation of the sentences of a passage. Sentences were presented one at a time, as before, but once a sentence had been read, it was cleared from the screen before the next one was presented. Thus, sentences appeared one after another in the centre of the screen. This procedural change formed the basis of Experiments 4 and 5. One aim of these experiments was therefore to test the reliability of the findings of the first three experiments using a different procedure. The reliability of Experiments 2 and 3 in particular were examined since the passages used in Experiments 4 and 5 were identical to those used in Experiments 2 and 3.

Although the main purpose behind the procedural modification was to allow reading times for individual sentences to be measured more accurately, it also changed the memory requirements of the task. Readers were aware that they would not have the opportunity to look back in the text if they needed to clarify information. This has the unfortunate, but unavoidable, consequence of making the reading situation rather unnatural. But, in addition, it introduces the possibility that readers might use different strategies while reading passages in these circumstances (see Aaronson and Ferres, 1984). This possibility is acknowledged during the analysis of the results of these experiments. Reading and verification rates, in particular, were examined with this in mind; for example, different strategies could be reflected in an overall increase in reading times in comparison to Experiments 2 and 3 (which would suggest an attempt to memorise the sentences in some way), and/or a difference in the verification rates and number of errors (which would suggest different retrieval strategies).

EXPERIMENT 4 - Ambiguous passages, overlaid presentation

Method

Subjects

Twenty four students from Durham and Newcastle Universities took part in this experiment.

Summary of materials

The twelve experimental passages were the same as those used in Experiment 2 (see Table A 3.3). As in Experiment 2, there were four possible versions of each passage as a result of varying the order of the first four sentences (so that topic or nontopic was most recently mentioned) and varying whether the topic or nontopic was subject of the target sentence. Twelve of the fourteen filler passages from Experiment 2 were used in Experiment 4. The number was reduced in an attempt to prevent the problem of the screen going blank, thought to be caused by the demands on the PET's memory capacity. The questions associated with the filler passages were the same as in Experiment 2. Two filler passages were presented as practice passages.

Design

The design was exactly the same as that used in Experiment 2.

Procedure

The procedure was identical to that used in Experiment 2 except for the following changes. Each sentence disappeared as soon as the reader indicated that it had been read and understood. Sentences were consequently presented half way down the screen, starting at the extreme

left, instead of following on from each other as they did in Experiment 2. The title was also presented in the middle of the screen. The instructions to the readers were modified accordingly.

The only other difference in procedure was that, because the number of filler passages was reduced, the practice passages were counted in the first of the four blocks of six passages.

Results and Discussion

The number of errors on all questions (except the critical questions for which there were no right or wrong answers) ranged from 0 to 9, with a mean of 1.88.

Assignments

The number of assignments to the subject and object in each condition can be seen in Table 4.1. (The number of assignments in each passage are shown in Table A 4.1.)

Table 4.1 Assignments to the subject and object by
condition - Experiment 4

Topic most recently mentioned (ORDER Y)

Assignment to

	SUBJECT	OBJECT
T = S	61	11
NT = S	64	8
\bar{x}	63	10

Nontopic most recently mentioned (ORDER X)

Assignment to

	SUBJECT	OBJECT
T = S	62	10
NT = S	59	13
\bar{x}	61	12

Analyses of variance showed that the subject was chosen more often than the object as the referent of the pronoun (Min $F' = 71.17$, $df = 1, 18$, $p < .01$). There was no effect of the topic or nontopic as subject of the sentence, no effect of the order of presentation and no interactions. (See Table A 4.2 for the summary tables.)

Reading rates

There were two missing scores as a result of the screen going blank just before the presentation of the target sentence and one very fast time was excluded from the data. The remaining reading times (in ms) were transformed into rates as before.

The mean reading rate for each condition is shown below in Table 4.2. (The means for each passage are shown in Table A 4.3.)

Table 4.2 Mean reading rates (words per second) by
condition - Experiment 4

	Most recently mentioned		
	TOPIC	NONTOPIC	\bar{x}
T = S	3.63	3.91	3.77
NT = S	3.69	3.26	3.48
\bar{x}	3.66	3.59	

Analyses of variance revealed no influence of order of presentation and very little effect of the topic or nontopic as subject or the target sentence. Sentences were read faster when the topic rather than the nontopic was subject of the target sentence, but this difference was only marginally significant by readers ($F_1 = 3.35$, $df = 1, 23$, $p = .077$) and not significant at all by passages ($F_2 < 1$). There was no significant interaction. (The summary tables can be seen in Table A 4.4.)

The data were then separated into those where assignments were made to the subject and those where assignments were made to the object. (See Table A 4.5 for the passage means.) Problems with missing scores meant that, as in Experiment 2, analysis was only carried out on those sentences where subject assignments had been made. The resulting means are shown in Table 4.3 below. (The data were collapsed over order since this had no effect in the previous analysis.)

Table 4.3 Mean reading rates (words per second) by condition, subject assignments only - Experiment 4

T = S	NT = S
3.86	3.47

Analyses of variance revealed an increase in reading rates when the topic rather than the nontopic was subject of the sentence. But this was only reliable on the F_1 analysis ($F_1 = 5.19$, $df = 1$, 23 $p < .05$) and not on the F_2 analysis ($F_2 < 1$). (See Table A 4.6 for the summary tables.)

Verification rates

The verification times were converted to rates as before. Recency of mention was excluded from this analysis for the same reasons as in Experiment 2 and also because it had no effect in Experiment 3. Four means were missing from the F_1 data and were replaced using Winer's formula (Winer, 1970). The overall means by condition and response are shown in Table 4.4. (The means for each passage are shown in Table A 4.7.)

Table 4.4 Mean verification rates by condition and response - Experiment 4

Response	T = S	NT = S	\bar{x}
TRUE	3.30	3.19	3.25
FALSE	2.39	2.94	2.67
\bar{x}	2.85	3.07	

Analyses of variance showed that there was a reliable difference between 'true' and 'false' response rates (Min $F' = 5.90$, $df = 1, 25$, $p < .05$). 'True' responses were reliably faster than 'false' responses. There was a suggestion that verification rates were faster when the nontopic was subject but this difference was only reliable at the 5% level on the F_2 analysis ($F_2 = 5.08$, $df = 1, 11$, $p < .05$) and only marginally significant on the F_1 analysis ($F_1 = 3.34$, $df = 1, 23$, $p = .077$; Min $F' = 2.02$, $df = 1, 33$, $p > .1$). However, this effect was modified by an interaction between the subject of the target sentence and response type: Verification rates were only faster when the nontopic rather than the topic was subject for 'false' responses. Again, this interaction was only reliable at the 5% level by passages ($F_2 = 5.19$, $df = 1, 11$, $p < .05$) and not by readers ($F_1 = 4.09$, $df = 1, 19$, $p = .052$; Min $F' = 2.29$, $df = 1, 29$, $p > .1$). The main feature of the interaction was that the difference in verification rates for 'true' and 'false' responses was greater for questions whose associated target sentences had topic as subject. (The summary tables are shown in Table A 4.8.)

EXPERIMENT 5 - Unambiguous passages, overlaid presentation

Method

Subjects

Forty eight schoolchildren, aged from fifteen to eighteen, took part in this experiment.

Summary of materials

The twelve experimental passages and questions and the fourteen filler passages and questions were the same as those used in Experiment 3. (The experimental passages were the unambiguous versions of those shown in Table A 3.3.)

Design

The design of Experiment 5 was identical to that of Experiment 3.

Procedure

The task was a self-paced reading task, and the procedure was identical to that used in Experiment 4. The verbal instructions were the same as in Experiment 4, except that readers were told that they would have twenty six rather than twenty four short passages to read.

Results

The number of errors over all questions ranged from 1 to 14, with a mean of 6.42.

Reading rates

Reading times were transformed to rates as before. There were two missing scores as a result of the screen going blank just before target sentence presentation.

The mean reading rates by condition are shown below in Table 4.5. (The means for each passage are shown in Table A 4.9.)

Table 4.5 Mean reading rates (words per second) by condition - Experiment 5

<u>Topic most recently mentioned</u> (Order Y)			
Pronoun referent	TOPIC	NONTOPIC	\bar{x}
SUBJECT	4.00	3.91	3.96
OBJECT	3.56	3.55	3.56
\bar{x}	3.78	3.73	

<u>Nontopic most recently mentioned</u> (Order X)			
Pronoun referent	TOPIC	NONTOPIC	\bar{x}
SUBJECT	3.97	3.76	3.87
OBJECT	3.51	3.38	3.45
\bar{x}	3.74	3.57	

Analyses of variance showed that sentences were read faster when the pronoun referent was the subject rather than the object of the target sentence. This difference was reliable by readers ($F_1 = 8.78$, $df = 1, 46$, $p < .01$) but only marginally significant by passages ($F_2 = 4.19$, $df = 1, 11$, $p = .063$) and not significant on the Min F' test (Min $F' = 2.83$, $df = 1, 23$, $p > .1$). There was no significant effect of whether the pronoun referred to the topic or the

nontopic and there was only a slight effect of recency with sentences being read faster when the topic, rather than the nontopic, was the most recently mentioned character. However, this was only marginally significant by passages ($F_2 = 4.36$, $df = 1, 11$, $p = .058$) and not by readers ($F_1 < 1$). There were no significant interactions. (See Table A 4.10 for the summary tables.)

Analyses of sentences whose questions were later answered correctly or incorrectly showed no difference between these two sets of reading rates. (See Table A 4.12 for the summary tables and Table A 4.11 for the passage means.) Only the data from readers who produced both correct and incorrect rates were included in the analyses (the data from five readers were excluded).

Verification rates

Eighty seven rates were excluded because the question was answered incorrectly, and an additional five were excluded because the screen had gone blank during question presentation. The remaining times were converted to rates as before.

The mean verification rates for each condition are shown below in Table 4.6. The means were based on unequal sample sizes as a result of the large number of incorrect rates excluded from the data and their unequal distribution across conditions (see Table 4.6). Two means were missing altogether from the data arranged by readers and these were replaced using Winer's (1970) formula. (The means for each passage are shown in Table A 4.13.)

Table 4.6 Mean verification rates and errors by condition - Experiment 5

Topic most recently mentioned (Order Y)

Pronoun referent	TOPIC (Errors)	NONTOPIC (Errors)	\bar{x}
SUBJECT	4.00 (5)	4.02 (10)	4.01
OBJECT	3.59 (14)	3.37 (11)	3.48
\bar{x}	3.80	3.70	

Nontopic most recently mentioned (Order X)

Pronoun referent	TOPIC (Errors)	NONTOPIC (Errors)	\bar{x}
SUBJECT	3.90 (4)	4.15 (7)	4.03
OBJECT	3.67 (14)	3.75 (22)	3.71
\bar{x}	3.79	3.95	

Analyses of variance indicated that verification rates were reliably faster when the referent was the subject rather than the object of the target sentence (Min $F' = 4.96$, $df = 1, 48$, $p < .05$). There was no effect of the pronoun referring to the topic or the nontopic and no effect of recency, nor were there any interactions. (See Table A 4.14 for the summary tables.) The distribution of errors across conditions suggests that there were more errors when the referent was the object rather than the subject of the sentence. Recency of mention and whether the pronoun referred to the topic or the nontopic seemed to have little effect on the number of errors.

Discussion

Overall the results from these two experiments indicate that, in ambiguous passages, subject assignments were more frequent than object assignments and there was a tendency for reading rates to be faster when the topic rather than the nontopic was subject (especially when only subject assignments were considered). In the unambiguous passages, there was an effect of whether the pronoun referred to the subject or the object in both the reading rates and the verification rates but there was no effect of topic. Recency of mention had little effect in either type of passage (except for a slight influence on reading rates in the unambiguous passages).

On the whole, these data are fairly similar to those obtained in Experiments 2 and 3. The reliability of those findings have therefore been established using a different procedure. There are two main points of contrast. Firstly, the effect of the topic on reading rates was stronger in the ambiguous passages of Experiment 2 than in those of Experiment 4. Secondly, the effect of the subject was stronger in the unambiguous passages of Experiment 5 than in those of Experiment 3. This suggests that different processes may be involved in reading sentences of text presented cumulatively and sentences of text presented in an overlaid fashion. This illustrates the importance of the method of presentation of psycholinguistic materials (Kieras, 1978). A difference in strategies would not be surprising since the sentences are available for re-reading in the first case and not in the second.

The method of presentation used in Experiments 1, 2 and 3 seems the nearest to natural reading, since at least the sentences preceding the one being read are in view. Nevertheless, there are problems associated with it, particularly with ensuring the measurement of accurate reading rates for each sentence. And it is still not the same as normal reading where the sentences following the one being read are also in view. Yet, in future

experiments involving the presentation of passages of text, this method is used in preference to the method used in Experiments 4 and 5, because it comes closest to the natural reading process while still allowing the measurement of reading times.

It is possible that the way in which the sentences were presented in Experiments 4 and 5 (separately, one at a time) encouraged a reliance on factors within the sentence for resolving pronoun assignment. This would heighten the influence of the grammatical role of the referent. If this were the case, it might explain why the global topic (a discourse feature) appears to have no influence on assignment in Experiment 4, why its effect on reading rates is reduced in comparison to Experiment 2, and also why the effect of the subject appears to be stronger in Experiment 5 than in Experiment 3. In Experiment 5, reading rates were faster when the pronoun referred to the subject rather than the object and reference to the subject also produced faster verification rates than reference to the object. This implies faster retrieval when the subject, rather than the object, is the referent. There were also more errors when the referent to be retrieved was the object rather than the subject.

The difference in the retrieval rates for the subject and object was also found in Experiment 1 and, to a lesser extent, in Experiment 3. It was argued, in the discussion of Experiment 3, that the reduction in the subject's influence in that experiment was due to the simplification of the target sentences. While this may be true to some extent, it is obviously not the only factor affecting the influence of the subject on retrieval. When the method of presenting the sentences made greater demands on memory, as in Experiment 5, the subject again appears easier to retrieve, despite the fact that the target sentences are the same as the simplified ones used in Experiment 3. This appears to be another indication of the importance of sentence level factors in Experiment 5. The question of why the subject should be easier to retrieve is addressed

in later experiments (see Chapter 8).

The lack of an effect of the global topic on assignments in the ambiguous passages of Experiment 4 suggests, as in Experiment 2, that the topic has to be very obviously more important than the other characters in the text before it is preferred as a pronominal referent. It is also possible that, in Experiment 4, the influence of the topic was further reduced by a reliance on sentence level factors as a result of the method of sentence presentation.

The topic only had a very slight influence on reading rates in Experiment 4. The effect was slightly stronger when subject assignments alone were examined which suggests that, as in Experiment 2, its influence was on the ease of pronoun assignment in the second part of the sentence rather than on the first part of the sentence. (Ideally, the object assignment data should also be analysed, but unfortunately there was not enough data to allow such an analysis.) A similar conclusion is suggested by the fact that when the reading rates for those passages which produced consistent subject assignments in an independent check on materials were separated from those which did not (see Table A 3.34), the advantage for sentences in which the topic was subject appeared confined to those passages which produced consistent subject assignments (see Table A 4.15).

The influence of the topic on verification rates in Experiment 4 is rather complex, and difficult to explain. However, since the observed interaction with type of response was only significant by materials, it will not be considered further.

In the unambiguous passages, the effect of the topic was completely eliminated, as it was in Experiment 3. This adds further weight to the suggestion that the topic's effect on reading rates in the unambiguous passages of Experiment 1 was due to the greater frequency with which the topic was mentioned in that experiment. These results are also consistent with a greater reliance on sentence

level factors in Experiment 5.

Finally, the order of presentation of the sentences did not affect any of the variables investigated. Although there was a hint of faster reading rates when the topic, rather than the nontopic, was most recently mentioned in Experiment 5, the effect was only marginally significant by passages and not even marginally significant by readers. The lack of an effect of recency is consistent with the data from Experiments 2 and 3. Consequently, recency was not included as a factor in subsequent experiments. Instead, it was counterbalanced across conditions.

However, it is not possible to conclude that the recency of mention of an antecedent never affects the ease of pronoun comprehension. There are many experimental studies which suggest that it does (for example, Carpenter and Just, 1978; Clark and Sengul, 1979; Daneman and Carpenter, 1980) and in an investigation of naturally occurring texts, Hobbs (1978) observed that ninety eight percent of pronominal antecedents occurred in the same sentence as the pronoun or in the preceding sentence. Clancy (1980) found similar results for pronouns occurring in naturally produced spoken language. However, in Experiments 2 to 5, it was the recency of mention prior to the target sentence which was manipulated. The two potential antecedents always occurred in the clause preceding the pronouns in the target sentence. (It was the preceding clause which Clark and Sengul (1979) demonstrated to be particularly important.) So there was no differentiation between the two antecedents in this respect.

If recency were considered in terms of the antecedent for the pronoun (see Charniak, 1972 and Rosenbaum's, 1967, Minimal Distance Principle), then the nearest antecedent to the subject pronoun was the object of the first clause of the target sentence. This clearly had no effect in these experiments since the subject of the first clause of the target sentence had far more influence over assignments than the object.

The recency of mention of the characters before the target sentence as manipulated in Experiments 2 to 5 is assumed to be important for the local foregrounding of the characters before the target sentence is encountered. Tyler and Marslen-Wilson (1982) suggested that at least two sentences may be needed before foregrounding has an effect. Hirst (1981) pointed out that recency decays very fast but, even so, it is likely that in Experiments 2 to 5, there was not a great enough difference between the two characters in terms of recency of mention. The character which was most recently mentioned occurred in the sentence preceding the target sentence, but the other character was mentioned in the sentence before that. And the situation would be complicated further as far as the topic was concerned since this character would be more foregrounded than the nontopic independently of any effect of recency.

It is therefore not possible to conclude with any certainty that recency of mention is not an important factor in determining the ease of pronoun comprehension even though it had no influence in these experiments. Firstly, the manipulation did not involve the antecedents themselves as in previous experiments on this effect, and secondly, there probably was not a great enough difference between the mention of the most and least recently mentioned characters in the experimental manipulation.

The major point to emerge from these two experiments is that there seems to be a greater reliance on sentence level factors with increased memory load. This raises the question of the precise nature of these sentence level effects and also the question of their specific role in the comprehension of texts as opposed to isolated sentences.

Many experiments (for example, Ehrlich, 1980) have only used single sentences when investigating pronoun comprehension. It has already been argued that this is undesirable because it is so unlike the natural reading situation. But, in order to be able to argue this point convincingly, it is necessary to demonstrate that there are influences operating on pronoun comprehension in sentences

embedded in a text which are not present when the same sentences are presented in isolation.

The next experiments therefore examined the comprehension of the target sentences from Experiments 1 to 5 when they were presented in isolation.

CHAPTER 5

LOCAL EFFECTS IN SINGLE SENTENCES

Introduction

The main difference between the experiments included in this chapter and previous experiments is that the materials used are single, isolated sentences rather than passages of text. The target sentences from Experiment 1 (both ambiguous and unambiguous) were examined in Experiments 6(a), 7(a) and 8(a), and the target sentences from Experiments 2 and 3 were examined in Experiments 6(b), 7(b) and 8(b). (The materials from Experiments 2 and 3 were identical to those from Experiments 4 and 5, so reference will only be made to Experiments 2 and 3.)

The main purpose of these experiments was to isolate the influence of sentence level factors on the comprehension of the target sentences which had been used in previous experiments. The target sentences were therefore presented alone, with no preceding passage, but in all other respects, the reader's task was as similar as possible to that used in the passage experiments.

It was suggested, in the discussion of Experiments 4 and 5, that the extra memory load, produced by presenting sentences one at a time in those experiments, led to a greater reliance on the factors within the target sentence itself which influenced assignment. The identification of the sentence level factors operating in the single sentences used in Experiments 4 and 5 would allow this hypothesis to be tested. If sentence level factors were very important in Experiments 4 and 5, then the results obtained in Experiments 6(b), 7(b) and 8(b) (in which the target sentences from Experiments 4 and 5 were presented in isolation) should be very similar to those obtained in Experiments 4 and 5.

It was impossible to make the reader's task in the

single sentence experiments identical to that employed in Experiments 1 to 5. For example, it seemed unreasonable to ask questions about single sentences and thus determine assignment in the same way as in the passage experiments. The main reason for considering questions inappropriate was that there was not enough information in each sentence to warrant more than one question about each sentence. This question would have to be about assignment, and this would draw attention to the ambiguity of the assignment, as well as making it obvious that the experiment was concerned with the comprehension of pronouns. Reading rates and verification rates measured under these conditions would not be comparable to those obtained in the passage experiments.

The lack of questions meant that the only dependent variable in the experiment using unambiguous sentences (Experiment 8) was reading rate, and in the experiments using ambiguous sentences, two separate tasks were necessary; one to measure reading rates, and another to determine assignments. In the reading task (Experiment 7), readers simply read each sentence and pressed a key as soon as it had been understood. Thus, for an individual sentence, the task was very similar to that involved in the passage experiments. However, since no questions were asked, there was no way of knowing to whom the pronoun had been assigned in the ambiguous sentences: Hence the need for the assignment task (Experiment 6) in which readers indicated which person they thought the pronoun referred to.

The experiments in this chapter also had another aim. This was to find out whether the topic effect observed in Experiments 1 to 5 was a true discourse effect. For example, it is possible that such an effect could be the result of the gender of the topic character being more compatible with the action described by the verb in the pronominal clause than the gender of the nontopic character. However, if the topic effect were due to something other than the salience of the characters in the

discourse, then it should also be apparent when those sentences are presented in isolation.

The possibility of gender bias accounting for the topic effect previously observed was examined more explicitly in Experiment 9. A close examination of the unambiguous target sentences used in Experiments 1 to 5 suggested that, for some sentences at least, the topic character was more appropriate in terms of gender for the actions described in the sentences. In particular, a person of the topic's gender seemed more likely to carry out the action described by the second verb for which the pronoun was subject. For example, in Passage 2 (James) of Experiment 3, one version of the target sentence was "James started fighting Elaine and he kicked her." Kicking and fighting are stereotypically associated more with boys rather than girls so there may have been a preference for assigning the pronoun to the male character, James, in this sentence making sentences in which he was the referent easier to read. Since James was the topic of this passage, this would make sentences where assignment was to the topic apparently easier to read than those in which the nontopic was referent. So, in experiments using unambiguous materials, the topic effect could have been the result of gender bias instead. (Such an effect could have been introduced unwittingly into these experiments because the sentences were usually devised with the topic in mind.) This would be an instance of an effect of general knowledge on pronoun comprehension.

EXPERIMENT 6 (Ambiguous sentences, assignment task)

- (a) Materials from Experiment 1
- (b) Materials from Experiment 2

Method

Subjects

Twenty four people, students or staff from Durham University, participated in this experiment.

Summary of materials

There were two sets of experimental materials. One set (a) consisted of the twelve ambiguous target sentences used in Experiment 1 (see Table A 2.1). There were two versions of each sentence, as in Experiment 1. In one version of the sentence, the subject was the character who had been the topic in Experiment 1, and in the other, the subject was the character who had been the nontopic in Experiment 1. For ease of exposition, these characters will be referred to as the 'topic' and 'nontopic' in this series of experiments even though there is no basis for such a distinction when there is no preceding text. The second set of materials (b) consisted of the twelve target sentences from Experiment 2 (see Table A 3.3). Again, these sentences were presented in two conditions; with the 'topic' or 'nontopic' as subject of the sentence.

There were sixteen filler sentences. Like the experimental sentences, each filler sentence consisted of two coordinate clauses, joined by the conjunction 'and'. In the first clause two characters of the same gender were introduced by name, and in the second, they were referred to using pronouns. The reference of the pronouns was thus ambiguous by gender, as in the experimental sentences. However, unlike the experimental sentences, the assignment of the pronouns was biased by the content of the second

clause. In half the sentences, assignment was biased to the subject (for example, "Henry questioned his son and he asked him to tell him the truth") and in the other half, assignment was biased to the object (for example, "Dennis read Arthur the letter and he listened to him attentively"). Three judges confirmed the biases in these sentences. Two of each kind of sentence were used as practice sentences.

Design

Half the readers were presented with materials from Experiment 1 (set a) and half with materials from Experiment 2 (set b). For each set of materials, each reader saw only one version of each sentence. The two versions of the experimental sentences ('topic' or 'nontopic' as subject) were allocated to particular sentences using a Latin square. Thus, each reader saw half of the experimental sentences with 'topic' as the subject and half with the 'nontopic' as subject. And each sentence was presented to six readers in each condition. The same version of the filler sentences appeared throughout.

Procedure

An assignment task was used in this experiment. The sentences appeared, one at a time, in the middle of the PET's screen, starting at the extreme left. The readers were told that each sentence would be about two people who were mentioned by name in the first part of the sentence, and then again using pronouns in the second part. They were asked to read the sentence to themselves, and to indicate (by pressing one of two keys) who the first pronoun referred to; the first or the second person mentioned in the sentence.

The sentences were presented in normal upper and lower case script. The readers indicated the referent of the first pronoun by pressing one of two keys, marked '1' and

'2'. This response, and the time between the presentation of the sentence and the response, was recorded in ms. The depression of a response key caused the next sentence to appear on the screen. Those readers who were presented with materials from Experiment 1 (set a) were warned that some of the sentences might sound rather odd. This was because some of the experimental sentences from Experiment 1 sounded rather strange when they were taken out of the context of their passages (for example, the sentence from Passage 12: 'Rory met Alrie on the street one day and he bit him'). They were also warned that the sentences might contain an introductory phrase before the two people were mentioned by name. The full instructions given to these readers are shown below.

"I want you to read some sentences which will appear in the middle of this screen. Just read them to yourself at your normal pace. You will notice that near the beginning of the sentence, two people are mentioned by name and towards the end, they are mentioned again using two pronouns. I want you to decide who the first pronoun refers to. This pronoun will usually appear after 'and' in the sentence. If you think it refers to the first person mentioned by name, then press the key marked '1', if you think it refers to the second person mentioned, then press the key marked '2'. Please keep your fingers in position over these two keys so that you can press them as soon as you have made up your mind. Your key press will automatically bring up the next sentence.

Some of the sentences may have an introductory phrase before the two people are mentioned by name. And some of them may sound rather odd because they are taken out of context. Don't worry about it, just try to understand them as they are.

