Focus and Coherence in Discourse Processing

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Focussing in Spatial Mental Models

1. Introduction

While reading a text people develop a mental representation of it that does not
have much in common with the linguistic surface structure. Instead, it can be
seen as a constructive representation resulting from the interaction between the
text and the reader's linguistic and pragmatic abilities as well as his world-
knowledge. In theories of text processing this view is described as the construc-
tion of a *mental model* (e.g. Johnson-Laird, 1983, 1989; Garrod & Sanford,
1988a). Such a model can be regarded as being a surrogate of the world being
described and as consisting of concepts, that represent the entities of the real
world and their relations. During text reception the model is continuously up-
dated: every piece of new information modifies and – as the case may be –
reorganizes the model established so far and guides referential and inferential
processes itself.

It is assumed that cognitive structures within a mental model more or less
reflect the underlying physical structures. The topological structures of space
and time are modelled in the mental representation. In this respect *spatial models*
represent the spatial relations between the entities of the real world and their
qualities. In this context the central question is: To what extent does this spatial
representation have a quasi-pictorial quality and does the mental metric corre-
spond to the physical one? If so, the concept of a mental model can be seen here
as a cognitive map (McNamara, 1986; Wender & Wagener, 1990).

The assumption of an analogue format of representation is, for example, de-
duced from the so-called symbolic distance effect (Shepard, 1984): the time
needed for a mental comparison between two objects seems to depend on the
distance of the objects on the corresponding dimension. This effect was also
found to be induced by language (Bower, 1981). Taylor and Tversky (1992)
recently concluded that readers construct a similar spatial model irrespective of
receiving a verbal description or a map from a spatial scene. Moreover, other
empirical results show that the spatial structure of a current mental model in-
fluences text comprehension and production (e.g. Sanford & Garrod, 1981; An-
derson, Garrod & Sanford, 1983; Oakhill & Johnson-Laird, 1984; Oakhill &
Garnham, 1985; Wagener & Wender, 1985; Morrow, Greenspan, & Bower, 1987;
Garrod & Sanford, 1988a; Morrow, Bower, & Greenspan, 1989; Byrne &

Johnson-Laird, 1989; Bower & Morrow, 1990; Morrow, 1990; Herrmann & Grabowski, 1994, Chapter 3; Rinck & Bower, 1994). These spatial relations can be proved by the difference in the accessibility of *focussed* objects and persons in such a mental model.

In psycholinguistics 'focus' is conceptualized as a part of the mental discourse representation which is limited in size and accessible for referential consultation.[1] It results from the text comprehension process and is subject to continual adjustment on the part of the receiver (Sidner, 1983a, b). Various related concepts of focussing are, for example, the discourse pointer described by Carpenter and Just (1977), the buffer (working memory) of Kintsch and van Dijk (1978; also see van Dijk & Kintsch, 1983; Glanzer, Dorfman, & Kaplan, 1981; Monsell, 1984), the focus theory of Sidner and Grosz (Sidner, 1983a, b; Grosz & Sidner, 1986) or the explicit focus of Sanford and Garrod (1981; Garrod & Sanford, 1982, 1985; Sanford, Garrod, Lucas, & Henderson, 1983). All of these concepts assume a specialized reference domain of higher activation and preference for access within the constructed text representation.

This contribution considers mental models under the aspect of focussing by making use of the assumed spatial relations within a mental model. In line with our own research program, we will proceed as follows: first, we will ask whether the accessibility in a momentarily existing spatial model facilitates the processing of the relevant text information. Then we will turn to the question whether and – if yes – when objects are grouped within the mental representation. Finally, inferences in spatial models are discussed, that allow for conclusions about spatial relations not explicitly mentioned.

2. Accessibility of text concepts in spatial mental models

To integrate just received text information into an existing mental model, links are needed which could, for example, be provided by the spatial structure. It was found that spatial classifications of objects as well as anaphoric (coreference) processes were easier when the object in question was already part of the spatially associated mental model (Glenberg, Meyer, & Lindem, 1987; Morrow, Greenspan, & Bower, 1987; Rinck & Bower, 1994). The spatial structure seems to be one component that was able to produce focussing or foregrounding.

