Footnotes

1. By 'given information' we mean the information that the speaker assumes the listener already knows or can easily infer from the context. By 'new information' we mean information that the speaker assumes the listener does not know and cannot infer from the context.

2. This manipulation was included because of a suggestion by an anonymous journal reviewer. However, it had no consistent effects on either assignment preferences or reading times and so the results of this variable are not reported here.

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Such local salience effects are consistent with the centering theory of Grosz et al., in which there are two discourse centres. The forward-looking center contains all the discourse entities associated with the current theme ranked according to salience. The factors determining ranking are not completely specified but are thought to include initial mention and realisation as a pronoun (Gordon et al (1993). The backward-looking centre is normally the subject of the sentence. It refers to the highest ranked entity from the forward-looking center that is realised in the sentence and will be realised by a pronoun as long as there is a pronoun in the sentence. Our results agree with those of Gordon et al. concerning the role of initial mention in establishing the ranking of entities in the forward looking center. Thus, this model accounts for these local salience effects without difficulty.

However, the Grosz et al model has difficulty explaining how the pragmatic and context effects and their interaction with local salience contribute to comprehension. While Grosz et al identify a global theme (which they call 'topic') that specifies the states and events described by the discourse, they are primarily concerned with the nature of the representation needed to explain how the discourse theme is constructed and updated and how participants keep track of it. They have less to say about the processes that are involved in comprehension itself. They also seem to treat the global theme and local salience as distinct components of a discourse and so there is no easy mechanism for explaining how the two components combine during comprehension. By contrast, the scenario mapping model does show how discourse entities and global theme are linked during comprehension. By adding a component concerned with local salience, therefore, this latter model may more readily explain the processes involved in discourse comprehension. However, the main point that arises from our results is that a processing model of pronoun comprehension needs to take into account both local salience and global discourse structure.

In summary, we have found that both initial mention and sentence subject contribute to the salience of an entity in a mental model of a discourse and thus affect the accessibility of the antecedents of pronouns. These effects of salience occur over and above effects due to the pragmatic plausibility of the interpretation. We also found that in Non-Subject Clefts, the effect of initial mention was weakened in the absence of context. We attributed this result to the relationship between the given-new structure of the cleft and the information in the context, and to the difficulty of interpreting the new information in the absence of context. We also found that reading times were faster in the presence of context, a finding that we attributed to the ease of integrating the new information into the current mental model.

The effects of local salience concern the referential status of the discourse entities. By contrast, pragmatic plausibility and context concern the relational information contained in the global discourse structure. Therefore, our results suggest that a model of discourse processing needs to account for both of these components and how they are integrated during comprehension. Two models were reviewed, each of which considers one of these two components and modifications are suggested to each that would enable them to account for the present results. Our general conclusion, therefore, is that a model of discourse processing needs to explain how both local salience and global discourse structure are integrated and deployed in the comprehension of pronouns.

the commonly held view that subjecthood as well as initial mention is associated with the sentence topic (Bates and MacWhiney, 1982).

So how might discourse structure and local salience interact during comprehension? To address this question we will consider two different models of discourse processing. The scenario mapping model of Sanford and Garrod (1981; Garrod, Freudenthal and Boyle, 1994) provides a useful framework for understanding the role of the discourse theme. On the other hand, the centering theory of Grosz, Joshi and Weinstein (1983; Grosz and Sidner, 1985) provides the most useful framework for understanding the effects of local salience.

In their scenario mapping model, Sanford and Garrod distinguish between two components of episodic memory for a text, one component is the **explicit focus**, which stores "discourse entities" corresponding to the individuals currently under discussion. The other is the **implicit focus**, which contains "role slots", that is, the currently active information about these individuals that was either mentioned in the text or inferred from background knowledge of the discourse theme in conjunction with the text information. Discourse entities in explicit focus are normally referred to by pronouns while role slots are normally referred to by definite noun phrases. Discourse entities describe individuals only if they are linked to all the role slots associated with them in implicit focus. Furthermore, entities are maintained in explicit focus for as long as the role slots to which they are linked in implicit focus remain the discourse theme and as long as they are repeatedly referred to in the text. Variations in the salience of discourse entities is said to be a function of the links between entities and role slots: while all entities that are relevant to the current theme are held in explicit focus, only the key entities have strong and multiple links to role slots. The entity with the strongest and largest number of links is the most salient. These two memory partitions, explicit and implicit focus, can be said to correspond to the local salience of entities in a mental model (the entities in explicit focus) and the global discourse theme (role slots in implicit focus) (Garrod, 1994).

This model provides a natural account of the function of cleft sentences. At the semantic level, the head of the cleft, the assertion, identifies or introduces a discourse entity into explicit focus, while the predicate, the presupposition, looks for an antecedent in implicit focus. At the pragmatic level, the cleft makes explicit the relationship between the discourse entity in the head and the antecedent of the predicate (Delin, 1990), that is, it establishes the link between discourse entity and role slot in accordance with the scenario-mapping model. Therefore, a cleft may contribute to salience as defined in that model by adding another link between one of the discourse entities and a role slot. Of course, adding one more link may not be sufficient to make the entity the most salience. That will depend on the richness of the links between entities and roles in the mental model as a whole.

While this model is compatible with the effects of discourse theme and plausibility that we observed in our experiments, it may need to be supplemented to take account of the effects of local salience. According to Garrod et al., the only way that salience arises is as a result of the richness of the links between a discourse entity and role slots. However, our results reveal that there are local salience effects as well as those due to the global theme. In particular, initial mention and subjecthood were shown to compete in affecting the accessibility of the referent of a pronoun.

of context.

