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Structural Focusing, Thematic Role Focusing and the Comprehension of Pronouns

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Abstract

We describe an experiment to test the view that structural focusing and thematic role focusing are distinct. Subjects were presented with 2-clause sentences containing **because** or **so**. The first clause introduced two individuals occupying the thematic roles Goal and Source, while the subject of the second was either a pronoun or repeated name. Results showed that reading times for the second clause were facilitated when the pronouns referred to the Goal rather than Source, particularly when the clauses were connected by **so**. This facilitation occurred regardless of the surface position of the Goal and regardless of the type of anaphor, pronoun or repeated name. With pronouns, facilitation also occurred when the antecedent was in the first position in its clause, but only when the antecedent was the Source. With Repeated Names, reading times were slowed when the antecedent was in the first position, regardless of its thematic role. These findings suggest that there are two foci in an utterance, one containing the first noun phrase in the utterance and the other containing the preferred thematic role. We suggest that the focus based on initial mention corresponds to the forward looking center described by Grosz et al. (1963) and that the focus based on thematic roles is part of the global focus (Grosz and Sidner, 1986). We also discuss the implications of our results for Sanford and Garrod's (1981) scenario mapping model.

Introduction

The interpretation of pronouns is a central problem in discourse comprehension. The major issue that needs to be explained is how pronouns are understood so readily despite the fact that they contain little information to assist interpretation and are frequently ambiguous. A number of attempts to solve this problem make use of the notion of focusing. In a focus-based model, discourse entities are not equally weighted. Instead, they are ranked according to their salience, with the most highly ranked entity being the most accessible as a the antecedent for a pronoun. Focusing models differ in what they regard as the mechanism underlying focusing. Different researchers have argued for structural focusing (e.g. Grosz, Joshi and Weinstein, 1983), semantic/pragmatic focusing (e.g. Stevenson, Crawley and Kleinman, 1994) and focusing based on background knowledge of the topic of the discourse (e.g. Sanford and Garrod, 1981). In this paper, we argue that structural

focusing and semantic/pragmatic focusing achieve their effects through different mechanisms.

Work on structural focusing can be found in the computational literature, with Grosz et al.'s centering theory giving the most explicit account. According to Grosz et al., all discourse entities in an utterance are stored in a set of forward looking centers (abbreviated here as **Cfs**) that are ranked according to their salience. The **Cfs** link the current utterance to the subsequent one by providing potential antecedents for a pronoun. In addition, each utterance, except the first in a discourse, also contains a backward looking center (**Cb**) that links the current utterance to the previous one by being the preferred site for a pronoun. According to Gordon, Grosz and Gilliom (1993) and others, the **Cb** also refers to the highest ranked **Cf** and is normally the subject of the sentence. The factors that affect the ranking of the **Cf** are not completely determined, but in general, surface position, grammatical role, being the **Cb** of the utterance, and (in Japanese) empathy are thought to interact to determine ranking (Brennan, Friedman and Pollard, 1987; Kameyama, 1986; Walker, Iida and Cole, 1994). There is growing psychological evidence to support the main tenets of centering theory. First, pronouns in subject position that refer to the highest ranked **Cf** of the preceding utterance are interpreted more rapidly than repeated names in subject position (Gordon et al., 1993; Hudson D'Zmura, 1988; Hudson, Tanenhaus and Dell, 1986). This is attributed to an expectancy effect (Hudson D'Zmura, 1988) because the subject position is the preferred site of the **Cb**, which is normally a pronoun referring to the highest ranked **Cf**. Second, subject pronouns referring to the highest ranked **Cf** are interpreted more rapidly than subject pronouns referring to a lower ranked **Cf** (Hudson D'Zmura, 1988; Hudson et al., 1986). This can be attributed to structural focusing because the most accessible antecedent for a pronoun is the highest ranked **Cf**.

Semantic/pragmatic focusing has long been recognised in the psychological literature through work showing that the causal bias of a verb can affect the ease with which a pronoun can be resolved. For example, in a sentence continuation task using sentence fragments containing **because**, Garvey and Caramazza (1974) found consistent preferences for assigning a pronoun at the end of the

fragment to either the first noun phrase of a sentence (NP1) or the second noun phrase (NP2). They argued that when the verb imputed the cause of the action to the first noun phrase, an NP1 bias was observed, but when the verb imputed the cause of the action to the second noun phrase, an NP2 bias was observed. Further support for the idea that verbs affect the accessibility of an antecedent comes from studies of the time taken to make pronoun assignments (Caramazza, Grober, Garvey and Yates, 1977) and from probe recognition tasks (Stevenson, 1986).