In a study by Morrow, Greenspan, and Bower (1987, cf. also Wilson, Rinck, McNamara, Bower, & Morrow, 1993) subjects first had to memorize a layout of a building (a diagram of a research center) with objects in different rooms. Then they read narratives describing the protagonist's tour around the building in

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[1] This use of the term 'focus' differs from the linguistic one. Hajicova and Sgall (1984) and others try to isolate the focus on the text surface. In contrast to the definition given above they understand 'focus' as new information that cannot be derived from the preceding discourse context and which explicates the topic, i.e. the subject of a discourse passage.

order to accomplish a task (e.g. 'Joan made sure everything was arranged for her presentation... Then she walked from the laboratory to the library...'). To obtain a measure for accessibility of the critical objects, subjects had to decide, whether the objects were present in the room as mentioned in the last sentence or not. Results showed an advantage for access to objects from the room mentioned in the last sentence as opposed to objects from other rooms in the building. These findings confirm the assumption that the focus reflects spatial relations of the described situation: "Protagonist location and the temporal development of the protagonist's actions help organize understanding by governing the accessibility of information from the developing situation model" (Morrow, Greenspan, & Bower, 1987, p. 185).

In another study Glenberg, Meyer, and Lindem (1987) presented short passages like the following:

Example 1:

1	setting	*John was preparing for a marathon in August.*
2′	associated	*After doing a few warm-up exercises,*
		he put on his sweatshirt *and went on jogging.*
2″	dissociated	*After doing a few warm-up exercises,*
		he took off his sweatshirt *and went on jogging.*
3	filler	*He jogged...*

The first sentence was a setting sentence followed by a critical associated sentence or a dissociated sentence. They differ only with respect to the protagonist *'putting on* his sweatshirt' or *'taking off* his sweatshirt'. In the first case, the critical noun 'sweatshirt' was associated with the further scenario; in the second case, the critical noun was dissociated. Subsequently the text was completed with filler sentences. By using a referential task or an item recognition task the authors Glenberg, Meyer, and Lindem (1987) found increased response times for the critical noun 'sweatshirt' or the fitting pronoun 'it' when it was dissociated in the second sentence; it was recognized faster in the associated text version. To be more precise, this response time advantage became significant after one or two filler sentences.

With as yet unpublished data we replicated and extended this general result in our own laboratory (Hielscher, Müsseler, Reuther, & Rickheit, 1990). We used associated vs. dissociated texts similar to those of Glenberg, Meyer, and Lindem (1987). But in contrast to their texts we always introduced two persons, either one of them or both associated with the spatial scenario. This variation was exclusively attained by different verbal relations between the two persons.[2] Im-

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[2] The fact that verbs are involved, for example, in reference processes has been already known for some time (e.g. Caramazza, Grober, Garvey, & Yates, 1977; Garnham & Oakhill, 1985; McKoon & Ratcliff, 1993). Also, in the above example by Glenberg, Meyer, and Lindem (1987) it is only the verb that varies, but it does not become obvious if the associated/dissociated variation is established by the verb only. This is the case in our texts.

agine a situation in a restaurant where 'John *is flirting with* Mary' as compared to 'John *is thinking of* Mary'. Only the variation of the verb in the dissociated version ('thinking of') makes 'Mary' an indirect part of the spatial model; she may be anywhere but in the restaurant. In the associated sentence ('flirting with') both persons are interacting as explicit parts of the spatial scene. According to Glenberg, Meyer, and Lindem (1987) we expected a facilitated reference resolution for 'Mary' in the associated case.