The first four sentences are practice sentences and I'll stay with you while you read them so you can ask me about anything you don't understand. Just for these practice sentences, please point to the pronoun you are assigning, so that I can make sure you are making a

decision about the correct pronoun. OK? There are twenty four sentences altogether. Press the space bar when you are ready to start."

The instructions to the readers presented with the materials from Experiment 2 (set b) were identical except for the omission of the second paragraph.

The experimenter remained with the reader while the first four practice sentences were read in order to ensure that the correct pronoun was being assigned, and to clarify any other aspects of procedure, if necessary. The remaining twelve experimental and twelve filler sentences were presented, one at a time, in a different random order for each reader. The experimental session lasted for about five minutes, and the reader was informed that the session was over by the message "That's all thank you - you can go now" which appeared on the screen.

Results

Assignments

(a) Experiment 1 materials

The mean number of assignments to the subject and object in each condition is shown below in Table 5.1. (The number of assignments in each sentence are shown in Table A 5.1.)

Table 5.1 Mean number of assignments to the subject and object by condition - Experiment 6(a)

Assignment to	'T' = S	'NT' = S	\bar{x}
SUBJECT	4.42	3.58	4.00
OBJECT	1.58	2.42	2.00

As Table 5.1 shows, there were more assignments to the subject than to the object. However, analyses of variance showed that this difference was only significant by readers ($F_1 = 20.31$, $df = 1, 11$, $p < .01$). The difference was only marginally significant by sentences ($F_2 = 3.26$, $df = 1, 11$, $p = .096$), and hence not significant on the Min F' test (Min F' = 2.81, $df = 1, 14$, $p > .1$).

There was some suggestion of an interaction between assignment to the subject and object, and whether the subject of the sentence was the 'topic' or 'nontopic'. The number of assignments to the subject seemed to be even greater when the subject of the sentence was the character who had been the topic, rather than the nontopic, in the passage experiments. However, the interaction was only reliable by readers ($F_1 = 9.51$, $df = 1, 11$, $p < .05$), and not by sentences ($F_2 = 1.71$, $df = 1, 11$, $p = .22$). (See Table A 5.2 for the summary tables.)

(b) Experiment 2 materials

The mean number of assignments to the subject and object in each condition are shown in Table 5.2 below. (The data are shown for each sentence in Table A 5.3.)

Table 5.2 Mean number of assignments to the subject and object by condition - Experiment 6(b)

Assignment to	'T' = S	'NT' = S	\bar{x}
SUBJECT	4.42	4.33	4.38
OBJECT	1.58	1.67	1.63

Analyses of variance revealed a strong preference for assignments to the subject rather than the object (Min F' = 6.91, $df = 1, 13$, $p < .05$). There were no other significant effects. (See Table A 5.4 for the summary tables.)

Assignment rates

(a) Experiment 1 materials

The time taken to make the assignment to the subject or object was recorded (in ms) and divided by the number of words in the sentence (see Table A 2.7). It may seem unreasonable to divide assignment times by the number of words in the sentence since they include not only the reading time for the sentence, which might be expected to increase with the number of words in the sentence, but also the time needed to make the decision about which key to press, which would not. However, the variation in the number of words in the twelve experimental sentences was so high (from 9 to 29) that it was considered necessary to remove the variation in reading times caused by the variation in the number of words, even though this meant dividing the decision time by the number of words as well. The same criterion (50 ms per word) for elimination of very fast times was applied but no times exceeded this limit. Assignment times were transformed to rates as before.

The mean assignment rates by condition are shown in Table 5.3. (The means for each sentence are shown in Table A 5.5.)

Table 5.3 Mean assignment rates by condition - Experiment
6(a)

'T' = S	'NT' = S
2.19	2.05

Analyses of variance showed that there was no reliable difference between the assignment rates in the two conditions. (See Table A 5.6 for the summary tables.)

Assignment rates were also examined for subject and

object assignments separately. The mean rates are shown in Table 5.4 below.

Table 5.4 Mean assignment rates by condition and assignment - Experiment 6(a)

Assignment to	'T' = S	'NT' = S	\bar{x}
SUBJECT	2.30	2.20	2.25
OBJECT	1.83	1.77	1.80
\bar{x}	2.07	1.99	

Because there were problems with missing data (25% for the sentence means), analysis of variance was carried out by readers only. This analysis revealed that assignment rates were reliably faster when assignments were made to the subject rather than the object ($F_1 = 23.03$, $df = 1, 11$, $p < .001$). There was no main effect of the 'topic' or 'nontopic' as subject of the sentence and no interaction. (See Table A 5.7 for the sentence data and Table A 5.8 for the summary table.) Observation of Table A 5.7 indicates that, in general, the sentence means followed the same pattern.

(b) Experiment 2 materials

Assignment times were transformed to rates as before. The mean assignment rates are shown below in Table 5.5. (Table A 5.9 shows the individual sentence means.)

Table 5.5 Mean assignment rates by condition - Experiment 6(b)

'T' = S	'NT' = S
1.95	2.07

Analyses of variance showed that there was no reliable difference between the assignment rates in the two conditions. (See Table A 5.10 for the summary tables.)

Again, assignment rates were examined for subject and object assignments separately. The mean rates are shown below in Table 5.6. (See Table A 5.11 for the individual sentence means.)

Table 5.6 Mean assignment rates by condition and assignment - Experiment 6(b)

Assignment to	'T' = S	'NT' = S	\bar{x}
SUBJECT	1.92	2.11	2.02
OBJECT	1.95	1.66	1.81
\bar{x}	1.94	1.89	

Analysis of variance was carried out by readers only because of problems with missing scores (20.8% for sentence means). This analysis showed no evidence of differences in assignment rates as a function of 'topic' or 'nontopic' as subject of the sentence or assignment to the subject or object and no interaction between them. (See Table A 5.12 for the summary table.) The overall means calculated across sentences, shown in Table A 5.11, show exactly the same pattern of results.

EXPERIMENT 7 (Ambiguous sentences, reading task)

- (a) Experiment 1 materials
- (b) Experiment 2 materials

Method

Subjects

Twenty four students from Durham University volunteered to take part in this experiment.

Summary of materials

There were two sets of experimental sentences, one set (a) consisted of the ambiguous target sentences used in Experiment 1, and the other (b) consisted of the target sentences used in Experiment 2. These sentences were therefore identical to sets (a) and (b) used in Experiment 6. The filler sentences were also the same as those used in Experiment 6.

Design

The design and allocation of conditions to sentences in this experiment was identical to that in Experiment 6.

Procedure

As in Experiment 6, the sentences appeared one at a time in the middle of the PET's screen. But in this experiment, readers were not alerted to the ambiguity of the pronouns in the sentences. They were simply asked to read each sentence to themselves, and to press a key when the sentence had been understood. Again, those readers who were presented with sentences from Experiment 1 were warned not to worry if some of the sentences sounded rather odd. The full instructions for those readers were as follows.

(The instructions for the readers presented with sentences from Experiment 2 differed only in respect to this warning.)

"I want you to read some sentences which will appear in the middle of this screen. There are twenty four sentences altogether, and I want you to read them normally, to yourself, at your normal pace. Just read each one as it comes up on the screen, and as soon as you've understood it, press this key marked with a piece of paper. Keep your finger over the key so that you can press it as soon as you have understood the sentence. Some of the sentences might seem a bit odd because they are taken out of context. Don't worry about it, just try to understand them as they are. Any questions?

The first four sentences are practice ones, and I'll wait with you while you read them so you can ask me about anything you don't understand. Press the space bar when you are ready to start."

The time taken to read each sentence was recorded in ms. The remaining procedure was identical to that for Experiment 6.

Results

Reading rates

(a) Experiment 1 materials

Reading times were transformed to rates as before. The mean reading rate for sentences in which the 'topic' was subject was 3.99 words per second and for those in which the 'nontopic' was subject, 4.02 words per second. This difference was not reliable. (See Table A 5.13 for the sentence means and Table A 5.14 for the summary tables.)

(b) Experiment 2 materials

The mean reading rate when the 'topic' was subject was 3.73 words per second and when the 'nontopic' was subject was 3.52 words per second. Analyses of variance revealed that this difference was not reliable. (See Table A 5.15 for the sentence means and Table A 5.16 for the summary tables.)

EXPERIMENT 8 (Unambiguous sentences, reading task)

- (a) Experiment 1 materials
- (b) Experiment 3 materials

Method

Subjects

Forty eight students from Durham University took part in this experiment.

Summary of materials

There were two sets of experimental materials. In one set (a), the unambiguous versions of the twelve target sentences from Experiment 1 were used (see Table A 2.1). There were four conditions; TS, TO, NTS and NTO and, as in Experiments 6 and 7, the 'topic' and 'nontopic' characters refer to those who were the topic and nontopic in Experiment 1. The target sentence from Passage 6 (Mr Bentley) was changed slightly to ensure that assignment could be determined unambiguously, by gender. (The 'nontopic' character was called 'the lady driver' instead of 'the car driver' so that the sex of this character was made explicit.)

The second set of experimental materials (b) consisted of the twelve target sentences from Experiment 3 (the unambiguous versions of those in Table A 3.3). Again, there were four conditions (TS, TO, NTS and NTO).

The sixteen filler sentences were the same as those used in Experiment 6. As before, four of the filler sentences were used as practice sentences. These sentences contained pronouns which were ambiguous by gender, but assignment was constrained by the sense of the second clause, so that in half of the sentences, assignment was biased to the subject, and in the other half, to the object.

Design

Half the readers saw one set of materials, the remaining half saw the second set. A reader saw only one version (condition) of each sentence. The allocation of the four conditions to a particular sentence was determined using a Latin square. This was a repeated measures design which enabled each reader to see three sentences in each condition, and each sentence to be presented to six readers in each condition. There was only one version of each filler sentence.

Procedure

A self-paced reading task was used, and the procedure was the same as that used in Experiment 7. The instructions were also virtually identical to those used in Experiment 7.

Results

Reading rates

(a) Experiment 1 materials

The reading times (in ms) were transformed to rates as before. The overall mean reading rates for the four conditions are shown in Table 5.7. (See Table A 5.17 for the individual sentence means.)

Table 5.7 Mean reading rates (words per second) by condition - Experiment 8(a)

Pronoun referent	'TOPIC'	'NONTOPIC'	\bar{x}
SUBJECT	3.65	3.68	3.67
OBJECT	3.56	3.52	3.54
\bar{x}	3.61	3.60	

Analyses of variance revealed no significant effects of the pronoun referring to the subject or object or to the 'topic' or 'nontopic' and no significant interaction. (See Table A 5.18 for the summary tables.)

(b) Experiment 3 materials

Again, reading times (in ms) were transformed to rates. The mean reading rates for each condition are shown below in Table 5.8. (See Table A 5.19 for the individual sentence means.)

Table 5.8 Mean reading rates (words per second) by condition - Experiment 8(b)

Pronoun referent	'TOPIC'	'NONTOPIC'	\bar{x}
SUBJECT	3.31	3.38	3.35
OBJECT	3.44	3.16	3.30
\bar{x}	3.38	3.27	

Analyses of variance revealed that there were no reliable main effects of the pronoun referring to the subject or object or to the 'topic' or 'nontopic'. However, there was evidence of an interaction between these two factors although it was only reliable by sentences ($F_2 = 5.97$, $df = 1, 11$, $p < .05$) and not by readers ($F_1 = 3.98$,

df = 1, 24, p = .06) or on the Min F' test (Min F' = 2.39, df = 1, 32, p >.1). (See Table A 5.20 for the summary tables.) It appears that when the pronoun referent was the 'topic', reading rates were faster when the 'topic' was the object of the sentence, but when the pronoun referent was the 'nontopic', rates were faster when the 'nontopic' was the subject of the sentence.

EXPERIMENT 9 (Unambiguous sentences with gender bias, reading task)

Experiment 9 was an explicit test of the proposition that the genders of the antecedents in conjunction with the semantics of the verbs in the two clauses influences assignment. In addition, the experiment was a check on the possibility that this notion of gender bias might account for the topic effect previously observed. This latter possibility arises because there appeared to be a topic effect in Experiment 8(b).

Method

Subjects

Twenty four subjects, staff and students from Durham University, took part in this experiment.

Summary of materials

There were twelve experimental sentences, each with the same basic structure as the sentences used in previous experiments. They consisted of two coordinate clauses, joined by the conjunction 'and'. Two people were mentioned by name in the first clause, and again using pronouns in the second clause. The two people were of different sexes so pronoun antecedents could be determined unambiguously by gender. The verbs in the second clause were chosen so that the action they described was biased to a male or a female actor. Six verbs biased the action to a male, and six biased the action to a female. Two of the sentences (James and Carl) were the two sentences used in previous experiments which seemed to elicit the greatest degree of bias towards the gender of the topic character. The remaining ten sentences were chosen to elicit strong gender bias. The bias produced by these sentences was confirmed in a pilot study. The verbs in the first clause were

intended to be neutral with regard to the likely gender of the actor (except perhaps for the two sentences taken directly from Experiment 11).

Pilot study for the validation of experimental sentences

The preference for assignments to the male character in the 'male bias' sentences, and to the female in the 'female bias' sentences was checked by ten judges. The judges were all postgraduate students at Durham University. They were presented with a list of twelve sentences and asked to indicate their preference for two different endings to the sentence. The sentences were presented normally up to the conjunction 'and', then two versions of the second clause were presented; one with the male pronoun ('he') as subject of the verb, and the other with the female pronoun ('she') as subject. An example is shown below (5.2).

he flirted with her.

5.2 Karen talked to Paul at the disco and

she flirted with him.

The judges were asked to tick the most appropriate ending to the sentence.

There were two different lists of sentences. In each list, there were six sentences in which the second verb was intended to bias assignment to the male character, and six in which the second verb was intended to bias assignment to the female character. Each sentence referred to one male and one female character. The grammatical function of the biased character was counterbalanced across the two lists. A different order of sentences was used in the two lists, and each list was given to five judges.

The judges were asked to read the sentences and to tick the ending which seemed most appropriate. The experimental sentences were selected on the basis of the judges' choices and the verbs used in the two clauses of each of these sentences are shown below in Table 5.9. The

full sentences are shown in Table A 5.21 and the judges' choices can be seen in Table A 5.22.

Table 5.9 Verbs used in the two clauses of the experimental sentences - Experiment 9

BIAS	FIRST CLAUSE	SECOND CLAUSE
Male	started fighting	kicked
Male	played against	beat
Male	went with	paid for
Male	lived with	built (book shelves)
Male	engaged to	painted (house)
Male	took to (football match)	lifted up
Female	shared (house) with	nagged
Female	talked to	flirted with
Female	liked	cooked
Female	went (camping) with	washed (shirts
Female	walked home with	pirouetted
Female	went to see	restyled (hair)

A sentence was considered acceptable if the 'biased' ending was chosen more often than the other ending. This loose criterion was considered justified since most of the judges commented that they had tried hard not to be sexist in their responses. This shows that they were aware of the gender bias in the sentences, but suggests that they resisted it when choosing the most appropriate ending to the sentence. This may explain why the intended referent was chosen by all ten judges in only one sentence; that containing the verb 'flirted' (female bias). Two sentences did not satisfy this criterion but they were accepted because they were the ones considered most likely to have produced gender bias in previous experiments (see Table A 5.22).

Four versions of each sentence were used. These versions were the result of varying whether the subject

pronoun referred to the person to whom the verb was intended to bias assignment or to the other person, and whether the pronoun referred to the subject or object of the sentence. The number of words in the experimental sentences ranged from eight to thirteen with a mean of eleven (see Table A 5.21).

There were forty filler sentences. Their structure was the same as that of the experimental sentences; two coordinate clauses joined by 'and'. Two people were mentioned by name in the first clause, and at least one of them was mentioned again using a pronoun or a null anaphor (that is, by ellipsis) in the second clause. Unlike the experimental sentences, the two characters mentioned in the sentences were the same sex, so the assignment of pronouns in the second clause could not be determined by gender cues. Assignment was constrained, however, either by the meaning of the second verb, or by the meaning of the whole of the second clause. It was biased to the first person mentioned in the sentence (the subject) in one half of the sentences (for example, "The policeman chased the thief and he caught him in an alley") and to the second person mentioned (the object) in the other half (for example, "Dennis read Arthur the letter and he listened to him without interrupting"). The intended bias in assignment, to the subject or the object, was confirmed by three judges.

The twenty filler sentences in which assignment was biased to the subject of the sentence were part of another experiment not reported here. Consequently, unlike the sentences which biased assignment to the object, these twenty sentences were made up of ten paired sentences. The sentences in a pair were identical except that one contained a pronoun in the subject position of the second clause and the other did not, reference being achieved by ellipsis.

In addition to these forty filler sentences, four more were used as practice sentences. These were the same as the practice sentences used in Experiment 6. They

contained pronouns which were ambiguous by gender, but biased by the meaning of the second clause to the subject in two of the sentences, and to the object in the other two.

Design

This was a two factor, repeated measures design. The first factor was whether or not the pronoun in the second clause referred to the person to whom assignment was biased by the verb, and the second was whether the pronoun referred to the subject or object of the sentence. Each reader saw only one of the four versions of each experimental sentence. The allocation of the four conditions to a particular sentence was determined by a Latin square. The readers saw three sentences in each condition, and the sentences were presented to six readers in each condition.

Procedure

A self-paced reading task was used and the procedure was identical to that of Experiment 8.

Results

Reading rates

The reading times (in ms) were divided by the number of words in each sentence (see Table A 5.21) and the times were transformed to reading rates (in words per second) as before.

The overall mean reading rate for each condition is shown in Table 5.10 below. (See Table A 5.23 for the individual sentence means.)

Table 5.10 , Mean reading rates (words per second) by condition - Experiment 9

Pronoun referent	Person to whom verb biased assignment	Other person	\bar{x}
SUBJECT	4.15	3.71	3.93
OBJECT	3.79	3.67	3.73
\bar{x}	3.97	3.69	

Analyses of variance revealed no main effect of the grammatical function of the referent and no interaction, but there was a main effect of gender bias. Sentences in which the pronoun referred to the person to whom the verb biased assignment because of their gender were read faster than those in which the pronoun referred to the person of the opposite gender. This difference was reliable both by readers ($F_1 = 4.23$, $df = 1, 23$, $p < .05$) and by sentences ($F_2 = 5.64$, $df = 1, 11$, $p < .05$) but not on the Min F' test (Min F' = 2.42, $df = 1, 32$, $p > .1$). (See Table A 5.24 for the summary tables.)

Discussion

Overall, the results of Experiments 6 to 9 show that the topic effect observed in previous experiments was a true discourse effect since the topic had no influence in these single sentence experiments. The subject of the sentence influenced the assignment of ambiguous pronouns in Experiments 6(a) and 6(b) and the assignment rates of Experiment 6(a) but had no effect on the understanding of unambiguous pronouns in Experiments 8 and 9. However, there was an influence of the general knowledge factor, gender bias, in the unambiguous sentences of Experiment 9.

One of the main aims of this set of experiments was to isolate the factors influencing the comprehension of pronouns at the sentence level. Overall it appears that, in ambiguous sentences, there was a reduced influence of the subject and, in unambiguous sentences, only gender bias influenced the ease of pronoun comprehension.

Thus, the subject of the sentence appears to be an important influence on the assignment of ambiguous pronouns occurring in isolated sentences as well as in passages of text. In both assignment-task experiments, Experiments 6(a) and 6(b), there were more assignments to the subject than to the object and, in Experiment 6(a), assignment rates were faster for sentences in which assignment was made to the subject. However, the effect of the subject in these experiments appeared to be reduced in comparison to previous passage experiments. This is rather surprising since grammatical function of the referent is one of the few factors available for influencing comprehension in single sentences and might therefore be expected to be even more important

in such cases.

The fact that the subject assignment strategy is weaker in these single sentences than it was in the passage experiments makes it difficult to argue that the overlaid nature of presentation used in Experiments 4 and 5 caused a greater reliance on sentence level factors, as suggested in the Introduction to this chapter. In Experiments 4 and 5 the effect of the subject was stronger than in previous experiments whereas in these isolated sentences, its effect was weaker. It seems then that the stronger influence of the subject in Experiments 4 and 5 was not due to the target sentences being read as if they were in isolation. The difference between the results of the passage experiments using cumulative presentation, those using overlaid presentation and these sentence experiments illustrates the importance of the context within which psycholinguistic materials are presented.

A number of psychologists (for example, Ehrlich, 1979, 1980) have relied on single sentence experiments to study the factors affecting pronoun comprehension. The results of the experiments reported here show that the factors affecting comprehension at this level are not necessarily the same as those operating within passages of text and demonstrate the importance of studying comprehension at the text level as well. Not only are the effects of some factors (for example, *the subject) altered when sentences are presented in isolation, the effects of others disappear altogether. The influence of the global topic is one example.

The global topic of the passage experiments had no reliable effect on the understanding of the sentences presented in the single sentence experiments. This justifies the claim that the effect of topic was a true discourse effect in previous experiments. There was a slight hint of an influence of the 'topic' on assignment in the ambiguous sentences of Experiment 6(a) in an interaction between the number of assignments to the subject and object and whether the 'topic' or 'nontopic'

was subject of the sentence. However, this interaction was only reliable by readers and there was no evidence of a 'topic' effect on the reading rates of this experiment nor in any of the other single sentence experiments involving ambiguous pronouns (Experiments 6(b), 7(a) and 7(b)). It is therefore unlikely that such an effect could account for the influence of the topic in the passage experiments. There was also a suggestion of an effect of the 'topic' in the unambiguous sentences of Experiment 8(b) and one aim of Experiment 9 was to check whether the notion of gender bias could account for this 'topic' effect. This seems unlikely mainly because the effect of gender bias does not hold for the two sentences from Experiment 8(b) most likely to show the effect (see Table A 5.23). In addition, these two sentences did not produce strong gender bias responses in the pilot study (see Table A 5.22). Indeed, it seems unlikely that the topic effect observed in Experiment 8(b) was a reliable one. There are several reasons for this. Firstly, there was no topic effect at all in Experiment 8(a). Secondly, it was not a main effect of topic in Experiment 8(b), only an interaction. And thirdly, the interaction in Experiment 8(b) was not very reliable, being significant at the 5% level by sentences only. It therefore seems more likely that the effect of topic in Experiment 8(b) was a Type 1 error. To check this possibility, Experiment 8(b) was replicated exactly on a new sample of readers. The results showed no evidence of a topic effect either as a main effect or in an interaction. (See Table A 5.25 for the mean rates for each sentence and Table A 5.26 for the summary tables.) Thus it seems unlikely that the topic effect observed in the passage experiments was due to the peculiarities of the target sentences.

However, Experiment 9 does show that inferences from general knowledge, in this case gender bias, affects pronoun comprehension within single sentences. It seems that the verbs in a sentence (and particularly the one associated with the pronoun) can influence the ease of

pronoun assignment through biasing assignment to one gender rather than another. This suggests that general knowledge based on the semantics of the verb was able to influence the comprehension of pronouns whose assignment was constrained by gender. Indeed, gender bias is the only factor which influenced the understanding of unambiguous pronouns in these single sentence experiments. Readers apparently relied heavily on gender cues alone when these were available. For example, unlike the equivalent passage experiments, there was no effect of the sentence subject. Again, this demonstrates the reduction in the influence of the subject when sentences are presented alone.

One remaining question is whether the topic exerted its influence on the first or second part of the target sentences in the passage experiments reported in Chapters 2, 3 and 4. It may have influenced the first part of the sentence such that sentences were easier to read simply because the topic rather than the nontopic was subject. This might be because readers expected a further reference to the topic and because the subject as local topic of the sentence (if this definition is accepted) would then be identical to the topic^{of} the passage as a whole. Bernado (1980), for example, found that, given two ways of expressing the same event, four out of five judges chose the discourse topic as the subject of a sentence rather than a merely discourse mentioned referent. Alternatively, the topic may have influenced the second part of the sentence. Because of the strong subject assignment strategy, when the subject was the topic, assignments were usually to the topic and when the subject was the nontopic, assignments were usually to the nontopic. This means that faster reading rates when the topic was the subject could have been the result of assignments being easier when they were to the topic rather than the nontopic. This effect has already been demonstrated in the unambiguous passage experiments. But the question is unresolved as far as the ambiguous experiments are concerned. This question was investigated in the next set of experiments.

CHAPTER 6

AN EXPLORATION OF THE LOCUS OF THE TOPIC EFFECT - SEPARATE CLAUSE PRESENTATION

Introduction

In this set of experiments, the two clauses of the target sentences used in previous experiments were presented as separate sentences. This enabled the reading time for each clause to be measured accurately. The first clause of the target sentence which mentioned the topic and nontopic characters by name constituted one sentence, and the second (pronominal) clause which mentioned them again using pronouns constituted another sentence. Although the two clauses were now two sentences, for ease of exposition, they will still be referred to as clauses; the first or antecedent clause and the pronominal clause.

The general aim of this set of experiments was to find out exactly where in the target sentences the reading rate differences found in previous experiments were occurring. For example, the speed and ease of comprehension could have been influenced by the ease of integrating the information in the first clause of the sentence with the preceding text or by features specific to pronoun comprehension in the second clause. Alternatively, factors in both clauses may have been important. In addition, in experiments where no overall differences in reading rates were apparent, it is possible that there were differences in the two clauses which cancelled each other out. If this were the case, then measurement of the reading rates for the two clauses separately would allow such differences to be identified.

To satisfy the general aims outlined above, reading rates were measured for the two clauses of the target sentences when they were presented as part of a passage, and in isolation, for both ambiguous and unambiguous sentences. The passages used were the same as those used in Experiments 2 and 3 (and Experiments 4 and 5, although

reference will only be made to Experiments 2 and 3). The topic and nontopic were mentioned equally often and the recency of mention of the two characters was controlled. The sentences were presented cumulatively within a passage, as in Experiments 2 and 3. Experiments 10 to 12 used the materials from Experiment 2 (ambiguous materials). Experiments 13 and 14 used the unambiguous materials from Experiment 3. In Experiment 10, the two clauses of the ambiguous target sentences were presented within passages. In Experiments 11 and 12, they were presented in isolation and required either an assignment task (Experiment 11) or a reading time task (Experiment 12). In Experiment 13, the two clauses of the unambiguous target sentences were presented within passages. In Experiment 14, they were presented in isolation and a reading time task was used.