Why should initial mention be weakened in the absence of context? We suggest that it is due to the given-new structure of cleft sentences. Recall that in our target sentences, the cleft head was always the new information while the predicate contained the given information. Thus the pragmatic force of the sentence was consistent with its semantic force where the cleft head conveys asserted information while the predicate conveys presupposed information. Also, as we pointed out in the Introduction, the second context sentence picked out one individual from a set of individuals but did not identify the specific person concerned. Then the cleft head identified the specific person. In the presence of context, therefore, the first mentioned entity could be easily integrated into a mental model of the discourse. The context makes clear what new information is needed and the first mentioned noun phrase identifies that information, thus facilitating integration. However, in the absence of context, such integration is not possible and a new discourse entity has to be constructed from scratch. In other words, the new information in the cleft head may be more difficult to interpret in the absence of context and so is less accessible as an antecedent of the pronoun. Thus the results for first mention may be specific to these kinds of materials, leading them to moderate the overall effects of the local cues to salience. Nevertheless, our main finding still holds: Both subjecthood and initial mention contribute to local salience.

Inspection of the reading times in the two experiments (Tables 3 and 5) suggests that the times were facilitated in the presence of context, a suggestion that was confirmed by an analysis of variance on the reading times of the two experiments combined (for Subject Clefts, MinF'=13.83, df=1,117, $p<.001$; for Non-Subject Clefts, Min F'=5.40, df=1,107, $p<.05$). Such a facilitation would be expected given that integration into a model is facilitated in the presence of context. This suggestion is consistent with the idea that the presupposition acts like an anaphor (van der Sandt, 1988) and indicates to the reader or hearer that some antecedent to the presupposed information should be in the mental model of the discourse. If the presupposed information is not in fact in the model, then it must be inferred (Haviland and Clark (1974) or accommodated (Lewis, 1979) by the reader or hearer. In Experiment 2, where there was no context, such inferences would be needed.

Our results run counter to the view that cleft sentences make the clefted individual more salient by, in Sidner's terms, placing that individual on the top of the focus stack. If the clefted individual were always consigned to the top of the stack, then it should be the referent of choice when interpreting pronouns. We found that this was not the case. When the cleft head was in non-subject position, the subject of the sentence (consistent with pragmatic constraints of the discourse theme) exerted a conflicting influence on salience. These results are consistent with those of Delin (1990). A more plausible view of clefts, therefore, is that they highlight the link between the asserted entity and the presupposition by making that link explicit, as Delin suggested. This is in contrast to the use of initial mention or sentence subject to increase the salience of the discourse entity itself.

In general, therefore, our results support the view that the salience of a discourse entity is a joint function of the global discourse structure and the way that the information is presented at the local sentence level. In addition, the finding that the sentence subject has salience enhancing properties can be said to support

two levels - local and global. At the local level, discourse entities are made more or less salient as a function of the way the information is presented in each sentence. These local cues also identify and maintain the thematic subject, the main character in the discourse as a whole. However, at the global level, discourse entities occupy specific roles in the states and events that make up the discourse theme. Thus the plausibility of a specific interpretation of a pronoun in the discourse is assessed with respect to the overall discourse theme. At the same time, the interpretation is also assessed with respect to its plausibility in the situation described by the sentence itself. The results of our experiments are consistent with this general view by showing that the ease with which a clause containing a pronoun is interpreted is a joint function of these two components of discourse - local salience and global discourse structure. In particular, our results show that over and above the influence of discourse context and pragmatic plausibility, both the sentence subject and the first mentioned antecedent play important roles in signalling local salience.

We found, as expected, a general advantage for pragmatically biased assignments. We also found a general advantage for Subject Clefts, in which the two local cues agree, compared to Non-Subject Clefts, in which the two local cues conflict. However, over and above these general advantages, there were more specific effects that depended on the nature of the pragmatic bias and the presence or absence of context.

In Subject Clefts and in the presence of context, the assignment preferences and reading times reflect the impact of the two local cues against a background of changes in pragmatic bias. The assignment preferences were strongest in the Bias to Subject condition, where local signals and pragmatic bias agree, next strongest in the Bias to Non-Subject condition, where the local signals both conflict with the pragmatic bias and weakest in the No Bias condition, where pragmatic cues were not available and only the local signals could influence assignment. Thus, as expected, pragmatic bias had a strong effect on assignments, but its effect was also moderated by the influence of local cues to salience. On the other hand, the reading times were affected by the overall difficulty of making an assignment. They were faster in the Bias to Subject condition than in the other two conditions. The effect of context on Subject Clefts was that, in the absence of context, the assignment preferences in the Bias to Non-Subject condition were reduced to the same level as those in the No Bias condition, suggesting that initial mention has a weaker effect in the absence of context.

In Non-Subject Clefts, subjecthood and initial mention conflict and the patterns of assignment preferences and reading times reflected this conflict. Both with and without context, the assignment preferences were stronger in the two Bias conditions, where one of the two local signals agreed with the pragmatic bias, than in the No Bias condition, where there was no pragmatic bias. to Non-Subject condition, where pragmatic bias assigns the pronoun to the. Indeed, the assignment preferences were close to chance level in this latter condition, reflecting the fact that the two local cues favoured conflicting assignments. The reading times in the presence of context showed the same pattern of results: Times in the two Bias conditions were faster than those in the No Bias condition. However, in the absence of context, reading times were faster in the Bias to Subject condition than in the other two conditions. This results is consistent with the suggestion above that the effect of initial mention is weakened in the absence

These results confirm our major predictions, since we find once again, that assignment preferences are greater with Subject than with Non-Subject Clefts, and that pragmatic bias plays a role in assignment, the preferences in the No Bias condition being lower overall than those in the two bias conditions. Although the interaction between Cleft and Bias failed to reach significance in this experiment, the overall pattern of preferences is the same as that in Experiment 1. With Subject Clefts, the preferences are greatest in the Bias to Subject condition, where all cues to assignment agree, and weakest in the No Bias condition, where there are no pragmatic cues. With Non-Subject Clefts, the preferences were strongest in the two Bias conditions, where one of the two local signals agreed with the pragmatic bias, and weakest in the No Bias condition, where there were no pragmatic cues and performance was at chance level.