More recently, Stevenson, Crawley and Kleinman (1994) have shown that these verb bias effects reflect preferences for certain thematic roles rather than others. Stevenson et al. used sentence continuation tasks where the sentence fragments contained pairs of thematic roles and found that people preferred to assign a pronoun to the thematic role associated with the consequences of the event described by the fragment. For example, when completing sentence fragments containing Goal and Source thematic roles, as in the examples below, the continuations revealed that the pronoun was most likely to be assigned to the Goal, regardless of whether it was mentioned first or second in its clause.

(1)   John seized the comic from Bill and he ...... *(Goal in first position)*

(2)   John passed the comic to Bill and he .... *(Goal in second position)*

Similar results were found for fragments containing Agent and Patient thematic roles, where the preference was for the Patient. In addition though, there was also an effect of surface position: first mentioned antecedents were preferred to second. Thus, there was evidence of structural focusing alongside thematic role focusing, although focusing due to thematic role produced the strongest effects. The thematic role focusing was attributed to the fact that Goals and Patients are associated with the consequences of events and it is the consequences of the described event that are most highly focused in a model of the discourse. To test this idea, continuations were obtained for sentence fragments ending in either 'so' or 'because'. It was anticipated that 'so' would reinforce the preference for consequences while 'because' would modify it. This is because 'so' directs attention to the consequences of an event while 'because' directs attention to the initiating conditions (the cause) of an event. The results confirmed the predictions, thus supporting the view that the thematic role preferences arise because the individual associated with the consequences of a described event is the most highly focused in a model of the discourse.

However, Stevenson et al. also found evidence to suggest that structural focusing is distinct from thematic role focusing. In their experiments, they included conditions in which the sentence fragments did not contain a pronoun. In these cases too there was a preference for the first person mentioned in the continuation to refer to the thematic role associated with the consequences of the described event, Goal or Patient. However, the choice of referring expression, pronoun or repeated name, depended on the surface position/grammatical role[1] of the antecedent. Pronouns were used to refer to the first mentioned antecedent while repeated names were more likely to be used to refer to the second mentioned antecedent. These results support Gordon et al.'s notion of a **Cb** that is the expected site of a pronoun and suggest further that the choice of referring expression is governed by structural focusing, while the choice of antecedent is governed by thematic role focusing.

The purpose of this experiment was to test the proposition that structural and thematic role focusing are distinct. Subjects were presented with 2-clause sentences containing either 'because' or 'so'. The first clause contained Goal and Source thematic roles, while the subject of the second clause was either a pronoun or a repeated name that referred to one of the two thematic roles. Reading times were measured for the second clause. We expect both structural focusing and thematic role focusing to influence the reading times.

Taking the Pronoun sentences first, the times should be facilitated when the pronoun refers to the Goal. This facilitation should occur regardless of the surface position of the Goal, since a subject pronoun (the **Cb** in Grosz et al.'s terms) normally refers to the most highly ranked **Cf**, and according to Stevenson et al.'s data, this will be the Goal. We also expect the reading times to be facilitated when the pronoun refers to the first mentioned antecedent, as predicted by centering theory, since Stevenson et al. observed an effect of surface position as well as of thematic role. However, it is also possible that structural effect will be modified by focusing due to thematic role, since thematic role focusing took precedence over structural focusing in Stevenson et al.'s study. Finally, since thematic role focusing is modified by the focusing properties of the connective, we also expect the reading time facilitation due to thematic roles to be mostly confined to So sentences.

In the Repeated Name sentences, we also expect to find facilitation due to thematic role focusing, since Stevenson et al. found a preference for references to the Goal even when the continuation contained a name. For structural focusing, we are concerned in these sentences with the expectancy effect. Gordon et al. (1993), Hudson-D'Zmura (1988) and Hudson et al. (1986) have all found that when an anaphor is in subject position and refers to the highest ranked **Cf** in the previous utterance, reading times are slowed when the anaphor is a repeated name as opposed to a pronoun. In our experiment, we cannot directly compare the Pronoun and Repeated Name conditions because the conditions were presented to independent groups of subjects. However, if structural focusing is distinct from thematic role focusing, then in the present experiment this would mean that repeated names should lead to slower times only when the antecedent is the structural focus, that is, the first mentioned noun phrase. Finally, as was the case

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[1] The surface positions and grammatical roles of the antecedents co-varied in the experiments.

with Pronoun sentences, we expect thematic role focusing to be more evident in So than Because sentences.

Method

Subjects: The subjects were 32 student volunteers from the University of Durham.