In addition to the general purpose of this set of experiments, the more specific aim of Experiments 10 and 13 was to investigate the locus of the topic effect in the passage experiments. The separate clause presentation also allowed examination of pronoun assignment across sentence boundaries.

EXPERIMENT 10 (Ambiguous passages)

Method

Subjects

Twelve students from Newcastle University volunteered to take part in this experiment.

Summary of materials

There were twelve experimental passages; they were the same as those used in Experiment 2 except that the sentences were reduced in length. In each passage, the two coordinate clauses of the target sentences were split into two separate sentences. The first clause (which mentioned the topic and the nontopic characters by name) constituted one sentence, and the pronominal clause (which mentioned the two characters again using pronouns) constituted another sentence. The two characters were the same gender so the pronouns were ambiguous. The first of the new pair of target sentences was exactly the same as the first clause of the original target sentence, and finished just before the conjunction. The second started with the conjunction and thereafter was identical to the original pronominal clause. This separation of the two clauses just before the conjunction was possible in all but one of the experimental passages. The exception was Passage 1 (Mary), the only passage in which the conjunction was not 'and'. The original target sentence is shown in 6.1.

6.1 Mary asked Jenny to phone the theatre to see what was on when she joined her for breakfast.

It was clearly not possible to start the second sentence of the new pair with the conjunction 'when'. The target sentence was therefore changed slightly so that the new sentences were joined by the conjunction 'and', as shown in

6.2.

6.2 Mary joined Jenny for breakfast. And she asked her to phone the theatre to see what was on.

With the exception of this sentence, all the words from the original target sentence were retained in the new pairs of sentences. They were therefore directly comparable to the target sentences used in previous experiments.

As in Experiment 2, there were two versions of each pair of target sentences: $T = S$ and $NT = S$. Recency of mention of the two characters was counterbalanced across conditions, readers and passages to ensure that it was not confounded with the effect of topic or nontopic as subject of the target sentence pair.

In addition to splitting the target sentences, all the other sentences in the experimental passages were reduced in length. Most sentences were split into two or three shorter sentences. The number of sentences in each passage rose from six to between twelve and seventeen. This was intended to ensure that the pair of target sentences did not stand out as shorter than the rest.

In order to be able to counterbalance the recency variable, it was necessary to treat the sentences produced from splitting one sentence in the original passage as if they were still one sentence. This was to enable the order of sentences about the topic and the nontopic which were presented before the target sentences to be varied between Order X (nontopic most recently mentioned) and Order Y (topic most recently mentioned). (See the Introduction to Experiment 2.) The information which constituted one sentence in Experiment 2 (which was now contained in two or three sentences) was therefore treated as a unit. The experimental passages can be seen in Table A 6.1.

As before, there were three questions after each experimental passage, each requiring the answer 'true' or 'false'. The questions and their orders were identical to those used in Experiment 2 (see Table A 3.3).

The filler passages were based on those used in Experiment 2, but only twelve instead of fourteen passages were used. Most sentences in the filler passages were split into shorter sentences so that the sentences in the experimental passages did not stand out as shorter in length. The number of sentences in each filler passage rose from six to between twelve and fifteen, a range similar to that for the experimental passages. Some of the sentences in the filler passages had to be changed slightly so that their length could be reduced. As a consequence, some of the questions associated with the filler passages also had to be changed. An example of a filler passage is shown in Table A 6.2. The first two passages were used as practice passages.

Design

The only factor varied in this experiment was whether the topic or the nontopic was subject of the first of the pair of target sentences. Recency of mention was counterbalanced across conditions, readers and passages. A Latin square design was used to allocate one of the two conditions to particular passages so that each reader saw six passages in each condition, and each passage was presented to six readers in each condition. Apart from this, the design was identical to Experiment 2.

Procedure

The procedure and instructions were identical to those used in Experiment 2 except that there were twelve instead of fourteen filler passages so the two practice passages were included in the four blocks of six passages presented.

Results

The number of errors on all questions (except the critical questions for which there was no right or wrong answer) ranged from 1 to 7 with a mean of 3.67.

Assignments

The mean number of assignments made to the subject and object of the first clause of the target sentence by condition is shown below in Table 6.1. (The individual passage data are shown in Table A 6.3.)

Table 6.1 Mean number of assignments to the subject and object by condition - Experiment 10

Assignment to	T = S	NT = S	\bar{x}
SUBJECT	5.25	5.08	5.17
OBJECT	0.75	0.92	0.84

Analyses of variance showed that there were many more assignments to the subject than to the object in both conditions (Min $F' = 48.25$, $df = 1, 20$, $p < .01$). There were no other significant effects. (See Table A 6.4 for the summary tables.)

Reading rates

Unlike previous experiments, in this one there were two measures of reading time for each condition; one for the first clause and one for the pronominal clause. These reading times were divided by the number of words in the appropriate clause (see Table A 6.5) and then transformed to rates. One very fast time was eliminated from the data before the transformation to rates. One other reading time was missing from the data as a result of the screen going

blank during target sentence presentation. (This occurred during presentation of the second, pronominal clause. It was not necessary to exclude the time for the first clause since this sentence would not have been affected by the screen interference in the following sentence.)

The overall mean reading rates for the two clauses by condition are shown below in Table 6.2. (The means for each passage are shown in Table A 6.6.)

Table 6.2 Mean reading rates (words per second) by condition for each clause - Experiment 10

	CLAUSE		\bar{x}
	FIRST	PRONOMINAL	
T = S	3.15	3.94	3.55
NT = S	3.22	3.78	3.50
\bar{x}	3.19	3.86	

Analyses of variance were then carried out (the first/pronominal clause factor was treated as an independent factor in the F_2 analysis in all experiments reported in this chapter). The analyses revealed no influence of condition on reading rates, but there was a tendency for the pronominal clause to be read faster than the first clause. This was highly significant by readers ($F_1 = 21.91$, $df = 1, 11$, $p < .001$) but only marginally significant by passages ($F_2 = 3.60$, $df = 1, 22$, $p = .068$) and on the Min F' test (Min F' = 3.09, $df = 1, 28$, $p < .1$). There was no interaction. (See Table A 6.7 for the summary tables.)

The data were then separated into those in which subject assignments were made and those in which object assignments had been made (see Table A 6.8 for passage means). Problems with missing scores (20.83% in the data arranged by readers and 22.92% by passages) meant that only the reading rates from sentences where subject assignments

were made were submitted to analyses of variance. The resulting means are shown in Table 6.3 below.

Table 6.3 Mean reading rates (words per second) by condition for each clause, subject assignments only - Experiment 10

	CLAUSE		\bar{x}
	FIRST	PRONOMINAL	
T = S	3.22	3.97	3.60
NT = S	3.18	3.66	3.42
\bar{x}	3.20	3.82	

Analyses of variance revealed a difference between the reading rates for the two clauses; the pronominal clause was read more quickly. This difference was highly significant by readers ($F_1 = 20.65$, $df = 1, 11$, $p < .01$), but only marginally significant by passages ($F_2 = 3.60$, $df = 1, 22$, $p = .068$) and on the Min F' test (Min F' = 3.07, $df = 1, 29$, $p < .1$). There was no influence of condition and no interaction. (See Table A 6.9 for the summary tables.)

Verification rates

Verification times were transformed to rates as before. The mean verification rate for each condition is shown below in Table 6.4. (See Table A 6.12 for the individual passage means.) Unlike previous analyses of verification rates, type of response was not included as a factor in this experiment because prior analyses indicated no difference in the rate of 'true' and 'false' responses (see Table A 6.10 for the passage means and Table A 6.11 for the summary tables).

Table 6.4 Mean verification rates by condition -
Experiment 10

T = S	NT = S
3.02	2.93

Analyses of variance showed no difference in verification rates for the two conditions. (See Table A 6.13 for the summary tables.)

EXPERIMENT 11 (Ambiguous sentences, assignment task)

Method

Subjects

Twelve students from Newcastle University volunteered to take part in this experiment.

Summary of materials

The materials in this experiment consisted of the twelve target sentence pairs used in Experiment 10. They were presented in isolation, with no preceding passage. The first clause mentioned the characters who had been the topic and nontopic in the passage experiments by name. Since there was no passage preceding the target sentences in this experiment, there is no justification for such labels, but they will be retained for ease of explanation. The pronominal clause began with the conjunction of the original target sentence (from Experiments 2) and mentioned the 'topic' and 'nontopic' characters using pronouns. The gender of the two characters was the same, so the pronouns were ambiguous by gender. The experimental sentences can be seen in Table A 6.1 (underlined). There were two versions of each experimental sentence, as in Experiment 10: 'T' = S and 'NT' = S.

There were sixteen filler sentences. They were identical to those used in Experiment 6 except that the two clauses of the sentences were split into two separate sentences to be consistent with the experimental sentences (for example, 'Henry questioned his son. And he asked him to tell him the truth.').

Design

The only factor varied in this experiment was whether the 'topic' or the 'nontopic' was subject of the first clause of the target sentence. Each reader saw only one of these two versions of each sentence. A Latin square was used to allocate one of the two versions to particular sentences. Thus, each reader saw six experimental sentences with the 'topic' as subject of the first clause, and six with the 'nontopic' as subject and each sentence was presented to six readers in each condition.

Procedure

An assignment task was employed in this experiment. The two clauses of each experimental sentence were presented, one at a time in the middle of the PET's screen, starting at the extreme left. To begin presentation of the sentence pairs, the space bar on the PET was pressed and the first sentence of the pair appeared. The readers were asked to read the first sentence to themselves, and to press one of two keys as soon as they had understood it. The key press caused the second sentence of the pair to appear directly underneath the first, again starting at the extreme left. The first sentence remained on the screen while the second sentence was read. This allowed the two sentences to appear as a pair, and allowed reference to the first sentence while the pronouns were assigned in the second. In this way, the task was comparable to that used in Experiment 6 where the target sentences were also presented alone, but not split in two, so the first clause was necessarily available when assignment was made. It also made the task comparable to that in Experiment 10 where the cumulative presentation of the sentences in a passage meant that the first clause was still on the screen when the pronominal clause was read.

The readers were asked to indicate whether they had assigned the first pronoun to the first or second person

mentioned in the first sentence. They indicated their choice by pressing one of two keys (marked '1st' and '2nd'). When one of these keys was pressed, the screen cleared and the first of the next sentence pair appeared. During the practice trials, the experimenter checked that it was the first pronoun which was being assigned.

The verbal instructions were as follows.

"I want you to read some sentences which will appear in the middle of this screen. The sentences will appear in pairs. In the first sentence of a pair, two people will be mentioned by name, and in the second they will be mentioned again using pronouns (for example, 'he' or 'she'). The first sentence of each pair will appear on its own to begin with. I want you to read it to yourself and, as soon as you have understood it, press one of these two keys marked with a piece of paper. It doesn't matter which one you press. When you press one of the keys, the next sentence of the pair will appear underneath the first. Again, read it to yourself and, as soon as you have understood it, I want you to decide whether you think the first pronoun in the sentence referred to the first or the second person mentioned in the previous sentence. The first pronoun is always the second word in the sentence. If you think it referred to the first person, press the key marked '1st', if you think it referred to the second person, press the key marked '2nd'. Please keep your fingers over these keys while you are reading so that you can press one of them as soon as you have made up your mind. This time when you press one of the keys, the sentence pair you have just read will disappear and the first sentence of the next pair will appear, and you do the same again. Do you understand?"

The first four sentences are practice ones; I will stay with you while you read them and you can ask me about anything you don't understand. Just for these practice sentences, please point to the pronoun you are making your decision about so that I can check it is the right one.

There are twenty six sentences altogether. Press the space bar when you are ready to start."

The experimenter remained with the reader while the first four practice sentences were read to ensure that the correct pronoun was being assigned, and to clarify any other aspects of procedure when necessary. The remaining twelve experimental and twelve filler sentence pairs were presented in a different random order to each reader. The experimental session lasted for about five minutes, and the reader was informed that it was over when the message "That's all thank you - you can go now" appeared on the screen.

The time taken to read the first clause and the time taken to make the assignment in the pronominal clause were recorded in ms. The response ('first' or 'second') was also recorded.

Results

Assignments

The mean number of assignments made to the subject and the object of the first clause in each condition is shown in Table 6.5 below. (The individual sentence data are shown in Table A 6.14.)

Table 6.5 Mean number of assignments to the subject and object by condition - Experiment 11

Assignment to	'T' = S	'NT' = S	\bar{x}
SUBJECT	4.42	4.58	4.50
OBJECT	1.58	1.42	1.50

Analyses of variance showed that there were more assignments to the subject than to the object in both conditions (Min F' = 6.99, df = 1, 17, p <.05). There were no other significant effects. (See Table A 6.15 for the summary tables.)

Assignment rates

The time taken to read the first clause and the time taken to make the assignment in the pronominal clause was recorded for each condition ('T' = S and 'NT' = S). For ease of explanation, both times will be referred to as assignment times. One assignment time, from a pronominal clause, was missing but the rest were divided by the number of words in the appropriate clause (see Table A 6.5) and then transformed to rates.

The mean assignment rates for each clause as a function of condition are shown below in Table 6.6. (The means for each sentence can be seen in Table A 6.16.)

Table 6.6 Mean assignment rates by condition for each clause - Experiment 11

	CLAUSE		\bar{x}
	FIRST	PRONOMINAL	
'T' = S	2.92	2.35	2.64
'NT' = S	2.96	2.54	2.75
\bar{x}	2.94	2.45	

Analyses of variance revealed no significant effects. (See Table A 6.17 for the summary tables.)

Assignment rates were also examined for subject and object assignments separately (see Table A 6.18 for the sentence means). Problems with missing scores (8.3% by readers and 25% by sentences) meant that only the subject assignment data were submitted to analyses of variance. In the F_2 data, two scores were replaced using Winer's (1970) formula. The overall means are shown in Table 6.7.

Table 6.7 Mean assignment rates by condition for each clause, subject assignments only - Experiment 11

	CLAUSE		\bar{x}
	FIRST	PRONOMINAL	
'T' = S	3.03	2.47	2.75
'NT' = S	2.92	2.57	2.75
\bar{x}	2.98	2.52	

As in the previous analyses, there were no significant effects. (See Table A 6.19 for the summary tables.)

EXPERIMENT 12 (Ambiguous sentences, reading task)

Method

Subjects

Twelve students from Newcastle University took part in this experiment.

Summary of materials

The experimental and filler sentences used in this experiment were exactly the same as those used in Experiment 11.

Design

The design and allocation of sentences to each of the two conditions were identical to those in Experiment 11.

Procedure

In this experiment, the task was a self-paced reading task. The sentences were presented in the same way as in Experiment 11; one sentence pair at a time. The first clause appeared on its own in the middle of the screen, starting at the extreme left. The readers were asked to read the sentence to themselves, and to press a key as soon as they had understood it. The pronominal clause then appeared underneath the first clause, again starting at the extreme left. As before, the reader's task was to read this sentence to themselves and to press the key as soon as they had understood it. When the key was pressed for the second time, the sentence pair disappeared and was replaced by the first clause of the next pair. The experimental and filler sentences were presented in a different random order to each reader. The verbal instructions were as follows.

"I want you to read some sentences which will appear

in the middle of this screen. The sentences will appear in pairs. The first sentence of each pair will appear on its own to begin with. Just read it to yourself and, as soon as you have understood it, press this key marked with a piece of paper. When you press the key, the second sentence of the pair will appear directly underneath the first. Again, read it to yourself and, as soon as you have understood it, press the key again. Keep your finger over the key while you read so that you can press it as soon as you have understood what you have read. When you have pressed the key to indicate that you have understood the second sentence, both sentences will disappear from the screen and the first of the next pair will appear.

There are twenty six sentences altogether. The first four are practice ones, and I'll wait with you while you read them, so you can ask me about anything you don't understand. Press the space bar when you are ready to start."

The experimental session lasted about five minutes, and the reader was informed that it was over by a message on the PET's screen.

The time taken to read each sentence was recorded in ms.

Results

Reading rates

The reading times (in ms) for each clause of the target sentence were divided by the number of words in the appropriate clause (see Table A 6.5) and transformed to reading rates (in words per second) as before. The mean reading rates for each clause as a function of condition are shown in Table 6.8. (The means for each sentence are shown in Table A 6.20.)

Table 6.8 Mean reading rates (words per second) by condition for each clause - Experiment 12

	CLAUSE		\bar{x}
	FIRST	PRONOMINAL	
'T' = S	3.39	4.42	3.91
'NT' = S	3.32	4.15	3.74
\bar{x}	3.36	4.29	

Analyses of variance showed that the pronominal clause was read faster than the first clause, (Min F' = 5.84, df = 1, 33, p <.05); but there was no influence of condition on reading rates and no interaction. (See Table A 6.21 for the summary tables.)

EXPERIMENT 13 (Unambiguous passages)

Method

Subjects

Twenty four students from Newcastle University volunteered to take part in this experiment.

Summary of materials

The experimental passages were the unambiguous versions of those used in Experiment 10 (see Table A 6.1). Whereas the passages in Experiment 10 were based on the ambiguous passages of Experiment 2, the ones in this experiment were based on the passages used in Experiment 3. Consequently, unlike Experiment 10, the topic and nontopic characters were different sexes so that the pronouns in the pronominal clause of the target sentence could be diambiguated by gender. In all other respects, the passages were the same as those in Experiment 10. (All correct answers to the critical question required the answer 'true'.)

The twelve filler passages were identical to those used in Experiment 10 and, as before, the first two were used as practice passages. The questions were changed so that the responses required for each passage were two 'false' and one 'true'. This was to equalise the number of 'true' and 'false' responses over all the passages (experimental and filler).

Design

Two factors were varied in this experiment; the pronoun referred to the topic or the nontopic, and to the subject or object of the first clause. The four resulting conditions were allocated to particular passages using a Latin square. Each reader saw only one version of each

passage with three passages in each condition, and each passage was presented to six readers in each condition. In all other respects the design was the same as that in Experiment 10.

Procedure

The task was a self-paced reading task, and the procedure was the same as in Experiment 10 except that sentence presentation was controlled by a key press and not depression of the space bar. (This was because of a change in the microcomputer used.)

Results

General comprehension check

The number of errors made across all questions ranged from 0 to 10, with a mean of 4.04.

Reading rates

The reading times (in ms) for each clause of the target sentence were divided by the number of words in the appropriate clause (see Table A 6.5). One score was missing from the data and one very fast time was eliminated from the data but all others were transformed to reading rates (in words per second).

The mean reading rate for each clause as a function of condition is shown below in Table 6.9. (The means for each passage are shown in Table A 6.22.)

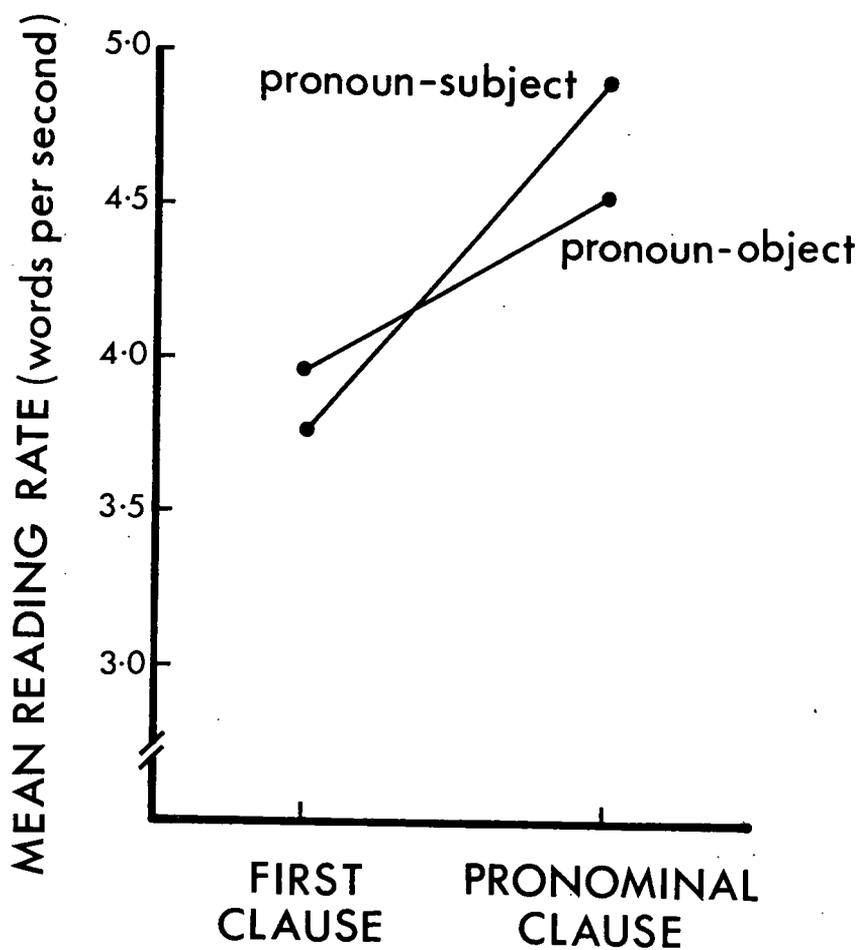
Table 6.9 Mean reading rates (words per second) by condition for each clause - Experiment 13

<u>FIRST CLAUSE</u>			
Pronoun referent	TOPIC	NONTOPIC	\bar{x}
SUBJECT	3.86	3.70	3.78
OBJECT	3.97	3.97	3.97
\bar{x}	3.92	3.84	

<u>PRONOMINAL CLAUSE</u>			
Pronoun referent	TOPIC	NONTOPIC	\bar{x}
SUBJECT	4.94	4.88	4.91
OBJECT	4.60	4.46	4.53
\bar{x}	4.77	4.67	

Analyses of variance showed that the pronominal clause was read more quickly than the first clause (Min F' = 4.54, df = 1, 28, p < .05). But the difference between the reading rates for the two clauses was modified by an interaction with whether the pronoun referred to the subject or the object of the first clause. This interaction was significant by passages (F_2 = 7.77, df = 1, 22, p = .01), but only marginally significant by readers (F_1 = 3.59, df = 1, 23, p = .068) and hence not significant on Min F' (Min F' = 2.46, df = 1, 40, $.1 < p < .75$). As Figure 6.1 shows, this interaction indicates that there was a greater difference between the reading rates for the first and pronominal clauses when the pronoun referent was the subject rather than the object. There were no other significant effects. (See Table A 6.23 for the summary tables.)

Figure 6.1 Mean reading rates for each clause where the pronoun referent was the subject or object - Experiment 13



Analyses of the reading rates for each clause for those sentences whose questions were later answered correctly or incorrectly showed only an effect of clause type (Min $F' = 4.86$, $df = 1, 35$, $p < .05$) and no effect of correct or incorrect question answering and no interaction. (See Table A 6.24 for the passage means and Table A 6.25 for the summary tables. Only the data from readers and passages which produced both correct and incorrect rates were included in the analyses.)

Verification rates

There were thirty two scores missing as a result of errors. All correct verification times were transformed to rates as before. The mean verification rates for each condition are shown below in Table 6.10. The means were based on unequal sample sizes because of the exclusion of incorrect rates from the data and their uneven distribution across conditions (see Table 6.10). (The means for each passage are shown in Table A 6.26.)

Table 6.10 Mean verification rates and errors by condition
- Experiment 13

Pronoun referent	TOPIC (Errors)	NONTOPIC (Errors)	\bar{x}
SUBJECT	4.77 (6)	4.46 (6)	4.62
OBJECT	3.79 (7)	4.09 (13)	3.94
\bar{x}	4.28	4.28	

Analyses of variance revealed a difference in the rate of verifying the critical question when the pronoun in the target sentence referred to the subject or the object of the first clause. Verification rates were reliably faster when the pronoun referred to the subject (Min $F' = 7.41$, $df = 1, 29$, $p < .05$). There was no difference between the verification rates for the questions when the pronoun in

the associated target sentence referred to the topic or the nontopic, and there was no interaction. (See Table A 6.27 for the summary tables.)

The distribution of errors across conditions suggests that there were slightly more errors when the pronoun referent was the nontopic and object than in the other three conditions. However, this difference would not be statistically significant.

EXPERIMENT 14 (Unambiguous sentences)

Method

Subjects

Twenty four students from Newcastle University volunteered to take part in this experiment.

Summary of materials

The twelve experimental sentences used in this experiment were identical to the target sentence pairs used in Experiment 13, but they were presented in isolation, not preceded by passages. The experimental sentences were thus the unambiguous versions of the sentences underlined in Table A 6.1.

Both practice and filler sentences were identical to those used in Experiments 11 and 12.

Design

Two factors were varied in this experiment. The subject pronoun referred to the 'topic' or the 'nontopic' and to the subject or the object of the first clause. Four versions (or conditions) of each experimental sentence were therefore generated. A reader saw only one version of each sentence, and allocation of a condition to a particular sentence was determined by a Latin square. Each reader saw three sentences in each condition, and each sentence was seen by six readers in each condition. Only one version of each filler sentence was presented.

Procedure

A self-paced reading task was used in this experiment, and the procedure and instructions were identical to those used in Experiment 12.

Results

Reading rates

The reading times (in ms) for each clause of the target sentence were divided by the number of words in the appropriate clause (see Table A 6.5) and then transformed to reading rates (in words per second).

The overall mean reading rates for each clause in each condition are shown below in Table 6.11. (The means for each sentence are shown in Tables A 6.28.)

Table 6.11 Mean reading rates (words per second) by condition for each clause - Experiment 14

<u>FIRST CLAUSE</u>			
Pronoun referent	'TOPIC'	'NONTOPIC'	\bar{x}

SUBJECT	3.54	3.65	3.60
OBJECT	3.72	3.63	3.68

\bar{x}	3.63	3.64	
<u>PRONOMINAL CLAUSE</u>			
Pronoun referent	'TOPIC'	'NONTOPIC'	\bar{x}

SUBJECT	4.41	4.27	4.34
OBJECT	4.28	4.30	4.29

\bar{x}	4.35	4.29	

Analyses of variance showed that reading rates for the pronominal clause were faster than those for the first clause ($F_1 = 21.97$, $df = 1, 23$, $p < .001$; $F_2 = 4.34$, $df = 1, 22$, $p < .05$; $\text{Min } F' = 3.62$, $df = 1, 30$, $p < .1$). There were no other main effects and no interactions. (See Table A 6.29 for the summary tables.)