3.2.2 Reading Times: The mean reading times for the clause containing the pronoun are shown in Table 5.

	SC	NSC	Means
BS	2355	2494	2425
BNS	2679	2676	2678
NB	2831	2724	2777
Means	2622	2631	

Table 5: Mean reading times (in msecs) in Experiment two. (BS=Bias to Subject; BNS=Bias to Non-Subject; NB=No Bias; SC=Subject Clefts; NSC=Non-Subject Clefts.)

Analyses of variance revealed a main effect of Pragmatic Bias (MinF'=3.33, df=2,108, p<.05.). No other effects were significant (all Fs < 1). The main effect of pragmatic bias arises because the reading times in the Bias to Subject condition are faster that those in the Bias to Non-Subject and No Bias conditions.

As far as Subject Clefts are concerned, these results are comparable to those of Experiment 1. The results, therefore, are in agreement with our general predictions. since reading time is only facilitated when the pragmatic cues and the two local cues converge on the same interpretation. When the two sets of cues conflict, as the Bias to Non-Subject condition, and when there are no pragmatic cues at all, as in the No Bias condition, comprehension is impeded.

However, with Non-Subject Clefts, the results differ from those in Experiment 1. In Experiment 1, the reading times were comparable in the two Bias conditions, consistent with the fact that in both conditions, one of the two local signals agreed with the pragmatic bias. However, in this experiment, the reading times were not comparable in the two bias conditions. Instead, the Bias to Subject condition produced faster times than the other two. In the Bias to Subject condition, the pragmatic bias favours the subject. Thus, these results suggest that, in the absence of prior context, subjecthood takes precedence over initial mention when the two cues conflict.

4.0 GENERAL DISCUSSION

A mental model of a discourse represents the currently relevant situation described by the discourse. It consists of states and events and of the individual entities participating in those states and events. A mental model is structured at

pragmatic bias to determine the assignment preferences in the two bias conditions and we expect local salience to determine the preferences in the No Bias condition. However, we also anticipate that the impact of these variables will be reduced relative to their impact in Experiment 1, because of the lack of a context in relation to which the information structure of the cleft is relevant.

3.1 METHOD

3.1.1 Subjects: Forty eight student volunteers from the University of Durham served as subjects.

3.1.2 Materials: The target sentences were the same as those used in Experiment 1, but there were no context sentences in this experiment. The questions and the filler sentences were also the same as those in Experiment 1.

3.1.3 Design and Procedure. The design and procedure were the same is in Experiment 1.

3.2 RESULTS AND DISCUSSION

3.2.1 Pronoun assignments: The mean percentage of preferred assignments are shown in Table 4. The preferred assignments were to the subject in the Bias to Subject and No Bias conditions and to the non-subject in the Bias to Non-Subject condition.

	Assignments	SC	NSC	Means
BS	Subject	90	62	76
BNS	Non-Subject	82	63	73
NB	Subject	77	56	66
Means		83	60	

Table 4: Mean Percentage of Cleft Assignments in Experiment two. (BS=Bias to Subject; BNS=Bias to Non-Subject; NB=No Bias; SC=Subject Clefts; NSC=Non-Subject Clefts.)

Analyses of variance on the assignment preferences revealed a main effect of Cleft (MinF'=21.92, df=1,58, $p<.001$) and a marginal effect of Bias ($F^1=3.91$, df=2,94, $p<.03$; $F^2=2.91$, df=2,46, $p<.07$; MinF'=1.67, df=2,110, ns.). The interaction was not significant ($F^1=1.64$, df=2,94, $F^2=2.02$, df=2,46). The main effect of Cleft arises because subject clefts produced stronger assignment preferences than non-subject clefts and the marginal effect of Pragmatic Bias arises because the preferences in the No Bias condition are lower than in the other two conditions.

As was the case in Experiment 1, the assignment preferences with Non-Subject Clefts in the No Bias condition were very close to 50%. To assess whether these preferences were significantly different from chance, one sample t-tests compared the results of this condition to the 50% chance level. The results showed that the preferences were not significantly different from chance (subjects analysis: t=1.22, df=47; sentences analysis: t=1.45, df=23).

	SC	NSC	Means
BS	1739	2068	1904
BNS	2167	2100	2134
NB	2124	2352	2238
Means	2010	2173	

Table 3: Mean reading times (in msecs) in Experiment one. (BS=Bias to Subject; BNS=Bias to Non-Subject; NB=No Bias; SC=Subject Clefts; NSC=Non-Subject Clefts.)

Analyses of variance on the data in Table 3 revealed a marginal effect of Cleft (F^1=9.72, df=1,47, p<.01; F^2=3.91, df=1,23, p<.07, MinF'=2.79, df=1,42, ns.): clauses in sentences containing subject clefts were read more quickly than those in sentences containing non-subject clefts, and a main effect of Pragmatic Bias (MinF'=3.26, df=2,120, p<.05): the Bias to Subject condition produced the fastest times, the Bias to Non-Subject condition the next fastest and the No Bias condition the slowest. The interaction between Cleft and Bias failed to reach significance (F^1=5.82, df=2,94, p<.01; F^2=2.37, df=2,46, ns.). However, the ordering of the reading times was different in the two Cleft conditions. With Subject Clefts, the Bias to Subject condition produced faster times than either the Bias to Non-Subject or the No Bias condition. (Bias to Subject **vs.** Bias to Non-Subject: MinF'=3.92, df=1,61, p<.1; Bias to Subject **vs.** No Bias: MinF'=3.03, df=1,63, p<.1; Bias to Non-Subject **vs.** No Bias: F's<1.) With Non-subject Clefts, the times in the Bias to Subject and Bias to Non-Subject conditions were both faster that those in the No Bias condition (although only on F^1 in the Bias to Non-Subject comparison). (Bias to Subject **vs.** No Bias: MinF'=3.71, df=1,43, p<.1; Bias to Non-Subject **vs.** No Bias: F^1=6.01, df=1,47, p<.02; F^2=2.83, df=1, 23; Bias to Non-Subject **vs.** Bias to Subject : F's <1).