One associative vs. dissociative verb[3] was embedded in five-sentence passages like the following one:

Example 2:

1	setting	*The restaurant is quite empty.*
2'	associated	*At the table in the corner Mary is flirting with John.*
2"	dissociated	*At the table in the corner Mary is thinking of John.*
3	filler	*She eats some vegetables with meat.*
4	filler	*The drink tastes very good.*
5	coreference	He/John *wants to go to the theatre with her.*

The first sentence provided the setting information determining the scenario, in this case a restaurant. The second sentence was either an associated or dissociated one; to avoid ambiguous coreference relations even for the pronoun (in sentence 5), it always introduced a female and a male person. The two text versions differed only in the use of the verb in sentence 2. In the two following filler sentences the female person was focussed on. Here it was important that she stayed part of the scenario. In the critical fifth sentence a coreference to the male person mentioned in sentence 2 had to be established. This co-referential process was initiated either by a pronoun or by repeating the Christian name.

As the results of Glenberg, Meyer, and Lindem (1987) and others suggest, the male person is still in focus if he is spatially associated. Thus, the prediction would be that the resolution of the *reference pronoun* 'he' should be easier if 'he' is part of the spatial surrounding (as compared to the condition where 'he' is not). According to Sanford and Garrod (1981; Garrod & Sanford, 1982, 1985) 'he' is still present in the explicit focus. However, in the dissociated version a time-consuming focus shift should be necessary to establish the pronominal reference.

We used a word-incremental reading technique to gather time latencies which are assumed to reflect underlying cognitive processes: a text is displayed on a computer screen incrementing word by word, with reading times individually

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[3] About 100 different verbs were tested in a verb inventory, a questionnaire with sentences containing those verbs, we assumed to associate or dissociate the two persons. Subjects had to rate the spatial distance between the two interacting people on 5-point-Likert-scales. The results of this study therefore allowed us to select extreme groups of spatial associative (e.g. 'to kiss s.o.', 'to meet s.o.' or 'to dance with s.o.') and dissociative verbs (e.g. 'to characterize s.o.', 'to write to s.o.' or 'to look for s.o.'). Of course, nothing could be said about the cognitive relevance of this spatial verb dimension in text comprehension.

controlled by the reader (for validity of this technique compare, e.g., Günther, 1989). The reading times of the critical reference words[4] were statistically analysed (Fig. 1).
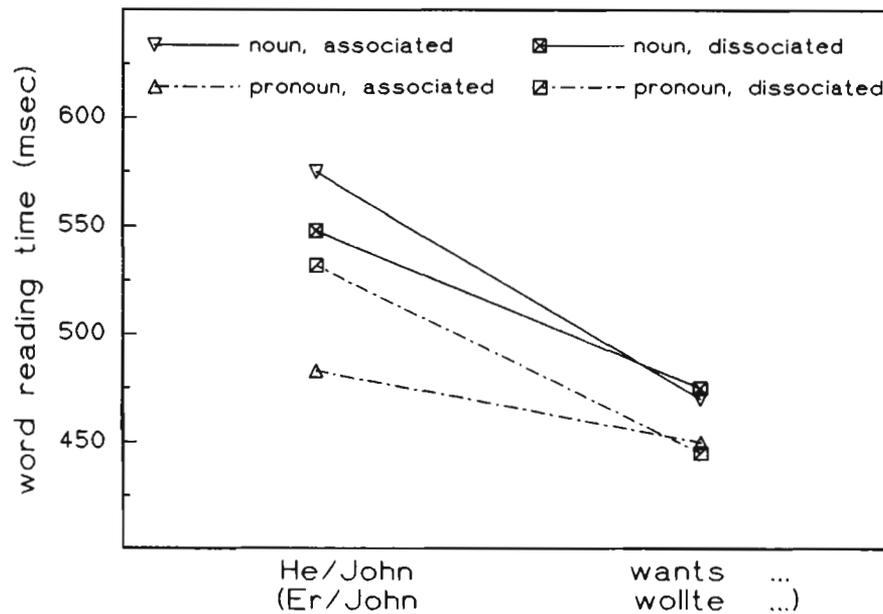

Figure 1: Word reading times of the critical reference (pronoun or noun) and the following verb (here 'wollte') depending on the associative/dissociative introduction of the reference person (cf. text example 2).