Discussion

Overall, the results of this series of experiments indicate that there is still an effect of the subject when the target sentences from previous experiments were split in two and assignment was across a sentence boundary. There were more assignments to the subject than to the object both in the ambiguous passages and in the ambiguous sentences (Experiments 10 and 11). The subject also had an effect on verification rates in the unambiguous passages of Experiment 13. The pronominal clause was read faster than the first clause in all experiments involving a reading task and, in Experiment 13, the reading rates showed an interaction between this factor and whether the pronoun referent was the subject or the object. The topic, however, had no effect.

In addition to the strong subject effect evident in the assignments made in the ambiguous sentences of Experiments 10 and 11, there was also a suggestion of an influence of the subject on the verification rates of the ambiguous passages in Experiment 10. Verification rates for questions whose answers implied assignment to the subject were compared with those for questions whose answers implied assignment to the object. Analyses showed that subject assignment rates were faster than object assignment rates ($F_1 = 11.30$, $df = 1, 9$, $p < .01$; $F_2 = 10.33$, $df = 1, 6$, $p = .018$). (See Table A 6.30 for passage means and Table A 6.31 for the summary tables. Only those readers or passages which provided both subject and object assignment means were included in the respective analyses; hence calculation of Min F' was not appropriate.) Thus, retrieval of the referent was easier when the referent was the subject of the previous clause. There was also a suggestion that assignment rates were faster when assignment was to the subject rather than the object in the ambiguous sentences of Experiment 11. When the data for subject and object assignments were considered separately, the overall mean assignment rates by condition appeared

slower for the object assignment data than for the subject assignment data (see Table 6.7 and Table A 6.32). However, the number of missing scores made statistical analysis of this difference unsuitable.

In the unambiguous experiments, the subject only influenced the comprehension of pronouns occurring within passages of text (Experiment 13): The effect of clause type on reading rates was modified by an interaction with whether the pronoun referent was the subject or object. The pronominal clause was read faster when the referent was the subject rather than the object, again indicating the importance of a subject assignment strategy. There was also an influence of the subject on verification rates in this experiment. The subject appeared easier to retrieve during question answering than the object. As in previous experiments (3 and 5), it is not clear why the subject should be more salient during question answering. An explanation based on matching the order of the names in the critical question with those in the target sentence cannot account for the same effect in Experiment 1, and so seems unlikely to account for it in the other experiments. And it seems unlikely that it is simply because of its grammatical role that the subject is important. A more reasonable explanation is that it is its role as the local topic of the sentence that makes it easier to remember than the object. However, this cannot be demonstrated here, and is investigated in a later set of experiments (see Chapter 8).

There was no difference between the reading rates for sentences whose questions were later answered correctly or incorrectly suggesting that errors were due to problems with retrieval rather than comprehension (and the pattern of errors suggested most problems when the referent to be retrieved was the nontopic and object).

When the sentences containing unambiguous pronouns were presented in isolation, in Experiment 14, the effect of the subject assignment strategy on reading rates disappeared altogether. Readers appeared to rely solely on

gender cues, as they did in the other experiments in which single sentences containing unambiguous pronouns were presented alone (for example, Experiments 8(a), 8(b) and 9).

But once again, there is strong evidence for the importance of the grammatical subject in pronoun comprehension, although the precise reason for its effect is not clear. The subject could be important in itself, or as part of a parallel function strategy. Or, alternatively, its importance could lie in its role as the local topic of the sentence. These questions are addressed in later experiments (see Experiments 19 and 20).

Unfortunately, there was no strong evidence for a topic effect in either of the passage experiments reported in this chapter. (As expected, there was no evidence for such an effect in the sentence experiments.) In Experiment 10, where ambiguous passages were presented, there was no influence of the topic on assignments, on reading rates or on verification rates.

The absence of a clear topic effect made it difficult to address the question of the location of the topic effect found in previous experiments. The little evidence there was for an effect of topic (in the form of trends in reading rates in Experiment 10) pointed to an influence on the ease of assignment rather than on the first part of the sentence but the difference was not large enough to produce a significant effect of the topic.

The reduced influence of the topic in these experiments is consistent with the reduction seen in Experiments 2 to 5 compared with Experiment 1. This appears to be associated with a reduction in the number of features signalling the topic as such. It could be that in these experiments, the separate clause method of presentation further reduced the influence of the topic, possibly because assignment was between sentences rather than within a single sentence.

Despite the slightly unnatural nature of the presentation used in these experiments, readers apparently

had no difficulty in performing the reading and assignment tasks required and this method of presentation was important for allowing the measurement of reading times in the two clauses separately. Overall, it revealed a difference between the reading rates for the two clauses. The pronominal clause was read more quickly than the first clause in all experiments which involved a reading task (Experiments 10, 12, 13 and 14). Although the pronominal clause was usually shorter than the first clause, this cannot account for this difference since the measure taken was reading rate per word. The actions described in the two clauses were of comparable complexity, and it is therefore unlikely that the first clause was harder to comprehend than the pronominal clause. The most reasonable explanation seems to be that the difference reflects the difference between the ease with which reference can be achieved using pronouns (in the pronominal clause), in comparison to names or noun phrases (in the first clause). This is not surprising since the function of pronouns is to allow easy reference to characters mentioned previously in the text. Such a finding is consistent with previous work in this area (for example, by Lesgold, 1972).

The clause difference was not found in Experiment 11 in which the task was an assignment task rather than a reading task. In this experiment, the time recorded for the first clause was a reading time, whereas the time recorded for the pronominal clause included the time taken to identify the referent as well as a reading time. It is reasonable to assume that the advantage which the pronouns gave to the reading time was obscured by the extra time taken to identify the referent. As a result, if anything, readers took longer to 'read' the pronominal clause than the first clause.

Turning now to the general nature of the experimental tasks so far used in this thesis, while the reading and assignment tasks are valuable for being sensitive to the ease of comprehension of ambiguous and unambiguous pronouns in single sentences and in sentences embedded within

passages, they are limited in certain respects. For example, only one sentence structure has been considered; a sentence consisting of two coordinate clauses and containing two pronouns in the second clause. And in the unambiguous sentences, the referent of the subject pronoun was constrained by gender to one of two characters. The use of the same structure in a number of different experiments does have some advantages. One advantage is that it allows closer examination of effects found in earlier experiments and the examination of the influences of other factors on these effects without the problems of introducing additional influences through changes to the structure of the sentences. This is the main reason for using the same structure in the experiments so far reported. And it can be useful to constrain assignment by the use of unambiguous pronouns to allow examination of the effects of particular assignments on reading rates.

But it could be argued that the assignments made in these sentences, and thus the strategies exposed, are not very general, and only apply to the particular structure of sentences used. For example, although the subject assignment strategy is obviously very important in the target sentences used in the experiments reported so far, it is possible that a writer would normally use ellipsis when referring to the subject of the previous clause, not a pronoun, since ellipsis allows unambiguous reference to the subject. On the other hand, if this were the case, then a pronoun might be expected to signal to the reader that the referent is someone other than the subject (namely the object in the sentences used here); yet this did not appear to occur. But this could be a result of the type of sentence structure used. It is possible, for example, that the assignment in sentences containing two pronouns is different from that in sentences containing only one.

Some of these questions were investigated in the next set of experiments using a different experimental task. This task was a sentence completion task. It was chosen because it can answer the question of whether the type of

sentence used in the previous experiments was unnatural. It gives readers the freedom to generate the type of reference which seems most appropriate, both in respect of the reference term used and the person referred to. It is therefore possible to check whether the type of assignment found in the previous experiments occur naturally.

CHAPTER 7

AN EXAMINATION OF TOP-DOWN AND BOTTOM-UP PROCESSES - SENTENCE COMPLETION TASK

Introduction

This set of experiments involved a sentence completion task. Readers were asked to complete a sentence fragment which consisted of one clause in which two characters were mentioned by name. The fragment began with the name of one of these characters who was the subject of a transitive verb. The other character was the object of this verb. The readers were asked to finish the sentence by referring to at least one of the two characters mentioned at the beginning of the sentence. This allowed examination of who they referred to (for example, the subject or the object) and how reference was made (for example, by ellipsis or a pronoun).

In order to allow comparison with previous experiments, the sentence fragments used were the first clauses of the target sentences used in previous experiments. They were presented either alone or within passages, and with two characters of the same gender or two characters of different genders. The ambiguous sentence fragments ended either with a pronoun (the 'pron' condition) or with a conjunction (the 'and' condition). All the unambiguous fragments ended with a conjunction.

These experiments had two main aims. Firstly, they allowed strategies of reference assignment to be investigated using a different task to those used previously. In particular, the assignments made in the ambiguous 'pron' condition could be compared with those made in previous experiments using reading and assignment tasks since the reader's task when encountering a pronoun at the end of a fragment is similar to that in the reading or assignment task experiments. The pronoun must be assigned before completion of the fragment.

The second aim was to investigate whether the effects of subject and topic are better thought of as the result of top-down or bottom-up strategies. If they are top-down strategies, then there should be a preference for completions beginning with a reference to these entities. However, if they are bottom-up strategies, only operating when a pronoun is encountered, then there should be no such preference. The ambiguous experiments are particularly relevant to this distinction since the ambiguous sentence fragments ended either with or without a pronoun. If the effects of subject and topic were bottom-up, these entities should only be preferred as first referents when the fragment ends in a pronoun, but if they are top-down, then they should be preferred whether or not there is a pronoun at the end of the fragment.

In addition to an examination of who was the most likely referent when completing the sentence fragments, the use of three reference terms was examined. These were ellipsis, pronouns and names or noun phrases. One aim was to find out whether there were any preferences for using one term to refer to a particular referent. It might be expected, for example, that ellipsis would be used to refer to the subject of the sentence fragment since this type of anaphora is syntactically controlled and therefore unambiguous. Consequently, it might be expected to be used more often in the ambiguous experiments where no gender cues were available to determine assignment.

The sentence fragments consisting of the first clause of the unambiguous target sentences from Experiment 3 were presented within passages in Experiment 15. In Experiment 16, the sentence fragments consisting of the first clause of the ambiguous target sentences from Experiment 2 were presented within passages. The unambiguous sentence fragments were presented alone in Experiment 17 and the ambiguous sentence fragments were presented in isolation in Experiment 18.

EXPERIMENT 15 (Unambiguous passages)

Method

Subjects

Forty four students from Durham University took part in this experiment.

Summary of materials

The twelve experimental passages were based on those used in Experiment 3 (the unambiguous versions of those in Table A 3.3). The only difference was that the sixth sentence was omitted and the fifth, target, sentence ended after the first clause. The topic and the nontopic characters were different sexes and were mentioned by name in the first clause of the target sentences. All of the target sentences ended with the conjunction from the original sentence ("and" in all but one passage).

As in Experiment 3, there were two versions of the first clause of the target sentence. In one version, the topic was the subject of a transitive verb ($T = S$) and in the other, the nontopic was the subject ($NT = S$). The recency with which the topic and the nontopic were mentioned before the target sentence was counterbalanced across conditions, readers and passages.

There were no filler passages in this experiment because there was no need to counter a possible set for ambiguity or to distract attention from the structure of the target sentences as in other experiments in this series.

Design

Only one factor was varied in this experiment, namely $T = S$ and $NT = S$. Each reader saw only one version of each passage and a Latin square was used to determine which

passages were presented in a particular version. Each reader was given six passages in each condition and each passage was given to twenty two readers in each condition in a repeated measures design.

The order of the first four sentences in each passage was counterbalanced across conditions, readers and passages.

Procedure

The readers' task was to read each passage and to complete the sentence fragment at the end by referring to at least one of the two characters mentioned in the first clause. Each reader was given a booklet containing a printed passage on each page. The order of the passages was randomised for each reader. The readers were allowed as much time as they needed to read the passages and to complete the sentences, although they were urged not to spend too much time on each one. This was intended to encourage them to write down the most natural ending which occurred to them. The instructions were printed on the first page of each booklet and were as follows.

"I want to find out how people would normally complete the sentence fragments at the end of the passages in this booklet. Please read each passage carefully, and when you have finished a passage, complete the last sentence by mentioning at least one of the two characters mentioned in the first part of that sentence. Make your completions as natural as possible. Try not to take too long over each one."

Results

The completions were recorded and tabulated according to the character referred to (the referent) and how reference was achieved (the reference term). In some completions, other information was inserted between the conjunction and the first mention of a character, usually

as a subordinate clause. When this occurred, the intervening material was ignored and the first mention following it was recorded.

The referent was categorised as subject of the sentence, object of the sentence or both. There was also an 'ambiguous' category for those completions where it was not clear who the referent was, a category for references to 'other' characters and a category for 'unintelligible' completions. This category included those endings where no character was mentioned (for example, "and ... it was raining") and ungrammatical completions.

The use of three reference terms was tabulated; ellipsis (including any kind of ellipsis as long as it involved an elliptical reference to the subject), pronouns (including possessive pronouns) and names (including descriptive noun phrases, such as 'the car driver').

In some cases the completions were difficult to categorise so all first referents and reference terms recorded by the experimenter were checked by a second person, and any completions in which there was a discrepancy were given to a third judge. There were only 20 discrepancies out of a total of 528 completions (about 4%) and these were settled by the third judge. Only if a referent or reference term was categorised in the same way by at least two judges was the categorisation accepted. Any others were judged to be 'ambiguous'.

Choice of referent

The overall frequencies of subject and object references (out of a total of 528 completions) are shown below in Table 7.1. (See Table A 7.1 for the subject and object frequencies for individual passages and Table A 7.2 for the overall frequencies of ambiguous, both, other and unintelligible references.)

Table 7.1 Frequency with which the subject and object were mentioned first, by condition - Experiment 15 (unambiguous passages)

Referent	T = S	NT = S	\bar{x}
SUBJECT	163	158	161
OBJECT	55	52	54
\bar{x}	109	105	

The subject of the fragment was clearly the preferred referent in both conditions. About 60% of the references were to the subject both when the topic and when the nontopic was the subject (and about 20% were to the object). The topic did not appear to influence completions.

Choice of referent and reference term

Table 7.2 shows the overall number of completions in which the reference term was ellipsis, a pronoun or a name when the referent was the subject or the object. (See Table A 7.3 for the individual passage data and Table A 7.2 for the choice of reference terms to refer to ambiguous, both, other and unintelligible referents.)

Table 7.2 Frequency with which different reference terms used to refer to the subject and object by condition - Experiment 15 (unambiguous passages)

Reference term	Referent:	T = S		NT = S	
		SUBJECT (and T)	OBJECT (and NT)	SUBJECT (and NT)	OBJECT (and T)
Ellipsis		116	-	106	-
Pronoun		32	38	47	19
Name		15	17	5	33

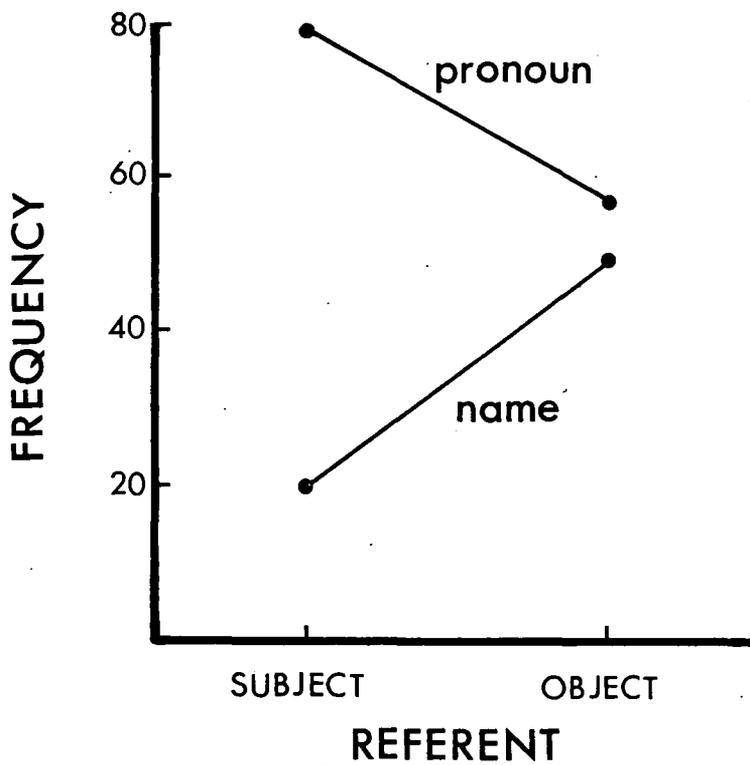
In order to be consistent with previous analyses, analyses of variance were performed on these completion data despite problems with missing scores in some cells of the data. However, where analyses of variance were used in these circumstances, the basic pattern of results was confirmed using nonparametric tests. Where multiple comparisons were carried out, these were based on sign tests following Friedman tests (Leach, 1979) or on Tukey tests (Winer, 1970) following analysis of variance.

In this experiment, when the subject was the referent, ellipsis was clearly the preferred reference term. This preference for elliptical reference was evident in an analysis of variance on the number of elliptical, pronominal and nominal references to the subject by condition. There was a significant main effect of reference type ($F_2 = 40.13$, $df = 2, 20$, $p < .0001$) but there was no effect of whether the topic or nontopic was subject of the sentence and no interaction. Multiple comparisons showed that there were significantly more elliptical references than either pronominal or nominal references but that the number of pronominal and nominal references did not differ. (See Table A 7.4 for the summary table. Analysis of variance was performed by passages only because there were too many missing scores by readers. In addition, Passage 1 (Mary) was excluded from the F_2

analysis because the use of the conjunction 'when' in that passage did not allow the possibility of elliptical reference.)

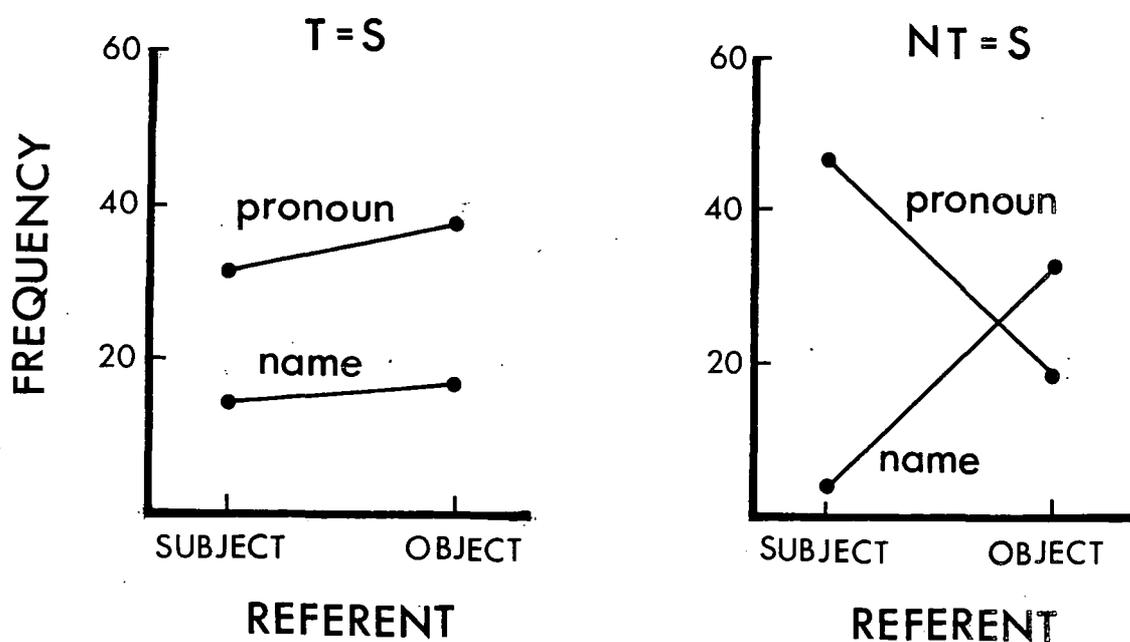
An examination of the use of pronouns and names to refer to the subject and object (across condition) suggests an interaction such that pronouns were more likely to be used to refer to the subject than the object and names were more likely to refer to the object than the subject (see Figure 7.1). Analysis of variance on the frequency with which pronouns and names were used to refer to the subject and object by condition confirmed this suggestion ($F_2 = 5.40$, $df = 1, 11$, $p < .05$). (Analysis by readers was not suitable because of the large number of missing scores but Passage 1 was included in this analysis since ellipsis was not involved.)

Figure 7.1 Frequency with which pronouns and names were
used to refer to the subject and object - Experiment 15



In addition to the interaction between the use of pronouns and names and reference to the subject and object, there was also a main effect of reference type ($F_2 = 27.0$, $df = 1, 11$, $p < .001$) with more pronominal than nominal references. But there was also a significant three way interaction between whether the topic or the nontopic was subject of the sentence, reference to the subject or object and use of a pronoun or name ($F_2 = 8.78$, $df = 1, 11$, $p = 0.013$). There were no other significant effects (see Table A 7.5 for the summary table). The three way interaction is illustrated in Figure 7.2.

Figure 7.2 Frequency with which pronouns and names were used to refer to the subject and object by condition - Experiment 15



Observation of Figure 7.2 suggests that the two way interaction between the use of names and pronouns and reference to the subject or object was only evident in those sentences in which the nontopic was subject. Where the topic was subject, there was a general preference for the pronoun rather than the name and no interaction. This interpretation was supported by tests of simple interaction effects. (Where the topic was subject, pronouns were used more frequently than names ($F_2 = 9.90$, $df = 1, 11$, $p < .01$) and there was no effect of subject/object references and no interaction. But where the nontopic was subject, while pronouns were still used more often than names ($F_2 = 14.77$, $df = 1, 11$, $p < .01$) and there was still no effect of subject/object references, there was a significant interaction between the use of pronouns and names and reference to the subject or object ($F_2 = 12.80$, $df = 1, 11$, $p < .01$). See Table A 7.6 for the summary tables.)

EXPERIMENT 16 (Ambiguous passages)

Method

Subjects

Fifty six students from Durham University volunteered to take part in this experiment.

Summary of materials

The twelve experimental passages were based on those used in Experiment 2 (see Table A 3.3). The principal difference was that the sixth sentence was omitted and the fifth sentence ended after the first clause. The first clause of the fifth, or target, sentence mentioned the topic and the nontopic by name. These two characters, introduced in the first four sentences of the passage, were the same gender.

As in Experiment 2, there were two versions of the first clause of the target sentence; T = S and NT = S. In addition, the clause ended either with the conjunction of the original target sentence (the 'and' condition) or with the conjunction plus a pronoun (the 'pron' condition). For example, the target sentence in Passage 7 (Herbie) appeared either as shown in 7.1 or as shown in 7.2 below.

7.1 Herbie saw the policeman and ... ('and' condition)

7.2 Herbie saw the policeman and he ... ('pron' condition)

When the sentence ended in a pronoun, it clearly referred to one of the two characters mentioned in the first clause of the target sentence fragment, but it could not be disambiguated by gender because the two characters were the same sex. The readers could therefore choose the referent which seemed most appropriate and continue the sentence accordingly.

Recency of mention of the two characters was counterbalanced across conditions, readers and passages.

There were twelve filler passages and these were also based on those used in Experiment 2. Two of the filler passages used in that experiment were omitted and the rest were altered, where necessary, so that the first clause of the fifth sentence referred to two characters of different sexes. One of these characters was the 'topic' character whose name was used as the title of the passage, and the other was a minor character introduced earlier in the passage. The two characters were different sexes. As in the experimental passages, the fifth sentence was terminated after the first clause in which the two characters were mentioned and the clause ended in one of two ways; with the conjunction "and" or with the conjunction plus a pronoun. The pronoun used was "he" and, because the two characters in the first clause were different sexes, the referent of this pronoun could be disambiguated by gender. Thus readers could not always expect the sentence fragments which ended with a pronoun to end with an ambiguous pronoun, as they did in the experimental passages. For half of the sentences where the ending was "and he", the subject of the first clause was a male character (and assignment was to the subject) and for the other half, the subject was a female character (and assignment was to the object). Similarly, for those sentences which ended with the conjunction alone, half had a male character as subject and the other half had a female character as subject. Over all twelve filler passages, male and female characters were subject and object of the first clause equally often. An example of a filler passage is shown in Table A 7.7.

Design

Two factors were varied in the experimental passages of this experiment. The subject of the first clause of the target sentence fragment was either the topic or the

nontopic of the passage. In addition, the fragment ended with either the conjunction of the original target sentence (the 'and' condition) or with the first pronoun of the pronominal clause (the 'pron' condition). These two factors combined to produce four versions of each target sentence fragment. A Latin square was used to allocate these four conditions to particular passages so that each reader was presented with three passages in each condition, and each passage was presented to fourteen readers in each condition in a repeated measures design. The order of the first four sentences of each passage was counterbalanced across conditions, readers and passages.

There were four versions of the filler passages, but each passage appeared in only one version throughout the experiment. The four versions were the result of varying whether the fifth sentence fragment ended with the conjunction "and", or with the conjunction plus the pronoun "he", and whether a male or a female character was subject of the first clause of the fragment (and thus whether assignment was to the subject or object of this clause). Three filler passages were shown in each of these four versions.

Procedure

The experimental task and procedure were the same as in Experiment 15 except that there were twelve filler passages in addition to the experimental passages. The order of the passages was randomised for each reader.

Results

The first referent and reference term in each continuation were recorded as in Experiment 15 and checked by a second person. (It was particularly important to check the tabulation of the completions when the fragment ended in an ambiguous pronoun.) There were 47 discrepancies out of 672 completions (about 7%). Only if

the referent and reference term were categorised in the same way by two judges were they accepted. Any others were categorised as 'ambiguous'.

Choice of referent

The overall frequency with which the subject and object were mentioned first in each condition (out of 672 completions) is shown below in Table 7.3. (See Table A 7.8 for the individual passage data and Table A 7.9 for the frequency of ambiguous, both, other and unintelligible referents.)