Materials and Design: Each subject read 32 sentences containing either pronouns or names. In all other respects the materials were identical for the two groups of subjects. All the sentences consisted of two clauses connected by either **because** or **so**. The first clause introduced two individuals occupying Goal and Source thematic roles and the second clause contained either a pronoun or a repeated name that referred to one of these two individuals. In half the sentences, the Goal was mentioned first in the clause and in the other half it was mentioned second. In half the Pronoun sentences, the content of the second clause biased the assignment of the pronoun to the Goal. In the remaining half, it biased the assignment to the Source. The same content also appeared in the Repeated Name sentences. There were therefore four factors in the experiment, all but the first being repeated across subject groups. The first factor was Type of Anaphor (Pronoun vs. Repeated Name), the second was Surface Order (Goal first vs. Goal second), the third was Type of Connective (Because vs. So) and the fourth was Antecedent (Goal vs Source). An example set of materials is shown in Table 1.

Table 1: Examples of Materials Used in the Experiment

GOAL FIRST

Malcolm won some money from Stuart

BECAUSE
he/Malcolm was very good at poker
he/Stuart was very bad at poker

SO
he/Malcolm ended up feeling rich
he/Stuart ended up feeling poor

GOAL SECOND

Stuart lost some money to Malcolm

BECAUSE
he/Malcolm was very good at poker
he/Stuart was very bad at poker

SO
he/Malcolm ended up feeling rich
he/Stuart ended up feeling poor

To ensure that the content of the second clause was suitably biased to the intended antecedent, an initial large pool of sentences containing pronouns was constructed each with a second clause designed to bring about the intended assignment. These sentences were then presented to 3 independent judges who were asked to say who the pronouns referred to. Those sentences where all 3 judges gave the intended assignment were kept for inclusion in the experiment. Where there was disagreement, the second clause was changed to make the pragmatic bias stronger and these modified sentences were then given to a new set of 3 independent judges to say who the pronouns referred to. Once again, those sentences where all 3 judges agreed were kept for inclusion in the experiment while those where there was disagreement were modified and given to 3 more judges. This procedure continued until there were 16 Goal First sentences and 16 Goal Second sentences in which the second clause was unanimously judged to refer to the intended antecedent in each of the 8 conditions defined by Type of Connective, Position of the Goal and Thematic Role of the Antecedent. The critical second clauses were all either 5 or 6 words long. A question was also asked about each sentence, e.g. 'Was it Stuart who won the money?' For half the questions in each condition, the intended answer was 'yes'. For the other half, it was 'no'. The questions were designed to encourage comprehension and to ascertain that the pronouns were assigned to the intended antecedent.

Procedure: Subjects carried out a self-paced reading time task. Each sentence was presented on a computer screen one clause at a time and subjects were instructed to press the space bar as soon as they had read and understood a clause. Once the second clause had been read, the screen cleared and the question was presented. After answering the question by pressing one of two keys marked **YES** and **NO**, subjects were prompted to start the next trial. The time taken to read the clause containing the pronoun or repeated name was recorded in milliseconds. The assignments of the pronouns was also recorded.

Results

Since two different groups of subjects completed the Pronoun and Repeated Name conditions, these two conditions were analysed separately. The mean reading times for the target clauses in the Pronoun sentences are shown in Table 2. Only times for clauses where the pronoun was assigned the intended antecedent are included.

Analyses of variance on the data in Table 2 revealed a main effect of thematic role: clauses were read more quickly when the pronoun referred to the Goal rather than the Source ($F^1=8.29$, df=1,15, p<.02; $F^2=6.56$, df=1,60, p<.02), and a main effect of connective: clauses were read more quickly in Because than in So sentences ($F^1=12.71$, df=1,15, p<.01; $F^2=10.59$, df=1,60, p<.01). There was also an interaction between thematic role and surface position ($F^1=14.18$, df=1,15, p<.01; $F_2=7.25$, df=1,60, p<.01): a surface position effect arises with Source thematic roles only. The interaction between Thematic Role and Connective was also significant ($F^1=14.18$, df=1,15, p<.01; $F^2=8.44$, df=1,60, p<.01): The facilitation for clauses

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where the pronoun refers to the Goal is confined to the So sentences.

Table 2: Mean reading times (in msecs) for the clauses containing pronouns.

| Connective | Thematic Role of Antecedent | Surface Position of the Antecedent | | |
		First	Second	Means
BECAUSE	Goal	1657	1605	1631
	Source	1597	1846	1721
	Means	1627	1725	
SO	Goal	1689	1669	1679
	Source	2066	2282	2174
	Means	1877	1976	

Table 3 shows the percentage of correct responses to the questions in the Pronoun conditions. A correct response is one indicating that the pronoun had been assigned to the intended antecedent.