These results also confirm our expectations. Once again, as expected, there was a general facilitation for Subject Clefts, where the two local signals to sentence topic agree, and there was facilitation that depended on the precise combination of pragmatic bias and the two local signals. With Subject Clefts, reading times were fastest in the Bias to Subject condition, where pragmatics favours the same individual as the two local signals. These times were faster than those in either the Bias to Non-Subject condition, where the pragmatically plausible interpretation conflicts with the local two signals, or the No Bias condition, where there were no pragmatic cues. With Non-Subject Clefts on the other hand, where pragmatics always agrees with one of the two local signals, both Bias conditions produced faster times than the No Bias condition, where pragmatic cues were absent and the local cues conflicted. Thus, both the assignment preferences and the reading times support our predictions concerning the impact of subjecthood and initial mention over and above pragmatic plausibility.

3.0 EXPERIMENT TWO

To assess the role of discourse theme in more detail, we conducted Experiment 2, in which we used the target sentences from Experiment 1 but not the context sentences. Thus the plausibility of the clause containing the pronoun can only be assessed with respect to the situation described by the sentence. We expect

stronger assignment preferences that non-subject clefts and the main effect of Bias arises because assignment preferences in the No Bias condition are lower than in the other two conditions. Individual comparisons indicated that the interaction arises because the effect of Bias was different in the two Cleft conditions. With Subject Clefts, the assignment preferences were significantly greater in the Bias to Subject condition than in the No Bias condition (MinF'= 3.81, df=1,48, p<.1) while the Bias to Non-Subject condition fell between these two extremes and was not significantly different from either of them (BNS vs. NB: MinF'<1; BNS vs. BS: MinF'=1.44, df=1,60). With the non-subject clefts, on the other hand, the two Bias conditions produced significantly stronger assignment biases than the No Bias condition (BS vs. NB: MinF'=7.11, df=1,70, p<01; BNS vs. NB: MinF'=12.24, df=1,67, p<001; BS vs. BNS: MinF'-1.00, df=1,53).

Inspection of the data in the table also indicates that the assignment preferences with Non-Subject Clefts in the No Bias conditions are close to 50%. To assess whether or not the preferences in this latter condition were significantly greater than chance, one sample t-tests were used to compare the results to the 50% chance level. The results showed that the preferences did not differ significantly from chance (by subjects: t=1.01, df=47; by sentences: t=1.13, df=23).

Thus the assignment preferences confirm our expectations. As expected, assignment preferences were consistent with the pragmatic bias of the sentence, and there was an overall advantage for assignments in Subject Clefts, where both local signals, subjecthood and initial mention, agree. Furthermore, the pattern of assignments reflected the particular combination of pragmatic bias and local signals. With Subject Clefts, the preferences are strongest in the Bias to Subject condition, where pragmatic plausibility and the two local signals all converge on the same interpretation and weakest in the No Bias condition, where pragmatic cues were unavailable and the two local cues connflicted. Where pragmatic bias conflicts with the two local signals, as was the case in the BNS condition, the assignment preferences were not significantly different from either of the other two conditions. Thus, the results reveal an effect of the two local signals over and above the effects due to pragmatic bias.

In the Non-Subject Clefts on the other hand, the two local signals of subjecthood and initial mention conflict and the pattern of assignment preferences reflects this conflict. Assignment preferences are stronger in the two Bias conditions, where one of the two local signals agrees with the pragmatic bias, than in the No Bias condition, where pragmatic cues are unavailable. Indeed, in this latter condition, in contrast to the same condition in the Subject Clefts, assignment preferences were at chance level, reflecting the lack of cues to a unique interpretation.

2.2.2 Reading Times: The mean reading times for the clause containing the pronoun are shown in Table 3.

conditions so that the number of **Yes** and **No** answers was counterbalanced over subjects and materials.

2.1.3 Design and Procedure. A repeated measures design was used with each subject seeing sentences from all the conditions. There were two factors investigated in the experiment, **Cleft** (Subject or Non-Subject) and **Pragmatic Bias** (Bias to Subject, Bias to Non-Subject or No Bias). A self-paced reading time task was used. Subjects were presented with each sentence, one clause at a time, on a computer screen and required to press the space bar as soon as they had read and understood each clause. The subject's response caused the clause to be removed and the next one presented. After the second clause was removed, the question appeared and the subject pressed one of two keys, labelled **Yes** and **No** to indicate their response. Once the question had been answered, the next trial was presented. Forty eight filler sentences were also included. These were sentences from another experiment. An example is **The monitors were near to the meter and they were adjacent to the dial**.

Each subject's interpretation of the pronoun, as measured by their answer to the question, was recorded. The time taken to read the second clause in the target sentence was also recorded.

2.2 RESULTS AND DISCUSSION

Results are reported for the 6 conditions defined by 2 types of Cleft and 3 kinds of pragmatic bias. For each sentence and each subject, the preferred assignment was determined and the time taken to read the second clause was calculated. Analyses of variance were performed on these data with both subjects and items as random variables. Unless otherwise stated, an alpha level of .05 was accepted for the individual subjects and items analyses while a level of .1 was accepted for Min F'.

2.2.1 Pronoun assignments: The preferred assignments were to the subject antecedent in the Bias to Subject and No Bias conditions and to the non-subject antecedent in the Bias to Non-Subject condition. The percentage of preferred assignments in each condition are shown in Table 2.