Table 7.3 Frequency with which the subject and object were mentioned first, by condition - Experiment 16 (ambiguous passages)

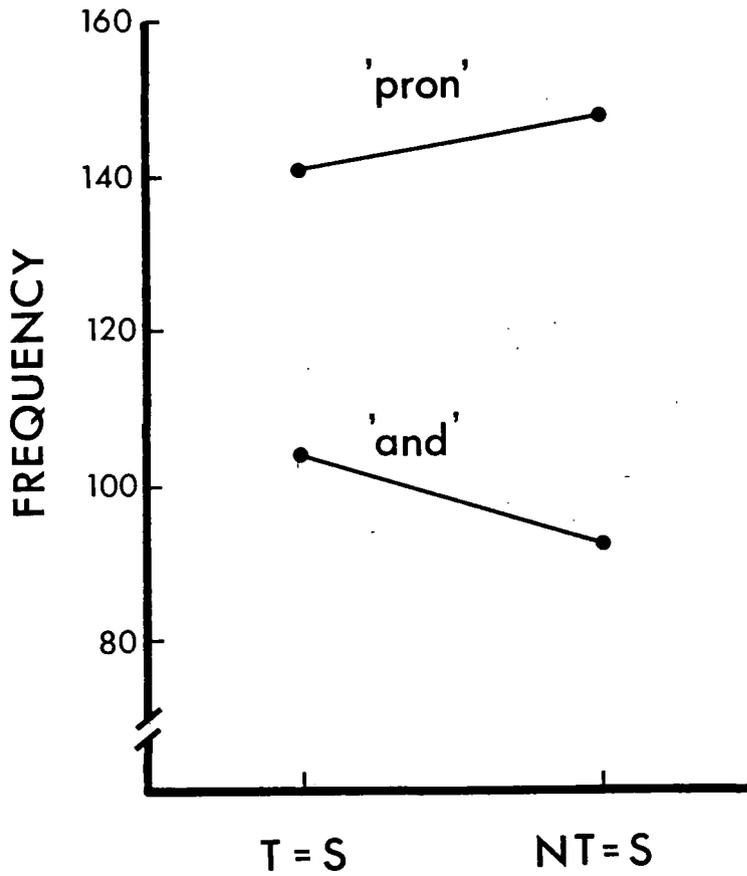
Condition	Referent			
	SUBJECT		OBJECT	
	'and'	'pron'	'and'	'pron'
T = S	104	141	25	15
NT = S	92	148	24	10
\bar{x}	98	145	25	13

Completions in which the subject was mentioned first far exceeded those in which the object was mentioned first, in all four conditions. This difference is so striking that statistical analysis is unnecessary.

Analyses of variance were performed on the number of completions in which the subject was mentioned first by condition (there were too many zeros to include object completions - see Table A 7.8). The number of completions in which the subject was mentioned first was greater in the 'pron' condition than in the 'and' condition (Min F' = 16.60, df = 1, 20, p <.01). There was no main effect of

whether the topic or the nontopic was subject of the first clause of the fragment, but this factor did interact with the type of fragment ending ('pron' or 'and'). The interaction was reliable at the 5% level by passages ($F_2 = 5.26$, $df = 1, 11$, $p < .05$), but only marginally significant by readers ($F_1 = 3.46$, $df = 1, 55$, $p = .065$) and therefore not reliable on the Min F' test (Min F' = 2.09, $df = 1, 48$, $p > .1$). The interaction is illustrated in Figure 7.3 and suggests that readers are more likely to refer to the topic than to the nontopic (in the 'and' condition), but when the task involves pronoun assignment (in the 'pron' condition), the topic of the passage has only a minimal effect. (See Table A 7.10 for the summary tables).

Figure 7.3 Frequency of subject completions where fragment ended in a pronoun or conjunction and where topic or nontopic was subject - Experiment 16



There were slightly more object references in the 'and' condition than in the 'pron' condition but there seemed to be no effect of whether the topic or nontopic was subject.

Choice of referent and reference term ('and' condition only)

The frequency with which each reference was used to refer to the subject or object by condition is shown in Table 7.4. (The reference terms chosen for the subject and object for each passage are shown in Table A 7.11 and the reference terms used to refer to ambiguous, both, other and unintelligible referents are shown in Table A 7.12.

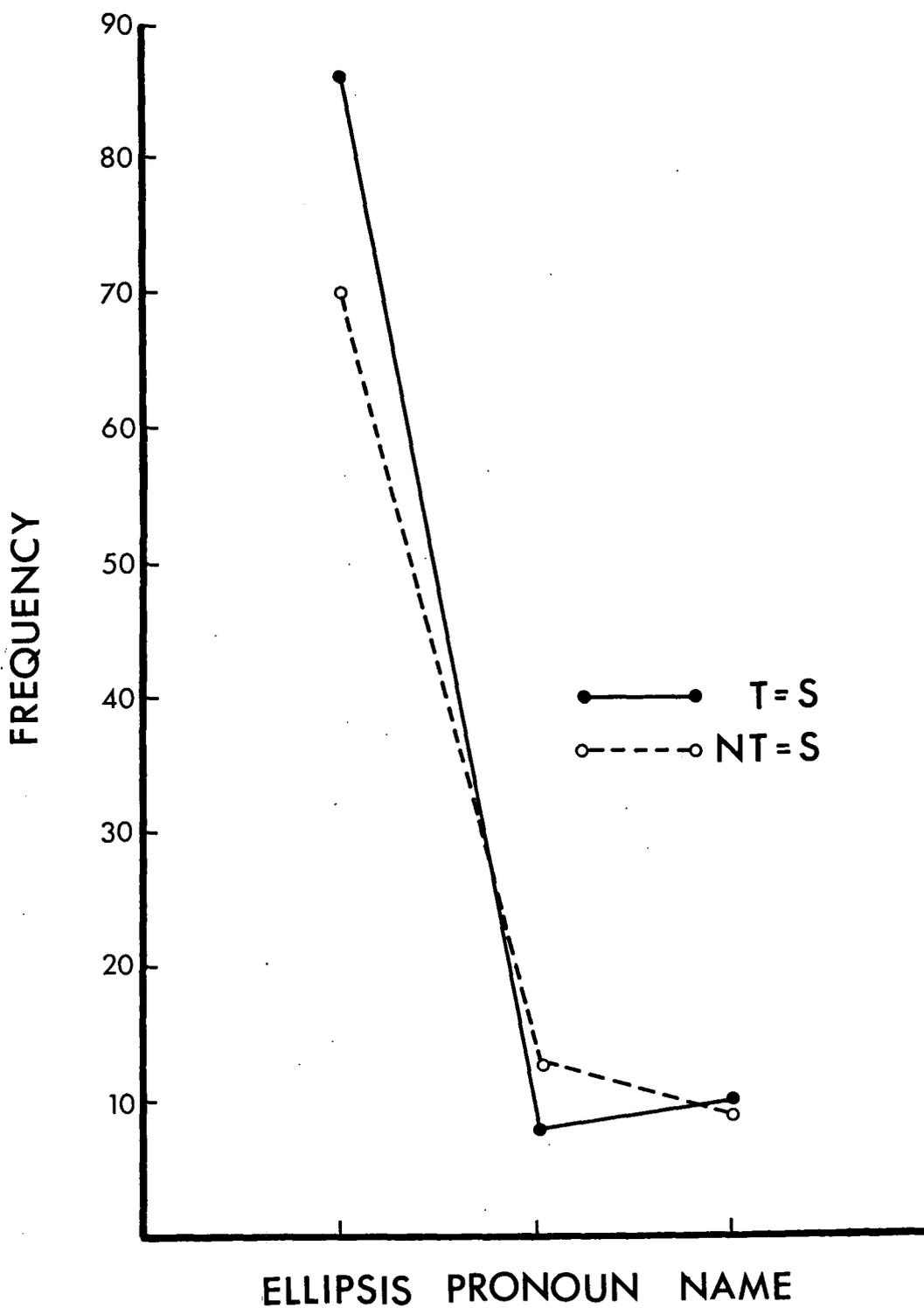
Table 7.4 Frequency with which different reference terms were used to refer to the subject and object by condition - Experiment 16 (ambiguous passages)

Reference term	Referent:	T = S		NT = S	
		SUBJECT (and T)	OBJECT (and NT)	SUBJECT (and NT)	OBJECT (and T)
Ellipsis		86	-	70	-
Pronoun		8	4	13	1
Name		10	21	9	23

It is clear from Table 7.4 that ellipsis was by far the most frequent reference term when the subject was the referent. Analysis of variance on the number of elliptical, pronominal and nominal references to the subject by condition showed a significant main effect of reference term ($F_2 = 37.68$, $df = 2, 20$, $p < .0001$). Multiple comparisons (using Tukey tests) showed there was a significant difference between the use of ellipsis and pronouns and between the use of ellipsis and names, but not between pronouns and names. There was a marginal effect of whether the topic or the nontopic was subject of the

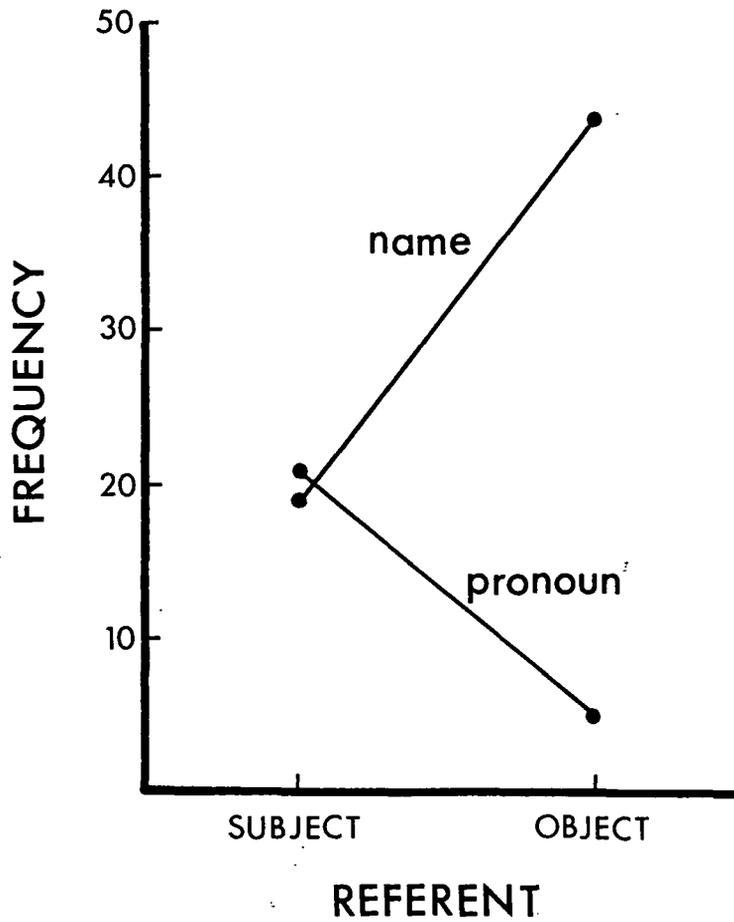
sentence ($F_2 = 3.49$, $df = 1, 10$, $p = .09$) and a marginal interaction ($F_2 = 3.33$, $df = 2, 20$, $p = .06$) illustrated in Figure 7.4. Figure 7.4 suggests that there was a greater use of ellipsis and a lesser use of pronouns when the topic was subject than when the nontopic was subject. (See Table A 7.13 for the summary table. Analysis was performed by passages only because there were too many missing scores by readers and Passage 1 was excluded from the F_2 analysis because elliptical reference was not possible.)

Figure 7.4 Frequency with which ellipsis, pronouns and
names were used to refer to the subject by condition -
Experiment 16



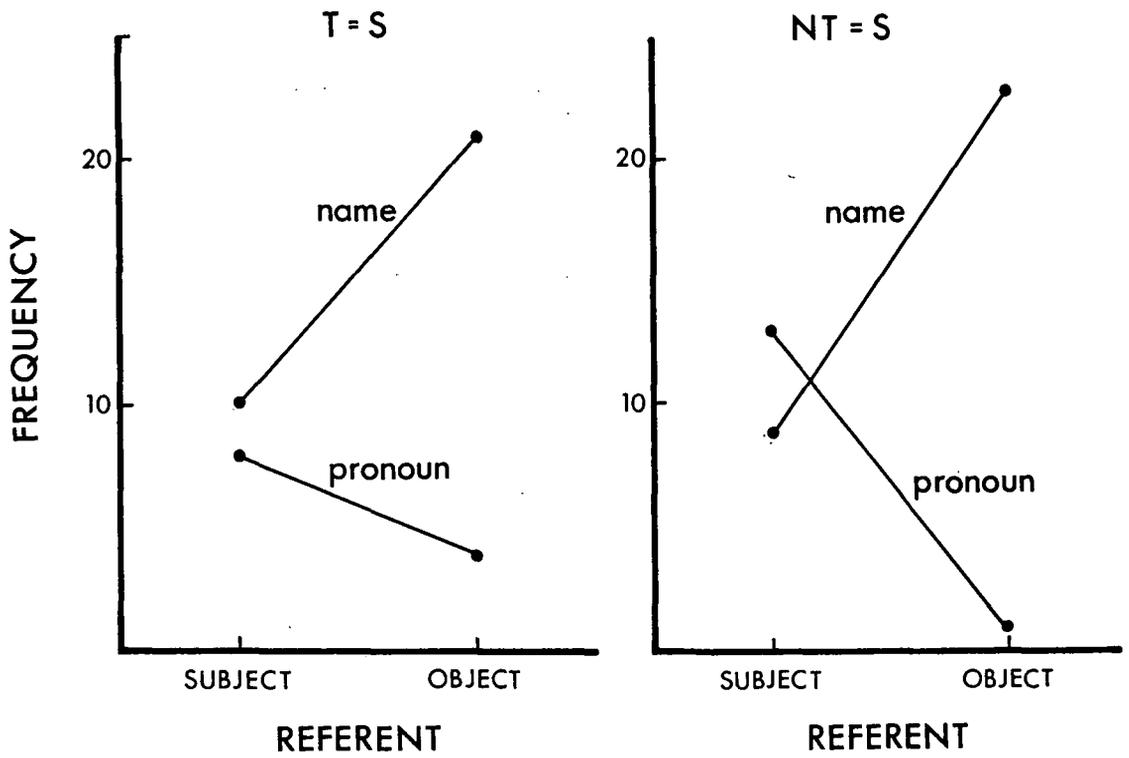
An examination of the use of pronouns and names to refer to the subject and object across condition shows that, as in Experiment 15, pronouns were used to refer to the subject more than the object and names were used to refer to the object more than the subject (see Figure 7.5).

Figure 7.5 Frequency with which pronouns and names were
used to refer to the subject and object - Experiment 16



However, unlike Experiment 15, names were generally used more frequently than pronouns. There were too many missing scores to perform analysis of variance on the number of pronominal and nominal references to the subject and object by condition but the pattern of data illustrated in Figure 7.6 shows that in this experiment, unlike Experiment 15, the preference for pronouns when referring to the subject and for names when referring to the object was evident both when the topic was subject of the sentence and when the nontopic was subject.

Figure 7.6 Frequency with which pronouns and names were used to refer to the subject and object by condition - Experiment 16



EXPERIMENT 17 (Unambiguous sentences)

Method

Subjects

Twenty schoolchildren (aged about fourteen years old) took part in this experiment.

Summary of materials

The experimental materials consisted of the twelve target sentence fragments from Experiment 15 presented in isolation, with no preceding passage. (Sentence 6, Mr Bentley, had to be altered slightly for use in this single sentence experiment. "The car driver" was changed to "the lady driver" so that it was clear that the two characters in the sentence fragment were different sexes.) The absence of a preceding passage meant that, unlike Experiment 15, there was only one version of each sentence. The number of fragments in which a male or a female character was subject of the first clause was equalised.

There were no filler sentences.

Design

There was only one version of each experimental sentence fragment. One male and one female character were mentioned by name in the first clause of each fragment and each fragment was terminated by the conjunction following this clause. The gender of the character who was subject of the first clause was counterbalanced across sentences.

Procedure

The readers' task and the procedure were essentially the same as in Experiment 15 except that readers were required to complete sentences appearing alone rather than

in passages. The instructions were as follows.

"I want to find out how people would normally complete the sentence fragments in the booklets I've given you. Please write a completion to each sentence by mentioning at least one of the two characters mentioned in the first part of the sentence. Try not to take too long over each one. You've got about five minutes to do them in."

Results

The completions were recorded and tabulated according to who was mentioned first in the completion and how the reference was achieved, in the same way as in Experiment 15. There were 6 discrepancies out of a total of 240 completions (2.5%) and these were resolved by a third judge.

Choice of referent

The frequency with which the subject and object were mentioned first is shown in Table 7.5. (See Table A 7.14 for the individual sentence data and Table A 7.15 for the frequency with which ambiguous, both, other and unintelligible references were made.)

Table 7.5 Frequency with which the subject and object were mentioned first - Experiment 17 (unambiguous sentences)

SUBJECT	OBJECT
158	60

The subject was clearly the most frequently mentioned first referent (66% of all first references were to the subject and 25% were to the object).

Choice of referent and reference term

Table 7.6 shows the frequency with which each reference term was used to refer to the subject and the object. (See Table A 7.16 for the individual sentence data and Table A 7.15 for the reference terms used for both and other referents (there were no ambiguous or unintelligible referents in this experiment.))

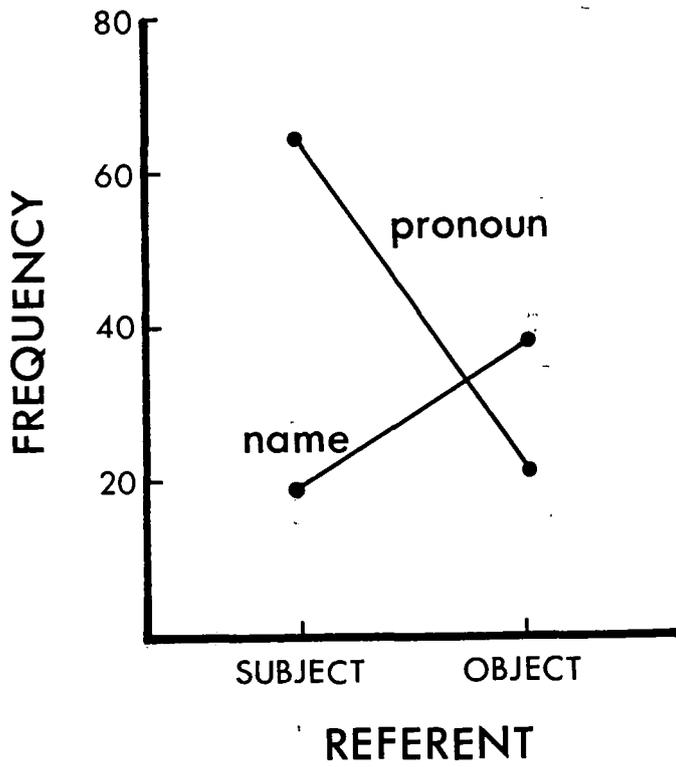
Table 7.6 Frequency with which different reference terms were used to refer to the subject and object - Experiment 17 (unambiguous sentences)

Referent	Reference term		
	Ellipsis	Pronoun	Name
Subject	74	65	19
Object	-	22	38

Analyses of variance were performed on the reference terms used to refer to the subject of the sentence (names were not included in the F_1 analysis because there were too many missing scores - 45%). The F_2 analysis showed a reliable effect of the use of the three reference terms ($F_2 = 12.91$, $df = 1, 11$, $p < .001$) and a Newmann Keuls analysis (Ferguson, 1976) showed that the difference was the result of fewer nominal references than either elliptical or pronominal references. (The F_1 analysis confirmed the lack of a difference between elliptical and pronominal references to the subject.) (See Table A 7.17 for the summary tables.)

Figure 7.7 shows the frequency with which pronouns and names were used to refer to the subject and object.

Figure 7.7 Frequency with which pronouns and names were
used to refer to the subject and object - Experiment 17



Once again, there appears to be an interaction such that pronouns are preferred for reference to the subject and names for reference to the object. This was confirmed using analysis of variance ($F_2 = 33.99$, $df = 1, 11$, $p < .001$). There was also a significant main effect of reference type ($F_2 = 11.96$, $df = 1, 11$, $p < .01$) with more pronominal than nominal references, but there was no effect of whether references were to the subject or object. (See Table A 7.18 for the summary table. Analysis was performed by sentences only because there were too many missing scores by readers.)

EXPERIMENT 18 (Ambiguous sentences)

Method

Subjects

Forty second year psychology undergraduates from Durham University took part in this experiment as part of a practical demonstration.

Summary of materials

The experimental materials consisted of the twelve target sentence fragments from Experiment 16 presented in isolation, with no preceding passage. Since there was no preceding passage, neither character was set up as a topic character, so the way in which the fragment ended was the only factor varied in this experiment ('and' or 'pron' condition).

In addition to the experimental sentence fragments, there were twelve filler fragments with the same structure as the experimental ones. Unlike the experimental sentences, the characters introduced in the first clause of the filler fragments were different in gender. Half ended with the conjunction "and" (for example, 'Malcolm annoyed Gillian and') and half with the conjunction plus the pronoun "he" (for example, 'Barry hated his aunt and he'). In addition, a male character was subject of the first clause in half the fragments and a female character was subject in the other half. Thus, over all twelve filler fragments, male and female characters were subject of the first clause equally often and, when there was a pronoun, it referred to the subject and the object of the first clause equally often. There were four versions of the filler sentences (as a result of varying whether the fragment ended in "and" or "and s/he", and whether a male or female character was subject of the first clause) and three of each version were presented.

Design

Only one factor was varied in the experimental sentence fragments of this experiment (whether the fragment ended either with a conjunction, or with a conjunction plus a pronoun). A Latin square was used to allocate one of these conditions to a particular sentence fragment. As a result, each reader was given six sentence fragments in each condition, and each sentence was given to twenty readers in each condition in a repeated measures design. Each filler sentence appeared in one version throughout.

Procedure

The procedure was essentially the same as in Experiment 17 except that the instructions were presented verbally to groups of about six readers at a time.

Results

The completions were recorded and tabulated according to who was referred to first in the completion, and how that reference was made, in the same way as in Experiment 17. There were 52 discrepancies out of a total of 480 completions (about 11%) and these were settled by a third judge.

Choice of referent

The frequency with which the subject and object were mentioned first is shown below in Table 7.7. (See Table A 7.19 for the individual sentence data and Table A 7.20 for the frequency with which ambiguous, both, other and unintelligible references were made.)

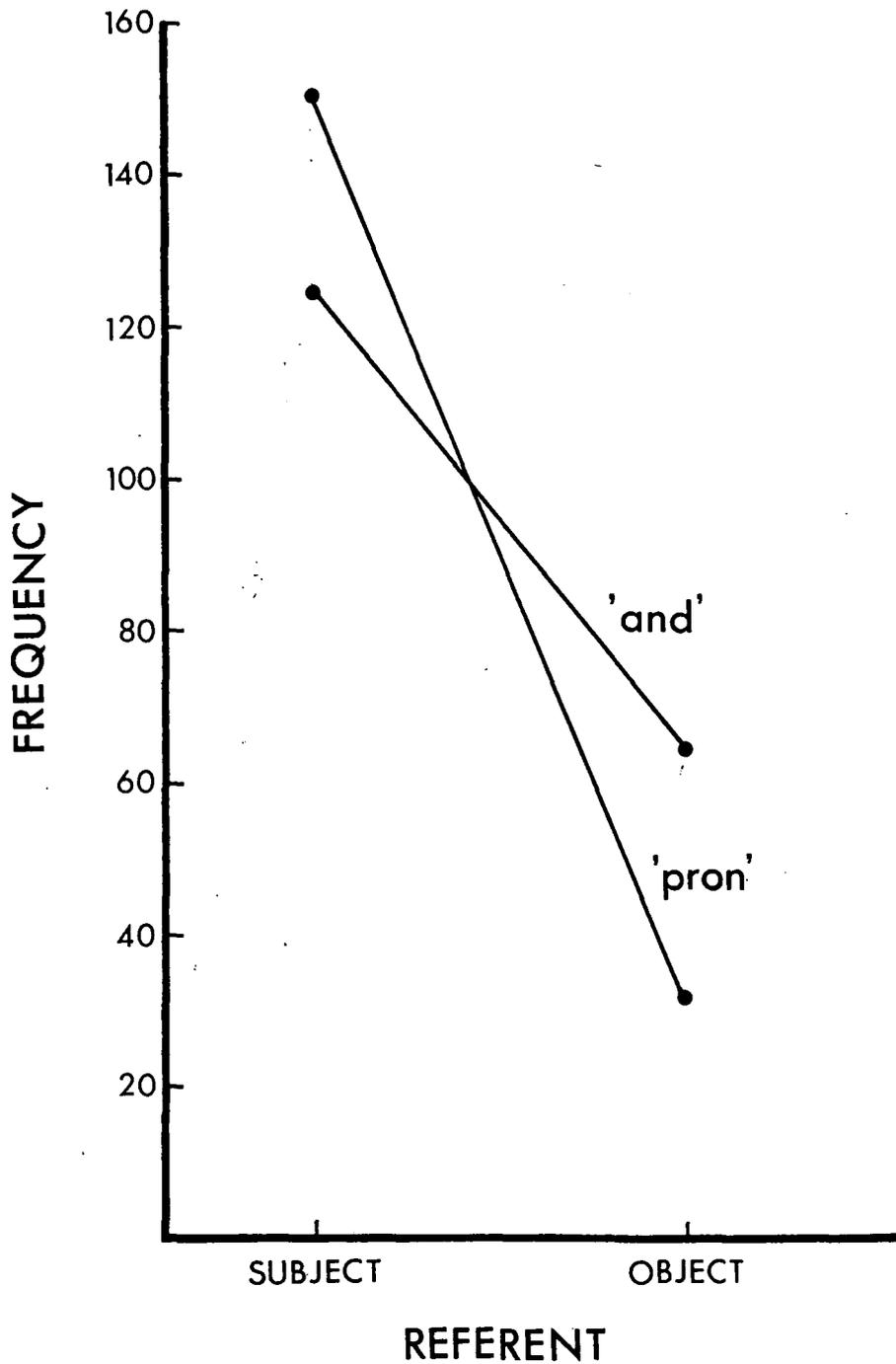
Table 7.7 Frequency with which the subject and object were mentioned first, by condition - Experiment 18 (ambiguous sentences)

Referent	Condition		\bar{x}
	'and'	'pron'	
SUBJECT	125	151	138
OBJECT	64	33	49
\bar{x}	95	92	

Clearly the subject was mentioned first more frequently than the object in both conditions.