In line with our hypothesis, the reading times of the pronouns showed significant differences. As predicted the pronoun in the associated version was read about 50 msec faster than the pronoun in the dissociated version. Here, our predictions are correct.

Our assumptions for *noun references* (with the full definite noun phrase, i.e. the repetition of the Christian name 'John' in the above example) were not that clear. Following the same reasoning, one could expect results similar to pronominal coreference. However, according to Garrod and Sanford (1982; 1988b; Sanford, Garrod, Lucas, & Henderson, 1983), a full definite noun phrase induces

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[4] In this experimental design we included the reading times of the anaphor and the verb of the critical reference sentence. This additional independent variable tests whether the anaphor is assigned to the referent on reading the pronoun (e.g. Just & Carpenter, 1980) or whether even the reading time of the verb is influenced by the different experimental conditions. The latter would assume a *cognitive lag* between reception and processing of the pronoun (e.g. Rayner, 1978; Ehrlich & Rayner, 1983; also cf. the 'postponatian' hypothesis by Vonk, 1985; Sanford & Garrod, 1989; Sichelschmidt & Günther, 1990). As one can see from the results, this does not seem to be the case in Figure 1 (but cf. Figure 2 and 3).

a longer search right from the beginning in the *explicit and implicit focus*. Moreover, if the reference person is only loosely connected with the spatial scenario, it is more than likely that after two filler sentences he/she is no longer represented in the explicit focus anyway. In that case a pronoun would be linguistically inadequate. Then the repetition of the Christian name would be the more appropriate form in the dissociative version than in the associative version. If 'John' is not part of the focus in the spatial model it may be more common to repeat the whole noun phrase (i.e. his name). As a consequence, the pronominal resolution should be even slower than the resolution by repetition of the name in the dissociative text.

The first striking result in this respect was the enhanced reading time for the Christian name – less time was used for the pronoun. Similar results are reported by other researchers (Garrod & Sanford, 1982, 1988b; Sanford, Garrod, Lucas, & Henderson, 1983). At first sight the result is astonishing because pronominal resolution should be an additional and therefore time-consuming process in text comprehension. But – on the contrary – using a pronoun seems to facilitate comprehension! It is beyond the scope of this paper to explain this phenomenon and solve the problem, but a simple explanation would be the difference in the number of letters: pronouns are shorter than names and usually longer words need longer reading times (see Rickheit, Günther, & Sichelschmidt, 1992). Another explanation starts from the assumption that there are different processes involved for resolving pronouns and noun anaphors (Cloitre & Bever, 1988). A further explanation is related to a functional point of view: a pronoun may signal a focus maintenance whereas a noun anaphor may signal a focus shift (Schnotz, 1988; Müsseler, 1994). This distinction could have produced the reading time differences, too. Taking all data into account, we cannot definitely decide between the alternative explanations at this point in time.

Let us now turn to the difference between the associated and dissociated version. Repeating the Christian name was found to facilitate the resolution in the dissociated version as compared to the associative version. As expected the reverse pattern of results was found for pronouns. This difference was expressed in a significant three-way-interaction between the factors 'spatial reference' (associated vs. dissociated), 'antecedent' (noun vs. pronoun), and the 'critical word' in the fifth sentence (noun/pronoun vs. verb). Based on this result we assume a prominent difference between processes involved in pronominal and nominal coreference, indicating again the inadequate use of a pronoun to refer to a non-focussed object.

To summarize, the experiment confirmed the results of former studies and indicated that the spatial model influenced processes of reference resolution. It made a difference whether a person or an object was an explicit part of the spatial mental model. This spatial relation seemed to determine the status of the person in focus. Being in focus was an important criterion for adequacy and facility to interpret a noun or pronoun referring to this person.