	Assignments	SC	Non-SC	Means
BS	Subject	87	68	78
BNS	Non-Subject	81	75	78
NB	Subject	75	52	63
Means		81	65	

Table 2: Mean Percentage of Cleft Assignments in Experiment one. (BS=Bias to Subject; BNS=Bias to Non-Subject; NB=No Bias; SC=Subject Clefts; NSC=Non-Subject Clefts.)

Analyses of variance on the data in the table revealed the following significant effects. There was a main effect of Cleft (MinF'=21.06, df=1,61, p<.001), a main effect of Bias (MinF'=7.86, df=2,133, p<.01) and a significant interaction between Cleft and Bias (F^1=4.64, df=2,94, p<.02; F^2= 5.18, df=2,46, p<.05; MinF'=2.45, df=2,128, p<.1). The main effect of Cleft arises because subject clefts have

local signals. With Subject Clefts, the local signals agree and so the pragmatic bias may not need to be as strong as in Non-Subject Clefts. Second, if materials are pretested so that the pragmatic bias determines assignment equally in all conditions, one of the effects we are interested in - the interpretation of the pronoun - would be completely masked by pragmatics and so may lead to false conclusions concerning the relative roles of pragmatics and local salience. Thus, we aimed to use materials where the intended interpretation was always plausible, without prejudging the issue by ensuring beforehand that the intended assignment would be chosen equally often in each condition.

Two context sentences, each consisting of one clause, preceded each target sentence. This context was designed to make the pragmatic given-new structure of the cleft match the semantic presuppositional structure (see Delin, 1990). Thus the head of the cleft, which contains the asserted information, also conveyed new information, while the predicate, which contains the presupposition, also conveyed given information. To achieve the above matching, each combination of Cleft (subject or non-subject) and Attachment (argument or adjunct) had a different pair of context sentences, while the targets in the three Pragmatic Bias conditions were preceded by the same pair of context sentences. Examples of combinations of contexts and targets are shown in Table 1.

Subject Clefts	Non-Subject Clefts
Context:	Context:
The firm was planning to make Ken redundant. One of the managers had to break news to him.	Mike was concerned about the new list of redundancies. One of the union officials was the the bad first to learn the bad news.
Target:	Target:
It was Mike who broke the news to because	It was Ken who Mike broke the news Ken to because
Bias to Subject	
he was able to do it sympathetically.	he was able to do it sympathetically.
Bias to Non-Subject	
he had to be told straight away.	he had to be told straight away.
No Bias	
he had always been a decent chap.	he had always been a decent chap.

Table 1: Examples of materials used in Experiment one.

Twelve lists of materials were constructed from these sentences, each one containing 4 sentences from each of the 6 conditions that result from crossing two types of clefts (subject or non-subject) and two types of Attachment (Argument or Adjunct) with three pragmatic bias conditions. No sentence occurred more than once in a list and across all twelve lists, each sentence appeared in all the conditions. A question designed to identify the interpretation of the pronoun accompanied each sentence. For example, **Was it Mike who was sympathetic**? The questions referred to each individual equally often across the twelve

since Ken is mentioned first while Mike is the subject.

As was mentioned above, we attempted to make the impact of the discourse theme comparable across the two cleft conditions. In the Subject Cleft example the discourse theme concerns the need for one of the managers to break the bad news about redundancy to Ken. The pragmatic biases to the subject and to the non-subject in the targets are both compatible with this topic. The cleft head identifies Mike as the manager who broke the bad news to Ken, while the predicate of the cleft indicates that the bad news was broken to Mike. In the Non-Subject Cleft, the discourse theme consists of Mike's concerns about the redundancies and the fact that one of the union officials hears the news first. In the target, Ken is the clefted individual and the fact that it was Mike who broke the bad news is the predicate. Thus, regardless of whether the subject or non-subject is clefted, both propositions in the cleft sentences are relevant to the theme. Consequently, the interpretations of the sentences in both of the bias conditions, and either interpretation in the No Bias conditions, are theme related. Hence, they should not exert any differential effects on our manipulations.

2.1 METHOD

2.1.1 Subjects: Forty eight student volunteers from the University of Durham served as subjects.

2.1.2 Materials: Twenty four sentences were constructed so that either the subject or the non-subject could be clefted. Each sentence consisted of two clauses conjoined by **because**. The first clause introduced two individuals, one of which was clefted. In the **Subject Cleft** condition, the subject was clefted while in the **Non-subject Cleft** condition, the non-subject was clefted. Additionally, in each cleft condition the non-subject was either an argument or an adjunct[2]. The second clause contained a pronoun that referred to one of the two individuals introduced in the first clause and it appeared in three versions corresponding to the three **Pragmatic Bias** conditions. The versions differed according to whether or not the content of the clause allowed pragmatic inferences based on knowledge of the discourse theme to constrain the assignment of the pronoun to one of the two characters. In one condition, the content did not bias assignment to either the subject or the non-subject antecedent (**No Bias condition**), in the second, the content biased assignment to the sentence subject (**Bias to Subject condition**) and in the third, the content biased assignment to the non-subject (**Bias to Non-Subject condition**).

In the biased conditions, assignment of the pronoun to the other character was judged to be implausible. The intended biases and non biases were agreed on by the two authors who each judged the sentences independently and then repeatedly revised the sentences until both authors agreed with the intended pronoun assignments. This procedure is different from the one that is sometimes used to construct materials such as these. In the alternative procedure, pragmatic bias is determined by pretesting the materials and choosing sentences in which some specific proportion of pre-test subjects select the intended referent of the pronoun (e.g. Garrod et al., 1994; Marslen-Wilson et al., 1993). We did not use that procedure for two reasons. First, the pragmatic bias may end up being stronger in those conditions where a reduction in the bias effect is expected, the Non-Subject Clefts in our experiment. In order to pass a pre-test, the pragmatic bias would have to be sufficiently strong to overcome the conflict between the two

clause did not, as far as was possible, constrain the interpretation of the pronoun, as in the examples below:

(5) It was Mike who broke the news to Ken because he had always been a decent chap.
(6) It was Ken who Mike broke the news to because he had always been a decent chap.