Analyses of variance were performed on the number of subject and object completions in each condition. (Only subject completions were included in the F_1 data because there were too many missing scores in the object completion data - 30% in each condition.) The analysis by sentences showed a reliable difference in the overall number of subject and object completions ($F_2 = 13.42$, $df = 1, 11$, $p < .01$) with more subject than object completions. There was no effect of condition ('and'/'pron'), but there was a significant interaction between the number of subject and object completions and condition ($F_2 = 9.07$, $df = 1, 11$, $p = .012$). As Figure 7.8 shows, there were more subject completions and fewer object completions in the 'pron' condition than in the 'and' condition. Thus, when the task was one of assignment ('pron' condition), there were more subject assignments and when the task was a choice of referent ('and' condition), there were relatively more object assignments.

Figure 7.8 Frequency of subject and object completions in
fragments ending with a pronoun or conjunction -
Experiment 18



The analysis of subject completions by readers showed a similar effect. There were marginally more subject completions in the 'pron' condition than the 'and' condition ($F_1 = 3.56$, $df = 1, 39$, $p = .063$). Since the overall number of completions in which the subject and object were mentioned first was about the same in the two conditions, a difference in the number of subject completions in the two conditions is an indication of the interaction found in the F_2 analysis. (See Table A 7.21 for the summary tables.)

Choice of referent and reference term ('and' condition only)

Table 7.8 shows the frequency with which different reference terms were used to refer to the subject and object ('and' condition only). (See Table A 7.22 for the individual sentence data and Table A 7.23 for the reference terms used to refer to ambiguous, both, other and unintelligible referents.)

Table 7.8 Frequency with which different reference terms were used to refer to the subject and object - Experiment 18 (ambiguous sentences)

Referent	Reference term		
	Ellipsis	Pronoun	Name
Subject	104	15	6
Object	-	5	59

Clearly, the most common means of referring to the subject was through ellipsis. Elliptical references accounted for 83% of all references to the subject (and analysis is not necessary). As far as pronoun and names are concerned, although the numbers are low, the pattern is the same as in Experiment 17; pronouns were more likely

to be used to refer to the subject while names were clearly preferred for object reference. Indeed, names account for 92% of the references to the object.

Discussion

Overall, the results of this series of experiments indicate the following. In all four experiments, the subject was clearly the most frequently chosen first referent. In the ambiguous experiments (16 and 18), there were even more subject completions when there was a pronoun at the end of the fragment rather than simply a conjunction. The influence of the topic was less pronounced than the influence of the subject. However, in the ambiguous passages of Experiment 16, there was some effect of the topic. When the task involved choice of a referent ('and' condition), the topic was more likely to be chosen than the nontopic, whereas when the task involved assignment ('pron' condition), there was a minimal effect of the topic. There was also a marginal interaction between the use of ellipsis, pronouns or names to refer to the subject and whether the topic or nontopic was subject of the fragment. There appeared to be more elliptical references when the topic was subject. There was no effect of the topic in the unambiguous passages of Experiment 15 except in a three way interaction between reference to the subject or object, use of pronouns or names and whether the topic or nontopic was subject of the fragment. The most straightforward explanation of this appears to be that it was only in Experiment 15 when the topic was subject that there was an exception to the finding that when pronouns and names alone were considered, pronouns were used more often to refer to the subject and names to refer to the object. This pattern was found in Experiment 16 (both when the topic was subject and when the nontopic was subject), Experiment 17 and Experiment 18, but only in Experiment 15 when the nontopic was subject. However, when considering references to the subject, it must be remembered that, except in the unambiguous sentences of Experiment 17, ellipsis was by far the most frequently used reference term. (In Experiment 17, ellipsis and pronouns were used with equal frequency.) The use of names was greater than

the use of pronouns in the ambiguous experiments (16 and 18) and the use of pronouns was significantly greater than the use of names in the unambiguous experiments (15 and 17).

The strong preference for the subject as the first mentioned referent in all experiments, even where there was no pronoun at the end of the fragment, suggests that the influence of the subject is top-down rather than bottom-up. However, the finding that in both ambiguous experiments (16 and 18) there were even more subject completions when there was a pronoun at the end of the fragment suggests that there is something more than an expectation that the subject will be mentioned first. There also seems to be a preference for subject assignments when a pronoun is present at the end of a fragment. In Experiment 16 (ambiguous passages), it could be argued that this preference is because there were two categories of referent available in the 'and' condition which were not available in the 'pron' condition (both and other) which led to an increase in the total number of subject plus object completions in the 'pron' condition (314) compared to the 'and' condition (245). However, the extra completions were not distributed equally between the subject and object. Indeed, there were even fewer object completions in the 'pron' condition than the 'and' condition. Furthermore, the same increase in the number of subject completions in the 'pron' condition was found in Experiment 18 (ambiguous sentences) when the overall number of subject plus object completions in the two conditions was the same. (In Experiment 18, the extra two categories of referent available in the 'and' condition were compensated by a greater number of ambiguous referents in the 'pron' condition). So, in both Experiments 16 and 18, when the task was one of assignment (in the 'pron' condition), there was an even greater tendency to refer to the subject than when the task was purely choice of a referent (in the 'and' condition). These results are consistent with the results of previous experiments which have shown the importance of

the subject for pronoun assignment. It is worth noting that when readers were free to choose their own reference term in the 'and' conditions of Experiments 16 and 18, they appeared sensitive to their potential ambiguity and there were few ambiguous references.

The topic had no effect in the unambiguous passages of Experiment 15. However, in the ambiguous passages of Experiment 16 there was a suggestion of a greater preference for subject completions when the topic rather than the nontopic was subject but only for fragments ending in the conjunction ('and' condition). (This effect was evident in a marginal main effect of whether the topic or nontopic was subject when the use of ellipsis, pronouns and names for subject completions was examined for the 'and' condition only, and in an interaction between whether the topic or nontopic was subject and whether the fragment ended in "and" or a pronoun when subject completions were analysed.) This suggests that the influence of the topic was the result of a top-down expectation that the topic would be mentioned next rather than a bottom-up influence of the presence of a pronoun to be assigned. This finding is consistent with Anderson et al's (1983) finding that the number of completions involving the topic of a passage was greater than the number involving a scenario-bound character.

The fact that the topic appeared to have more influence in the ambiguous passages of Experiment 16 than in the unambiguous passages of Experiment 15 is consistent with earlier experiments which have shown that the topic has more effect when there are no gender cues to determine pronoun assignment unambiguously. In the unambiguous sentence completions experiments there was no pronoun in the sentence fragments presented but presumably the possibility of exploiting a gender cue led to a reduction in the effect of the topic. (This is perhaps a surprising influence of a potential local gender cue over a top-down expectation that the topic would be mentioned next.)

In the unambiguous experiments and in the 'and'

conditions of the ambiguous experiments, there was a choice of which reference term to use as well as which referent to mention first. The most striking aspect of these data is the preference for using ellipsis to refer to the subject. Ellipsis was used significantly more often than either pronouns or names in Experiments 15, 16 and 18 (and there was no difference in the frequency of pronominal and nominal references). The only exception to the preference for ellipsis was in the unambiguous sentences of Experiment 17 where pronouns were used as frequently as ellipsis (and much more often than names). The three reference terms can be thought of as three points on a continuum of economy of reference from ellipsis (as the most economical) to a name (as the least economical) with a pronoun somewhere in between. The overall preference for ellipsis probably reflects a preference for the most economical yet unambiguous reference term. In the ambiguous experiments, a pronoun would not be unambiguous in terms of simple gender cues and a name is not economical. In the unambiguous experiments (15 and 17), however, a pronoun is also available for unambiguous and fairly economical reference to the subject. Even so, pronouns were only used as frequently as ellipsis in the single sentence experiment (17), not in the passage experiment (15). (However, it should be remembered that even though there was a great preference for ellipsis when readers had a choice, pronouns were used effectively for reference to the subject in the 'pron' conditions of the ambiguous experiments where readers had no choice.) The reason for the difference between the use of ellipsis and pronouns in the single sentence and passage experiments is not clear but it could be that the discourse preceding the fragment in Experiment 15 encouraged a more natural, economic style than the isolated, unconnected fragments of Experiment 17. Alternatively, the different subject populations in the two experiments may have been responsible (University students in Experiment 15 and schoolchildren in Experiment 17).

In addition to the strong preference for ellipsis,

there was an interaction between the use of pronouns and names and reference to the subject and object in all four experiments. Pronouns were used more often for reference to the subject and names for reference to the object. (The only exception was in Experiment 15 when the topic was subject of the sentence; pronouns were used more often than names for reference to both the subject and the object.) This pattern of pronominal and nominal reference again reflects the importance of the subject for pronoun assignment. When reference to the subject was intended, the more economical pronoun was preferred but when reference to the object was intended, the more explicit name was preferred. So, the subject influenced the choice of reference term as well as choice of first referent.

There was also an influence of the potential use of a gender cue on the choice of reference term. The preference for the use of a name to refer to the object was even stronger in the ambiguous experiments than the unambiguous ones. Not surprisingly, when a pronoun was potentially ambiguous, a name was used even more often for reference to the object (90 - 92% in the ambiguous experiments, 16 and 18 compared with 47 - 63% in the unambiguous experiments, 15 and 17). Such sensitivity to the potential ambiguity of pronouns in the ambiguous experiments is also evident in the overall frequency of use of pronouns compared to names in the ambiguous and unambiguous experiments. Pronouns were used significantly more often than names in the unambiguous experiments (15 and 17) whereas names were used more often than pronouns in the ambiguous experiments (16 and 18).

There was also some evidence for an influence of the topic on the choice of reference term. There was a marginal interaction between the use of ellipsis, pronouns and names to refer to the subject and whether the topic or nontopic was subject of the fragment in Experiment 16. The interaction indicated that there were slightly more elliptical references to the subject when the topic was subject. Thus it appears that there was a preference for

the most economical reference term when referring to the topic. This is consistent with the work of Clancy (1980) on speaker's choice of reference term and with the observation of Grimes (1978) that, in some languages, ellipsis is reserved for the main character.

So, there was an influence of both the local subject and the global topic in these sentence completion experiments. The similarity between the findings of these and previous experiments suggests that the sentence structure used in previous experiments was not unnatural. For example, ellipsis cannot always have been expected for reference to the subject otherwise there would not have been even more subject completions following a pronoun. And there was a preference for the subject as the first referent in a variety of different sentence structures.

In these experiments, the subject emerges once more as an important influence in the comprehension of pronouns. The results suggest that part of its effect is the result of a top-down expectation that there will be further reference to the subject but that there is an even stronger effect when there is a pronoun to be assigned. However, it is not clear exactly which aspect of the subject is important. This question is examined in the next experiments.

All the target sentences used so far have been in the active voice. Consequently the roles of surface subject and deep subject have been confounded with initial position in the sentence, as they usually are in English (Chafe, 1976). The initial referent of a sentence may be important in pronoun comprehension as the local topic of that sentence. So, the subject in the active target sentences of previous experiments could have influenced pronoun comprehension in its role as surface subject, deep subject or local topic of the sentence. In the next two experiments, an attempt was made to determine which of these roles was most important by separating the surface and deep subject in passive sentences. Unfortunately, the use of the passive does not allow a separation of the

surface subject from the local topic (since the surface subject is still the first character mentioned in a passive sentence). However, it was considered important to separate the surface and deep roles of the subject and object first and to investigate the separate roles of surface subject and local topic later if necessary.

CHAPTER 8

SURFACE SUBJECT ROLE OR DEEP SUBJECT ROLE? - SINGLE SENTENCE PRESENTATION

Introduction

The aim of this series of experiments is to examine the effect of the subject found in earlier experiments in more detail. The roles of surface and deep subject were separated by using sentences in the passive voice.

There are two main views concerning whether the surface or deep subject should be important in the passive. The most common view is that the passive emphasises the deep object (surface subject) by placing it at the beginning of the passive sentence (for example, Johnson-Laird, 1968a, 1968b). The deep object is often held to be important as the local topic of such a sentence. Others, however, believe that the passive serves to direct attention to the deep subject as the focus of new information in the sentence (for example, Fillmore, 1968).

A number of strategies of pronoun assignment would predict assignment of a subject pronoun to the first character mentioned in a passive clause or sentence (that is, to the surface subject or deep object). A parallel function strategy (based on surface roles), a subject assignment strategy and a strategy which assigned a subject pronoun to the local topic of a sentence (to preserve the local topic from one clause or sentence to the next) would all make this prediction. Such a prediction is consistent with the findings of Caramazza and Gupta (1979).

But there are also reasons to suppose that a subject pronoun would be assigned to the second character (the deep subject or surface object) of a passive sentence. Firstly, readers might assign a pronoun to the deep subject as a result of its importance as the focus of the sentence. Such a strategy would be based on an expectation that the new, focused information of a previous clause or sentence

would be the most likely candidate for future reference. For example, Jarvella and Engelkamp (1983) pointed out that there is a tendency for what is presented as the focus in one utterance or sentence to become the topic of the following sentence. Thus, they argued that the focus of attention may be a major potential antecedent later in the text.

Secondly, parallel function based on deep rather than surface grammatical roles would make the same prediction. The deep subject of one clause, for example, would be expected to be the deep subject of the next. Thus, if the deep subject of the second clause were a pronoun, it would be interpreted as coreferential with the deep subject of the previous clause (the second character in a passive sentence).

The major consideration in this chapter is whether the pattern of assignments in the passive sentences imply that the strong subject assignment strategy in the active target sentences of previous experiments was due to the subject's surface or deep role.

The sentences used had the same structure as in previous experiments. They were chosen carefully so that they elicited consistent subject assignments in the active voice but also permitted object assignments to be made. The first clause was presented in the passive voice and the second in the active voice. The two characters mentioned in the first clause were the same gender in Experiment 19 and different genders in Experiment 20.

EXPERIMENT 19 (Ambiguous sentences)

Method

Subjects

Ten students from Newcastle University took part in this experiment.

Summary of materials

Fifty sentences were used in this experiment; twenty six experimental and twenty four filler sentences.

All of the experimental sentences had the same structure as the target sentences used in the previous experiments, namely two coordinate clauses joined by the conjunction "and" (with the exception of Sentence 1, Mary, in which the conjunction was "when"). There was a transitive verb in each clause and in the first clause the verb was in the passive voice. Two characters of the same gender were introduced by name or definite noun phrase in the first clause and in the second clause they were referred to again using pronouns which were thus ambiguous by gender. The verb in the second clause was in the active voice.

Six of the experimental sentences were based entirely on target sentences used in previous experiments. These were the six in which the verb in the first clause converted naturally to the passive (the other six were not suitable for such a transformation). Apart from the change in the voice of the first verb, the sentences were identical to the original target sentences, and they will be referred to as the 'old' experimental sentences. They may be seen in Table A 8.1 (sentences 1 to 6).

The remaining twenty 'new' experimental sentences were devised so that, even though the first clause was presented in the passive in the experiment, when in the active voice it elicited consistent subject assignments. Object

assignments were, nevertheless, plausible. Since this experiment was intended to investigate the subject assignment strategy found previously in more detail, it was necessary to ensure that the sentences did yield subject assignments when in the active voice. But it was also important that assignment to the object was possible so that, when the first clause was transformed to the passive, assignment was not constrained to be to the deep subject just because of the semantics of the sentence.

All the 'new' sentences contained fifteen words. The 'old' sentences varied in the number of words from eleven to twenty one (with a mean of sixteen). In the 'new' sentences, both characters in each sentence were referred to either by name or by noun phrases. Names were used in all the 'old' sentences except Sentence 4 (Herbie) which contained one name and one noun phrase.

Two aspects of the sentences were determined by a prior pilot study. These were the preference for subject assignments and the plausibility of object assignments when the first clause was presented in the active voice. Three judges were each given a booklet containing a number of sentences thought to exhibit the desired characteristics printed in random order, one on each page. (The 'old' sentences were not included since their assignments were clear from previous experiments.) Both clauses of the potential 'new' experimental sentences were presented in the active voice and the judges were asked to read each sentence and to underline the character they understood to be the referent or the subject pronoun (underlined in red). They were told to work fairly quickly and, if they were unsure of an assignment, they were asked to mark the sentence with 'A' (for ambiguous). When they had finished making their first assignments, they were asked to read through the sentences again indicating with a tick whether the other referent in the sentence (the one they had not underlined) was a plausible referent for the subject pronoun.

A number of such pilot studies were necessary before a

sufficient number of 'new' experimental sentences were generated. Twenty sentences were eventually selected and these are shown in Table A 8.1 (sentences 7 to 26). The criterion for selection was that all three judges should have indicated a preference for assignment to the subject but also considered assignment to the object to be possible. The first clause of each sentence was then converted to the passive before presentation in the experiment. An example of a 'new' sentence is "Janet was welcomed by Carol and she told her it was nice to see her".

Twenty four filler sentences were used in this experiment. They had roughly the same coordinate structure as the experimental sentences. As in the experimental sentences, two characters were introduced as the subject and object of the transitive verb in the first clause, either by name or by definite noun phrase and they were referred to again in the second clause using pronouns. To ensure that the experimental sentences did not stand out, the two characters were the same gender and the pronouns in the second clause were ambiguous by gender.

In the filler sentences the assignment of the subject pronoun was constrained to the first character in one half of the sentences (for example, 'Anthony lent Michael the book and he asked him to return it the next day') and to the second character in the other half (for example, 'Dennis read Jack the letter and he listened to him attentively'). Assignment was constrained by the semantics of the sentence and, unlike the experimental sentences, the alternative assignment was not necessarily plausible. The bias in the filler sentence assignments was confirmed by three judges in the pilot study described above. In half the filler sentences the first clause was passive, in the other half, both the first clause and the second were active. There were thus four different types of filler sentences and six of each type were presented. (One of each type served as the practice sentences.)

Design and Procedure

An assignment task was used in this experiment. The procedure was identical to that used in Experiment 6(b) except that there were fifty instead of twenty four sentences so the session lasted about ten minutes. The instructions were altered to take account of these changes but, in all other respects, they were the same. The sentences appeared one at a time on the PET's screen and readers were asked to read each one and to press one of two keys to indicate whether they thought the first (subject) pronoun referred to the first or the second character mentioned in the sentence. Their assignment and the time taken to make it were recorded.

Results

Assignments

One assignment was excluded from the data because its recorded assignment time was zero. The mean number of assignments to the first and second character are shown in Table 8.1. (The data for individual sentences are shown in Table A 8.2.)

Table 8.1 Mean number of assignments to the first and second characters - Experiment 19

First character	Second character
8.4	17.5

Analyses of variance showed that there were significantly more assignments to the second character in the passive clause than to the first character. (Min $F' = 10.68$, $df = 1, 34$, $p < .01$). (See Table A 8.3 for the summary tables.)

Assignment rates

Times were divided by the number of words in the appropriate sentence because the number of words in the 'old' sentences was so variable (see Table A 8.1). They were then transformed to rates as before. The rates were separated into those where assignment was to the first character and those where assignment was to the second character. There were no assignments to the first character in three sentences and these scores were replaced using Winer's (1970) formula. The overall mean assignment rates are shown below in Table 8.2. (See Table A 8.4 for the individual sentence data. The preference for assignments to the second character meant that the means were based on unequal sample sizes.)

Table 8.2 Mean assignment rates for assignments to the first and second characters - Experiment 19

Assignment to	
First character	Second character
2.07	1.99

Analyses of variance showed that there was no reliable difference in the rate of assignment as a function of whether the pronoun was assigned to the first or the second character, either by readers ($F_1 < 1$) or by sentences ($F_2 = 1.64$, $df = 1, 22$, $p = .21$). (See Table A 8.5 for the summary tables.)

The rates for the 'new' sentences were analysed separately, without taking into account the number of words in the target sentence (the number of words was equated in the 'new' sentences). (See Table A 8.6 for the individual sentence means.) The results of this analysis were the same as those of the previous analysis. There was no

difference between the rate of assignment to the first and the second character either by readers ($F_1 < 1$) or by sentences ($F_2 = 1.81$, $df = 1, 16$, $p = .19$). (See Table A 8.7 for the summary tables.) Where assignment was to the first character, the overall mean assignment rate from the F_1 analysis was 1.45 and where assignment was to the second character, it was 1.38.

EXPERIMENT 20 (Unambiguous sentences)

Method

Subjects

Twenty students from Newcastle University volunteered to participate in this experiment.

Summary of materials

The twenty six experimental sentences in this experiment were the unambiguous counterparts to those used in Experiment 19 (see Table A 8.1). The gender of one of the two characters described by name or noun phrase in the first clause of the experimental sentences of Experiment 19 was changed by substituting a name of the opposite gender (but equal length, where possible). Because the assignment of the pronouns could be constrained by gender, there were two versions of each experimental sentence. In one condition, the subject pronoun referred to the first character of the passive clause and in the other, it referred to the second character.

The filler and practice sentences in this experiment were identical to those used in Experiment 19. Unlike the experimental sentences, the pronoun could not be assigned by gender but was biased by the semantics of the sentence to the first character in one half of the sentences and to the second character in the other half.

Design

One factor was varied in this experiment; whether the subject pronoun referred to the first or the second character mentioned in the passive clause. Each reader saw only one version of each sentence and the allocation of particular sentences to one of these two conditions was determined by a Latin square. Ten readers saw each

sentence in each condition.

Procedure

A self-paced reading task was used in this experiment. The procedure and instructions were the same as those used in Experiment 7(b) except that there were fifty instead of twenty four sentences. The time taken to read each sentence was recorded in ms.

Results

Reading rates

The reading times (in ms) were divided by the number of words in the sentence (see Table A 8.1) and transformed to rates. The overall mean reading rates for each condition are shown in Table 8.3. (The means for each sentence are shown in Table A 8.8.)

Table 8.3 Mean reading rates (words per second) by condition - Experiment 20

Assignment to	
First character	Second character
4.34	4.38

Analyses of variance showed that there was no reliable difference between the reading rates for sentences in which the pronoun referred to the first character and those in which it referred to the second character, either by readers or by sentences ($F_1 < 1$; $F_2 < 1$). (See Table A 8.9 for the summary tables.)

Discussion

Overall, the results of these experiments showed a strong preference for assignment of an ambiguous subject pronoun to the second character of a passive clause (the deep subject), but no effect of reference to the first or second character on assignment rates (in the ambiguous sentences of Experiment 19) or on reading rates (in the unambiguous sentences of Experiment 20). In Experiment 19, there was no difference between the analyses of assignment rates with or without a division by the number of words in the sentence.

The preference for assignment of an ambiguous subject pronoun to the deep subject of a passive clause suggests that the strong preference for the subject in previous experiments involving active target sentences was due to the subject's deep role rather than its surface role or its role as local topic of the sentence.

In the passive, the deep subject may be important in a parallel function strategy based on deep roles of the pronoun and antecedent or as the focus of the previous clause. Although it is not possible to separate the deep parallel function and the focus explanations for the second character assignment strategy unequivocally, the deep parallel function strategy appears to have the advantage of being able to explain the results of both the passive and the active experiments. There is little difference between the two characters in an active clause in terms of presupposition and focus, so an explanation based on the importance of the focused entity is unlikely to apply to active sentences. An explanation based on matching the deep relations within a sentence, on the other hand, can apply equally well to both active and passive sentences. Since the surface subject of an active sentence is also the deep subject, the tendency to assign the pronoun to the surface subject or the active target sentences of previous experiments could have been the result of matching the deep function of the subject pronoun with the deep function of

the grammatical subject in the previous clause. This explanation of the subject assignment strategy in the active experimental sentences has the advantage of allowing a parsimonious explanation based on deep parallel function to embrace both the passive and the active results.

The results of Experiment 19 are contradictory to those of Caramazza and Gupta (1979) who argued for the importance of the local topic for assignment on the basis of a preference for assignment of anaphoric and cataphoric pronouns to the surface subject of a passive clause. However, there are problems with their study, as already noted (p. 13). The results of Experiment 19 suggest that the local topic is not always an important candidate for pronoun assignment.

It should be noted that a simple strategy by which readers assigned a pronoun to the most recently mentioned character would also account for the pattern of assignments found in Experiment 19. However, there is no reason to suppose that such a simplistic strategy should operate, particularly as it could not account for the assignment preferences found in the active sentences of previous experiments.

Although a parallel function strategy based on the deep roles of pronoun and antecedent could account for the pattern of assignments in both the active and passive sentences used in this thesis, the same strategy of assignment need not necessarily operate in both active and passive sentences. It has often been claimed that the two voices convey different meanings (Anisfeld and Klenbort, 1973; Chomsky, 1957; Johnson-Laird, 1968a, 1968b; Ziff, 1966) and a difference in emphasis for the purposes of future reference could be part of this difference. Indeed, it is clear that the deep parallel function explanation cannot apply to all passive sentences (at least if one considers assignment in single sentences in isolation) since one of the main functions of the passive is to allow the omission of the deep subject in an agentless passive. Clearly there would then be no alternative but to assign a

subsequent pronoun to the deep object of such a passive. Deep parallel function matching would be impossible and the strategy of assignment in agentless passives would differ from that found in the full passives of Experiment 19. Since it is not even possible to provide a parsimonious account of assignment (such as deep parallel function) to all passive sentences, it is equally possible that there is no parsimonious account of assignment in active sentences and full passives. For example, the surface (and deep) subject could be important in active sentences because of its role as the local topic of the sentence and yet, in the passive, the deep subject could be important because it is the focus of the sentence. In any case, this consideration weakens the argument for deep parallel function and implies that an explanation based on the importance of the deep subject as the focus of the sentence should not be dismissed too readily on these grounds.

Although the focus explanation has no direct support in terms of pronoun comprehension, it does seem a reasonable explanation given the evidence for the importance of the deep subject in its focused role in the passive (Klenbort and Anisfeld, 1974). It also seems reasonable that the importance of the deep subject should be emphasised in a full passive since, if it were not important, it could be omitted altogether in an agentless passive. In any case, in answer to the question raised in the Chapter 1 (p. 42) of whether a pronoun should be assigned to the local topic or to the new information as the focus of a sentence, the results of Experiment 19 suggest that, at least for passives, the focus of the sentence is more important. However, it should be noted that, conversely, if the local subject is roughly equated with the subject of an active sentence and the focus with the end of an active sentence, all the previous experiments in this thesis would suggest that the local topic is more important than the focus. Again, this suggests that assignment preferences in actives and passives may differ.