3. Complex concepts in spatial mental models

In the text example above we wanted a reference resolution for only one person. Yet, another question results from the concept of plural reference: it is possible to refer to both, i.e. 'John' and 'Mary' via the plural pronoun; how is this pronominal coreference influenced by the associative vs. dissociative introduction of both persons? To test this we modified the filler and the critical reference sentences:

Example 3:

1	setting	*The restaurant is quite empty.*
2′	associated	*At the table in the corner Mary is flirting with John.*
2″	dissociated	*At the table in the corner Mary is thinking of John.*
3	filler	*He is a very goodlooking man.*
4	filler	*Sometimes he is a little bit shy.*
5	coreference	They/She want(s) *to go to the theatre.*
		(German original: Sie wollte(n) *noch ins Theater gehen.)*

In the critical reference sentence either the singular pronoun 'she' was used or the plural pronoun 'they' referring to both, 'Mary and John'. Note, that in German the meaning of the pronoun 'sie' is ambiguous: 'sie' can refer to 'Mary' alone or to both 'Mary and John'. Only the verb inflexion assigns the references to the singular or plural concept. To comprehend the plural pronoun the reader has to integrate the two singular persons to a whole plural entity (that fits the pronoun). We will refer to the process yielding such a plural entity as 'installing a *complex concept'* (Müsseler & Rickheit, 1990a; Kaup, 1994; for a more formal description cf. Eschenbach, Habel, Herweg, & Rehkämper, 1990; Schopp, 1995). The process of installing such a concept is an additional component in the process of text comprehension which therefore should take additional time, as opposed to the resolution of the singular version. Over the last years we have carried out several studies concerning this question (Hielscher & Müsseler, 1990; Müsseler & Rickheit, 1990b). Instead of associative or dissociative spatial contexts we used different coordinations for these experiments to introduce the persons, such as 'John and Mary...', 'John as well as Mary...' or 'Neither John nor Mary...'. For the point of time in the comprehension process when the complex concept is established, our predictions were analogous to these experiments:

Firstly, it can be argued that the plural complex is not installed until it becomes unavoidable for text reception, i.e., as soon as a person reads the pronoun 'sie' followed by the plural verb, the pronoun has to be related to both 'John and Mary'. Thus, at least at this point in time, the complex concept has to be generated. Consequently, one can assume that the singular pronoun is processed quicker than the plural pronoun because there is no additional component for installing a plural reference complex.

An alternative prediction implies that establishing the complex concept is independent of reading the pronoun. The plural complex is installed while read-

ing about the two persons in the introductory second sentence – especially in the associated text version. If this is the case, one can think of two possible alternatives for the pronominal resolution process: the first one claims that the singular concept fits the pronominal resolution just as well as the plural one. No processing time differences should occur. The second possibility claims that by installing the plural concept the singular concepts are deactivated. In the latter case, a refocussing of the singular concept is necessary for resolving the singular pronoun. This additional mechanism should be expressed in a processing time disadvantage for the singular pronoun.

The results showed absolutely no effect for our critical variation, the variation of the associated vs. dissociated version. Thus, contrary to the experiments reported above the resolution of the critical pronoun is not influenced by the spatial context. This may be due to a difference between example 2 and 3: In example 2 the male person within the *verbal* phrase of sentence 2 is used as coreference, whereas in example 3 this is the female person within the *nominal* phrase, or both persons. It seems that spatial effects are modified by such syntactical positions.

Independent of text version there is a tendency to an advantage of the plural pronoun at the verb and the following word if no filler sentences were used (Fig.2)[5]. Although the plural pronoun has to be related to both 'John and Mary' the resolution seems to be facilitated. This points to an installation of the plural concept while reading the prepronominal sentence. Otherwise, the reverse effect should be observable.

The difference here is small but points in the same direction, which preceding experiments in our laboratory have confirmed. What we found with a completely different method – using decision times instead of word incremental reading – was that the advantage of the plural pronoun depended on the coordination we used (Hielscher & Müsseler, 1990; Müsseler & Rickheit, 1990b). With coordinations like 'John and Mary' or 'John as well as Mary' there is an advantage in reaction time for the plural pronoun of about 50 msec. This contrasts with coordinations like 'John without Mary' or 'John instead of Mary' where no such differences were found. In the present experiment the dependent variable was word-reading time and even here the facilitation for the plural pronoun was found.