This condition enables us to assess the impact of the sentence subject in the absence of pragmatic constraints. In particular it enables us to discover whether subjecthood and first mention both influence salience and so exert comparable effects on comprehension. If this is the case, then there should be a preference for assigning the pronoun to the subject and first mentioned individual in sentences like (5), where subjecthood and initial mention converge on the same individual. But there should be no preference for either the sentence subject or the first mentioned individual in sentences like (6), where subjecthood and initial mention diverge. We would also expect the reading time for the pronoun clause to be faster in sentences like (5) than in sentences like (6).

In Experiment 1, the target sentences were preceded by two context sentences, the second of which picked out one individual from a set of individuals but did not identify the specific person concerned. Then the cleft head in the target sentence identified the specific person. For example, the context sentences for the subject cleft sentences shown above in (1), (3) and (5) were the following:

(7) The firm was planning to make Ken redundant.
One of the managers had to break the bad news to him.

Thus, we established a discourse theme with respect to which the target sentence can be interpreted and checked for plausibility. In the experiment, we endeavoured to keep the effect of discourse theme constant across conditions. However, as a check on our results, we conducted a second experiment in which the target sentences were presented in isolation. This enabled us to determine whether or not there were any specific effects that could be attributed to the discourse theme. We might anticipate, for example, that the given-new structure of the clefts sentences would make them more readily interpretable when they are preceded by a suitable context. However, we do not anticipate that our major findings concerning local topic and pragmatic bias will be seriously affected by the presence or absence of context.

2.0 EXPERIMENT ONE

In this experiment, our main variable is whether or not the two local signals to salience converge or conflict. In Subject Clefts, they agree but in Non-Subject Clefts they conflict. We examine the effects of this variable in target sentences that also vary the pragmatic bias to assignment and in the presence of a discourse theme. The discourse theme is established by means of two context sentences and an example can be seen in Table 1. With respect to the distinction made earlier between thematic subject and sentence topic, in the subject clefts in the table, Ken is the thematic subject in the context while Mike is the thematic subject in the non-subject clefts, The sentence topic is Mike in the target of the subject clefts, since Mike is both subject and first mentioned noun phrase. However, there is no clear topic in the target of the non-subject clefts,

described in the predicates of clefts were just as likely to be referred to by pronouns as were referents described in cleft heads. Delin suggests therefore that it is the relationship between the assertion and the presupposition that is made salient in a cleft, not a discrete discourse entity.

1.5 The experiments: While we used cleft sentences in our experiments so that we could disentangle the effects of initial mention from the effects of subjecthood, we should note that the clefted individual is also the first mentioned individual in these sentences and so effects attributed to initial mention could in principle be due to clefting. We will return to this issue in the Final Discussion, for the moment we simply note that we adopt Delin's view that clefts influence the salience of the link between the head and the predicate, not the head itself. We will, therefore, refer to effects of initial mention rather than of clefting. More critically though, our experiments are designed to determine the salience enhancing properties of the sentence subject and subjecthood is varied independently of the cleft head and initial mention. So if there is any salience due to clefting, it should reduce the anticipated effects of subjecthood and hence work against our hypothesis.

In sentences like (1) and (2) above (repeated below), the content of the second clause biases the assignment of the pronoun to **Mike**, the subject of the sentence, who is mentioned first in sentence (1) and second in sentence (2). By modifying the content of the second clause, we can also constrain the interpretation of the pronoun in the opposite direction to refer to **Ken** rather than **Mike**, as shown in (3) and (4) below:

(1) It was Mike who broke the news to Ken because he was able to do it sympathetically.
(2) It was Ken who Mike broke the news to because he was able to do it sympathetically.
(3) It was Mike who broke the news to Ken because he had to be told straight away.
(4) It was Ken who Mike broke the news to because he had to be told straight away.

In all of the above sentences we would expect the pragmatic bias to determine the interpretation of the sentence. Thus Mike should be the preferred referent in (1) and (2) while Ken should be preferred in (3) and (4). However, if subjecthood, as well as initial mention, exerts a local influence on salience, then the assignment preferences should be reduced in Non-Subject Clefts where subjecthood and initial mention conflict. While the pronoun assignments should be primarily determined by the pragmatic bias, as indicated above, the time taken to read the clause containing the pronoun should be affected by the overall salience of the two individuals, salience due to the closeness of the interpretation to the discourse theme and to the joint influence of subjecthood and initial mention. Thus we should find reading time differences within each kind of Cleft. With Subject Clefts we would expect reading times to be fastest when pragmatics favours the same individual as the one made salient by the local signals. But with Non-Subject Clefts, where the two local signals conflict, pragmatics will always agree with one of these two signals and so the reading times in the two bias conditions should be comparable.

We also included a third pragmatic condition, one where the content of the final

is any independent effect of the sentence subject over and above pragmatic plausibility. Second, we dissociate subjecthood from first mention through the use of it-cleft sentences. For example, the cleft sentence in (1) maintains the subject in initial position while in (2) the subject is not in initial position.

(1) It was Mike who broke the news to Ken because he was able to do it sympathetically.
(2) It was Ken who Mike broke the news to because he was able to do it sympathetically.

1.4 Functions of cleft sentences: The use of cleft sentences is usually considered to be a structural strategy to reflect informational distinctions in the message being conveyed (Vallduvi, 1993). In every language, speakers have choices about how to convey or package information, and it is a central tenet of studies in functional syntax that these choices are not random. Different syntactic constructions have different discourse functions, and knowing which constructions are appropriate or felicitous in a given context constitutes part of a speaker's general linguistic competence. There have been two main functions claimed in linguistics for syntactic constructions. One is to package the information so as to indicate the given and new information in the sentence and the other is to vary the referential status or salience of discourse entities. Cleft sentences, which we used in our experiments, have been associated with both of these functions.