However, in addition to the possibility that the

strategies operating in actives and passives differ, there is another reason to be cautious about concluding that the strong preference for subject assignments in previous experiments was due to the importance of the deep subject rather than the surface subject or local topic. It is possible that the preference for deep subject assignments in Experiment 19 was a result of the semantics of the particular sentences chosen. The experimental sentences of Experiment 19 were generated so that they elicited consistent subject assignments in the active voice with the intention that they should be comparable to the sentences used in previous experiments. It is possible that the sentences elicited consistent subject assignments in the active voice, not because of some general subject assignment strategy, but because assignment to that character was the most plausible given the meaning of the sentence as a whole. If this were the case, then assignment would be expected to be to the same character in the passive. The operation of such a 'strategy' based on the semantics of the sentence would appear in Experiment 19 as a strategy for assignment to the character with the same deep function simply because it is the deep function which is preserved in the transformation to the passive. It would appear as a strategy of assignment to the deep subject in particular simply because the sentences were chosen to elicit assignments to the deep subject in the pilot study.

It is clearly not possible to decide amongst these different explanations for the assignments obtained in Experiment 19 on the basis of the results obtained so far. And it is important to extend this study to include pronouns presented within passages of text.

The lack of an effect of assignment to the first or second character in the unambiguous sentences of Experiment 20 is perhaps not surprising. Previous single sentence experiments (for example, Experiments 8 and 14) also showed a tendency for readers to rely heavily on gender cues when they were available.

In Experiment 19, the assignment rates were analysed twice, once with a division by the number of words in the sentence and once without. The division of assignment rates by the number of words in a sentence is more problematic than the same procedure for reading rates since assignment rates include the time taken to indicate the assignment made which should not be affected by the number of words. However, the fact that there was no difference between the two analyses (with and without the division) suggests that such a division is not a problem and was justified in previous experiments (that is, in Experiments 6 and 11).

CHAPTER 9

DISCUSSION

The results of the present research will be summarised briefly before considering how they answer the main aims outlined in the Introduction.

9.1 Summary of results

Assignments

There was a strong preference for assigning a gender ambiguous, subject pronoun to the local subject of the sentence in all experiments, whether the target sentences were presented in text or in isolation. If anything, the effect of the subject was even stronger in the passage experiments (1, 2, 4 and 10) than in the single sentence experiments (6(a), 6(b), 11 and 19).

The preference for the subject was modified by an additional influence of the global topic in passage experiments but only when the topic was mentioned more frequently than the nontopic. When only the title and initial mention in a passage signalled the topic, it had no effect on the assignment of ambiguous pronouns.

The presentation of isolated target sentences in the passive voice in Experiment 19 showed that the subject pronoun was assigned more often to the second person mentioned in the sentence (the deep subject) than to the first person (the surface subject).

Reading and assignment rates

The subject had little effect on the rate of reading or the rate of assignment in any of the experiments reported here whether sentences were presented alone (Experiments 6 to 9, 11, 12, 14, 19 and 20) or embedded in text (Experiments 1 to 5, 10 and 13). The exceptions were

as follows. Subject assignments were faster than object assignments in isolated ambiguous sentences (Experiment 6(a)). However, this finding did not replicate with modified materials (Experiment 6(b)), although there was a slight effect in Experiment 11 (with separate clause presentation). There was also some evidence for faster reading rates when the pronoun referred to the subject in some of the unambiguous passage experiments (Experiments 1, 5 and 13, not 3) although, even here, the subject's effect was not strong.

Clearly, the subject had little effect whether or not there was a gender cue to determine assignment and whether or not the sentences were presented in isolation or embedded in text.

As expected, the topic had no effect on the reading or assignment rates in the single sentence experiments (Experiments 6 to 9, 11, 12 and 14). With the absence of an effect of the global topic and only a negligible effect of the local subject, it might seem that nothing except gender cues affected the comprehension of pronouns in single sentences. However, in Experiment 9, there was an effect of the gender bias inherent in the verb in the pronominal clause of the target sentence. This was the only general knowledge factor specifically examined in these experiments and it was the only factor which influenced the ease of assignment of gender constrained pronouns in isolated sentences. Its influence was not examined in sentences containing gender ambiguous pronouns nor in sentences embedded within text, although clearly it would be interesting to study its effect in these contexts.

The global topic did have some effect on reading rates in the passage experiments. Of those passage experiments in which gender ambiguous pronouns were presented (Experiments 1, 2, 4 and 10), the topic had its greatest effect on the reading rates of Experiment 1 where the topic was mentioned much more often than the nontopic. When frequency of mention did not distinguish the topic and the nontopic (Experiments 2, 4 and 10), the effect of the topic

on reading rates was reduced. Further, when the two clauses of the target sentence were presented as separate sentences in Experiment 10, the topic had no effect at all on reading rates.

The distinction between the topic and the nontopic in terms of frequency of mention was also important in the passages containing pronouns constrained by gender (Experiments 1, 3, 5 and 13). The topic only influenced reading rates when it was mentioned much more often than the nontopic (Experiment 1).

Verification rates

Verification rates were only measured in the passage experiments since no questions were asked in the single sentence experiments.

The influence of the subject on verification rates was stronger when there was a gender cue present in the unambiguous experiments (1, 3, 5 and 13). In the ambiguous passage experiments (1, 2, 4 and 10), the subject only influenced verification rates in Experiments 1 and 10 (and in Experiment 1 its effect was only marginally significant on the F_1 analysis). But in the unambiguous experiments, the subject influenced the verification rates in all four experiments (although its effect was only marginally significant in Experiment 3). Verification of the critical question was faster when the referent to be retrieved was the subject rather than the object.

The global topic had little influence on the verification rates, either for ambiguous or unambiguous pronouns.

Sentence completions

The sentence completion experiments (15 to 18) revealed that the effects of the local subject and the global topic could be generalised beyond the reading or assignment tasks used in other experiments.

The subject was by far the most frequently chosen referent at the beginning of the sentence completions in both the single sentence experiments (17 and 18) and in the passage experiments (15 and 16). When the sentence fragments mentioned two characters of the same gender (Experiments 16 and 18), the preference for completions involving the subject was even stronger when the fragment ended with a pronoun. Ellipsis was the most common reference term for referring to the subject in all four experiments, especially when the two characters mentioned in the fragment were the same gender. Thus, the possibility of using a gender cue influenced the choice of the reference term for referring to the subject (although only in the unambiguous sentence fragments of Experiment 17 were pronouns used as often as ellipsis to refer to the subject). Apart from the great preference for elliptical references to the subject, there was a strong tendency for pronouns to be used to refer to the subject and names for the object.

The influence of the global topic could only be examined in the passage experiments (15 and 16). Its influence was less marked than that of the subject. It had little effect in the unambiguous passages (Experiment 15) but in the ambiguous passages (Experiment 16), the topic was referred to more often when the task involved choice of a referent (the 'and' condition) rather than assignment (the 'pron' condition) and there were more elliptical references when the topic was subject.

9.2 Aims

9.2.1 The interrelationship between local and global factors

It is clear that all four of the factors examined in the Introduction (linguistic constraints, local heuristic strategies, textual factors and semantics and general knowledge) influenced the comprehension of the pronouns

presented in these experiments. At the sentence level, there was an influence of the local subject and a linguistic constraint in the form of a gender cue as well as an effect of the general knowledge factor, gender bias. And when the target sentences were presented within passages of text, there was an additional influence of the global topic of the passage. The influence of each of these factors will be considered separately before assessing their relative importance.

The local subject

The most striking influence of the local subject was on the assignment of ambiguous pronouns although it also influenced the rate of assignment of ambiguous pronouns in one of the single sentence experiments (6(a)) and the rate of retrieval of the referent in some of the passage experiments (both ambiguous: Experiment 10 and unambiguous: Experiments 1, 3, 5 and 13). The subject's effect on pronoun assignment was evident in a variety of tasks (from a reading task to a sentence completion task) and is consistent with previous work showing the importance of the subject for pronoun assignment both in single sentences (Kail and Léveillé, 1977 and Wykes, 1981 in children's comprehension; and Grober et al, 1978; Maratsos, 1973 and Sheldon, 1974 in adult's comprehension) and in text (Clancy, 1980; Garrod and Sanford, 1982; Hobbs, 1976; Purkiss, 1978).

The subject's effect on the rate of assignment is probably another reflection of the salience of the subject when a reader has to choose an antecedent for an ambiguous pronoun, but its effect on verification rates shows that it also has some salience in the reader's mental representation of the text after it has been read.

Although the effect of the subject is likely to be a result of some sort of local heuristic, the results of the experiments reported here do not allow a distinction to be made between an explanation based on parallel function and

one based on a simple subject assignment strategy. Although a number of previous researchers have argued for the importance of a parallel function strategy (for example, Carmazza and Gupta, 1979; Chafe, 1976; Cowan, 1980; Grober et al, 1978; and Sheldon, 1974), most of their results are equally compatible with an explanation based on a simple subject assignment strategy. In order to distinguish between them, there is a need to examine assignment in sentences containing noun phrases in both subject and object positions followed by a single pronoun in object position. Then, if this pronoun were assigned to the preceding subject, this would favour a subject assignment strategy, whereas if it were assigned to the preceding object, this would suggest that a parallel function strategy was operative. Since the only two experiments to have used such sentences (Maratsos, 1973 and Rondal et al, 1983) have produced conflicting results, there is clearly a need for further experiments of this type. Moreover, these experiments only looked at single sentences and it is important to examine the same effects within passages of text.

One reason for this is because Garrod and Sanford (1982) argue that it is only with sentence-initial, subject pronouns that readers show a preference for assignment to a previous subject. They interpret this preference in terms of topicalisation, arguing that the subject of a sentence in a text is usually taken to refer to what they call the 'thematic subject' of a discourse (apparently the same as the global topic). In support of their claim, they mention Karmiloff-Smith's (1980) finding that older children always reserve sentence-initial pronouns for reference to the central character in a story. Hence, there is good reason to test the subject assignment strategy and the parallel function strategy in texts as well as in single sentences. Garrod and Sanford's proposal that pronouns in subject position are usually taken to refer to the 'thematic subject' of a discourse is not directly relevant to this thesis. This is because sentence-initial pronouns were not

used here. However, Garrod and Sanford (1982) go on to suggest that the finding that a subject pronoun in a coordinate or subordinate clause tends to be assigned to the sentence subject may be explained in a similar way. This is relevant to the present study since it was the assignment of subject pronouns in a coordinate clause which was examined. However, although it is possible that this preference for the subject has something to do with the local topic, its influence can be dissociated from that of the global topic in a number of experiments. For example, in Experiments 2, 4 and 10, there was a preference for assignments to the subject in the absence of any preference for assignments to the global topic. So, the choice of the subject of a sentence as antecedent for a subject pronoun within a sentence cannot always be explained in terms of the 'thematic subject' at the discourse level. The possibility still remains, however, that it is as a local topic that the subject of a sentence exerts its influence.

In addition, it would be useful to examine whether it is the subject of a previous clause, the subject of a previous sentence or the subject of the sentence in which the pronoun occurs which is more important in the subject assignment strategy. Most formulations of the strategy are vague on this point. The distinction between assignment across or within sentence boundaries is also relevant here.

The global topic

The topic of the discourse influenced pronoun comprehension in a number of ways, but its effects appeared strongest when the topic was mentioned much more frequently than the nontopic (in Experiment 1). For example, in Experiment 1 (where the topic was signalled by the title of the passage, by initial mention in the passage and by frequency of mention) it influenced the way in which ambiguous pronouns were assigned. The preference for assignments to the subject was increased when the global topic was subject. So, the global topic appears to be

important both as a referent and as an antecedent for ambiguous pronouns (although only when it was signalled as topic by a number of different factors including frequency of mention).

It was noted in Chapter 1 that a pronoun should refer to given information (Allerton, 1978; Grimes, 1975). However, this does not explain the preference for assignments to the topic rather than the nontopic since, by the time the target sentence was encountered, both characters were given, both linguistically (proper names were used to refer to them) and informationally (having been mentioned several times fairly recently). But if one accepts the additional claim, that a pronoun must refer to a salient or foregrounded character (Chafe, 1972; Hirst, 1981; Sanford and Garrod, 1981), then this may explain the preference for the topic of the passage. The fact that the topic was the title of the passage, mentioned first in the passage and more frequently mentioned than any other character is likely to have made it more salient than any other character (including the nontopic) in the reader's mental representation of the text.

The preference for assignment to the global topic is consistent with previous work which suggests that a pronoun serves to maintain reference to the topic of a discourse. This suggestion has been made by linguists (Bolinger, 1979; Clancy, 1980; Creider, 1978), by AI workers (Grosz, 1977; Hirst, 1981; Levin, 1975; Winograd, 1972) and by psychologists (Anderson et al, 1983; Carpenter and Just, 1981; Garrod and Sanford, 1982; Henderson, 1982; Karmiloff-Smith, 1980; Marslen-Wilson et al, 1982; Olson, 1970; Purkiss, 1978; Sanford and Garrod, 1981; Whitehead, 1982). Thus, these results do not support Ehrlich (1979) and Wilks (1975) who claimed that thematic factors rarely (if ever) influence pronoun comprehension.

The tendency for more elliptical references to the subject when the topic was the subject in the sentence completion data of Experiment 16 is also consistent with the notion that the most inexplicit reference terms are

used to refer to the most salient characters in a text, such as the global topic (Anderson et al, 1983; Clancy, 1980; Givón, 1983; Grimes, 1975) or the local topic (Fletcher, 1984).

It is interesting to note that the effect of the discourse topic has usually been studied across sentence boundaries but that here it had an influence within a single sentence. However, there was no main effect of the global topic on assignments, it was only when the global topic was also subject of the sentence that it attracted more assignments than the nontopic, and then only when it was mentioned much more frequently than the nontopic (in Experiment 1).

The pronouns which were preferentially assigned to the global topic in Experiment 1 were in subject position within the second clause of the sentence. Thus, it is possible, as Garrod and Sanford suggested, that the preference for assignment to the global topic depends on the grammatical position of the pronoun itself. Further experiments investigating the assignment of pronouns in other positions (for example, the object position) would clarify this question.

The global topic not only influenced the way in which ambiguous pronouns were assigned; it also influenced the ease of comprehension of the target sentences. For example, the ambiguous target sentences of Experiment 1 were read faster when the topic rather than the nontopic was the subject, and the unambiguous target sentences were read faster when the pronoun referred to the topic rather than the nontopic. So, even in the presence of a linguistic constraint, the topic had an influence on the ease of pronominal reference. Indeed, the influence of the topic on the ease of comprehension appeared stronger than its effect on assignment since the former emerged as a main effect in a number of experiments (Experiment 1, ambiguous and unambiguous, Experiments 2 and 4) whereas the latter only appeared in interaction with an effect of the subject (in Experiment 1).

The topic's effect on the ease of comprehension, like its effect on assignment, was dependent on the number of factors signalling it as topic. It only influenced the ease of pronoun assignment in unambiguous sentences when it was very obviously more important than the nontopic (that is, when it was more frequently mentioned, in Experiment 1). In the ambiguous sentences, its effect was not only reduced when frequency no longer signalled it as topic, its effect was also rather different. In Experiment 1, in addition to its effect on assignment, the topic appeared to influence the ease of reading the antecedent clause (containing nominal referents) at the beginning of the target sentence. The target sentence was read faster when the topic was the subject of this clause. But in Experiments 2 and 4, where frequency of mention no longer distinguished the topic from the nontopic, the effect of the global topic appeared to be an improvement in the ease of reading the target sentence when the subject pronoun referred to the topic rather than the nontopic. Thus, in these experiments, the topic appeared to influence the comprehension of the pronominal clause. However, the evidence on which these inferences about the locus of the topic's effect were based was rather indirect and unsatisfactory. For example, in Experiment 2, it depended upon an analysis of reading rates by condition and assignment in which there were so many missing scores that only subject assignment data could be analysed statistically. Consequently, in Experiments 10 and 13 the target sentences were split so that the reading rates for the antecedent and pronominal clauses could be measured separately. This was intended to enable an effect of the topic on the antecedent clause to be distinguished from an effect on the pronominal clause.

As before, the global topic had no influence on the reading or verification rates of the unambiguous experiment (Experiment 13). Clearly, frequency of mention was the important factor causing an effect of the global topic on the reading rates for the unambiguous target sentences in

Experiment 1.

But unfortunately there was no reliable effect of the topic on the comprehension of the ambiguous pronouns in Experiment 10 either. So it was not possible to determine the locus of the topic's effect with any certainty. However, there was some slight evidence for an effect of the topic on the reading rates in this experiment. The pronominal clause appeared to be read slightly faster when the topic was subject (see Table 6.2). This effect was slightly more pronounced when those sentences in which subject assignments had been made were considered alone (see Table 6.3). This suggests that this small effect was due to an effect of the topic on the ease of assignment rather than on the antecedent clause as suggested by the results of Experiment 1. And since the results of the analyses of the reading rates in Experiments 2 and 4 also suggested that the topic was exerting its influence on the ease of assignment rather than on the antecedent clause, it would seem that this is the most likely explanation for its effect on the reading rates in all of the ambiguous passage experiments.

An alternative explanation is that the locus of the topic effect differed in Experiment 1. Experiment 1 was the only experiment in which the topic was mentioned much more frequently than the nontopic. And it could be that this influenced the locus of the topic effect. Readers may have developed an expectation that a sentence was likely to be about this character because most of the previous sentences in the passage had been concerned with the topic. So sentences in which the topic was subject may have been read faster than those where the nontopic was subject because they conformed with the reader's expectation. But even in Experiment 1, this could not have been the only effect of the topic. There was clearly an additional influence on pronominal assignment since there were more assignments to the subject when the subject was also the topic of the passage. This effect on assignments seems to have been the strongest effect of the topic since it

persisted in Experiments 2 and 4 even when the topic was no longer mentioned more frequently, although in these experiments it appeared as an effect on reading rates rather than an effect on assignments.

The topic's influence on reading rates can be interpreted in terms of its salience in the passage. If the topic is considered as more readily accessible in a reader's mental model of the text, it is understandable that comprehension should be easier when the topic was mentioned first in a sentence or when a pronoun referred to it. However, the topic had no effect on verification rates, so by the time the questions were answered, the topic does not appear to have been more salient than the nontopic otherwise questions in which the topic had to be retrieved as a referent should have been answered faster than those in which the nontopic had to be retrieved. Thus the nontopic appears to have been retrieved as quickly as the topic from the reader's mental representation of the passage.

The virtual elimination of the topic effect in Experiment 10 may have been due to the changed method of presentation of sentences in the passages. Since the target sentences were split in two, assignment had to occur across a sentence boundary rather than within a sentence. The lack of a global effect of the topic suggests there may be a strong local effect of the prior sentence in a passage which may over-ride global effects. This possibility implies that future experiments should examine the effects of a prior sentence in a text as well as local factors within the critical sentence and global textual factors. (This argument might seem to suggest that recency of mention, as manipulated in Experiments 2 to 5, should have had an effect on assignment. However, the pronoun antecedents in those experiments were still in the same sentence as the pronouns.) However, this observation does lend support to the argument presented earlier (p. 274) for the need for closer investigation of the location of the pronoun's antecedent.

The linguistic constraint - gender cue

The presence of a clear linguistic constraint on pronoun assignment in the form of a gender cue was found to modify the effects of the other factors examined. The influence of a clear gender cue is perhaps not surprising and is consistent with previous work which has shown its importance for pronoun comprehension (for example, Ehrlich, 1980; Springston, 1975).

But it was not the case that when gender cues were present, no other factors influenced pronoun comprehension. In Experiment 1, for example, both the local subject and the global topic influenced the rate of reading the target sentences containing pronouns constrained by gender. (Indeed, only in one of the passage experiments, Experiment 3, did readers appear to rely on gender cues alone.)

However, the influence of other factors tended to be reduced in the presence of gender cues both in the single sentence experiments and in the passage experiments. For example, in the single sentence experiments, when there was a gender cue available to determine assignment unambiguously, the only factor which influenced the ease of comprehension was a general knowledge factor associated with the gender bias of the verb in the pronominal clause (see Experiment 9). Unlike the ambiguous sentences, there was no influence of the local subject. Similarly, in the passage experiments, the influence of both the local subject and the global topic was reduced in the presence of a gender cue. The topic, for example, only influenced the ease of understanding the unambiguous target sentences when it was mentioned much more often than the nontopic (in Experiment 1), whereas it influenced the understanding of the ambiguous target sentences even when it was not mentioned more often. And, whereas there was an effect of the subject in the ambiguous passages of Experiment 2, there was no effect in the equivalent unambiguous passages of Experiment 3.

But the presence of gender cues led not only to a reduction in the influence of other factors, but also to a change in the nature of their influence in certain experiments. For example, in the passage experiments, the locus of the local subject's influence was altered when there was a gender cue to constrain the choice of antecedent. Instead of an influence on assignment or the ease of assignment, as there had been in the ambiguous experiments, there was a greater effect on the recall of antecedents during question answering. And in the passage experiments 10 and 13 (in which the two clauses of the target sentences were presented as two separate sentences), the local subject affected assignments in the sentences containing ambiguous pronouns but affected the reading rates of the sentences containing unambiguous pronouns. Similarly, whereas there was a preference for assignments to the topic and an effect of the topic on the reading rates for the first part of the sentence in the ambiguous sentences of Experiment 1, the presence of gender cues led to a shift in the influence of the topic to the ease of assignment, as shown in the reading rates.

Nevertheless, it is clear that other factors influenced pronoun comprehension even when gender cues alone were sufficient to determine assignment. Murphy (1984) also pointed out that syntactic cues alone cannot determine referential processing. He found that whether an expression establishes a new referent or refers to one, two or more discourse elements could not be determined simply from singular/plural syntactic cues but also required a consideration of the previous discourse context. He interprets his results in terms of a mental model approach to discourse comprehension.

Finally, there was an influence of the availability of gender cues on the choice of reference terms in the sentence completion experiments. As one might expect, where pronouns could be used to refer unambiguously to a referent through the exploitation of gender cues, there was an increase in their use. When such cues were not

available, there was a greater use of ellipsis to refer to the subject and a greater use of names to refer to the object.

General knowledge factor - gender bias

The gender bias of the verb in the pronominal clause of the target sentence influenced the ease with which the unambiguous single sentences of Experiment 9 were understood. Thus, general knowledge based on the semantics of the verb associated with the pronouns was able to influence their assignment even when a simple linguistic constraint (gender agreement) was sufficient to determine assignment. This is consistent with previous work which has shown the importance of general knowledge for the understanding of pronouns (for example, Hirst and Brill, 1980; Marslen-Wilson and Tyler, 1980).

Relative influence of local and global factors

In Experiment 1, factors operating at both the local sentence level and the global discourse level acted together to influence the comprehension of ambiguous pronouns. There were more assignments to the subject than to the object, but there were even more assignments to the subject when it was the global topic of the passage. In this experiment, the global topic was not only signalled by the title and initial mention, but also by frequency of mention. In the other passage experiments, where the topic was not mentioned more often than the nontopic, the topic no longer influenced assignment directly, but it did affect reading rates. Thus, while both local and global factors are clearly important, the local heuristic strategy of assignment to the subject (whether through parallel function or a simple assignment strategy) was more influential than the global topic when an antecedent for an ambiguous pronoun was sought. Even when the topic did influence assignment (in Experiment 1) it did not appear as

a main effect but in interaction with the subject.

In the unambiguous passages of Experiment 1, where assignment was constrained by gender, both the local subject and the global topic influenced the ease of comprehension. So where the topic was more frequently mentioned, it had an effect on the ease of understanding gender constrained pronouns. However, when it was no longer more frequently mentioned (in Experiments 3 and 5), its effect disappeared and only the local subject had an effect. But even the subject's effect was reduced in comparison to the ambiguous experiments (having an influence on verification rates rather than on the ease of assignment). Clearly, the presence of a linguistic cue reduced the influence of other factors on assignment. Indeed, when sentences containing a gender cue were presented in isolation, there was no effect of the local subject and only gender bias influenced assignment. Thus, at least in single sentences, this general knowledge factor appears to be more important than the local subject when assignment is constrained by gender.

Thus, the global topic had more effect when there were fewer local cues to assignment. In the absence of a local gender cue, the topic had an effect on the ease of assignment even when it was not more frequently mentioned than the nontopic, but when there was a local gender cue, it failed to have an effect unless it was very much more important than the nontopic. So it would seem that the effect of textual factors depends on the strength of factors operating at the local sentence level. When these factors exert a strong constraint on pronoun assignment, as is the case with gender cues, then the importance of discourse factors is apparently reduced.

Similarly, when looking at local sentence factors (either in sentences or in text), the degree of constraint which each factor exerts over pronoun assignment is evidently important. The presence of a linguistic constraint in the form of a gender cue is obviously a stronger constraint than a preference for assignment to the

local subject. Thus it is not surprising that the influence of the local subject is reduced in the presence of the linguistic gender constraint. The assignments suggested by general knowledge would also appear to be a strong constraint since there was an influence of such a factor even in the presence of a gender cue.

It is clear then that there are a number of factors acting together to influence the understanding of pronominal reference. This suggests that more than one strategy may operate at once, a view also advocated by Cowan (1980).

Overall, both local and global factors were important in the comprehension of pronominal reference in a number of different sentence contexts and tasks. The influence of local factors, particularly the subject effect and gender agreement, was strong even when sentences were presented within passages of text. But within passages, their influence was modified by the additional influence of the discourse factor, the global topic. The extent of this modification appeared to depend on the strength of the local influences; for example, there was less effect when gender cues were sufficient to determine assignment unambiguously.

The basic observations resulting from these experiments were as follows. The subject assignment strategy was very strong. It was apparent in every experiment using ambiguous target sentences. However, the use of a gender cue seemed to eliminate this strategy. The one factor which seemed to modify the effect of gender cue was the use of general knowledge. The effect of the topic appeared to be a graded one: Its effect increased as the number of factors signalling it increased. With a large number of features signalling it, the topic's effect was still present in the unambiguous target sentences. However, it did not override the subject effect.