Table 3: Percent Correct Responses to the Questions in the Pronoun Condition.

| Connective | Thematic Role of Antecedent | Surface Position of Antecedent | | |
		First	Second	Means
BECAUSE	Goal	97	95	96
	Source	89	83	86
	Means	93	89	
SO	Goal	89	84	86
	Source	78	84	80
	Means	83	84	

Analyses of variance on the correct responses revealed a main effect of Thematic Role ($F^1=10.13$, df=1,15, p<.01; $F^2=8.33$, df=1,60, p<.01) and a marginal effect of Connective ($F^1=3.91$, 1,15, p<.07; $F^2=5.35$, df=1,60, p<.03). There were more correct responses when the pronoun referred to the Goal than when it referred to the Source, and when the sentences were connected by 'because' rather than 'so'. No other effects were significant.

The mean reading times for the clauses containing repeated names are shown in Table 4. Analyses of variance on the data revealed the same two main effects as in the Pronoun sentences. There was a main effect of Thematic Role: clauses were read faster when the pronoun referred to Goal rather than Source ($F^1=4.65$, df=1,15, p<.05; $F^2=7.36$, df=1,60, p<.02)), and a main effect of connective: clauses were read faster in Because than in So sentences

($F^1=35.55$, df=1,15, p<.01; $F^2=5.92$, df=1,60, p<.03). There was also a main effect of the position of the antecedent ($F^1=4.65$, df=1,15, p<.05; $F^2=6.34$, df=1,60, p<.02). Reading times were slower when the antecedent was in initial rather than second position. In contrast to the Pronouns sentences, there was no interaction between Thematic Role and Connective ($F^1=1.46$, df=1,15; $F^2=$, df=1,60), although the pattern of results is in the predicted direction.

Table 4: Mean reading times (in msecs) for the clauses containing names.

| Connective | Thematic Role of Antecedent | Surface Position of Antecedent | | |
		First	Second	Means
BECAUSE	Goal	1595	1464	1530
	Source	1631	1495	1563
	Means	1613	1497	
SO	Goal	1692	1594	1643
	Source	1925	1805	1865
	Means	1808	1699	

Discussion

These results support the idea that thematic role focusing and structural focusing are distinct. As far as thematic roles are concerned, reading times were facilitated and pronoun assignments more accurate when the antecedent was the Goal rather than the Source. This facilitation held for repeated names as well as pronouns. Structural focusing, however, produced a different patter of results depending on whether the anaphor was a pronoun or a repeated name. When the clause contained a pronoun, reading times were facilitated when the antecedent was mentioned first but only when it was the Source. This focusing effect, therefore, was modified by thematic role and only emerged when the first mentioned antecedent was the non-focused thematic role. When the clause contained a repeated name, an expectancy effect was observed: Clauses were read more slowly when the name referred to the first mentioned antecedent compared to when it referred to the second mentioned antecedent, regardless of the thematic role of the antecedent. We also found that thematic role focusing was modified by the type of connective, while structural focusing was unaffected by the connective. We therefore conclude that thematic role focusing and structural focusing are distinct.

The results of the present experiment appear to conflict with those of Hudson D'Zmura (1988). In one of her experiments, she examined structural focusing in relation to focusing due to the causal bias of the verb, and she found clear evidence of structural focusing but no evidence of focusing due to the causal bias of the verb. She used two sets of materials. One set contained 'Agent verbs', where the causal bias was to the Agent (NP1); the other set

contained 'Patient verbs', where the causal bias was to the Patient (NP2). (These latter sentences contained what Stevenson et al. called Experiencer (NP1) and Stimulus (NP2) thematic roles.) Hudson D'Zmura found that the first mentioned antecedent was the most accessible to a subject pronoun, regardless of its thematic role. However, Stevenson et al. found that Experiencer-Stimulus sentences of the kind used by Hudson D'Zmura do not show thematic role preferences in the absence of other cues in the sentence that turn the state described by the verb into an event. In their study, the use of 'so' led to a preference of the Experiencer while the use of 'because' led to a preference for the Stimulus. Thus, the lack of an explicit connective in Hudson D'Zmura's study is probably responsible for the lack of any focusing due to causal bias.

The connective influenced the impact of thematic role focusing, as was the case in the Stevenson et al. study. The reading time advantage for Goal antecedents was mainly evident when the connective was so. So reinforces the focusing due to thematic role, while **because** modifies it. Thus, thematic role focusing, but not structural focusing, is also affected by other elements in the sentence that direct the reader's attention to one discourse referent rather than another.