The idea that the function of clefts is information packaging comes from researchers such as Hornby, (1972), Haviland and Clark (1974) and Fletcher (1984) who claim that clefts indicate that given information[1] is conveyed by the predicate while new information is conveyed in the cleft head. However, Delin (1990) found little support for this view and she suggests instead that clefts have both a semantic and a pragmatic function and that both of these functions contribute to the felicitous use of clefts. At the semantic level, the information in the predicate of a cleft conveys a **presupposition**, that is, information that is true regardless of the truth of the sentence as a whole. The head of the cleft on the other hand contains an **assertion,** that is, the element or elements named by the cleft instantiate the variable contained in the presupposition. Thus if a predicate presupposes that someone hit a ball, the head indicates who that someone was. At the pragmatic level, Delin argues that clefts have one of two information structures. In the first, the assertion (or head) contains new information while the presupposition describes old or inferable information. In the second, the assertion contains old information while the presupposition describes new or inferable information. Delin claims that these two information structures accounted for all the clefts in the samples that she studied. Since the semantic presuppositional function is concerned with truth conditions and not with the assumed mental state of the listener, it makes sense to talk of presuppositions containing new information.

As far as referential status is concerned, a number of people have claimed that cleft sentences render the clefted information more salient (Reichman, 1985; Sidner, 1979; Weinart and Miller, 1993). For example, Sidner suggested that discourse entities are stored in a 'focus stack' and she argues that cleft sentences have the function of placing the element referred to by the cleft head at the top of the stack, with the result that this element, the **expected focus** in Sidner's terms, is the first candidate to be considered when attempting to resolve a subsequent pronoun. However, Delin (1990) found in spoken corpuses that referents

1.3 Local salience and the sentence topic: One of the signals for identifying the thematic subject is the topic-comment structure of the individual sentences. More specifically, Kieras found that the thematic subject is most likely to be the topic of the individual sentences. It is the role of the sentence topic that we investigate in our experiments on pronoun comprehension. Both linguists and psychologists have suggested that topics hold a privileged place in short-term memory, either because they refer to given information (e.g. Halliday, 1967) or because they render the topic individual more salient (e.g. Givon, 1979). Pronouns are said to be the most likely way to refer to sentence topics (Fletcher, 1984; van Dijk and Kintsch, 1983, Chapter 5), a finding that is consistent with the idea that the sentence topic makes an individual more salient.

One question we need to ask, therefore, is what are the local signals in a sentence that identify its topic. One such signal is initial mention. Gernsbacher and Hargreaves (1988) found that when names are used as anaphors, initial position determines the salience of the antecedent, not subjecthood. And Gordon, Grosz and Gilliom (1993) showed that initial position affects the ranking of entities in the forward-looking centre. Initial mention has long been associated with the topic of a sentence. However, initial mention is not the only grammatical device to be associated with the sentence topic. The sentence subject, for example, has been assigned a similar role (e.g. Bates and MacWhiney, 1982).

The question of whether or not the sentence subject contributes to an antecedent's salience remains open. Gernsbacher (1989) found that first mentioned antecedents were activated more rapidly than second mentioned antecedents after a pronoun had been encountered, but in that study the first mentioned antecedent was also the sentence subject. Certainly, the sentence subject has been implicated in a number of important comprehension processes. As we mentioned above, Kieras (1981) found that which referent appears as the surface subject of individual sentences in a passage is a powerful signal to the thematic subject; and Gordon et al (1993) observed that the sentence subject is the favoured site for the backward-looking centre, that is, the preferred site for a pronoun. However, Gordon et al also claim that subjecthood does not affect the ranking of entities in the forward looking center, a finding that runs counter to the view that the subject contributes to local salience. It turns out, though, that the contribution of the subject to local salience cannot be completely ruled out in their experiments.

The idea that pronoun comprehension may involve the use of heuristic strategies such as a subject assignment strategy (Crawley, Stevenson and Kleinman, 1990) or a parallel function strategy (Nelson, Stevenson and Stenning, 1992; Stevenson, Nelson and Stenning, 1993) also highlights the potential importance of the sentence subject. However, the work on heuristic strategies has used sentences with minimal pragmatic cues to assignment and so it is possible that the sentence subject is ignored when there are more powerful pragmatic constraints on interpretation. Also, to a large extent, first mention and subjecthood go together and so it is not always clear that it is subjecthood that is important rather than first mention.

We remedy both of these situations in the present experiments. First of all, we examine the role of the sentence subject while at the same time varying the pragmatic constraints on assignment. In this way we can determine whether there

Sanford, 1983). Comprehension is also facilitated even in the absence of a stereotypical setting, as long as the interpretation of the pronoun is closely related to the discourse theme (McKoon, Ward, Ratcliff and Sproat, 1993). Pragmatic plausibility facilitates pronoun comprehension even when sentences are presented in isolation and so there is no discourse theme (e.g. Ehrlich, 1980; Stevenson and Vitkovitch, 1986). In these situations, local plausibility judgements ensure that the interpretation of a pronoun is consistent with the situation described by the sentence.

The facilitation for interpretations related to the discourse theme most likely arises because such an interpretation can be integrated into the current mental model in a straightforward way. In our experiments we investigate the impact on comprehension of having a discourse theme (Experiment 1) compared to presenting sentences in isolation (Experiment 2). In both experiments, we manipulate the salience of each potential antecedent of an ambiguous pronoun and the local plausibility of the 2 potential interpretations of the clause containing the pronoun. Our main reason for manipulating plausibility is to provide strong tests of the effects of local salience. Probably the most important constraint on the interpretation of pronouns is the pragmatic plausibility of the interpretation (e.g. Erhlich, 1980; Sanford and Garrod, 1981; Stevenson and Vitkovitch, 1986). This constraint is likely to be decisive no matter what the salience of the antecedent may be. In our experiments, therefore, we treat pragmatic plausibility as a backdrop against which to assess the effects of local salience.