A number of suggestions can be made about the way these different features are used in pronoun comprehension on the basis of these observations. First of all, gender

matching either occurs before subject assignment or both occur in parallel and gender matching is faster. Second, readers do not just use gender matching and complete assignments on this basis because general knowledge factors still influence assignment in unambiguous sentences. In addition, the topic appears to have an effect in terms of its salience. Further, it appears that when pronoun reference in a sentence is ambiguous, the subject assignment strategy is invariably evident. The salience of the topic seems to facilitate this process. One possible test of this view would be to investigate general knowledge factors in ambiguous sentences, both in isolation and in texts. One would still expect to find a subject effect, and a facilitatory effect of the topic. Finally, a highly salient topic also has a facilitatory effect on the comprehension of unambiguous pronouns.

Pronouns as reference terms

In the experiments reported in Chapter 6, the antecedent and pronominal clauses of the target sentences used in previous experiments were presented as separate sentences. The main aim of these experiments was to determine the locus of the global topic effect observed previously. The results have been discussed in these terms in the previous section on the global topic. However, the major outcome of these experiments was that when the reader's task was simply to read the sentences, the pronominal clause was read reliably faster than the antecedent clause in all experiments (whether the pronouns were ambiguous or unambiguous, and whether they were presented within single sentences or passages of text). But when the task was an assignment task (Experiment 11), this difference was not found. Clearly, the extra task increased the response time in this experiment.

It appears, therefore, that readers were able to understand and integrate the information in the pronominal clause faster and more easily than that in the antecedent

clause. This suggests that pronouns aided comprehension and integration even though it was necessary to assign them to previously mentioned antecedents. This supports the notion that pronouns function to allow easy reference to entities already mentioned in a text and to facilitate the integration of information in a text, as suggested by the work of Hirst and Brill (1980) and Lesgold (1972). And similar results were found by Purkiss (1978): In an experiment where either a pronoun or an anaphoric noun phrase referred to an antecedent in subject position, target sentences containing a noun phrase were read more slowly than those containing a pronoun even when three sentences intervened between the pronoun and antecedent. This also suggests that reference is easier when it is achieved via a pronoun rather than a noun phrase, but this was only the case when the antecedent was in subject position. In the experiments of Chapter 6, however, the pronominal clause was read faster than the antecedent clause whatever the assignment of the pronouns, that is, whether the antecedent was in subject or object position (although it should be noted that the distance between the pronouns and their antecedents was minimal).

9.2.2 Pronoun assignment in single sentences and in text

The present research showed a difference between the factors affecting assignment in single sentences and in passages, even when exactly the same sentences were involved. Since reading within texts is far more common than reading single sentences, in order to determine the processes normally involved in skilled reading, it is clearly necessary to study comprehension within texts, not just single sentences. Thus, the results presented here suggest very strongly that conclusions drawn from experiments using single sentences cannot be generalised to even the same sentences when they form part of a continuous text.

Not only are global factors precluded from operating

within single sentences (a serious drawback in itself for single sentence experiments), but the effects of local factors also differ depending on the context in which they occur. The effect of the local subject illustrates this. Its effect was stronger in the passage experiments than in the single sentence experiments: It influenced the reading rates or verification rates in all except one of the unambiguous passage experiments, but had no effect in any of the unambiguous sentence experiments. Similarly, the subject had a stronger effect on the assignment of ambiguous pronouns in the passage experiments than in the single sentence experiments. One might have expected the effect of such a local factor to be stronger within isolated sentences, but it appears that the more natural reading situation offered by the passage experiments encouraged a greater reliance on the local subject.

In addition, in the passage experiments, although the effect of other factors was reduced in the presence of a gender cue, they still had some effect (for example, in Experiment 1, both the subject and the global topic influenced the ease of assignment). In the sentence experiments, however, there was a much greater tendency to rely on gender cues alone (and only the general knowledge factor, gender bias, influenced assignment). It is possible that this heavy reliance on gender cues in the isolated sentences does not represent the normal assignment process but results from an unusual strategy being adopted to cope with the unnatural situation of reading such simple isolated sentences.

Nevertheless, it can be useful to study assignment within the single sentence. Ironically, its major advantage is the reduction in factors which can influence assignment, since this is also its main drawback when trying to generalise to natural assignment in text.

The factors affecting assignment not only differed depending on whether the target sentences were presented in isolation or in text, they also varied with the method of presentation employed in the experiment (for example,

cumulative or overlaid presentation in the passage experiments and as separate clauses or not in the sentence and passage experiments). Thus, in Experiment 10, the effect of the global topic was eliminated when the target sentences from Experiment 2 were split into two separate clauses. And in Experiment 4, where the sentences from Experiment 2 were presented one after the other (overlaid) rather than cumulatively, the effect of the global topic was again reduced. Clearly, it is important to examine factors thought to influence pronoun comprehension in more than one sentence context and with more than one experimental task.

9.2.3 Factors influencing the importance of the global topic for assignment

The influence of the global topic on assignment depended on the number of factors signalling it as such. The topic only influenced the assignment of ambiguous pronouns in Experiment 1 where frequency of mention as well as the title and initial mention in the passage indicated that it was the most important character in the passage. When only the title and initial mention determined which character was the topic (in Experiments 2, 4 and 10), there was no preference for the topic during assignment. Similarly, the topic only influenced the ease of assignment of unambiguous pronouns in Experiment 1, not in Experiments 3, 5 and 13 where only the title and initial mention determined the topic. Similar results were obtained by Moar (1982) who also found no effect of the global topic on the ease of assignment when only the title and initial mention signalled the topic as important. Thus, the global topic apparently has to be signalled by more than simply these two features in order to influence the assignment of ambiguous pronouns and the ease of assignment of pronouns constrained by gender.

It should be noted that the topic was still perceived as more important than the nontopic when only the title and

initial mention signalled it as such (see the judgement study in Chapter 3) and that it did have an effect on reading and verification rates for ambiguous target sentences (Experiments 1, 2 and 4). Thus, the title and initial mention in the passage were sufficient to signal the topic as more salient than the nontopic and to influence the ease of comprehension and recall. The title has often been implicated as a feature signalling the global topic (Dooling and Mullet, 1973; Kieras, 1979; Kozminsky, 1977) as has initial mention in a passage (Christensen, 1965; Kieras, 1979, 1980a; Sanford and Garrod, 1981). Kieras (1981b) found that an item was not regarded as the topic of a passage if it was merely placed in initial position in the first sentence of a passage, but as long as it reappeared later in the passage as subject of other sentences, it was perceived as a topic. Initial mention was always used together with later mention in subject position in the experiments reported here; thus the demonstration of an influence of the global topic defined according to these criteria is consistent with previous work in this area. The important additional implication of this work is that the effect of the global topic appears to be graded according to the number of features signalling it as such. Thus, it was only when the topic was signalled by more than the title and initial mention that it had an effect on the choice of antecedent for an ambiguous pronoun and on the ease of understanding pronouns constrained by gender.

Since it was the frequency with which the topic was mentioned which distinguished the topic in Experiment 1 from the topic in the other experiments, it would seem that this might be the critical factor for determining the topic's effect on assignment. In any case, frequency of mention appears to be an important contributor to the salience of the global topic and its effect on pronoun comprehension. This finding is consistent with other work which has suggested the importance of frequency of mention for allowing easy pronominal reference (Allerton, 1978) and

for determining the topic of a passage (Keenan, 1974; Kintsch and van Dijk, 1978). However, further experiments are necessary to determine whether it is specifically frequency of mention which is the important factor or whether it is simply the number of features signalling the topic which is important.

While the features of title, initial mention and frequency of mention were sufficient to produce an influence of the topic on the ease of assignment of gender constrained pronouns (Experiment 1), a further factor appeared to be important for the topic's effect on the assignment of gender ambiguous pronouns. It was only when the global topic was also subject of the target sentence that it attracted more assignments than the nontopic. This may be because, in subject position, the topic was perceived as the local topic of the sentence, thus adding to the salience of the character sufficiently to cause it to influence the choice of antecedent.

Experiment 1 also suggests that the global topic may influence assignment even when, as an antecedent, it appears in a textual position not traditionally associated with signalling the discourse topic. Two of the features signalling the topic occurred at the very beginning of the passage (title and initial mention) and the third was an attribute of the passage as a whole (frequency of mention), yet the topic influenced assignment in the fifth (target) sentence of the passage. Many previous experiments which have examined the effect of the topic on assignment have done so by placing the topic, as potential antecedent, in a position normally associated with the topic of the text (for example, Purkiss, 1978) thus confounding the effect of that particular position with the effect of the topic. Experiment 1 showed that the topic's effect on assignment does not depend on it appearing as an antecedent in a discourse topic-related position.

The recency with which the topic and nontopic characters were mentioned prior to the target sentence did not influence pronoun assignment in these experiments

(Experiments 2, 3, 4 and 5). This suggests that the local foregrounding of the two characters (in terms of the recency with which they were mentioned before the target sentence) was not as important as the global foregrounding of the topic in the text as a whole.

Thus, the global topic, operating at the textual level, is an important factor for pronoun assignment, its effect being graded and dependent on the number of features of the text signalling it. The graded effect was as follows. First, when the topic was signalled by the title, initial mention and frequency of mention, it influenced the ease of assignment of pronouns constrained by gender. (Sentences in which the pronoun was constrained to refer to the topic were easier to read than those in which it was constrained to refer to the nontopic.) In addition, it influenced the ease of comprehension of the antecedent clause of target sentences containing pronouns not constrained by gender, possibly because the frequency with which the topic had been mentioned in the preceding text led readers to expect a further reference to the topic at the beginning of the target sentence. Second, when the topic was signalled by the title, initial mention and frequency of mention and, in addition, was the subject of the sentence, the topic influenced the choice of antecedent for an ambiguous pronoun. (The subject of the sentence was chosen as an antecedent more often when it was the topic than when it was the nontopic.) Third, when only the title and initial mention signalled the topic, it had no effect on the ease of assignment of unambiguous pronouns and no effect on the choice of antecedent for ambiguous pronouns. Nevertheless, it did have an indirect effect on the assignment of ambiguous pronouns since it influenced the reading rates for ambiguous target sentences. This appeared to be an effect on the pronominal clause rather than on the antecedent clause, reflecting faster reading rates when the pronoun was assigned to the topic rather than the nontopic. Unfortunately, this latter proposition was not verified in Experiment 10 (see p. 279 for one

possible reason for this).

9.2.4 Surface or deep subject role?

In Experiment 19, an attempt was made to discover whether it was the surface or the deep role of the subject which accounted for its influence on pronoun comprehension. In this experiment, the target sentences were presented in the passive voice. Previous work in this area has not isolated the precise nature of the subject's influence with any certainty. Most of those arguing for the importance of the subject stress the importance of the surface role (for example, Grober et al, 1978 and Sheldon, 1974), although some stress the deep role (for example, Cowan, 1980), but in most cases there is no clear justification for either claim since the different roles have been confounded with each other. Indeed, most studies do not rule out the possibility that it is the subject's semantic role (for example, as agent) or its role as local topic which is important (although it should be noted that the relation between the subject and the local topic is far from clear).

Two studies did isolate the surface and deep roles of the subject (by using passive sentences), but they produced contradictory results; Caramazza and Gupta (1979) found a preference for assignments to the surface subject, whereas Cowan (1980) found a preference for the deep subject.

The results of Experiment 19 support Cowan's finding since there was a preference for assignment to the deep subject rather than the surface subject. This suggests that, in passives at least, the focus of a sentence may be more important than the local topic when assigning a pronoun. (However, if the local topic is roughly equated with the subject of an active sentence, and the focus with the end of an active sentence, the strong subject assignment strategy in previous experiments suggests that the local topic is more important than the focus.) However, while the deep subject was clearly more important than the surface subject for the assignment of the subject

pronoun in the passive sentences of Experiment 19, it does not necessarily follow that it is the deep subject which is important in active sentences. Although it would be more parsimonious to account for the importance of the subject in both active and passive sentences in terms of the deep subject, it is possible that the subject is important for different reasons in the two kinds of sentences. Several people have pointed out that actives and passives have different functions (for example, Johnson-Laird, 1968a, 1968b; Klenbort and Anisfield, 1974), so the subject might be expected to have different influences in these two types of sentences. Furthermore, it is clear that the deep subject cannot always be important even in passive sentences since some passive sentences do not have a deep subject. So it is possible that the subject is important for some other reason in active sentences, for example, it might act as the local topic of the sentence. This is not to say that the local topic need always be the subject of the sentence. It may just be that in the target sentences chosen for these experiments this was the case. Clearly, more experiments are needed in order to clarify the exact role of the subject which is critical in the comprehension of pronouns in active sentences.

Furthermore, the conclusion that the deep subject is important in passive sentences should also be treated with caution since it is possible that the results of Experiment 19 were due to an influence of semantics and general knowledge. One way to determine whether the preference for assignment to the deep subject in Experiment 19 was a consequence of the semantics of the sentence or a genuine deep subject effect would be to generate active sentences which produce consistent object assignments (but which also allow the possibility of subject assignments) and to present them in the passive voice in an assignment task. If the semantics of the sentence were important, then there should still be a preference for assignments to the object of the original sentence (the surface subject), whereas if there was a strategy of assignment to the deep subject, the

other character should become the preferred antecedent.

The possibility that the results of Experiment 19 were due to the semantics of the particular sentences used raises the question of whether it is desirable to use pronouns which are ambiguous by gender for studying pronoun assignment since, when generating such materials, it is very difficult to strike the right balance between producing sentences in which a pronoun is not clearly related to one or other of the two antecedents available and producing sentences in which it can be plausibly assigned to either of them. In other words, it is difficult to avoid either complete ambiguity (in which case, readers' assignments will reveal no preference) or biasing to one antecedent or the other (in which case, assignments will reveal nothing about the normal processes of comprehension, only the experimenter's ability to produce unambiguous sentences despite a lack of linguistic cues). It might therefore be better to produce sentences in which the assignment is ambiguous on the basis of the meaning of the sentence, but unambiguous through the use of a clear linguistic constraint (such as gender agreement). For example, by producing sentences in which the pronoun is constrained to the subject in different roles and measuring reading rates, it would be possible to determine the relative ease of these different assignments. The problem with this is that the results of the experiments reported in this thesis suggest that the subject may not influence the assignment of unambiguous pronouns in single sentences. It might therefore be better to use sentences within passages of text or a sentence completion task with 'ambiguous' sentence fragments in which two characters of the same gender are mentioned. The use of sentence fragments would avoid the problems of biasing due to the meaning of the whole sentence. Presentation of linguistically ambiguous passive fragments ending in a pronoun would allow a separation of the effects of the surface and deep roles of the subject. This should be done in both a single sentence context and within passages of

text. In the absence of any clear definition of a local topic, it does not seem possible to examine whether this could account for the effect of the subject. But this possibility should be borne in mind when examining the results of future experiments.

9.2.5 Top-down or bottom-up effects?

The question of whether the effects of the local subject and the global topic were top-down or bottom-up was mainly addressed by the sentence completion experiments in Chapter 7. The data suggested that, to some extent, the effect of the subject was top-down since there were many more completions involving the subject as the first mentioned referent than any other entity in all experiments. But there was an additional tendency for the presence of a pronoun at the end of a fragment to elicit more references to the subject. Thus, the influence of the subject was partly the result of searching for a pronoun antecedent.

The global topic had less effect in the sentence completion experiments, but its effect appeared to be top-down since there were slightly more subject completions when the topic was subject in the ambiguous passages of Experiment 16, but only when the fragment ended in a conjunction. When there was a free choice of who to refer to and how to make the reference, the topic was more likely to be referred to than when there was a pronoun at the end of the fragment. This result is consistent with Anderson et al's (1983) finding that the topic was more likely to be mentioned than a scenario-bound character when Subjects were asked to add a sentence to the end of a passage referring to these two characters. The results of Experiment 16 show that the topic's effect was not dependent on the presence of a pronoun, and suggest that it was due to an expectation that the topic would be mentioned next in the passage. A similar top-down interpretation for the topic effect is suggested by the reading rates for the

ambiguous target sentences of Experiment 1. Sentences were easier to read when the topic rather than the nontopic was subject of the antecedent clause, as would be expected if readers were expecting a further reference to the topic.

9.2.6 Importance of general knowledge factors

The way in which linguistic constraints and general knowledge factors act together to influence pronoun assignment is controversial. Some people believe that no other factors are important when there is a clear linguistic constraint, or at least that the linguistic constraint will be used first (for example, Ehrlich, 1980; Sanford and Garrod, 1981). Sanford and Garrod (1981) argue that the assignment of a pronoun need not involve a consideration of general knowledge factors or inferences if, for example, there is a clear gender cue available. They have shown that in some cases, sentences containing a pronoun whose assignment has to be determined on the basis of inference take longer to read if there is a linguistically appropriate, but semantically inappropriate, alternative antecedent available (Sanford et al, 1983). However, these were cases where there was no explicit antecedent for the pronoun and it may be that the need to find an explicit antecedent of any kind is stronger than the influence of general knowledge factors. Others believe that other factors do affect the ease of pronominal comprehension even in the presence of clear linguistic cues. For example, Springston (1975) found that assignment was faster when both a linguistic cue and a semantic factor (the Experiencer Constraint) determined assignment than when only a linguistic cue was available. And Caramazza et al (1977) found that even when a gender cue was available, the speed of understanding a sentence was influenced by whether the information following the second (pronominal) verb was consistent with the implicit causality suggested by the verb in the prior clause. Similarly, Hirst and Brill (1980) found an effect of plausibility (a general

knowledge factor) even when syntax alone was sufficient to determine assignment. And Tyler et al (1982) concluded from a number of experiments on the understanding of spoken language that lexical cues and pragmatic inferences have approximately equal influence on assignment.

The results obtained in the gender bias experiment (9) support the latter position that other factors do affect pronoun assignment even in the presence of a clear linguistic cue. In Experiment 9, there was an influence of a general knowledge factor despite the presence of a gender cue. Thus it would seem that the search for an antecedent does not begin (and possibly end) with a check on linguistic constraints. This, in turn, suggests that general knowledge always influences pronoun comprehension, not just when other cues fail to indicate a single antecedent.

But the absence of an effect of the local subject in the unambiguous single sentences of Experiments 8(a), 14 and 20 suggests that not all the factors which can influence assignment are operative in the presence of linguistic constraints. It would seem that the influence of a general knowledge factor was relatively more important than the local subject when assignment was constrained by gender.

The fact that there was an influence of gender bias in Experiment 9 suggests that assignment did not occur as soon as the pronoun was encountered. The bias was generated by the verb following the pronoun and it was often necessary for the whole of the pronominal clause to be understood before the bias was apparent. Since assignment could have occurred on the basis of gender cues as soon as the pronoun was encountered, the effect of gender bias suggests that assignment was not completed until the end of the clause containing the pronoun. However, there is an alternative explanation. It could be that assignment did occur as soon as the pronoun was encountered but that it was then checked against the subsequent information in the sentence. When that information biased assignment toward the antecedent

chosen on the basis of gender, then comprehension would be faster than when it biased assignment in the opposite direction.

Other work on this question does not provide a clear choice between these alternatives. The work of McKoon and Ratcliff (1980), on anaphoric NPs, and that of Chang (1980), on anaphoric pronouns, suggests that an anaphor activates its referent at least by the end of the sentence containing the anaphor. But others go further than this and argue that, where possible, an anaphor activates its antecedent as soon as it is encountered (Dell, McKoon and Ratcliff, 1983; Just and Carpenter, 1980; Just, Carpenter and Woolley, 1982). However, from their work on the measurement of eye movements during reading, Ehrlich and Rayner (1983) argue that, while processing may begin as soon as a pronoun is encountered, it need not be completed until some time later even when the information available allows an immediate assignment to be made. They argue that lexical access is completed during fixation (and in the case of a pronoun, this usually means retrieval of its gender and number) and maybe some syntactic parsing (Frazier and Rayner, 1982), but that assignment need not occur until some time later. This explanation is supported by the results of Experiment 9.

9.3 Theoretical issues raised by the research

The experiments reported here show how important both local and global factors are in the comprehension of pronouns. A number of factors from a local, linguistic, gender cue to the textual, global topic acted together to influence the understanding of the pronominal referents presented. Thus, one needs to consider how the influence of these factors may be brought together during language comprehension.

At least two levels of representation need to be considered; a superficial linguistic representation and a discourse model of some kind. Johnson-Laird (1983) has argued persuasively for the need for these two levels. For example, a superficial linguistic representation is necessary for the resolution of verb phrase ellipsis but such a representation alone is insufficient to account for the assignment of the type of pronouns used in this study. A useful way to understand the resolution of these pronouns is through a mental model of the text; a model whose structure does not depend on the linguistic structure of the sentences in the text but on the structure of the state of affairs described in the text (Garnham, 1981; Johnson-Laird, 1981; Johnson-Laird, 1983; Johnson-Laird and Garnham, 1980). A mental model is a representation of a reader's knowledge of the discourse and is constructed on the basis of what has occurred already in the text as well as general and specific knowledge. An account of text comprehension which employs only one level of representation, such as that put forward by Kintsch and van Dijk (1978), cannot handle reference resolution adequately (Johnson-Laird, 1983).

In addition to these two levels of representation, it is necessary to consider the way in which information in memory is organised in order to account for the way it can be used to understand written language, for example, through the construction of a mental model. Sanford and Garrod (1981) argue for the use of scenarios to guide the

reader to that knowledge in memory which is needed to understand a text. They propose a model of the use of knowledge based on the partitioning of memory into four parts. These partitions are based on a division into dynamic and static partitions (roughly equivalent to the notions of short and long term memory) which in turn are divided into text-based and knowledge-based partitions. They argue that the referent for a pronoun is sought in the dynamic, text-based partition which they call explicit focus (similar to the notion of working memory). The referent for a definite noun phrase, on the other hand, is sought from either the explicit focus partition or the dynamic, knowledge-based partition known as implicit focus (the current scenario). They therefore predict that the referent for a pronoun should be found more quickly than that for a definite noun phrase, a prediction which is supported by the results of the experiments reported in Chapter 6 in which the pronominal clause of the target sentence was read more quickly than the first clause.

Clearly, all three levels (superficial linguistic representation, mental model and organised knowledge in memory) are necessary for the understanding of pronouns. The information required to make use of a gender cue can be derived from the linguistic representation. During an initial syntactic and semantic parsing of the sentence to produce a linguistic representation, information will be obtained about the number and gender of each pronoun in the sentence. And similar lexical information will be obtained about each noun phrase. This would allow assignment of the pronoun through matching of this information as long as there was only one antecedent which was permissible on these grounds. However, it has been argued in this thesis that the process of understanding pronouns does not end here even if there is only one linguistically acceptable antecedent. General knowledge factors were found to influence the understanding of linguistically unambiguous pronouns in Experiment 9, and thus it seems that a reader will also make use of inferences from general knowledge

(that is, the third level of representation). This is understandable since the process of understanding a text invariably involves the use of inferences and it is unlikely that the inference process can be terminated simply because an antecedent has been found on the basis of linguistic cues. And it would appear that these inferences aid the process of comprehension for these linguistically unambiguous pronouns. This could either be because an antecedent can be accepted more quickly when more than one cue is available or because an antecedent chosen on linguistic grounds is always checked for its plausibility, and when inferences from general knowledge suggest the same antecedent, the checking process is faster.

When an antecedent for a pronoun has been chosen, this information is added to the mental model of the current discourse (that is, the second level of representation). But this is not simply a static repository for the decisions reached elsewhere in the process of comprehension. The structure and organisation of this model is important in itself for the understanding of pronominal reference. For example, an antecedent will be judged for its plausibility in terms of the mental model as well as more general knowledge. And, as the experiments reported here demonstrate, the current topic of the discourse, represented within the mental model, clearly influences the ease of understanding. It would seem that the global topic has special status within the mental model making it a likely candidate for a pronoun's antecedent. And when the global topic is chosen as an antecedent, it is likely that the information associated with the pronoun can be quickly linked to the global topic since it is already active in the mental model. If the antecedent is not in the foreground of the mental model, however, this process might be expected to take longer.

The precise nature of the interaction of the different factors influencing pronoun assignment still needs to be explored in detail. However, some suggestions can be made about the relative importance of the different factors on

the basis of these experiments (see p. 284). For example, it appears that general knowledge influences the understanding of pronouns even when there is a clear and simple linguistic cue to determine assignment, and both global and local factors appear to affect the understanding of linguistically ambiguous pronouns embedded within text.

Furthermore, the results of this study suggest that the degree of influence of global, textual factors depends on the strength of the factors operating at a local level. When a linguistic, gender cue was available, the global topic had to be very much more important than the other characters in the text (and presumably much more salient in the mental model) before it influenced the ease of understanding of the unambiguous pronouns. When there was no gender cue, however, the topic had some effect even when there were fewer cues to indicate the topic's salience in the text. Thus, whatever the strength of the topic, its influence seemed to depend on the strength of the local constraints. In addition, these results suggest that the topic's effect is graded according to the number of factors signalling it as important in the text. This suggests that an entity's topic status in the mental model is a continuum rather than a dichotomy: The greater the number of features signalling the topic as important, the greater its influence.

The effect of local factors also appeared to be influenced by the strength of other local factors. For example, the influence of the local subject was reduced when there was a strong linguistic cue available (gender agreement).

Thus, a reader appears to utilise as many cues as possible for the understanding of pronominal reference. Linguistic cues are clearly very important if they signal a unique antecedent. This is not surprising since a reader is unlikely to contravene linguistic constraints. However, these experiments showed that, at the text level, the global topic is also influential when understanding linguistically unambiguous pronouns and, at the sentence

level, general knowledge is also utilised. (Inferences from general knowledge are probably also used at the text level but this was not specifically studied in these experiments.) When no linguistic cues were present, both local heuristic factors and global factors appeared to be important. Again, it is likely that general knowledge influences assignment here too but this possibility was not addressed directly in these experiments. The study of the relative influence of these different factors should be extended to include the effect of general knowledge on the understanding of linguistically ambiguous pronouns. For example, it is possible that the lack of information with which to make inferences about the most likely antecedent caused a greater reliance on a mechanical heuristic strategy of subject assignment or parallel function than would otherwise be the case.

So, the linguistic constraint of gender agreement, some form of the local heuristic strategy of subject assignment, the global topic and general knowledge are all important for pronoun comprehension. This study makes it clear that there is a need to examine the influence of both local and global factors together, and to study them in a natural textual context, not simply in isolated sentences. Only in this way can a detailed and explicit account be provided of the ways in which linguistic knowledge, mental models and general knowledge interrelate during the comprehension of texts.