These results imply that additional processing capacity for installing the plural concept was expended in the *pre*pronominal sentence. Unfortunately, we have no means to test this idea on the basis of our data because our prepronominal sentences always introduce two persons. Still, it would be necessary to compare the processing times of singular and plural prepronominal sentences. In a recently published experiment Sichelschmidt and Günther (1990) did exactly

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[5] Note that in this experiment the reading times of the following words were also affected by the experimental manipulation. Evidence for the cognitive lag or postponation hypothesis, cf. note 4.
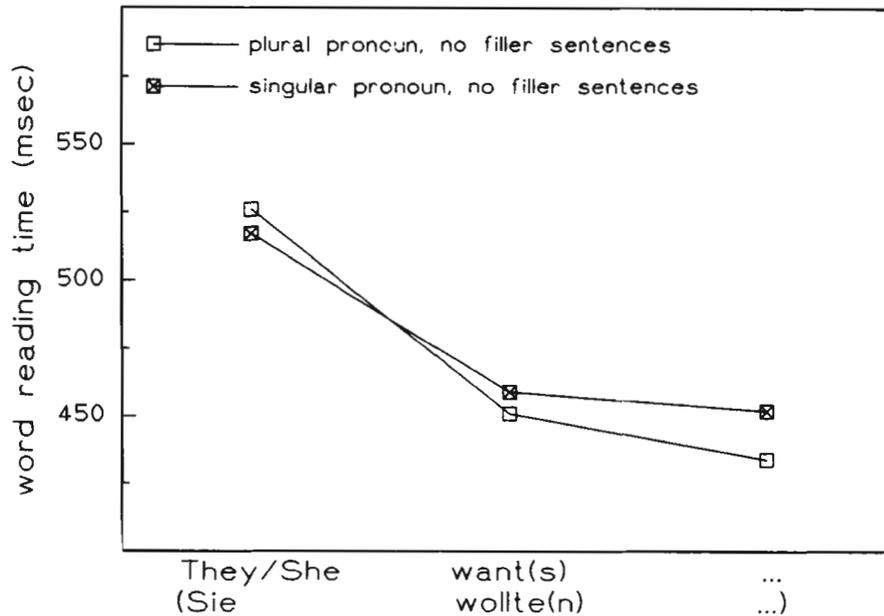
Figure 2: Word reading times of the critical reference (singular or plural pronoun 'Sie'), the singular or plural verb (here 'wollte' vs. 'wollten'), and the following word (...) immediately after the introduction of both persons (cf. text example 3). Because the statistical analysis of the associative/dissociative variation showed absolutely no main effect or interaction, the data of both versions were combined.

this, their findings verifying the prepronominal installation assumption (also cf. Müsseler & Terhorst, 1990).

What did we have to expect if there are additional filler sentences between the associated/dissociated sentences and the critical reference sentence? Within the filler sentences the focus is shifted to the male person which should have the effect of breaking down the complex concept. A consequence could be that the plural reference is more difficult to resolve than the singular one.

The results were in line with this hypothesis but again not affected at all by our critical spatial associative/dissociative variation. After the plural pronoun (or the determining verb) the reading times increase compared with the singular pronoun version (Fig. 3).