We should also note that there were differences in the content of the second clause across most of the conditions. This raises the possibility that the reading times are a result of systematic differences in the ease of comprehending these different clauses. We think this is unlikely for two reasons. First, the materials were comprehensively tested and modified until successive sets of three independent judges agreed on the assignment of the pronoun. Second, by using a large number of sentences, 16 Goal first and 16 Goal second, we reduced the likelihood of systematic differences between the conditions other than the differences due to the experimental conditions. Consequently, we feel confident that the results are due to our intended manipulations.

What do these results imply for theories of reference resolution? In centering theory, focusing depends on the ranking of Cfs according to structural aspects of the utterance. Following Gordon et al., we have identified the highest ranked **Cf** as the NP in initial position. An utterance also contains a **Cb**, which is responsible for the expectancy effect. According to Gordon et al., the **Cb** is normally a subject, and normally a pronoun that refers to the highest ranked **Cf** from the previous utterance that is realised in the current utterance. The present results support this view but further suggest that the **Cf**, as characterised by centering theory, is not the only form of focusing that can arise. Focusing also arises as a result of thematic role preferences. Thus, the centers that link the present utterance to subsequent ones, by providing potential antecedents for pronouns, may be either structural or semantic/pragmatic.

The **Cb**, on the other hand, is unaffected by thematic role focusing. An expectancy effect only arises when the antecedent is in initial position; that is, the structural focus of the preceding clause. Thus, the center that links the current utterance with the previous one is governed purely by structural factors.

Grosz and her colleagues also distinguish between centering theory, which is a theory of local focusing, and a theory of global structure, which is a theory concerning the purposes underlying the intentional structure of the discourse as a whole. Global focus is said to be responsible for the interpretation of definite descriptions (including repeated names) while local focus, the topic of centering theory, is said to be responsible for the interpretation of pronouns. This distinction between local and global focus may underlie the distinction between structural and thematic role focusing. Since these two forms of focusing have distinguishable effects, it is likely that they arise from different mechanisms. Thus, as Grosz and her colleagues have argued, structural focusing depends on local effects as identified by centering theory. Moreover, it seems to be specifically concerned with the relationship between the **Cb** and the surface position of the antecedent. However, we suggest that thematic role focusing is an aspect of global structure, an aspect that depends on the event structure of the situation described by the discourse.. If this is the case, then our results further suggest that the global focus affects the interpretation of pronouns as well as definite descriptions. Hence pronoun resolution does not lie solely in the domain of local focus..

In more pragmatically based theories, such as the scenario-mapping model of Sanford and Garrod (1981; Garrod, Freudenthal and Boyle, 1994), focusing is normally a function of background knowledge of the subject matter of the discourse, which determines the range of situations in which a discourse entity may appear. However, just as Grosz and Sidner distinguish between local and global focus, so Sanford and Garrod distinguish between the status of entities in the discourse and the event structure of the discourse. Consequently, two different mechanisms are specified that could be responsible for the two types of focusing. According to Sanford and Garrod, elements in a focus stack are stored in 'explicit focus' while the roles they occupy in the events described by the discourse are stored in 'implicit focus'.

As the model stands, focusing of a discourse entity is influenced by the strength of the links between an entity and the roles the entity occupies in the discourse. The results of the present experiment, together with the work on structural focusing, suggest that structural factors and thematic role information are also crucial for focusing and have separate sources. Thus, structural factors could be said to affect the status of entities in explicit focus, while thematic role preferences affect the status of roles in explicit focus. This model has the advantage, compared to Grosz's work on local and global focus, that the relationship between discourse entities and the roles they fill in the described events is clearly specified, thus enabling pronouns and repeated names to both be affected by thematic role focusing. However, it also has the disadvantage, compared to the work of Grosz et al., that there is no account of the relationship between the **Cb** and structural focusing.

In summary, we have found that both pronouns and repeated names are interpreted with respect to a thematic role focus as well as with respect to a structural focus. However, structural focusing only affects pronouns when the antecedent is the non-focused thematic role; while it affects repeated names when the antecedent is in initial position. The **Cb**, therefore, is only affected by structural focusing. We also suggested ways in which Grosz's models of local and global focus and Sanford and Garrod's pragmatic model of discourse need to be modified to take account of these findings. In particular, we suggested that thematic role focusing is an aspect of the global focus, and that therefore the global focus, as well as the local focus, influences pronoun interpretation; and we suggested that in the pragmatic model, structural focusing affects the status of entities in explicit focus while thematic role focusing affects the status of the roles in implicit focus, and that the important role of the **Cb** also needs to be considered.

Acknowledgements

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