The most salient entity in a sentence is commonly referred to as the topic of the sentence (e.g. Fletcher, 1984), which indicates the entity that the sentence in isolation is judged to be about (Reinhart, 1981). However, once embedded in a discourse, the sentence topic will also contribute to the salience of an individual in the discourse as a whole. We refer to this latter individual as the thematic subject. Although we are not concerned with the thematic subject in our experiments, we discuss it here before we go on to consider the sentence topic so that the discussion of sentence topic is seen in the broader context of the discourse as a whole.

1.2. The thematic subject: Individuals in a mental model of a discourse usually differ in their prominence. The most prominent individual has been variously referred to as the **topic** (Crawley and Stevenson, 1990; Perfetti and Goldman, 1974), the **focus** (Sidner, 1981), the **thematic subject** (Karmiloff-Smith, 1985; Garrod and Sanford, 1988; Marslen-Wilson, Tyler and Koster, 1993) and the highest ranked entity in the **forward-looking centre** (e.g. Grosz, Joshi and Weinstein, 1983). We will follow Karmiloff-Smith and others by using the term **thematic subject**, because it is more transparent in its meaning than the other terms and because terms like **topic** and **focus** each have more than one meaning in the literature.

The thematic subject may be signalled by a title (Schwartz and Flammer, 1981), by being the first mentioned individual (Kieras, 1980) or the most frequently mentioned (Perfetti and Goldman, 1974; 1975), by the topic-comment assignment of individual sentences (Kieras, 1981), and through the use of a name rather than a noun phrase (Sanford, Moar and Garrod, 1988). The thematic subject can be said to be the most highly focused individual in the discourse and is the most readily accessible for the assignment of a pronoun (Crawley and Stevenson, 1990; Garrod, Freudenthal and Boyle, 1994) .

1.0 INTRODUCTION

Pronouns are ubiquitous in discourse. They are used to refer to individuals or entities that have already been introduced into a discourse and each one can have a number of potential antecedents. Despite this, people interpret pronouns with considerable ease and may not even notice that there is more than one possible interpretation. What is more, pronouns have little lexical content to assist in finding the intended antecedent. Apart from agreement of person, number or gender, participants in a discourse must find other clues to aid interpretation. One such clue is the plausibility of the interpretation in relation to the situation described by the discourse; another is the context in which the pronoun occurs, that is, whether the sentence containing the pronoun is part of a larger discourse or whether it is presented in isolation. Yet another is the relative salience of the potential referents in a model of the discourse. In our experiments, we investigate the proposition that the interpretation of a pronoun depends on the above mentioned clues. In making this investigation, we distinguish between the **global structure** of a discourse: what the discourse is about and **local salience:** the status of discourse entities as a function of local cues such as sentence subject and initial mention.

1.1 Discourse structure and discourse theme: The structure of a discourse is inherently defined by relations among elements in a discourse or model of the discourse, rather than simply by the elements themselves. Thus, structure is established by the propositional information in the discourse, that is, the information that specifies the relations that hold among the elements and so conveys the content of the discourse. There are two aspects of content that are important for comprehension. One is the establishment of a discourse theme and the other is the way the interpretation of each incoming sentence is checked against the theme for its pragmatic plausibility. The discourse theme is the situation that the discourse, or section of a discourse, is about. It describes information that is predicated of the characters in the discourse and it corresponds to what Grosz and Sidner (1986) call the global discourse structure or what van Dijk and Kintsch (1983) call the gist of a text. In both cases the focus is on the discourse as a whole, rather than on single sentences or on individual sentences contained in the discourse. In this paper, we assume that the content or theme of a discourse is represented in a mental model (Johnson-Laird, 1983) or situation model (van Dijk and Kintsch, 1983) of the discourse. A mental model is a non-linguistic representation of the situation described by a discourse. It is structurally similar to part of the world rather than to any linguistic structure. Information that is not explicitly mentioned in a text can also be included in a mental model by means of inferences from general knowledge of the discourse theme acting in conjunction with the information in the sentence currently being processed. A mental model acts as a context within which the current sentence is interpreted and so may constrain the interpretation of the sentence.

Knowledge of the discourse theme enables people to assess the plausibility of each sentence according to its closeness to the theme and a close relationship facilitates comprehension. When there is a clearly defined discourse theme (for example, a stereotypical situation, such as dining in a restaurant) comprehension is facilitated for sentences containing pronouns that refer to individuals, such as a waitress, closely associated with the theme. When the same character is referred to after a change of theme, comprehension is slowed (Anderson, Garrod and

The Effects of Sentence Subject, Initial Mention and Pragmatic Plausibility on the Accessibility of a Pronoun's Antecedents*

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ABSTRACT

Two experiments showed that the accessibility of a discourse entity is jointly affected by the local salience of the antecedent and by two aspects of the discourse structure: the pragmatic plausibility of the interpretation of the clause containing the pronoun and the presence or absence of prior context. Subjects read target sentences containing two clauses. The first mentioned two individuals, while the second contained a pronoun that referred to one of the individuals. Cleft constructions were used in the first clause so that two local signals to salience, subjecthood and initial mention, could be disentangled. When the clefted individual was the subject, then subjecthood coincided with initial mention but when it was the non-subject, subjecthood and initial mention conflicted. The content of the second clause either biased the interpretation of the pronoun to refer to the subject or the non-subject of the first clause or there was no bias. Context sentences preceded the target sentence in Experiment 1, while the targets were presented in isolation in Experiment 2. Results showed that local salience, pragmatic bias, and discourse context all affected the pronoun assignment preferences and the time taken to read the clause containing the pronoun. We suggest, therefore, that models of discourse processing need to take account of how local salience and global discourse structure are integrated during comprehension.

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