In sum, the results showed that the plural reference resolution is facilitated immediately after both persons are introduced. It is rendered more difficult if filler sentences were inserted which implied a focus shift to one person only. Both effects were completely independent of the associative-dissociative variation.
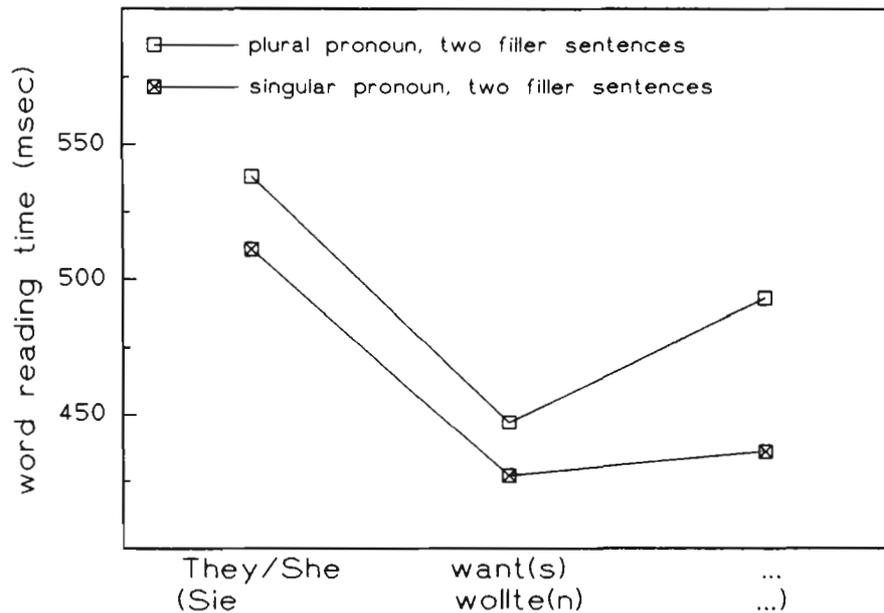
Figure 3: Word reading times of the critical reference (singular or plural pronoun 'Sie'), the singular or plural verb (here 'wollte' vs. 'wollten'), and the following word (...) after two filler sentences (cf. text example 3).

4. Inferences in spatial mental models

The experiments and examples mentioned so far dealt with the cognitive accessibility of persons and objects whose assignment to a present spatial model was induced by the text. Text conditions, in which the spatial assignment was avoided intentionally or no longer existed, contrasted these. Here, a (re-)activation of the concepts in question was necessary to resolve the reference.

Spatial relations in text processing are, however, also inferred from general knowledge. Inferences are given when new semantic information is generated from old information in a given context (Rickheit, Schnotz, & Strohner, 1985). It is typical for these inferences that the relations are not explicitly expressed on the text surface but implicitly drawn by the processing system.

In a more recent study by Morrow, Bower, and Greenspan (1989, cf. also Rinck & Bower, 1994) subjects again had to memorize a building layout and then read narratives of a protagonist moving from one room to another via a known room not explicitly mentioned in the text. Using the same method as described in section 2 the most interesting result was a higher accessibility to objects in a room that had not been mentioned than in a mentioned but less

relevant room – suggesting that in the current process of text comprehension the reader recurs to the newly learnt spatial model even if the text itself does not mention these spatial relations again.

Müsseler and Rickheit (1990a, c) tried to consult subjects' pre-experimental world knowledge instead of having them learn a spatial model before the text reception phase. This was done by the so-called *bridging inferences* which are used to relate anaphors back to the antecedent (Tanenhaus & Seidenberg, 1981; Dell, McKoon, & Ratcliff, 1983; Singer & Ferreira, 1983; Müsseler, Rickheit, & Strohner, 1985). The probably best-known example of a bridging inference comes from Haviland and Clark (1974; also cf. Clark, 1977; Just & Carpenter, 1978):

Example 4:
1′	close	*Horace got some* beer *out of the car.*
1″	distant	*Horace got some* picnic supplies *out of the car.*
2	critical reference	*The* beer *was warm.*

The referential distance between the first sentences and the second sentence varies only by the specification expressed in the concepts 'picnic supplies' vs. 'beer'. The relationship has to be constructed in the reader's knowledge who has to identify 'beer' as a 'picnic supply'. This process leads to an increase in reading time of the critical sentence. A similar reference is possible concerning spatial relations as well (Müsseler & Rickheit, 1990c, Exp. 3):

Example 5:
1	setting	*Karin drove her car through the countryside.*
2′	close	*She glanced across the* field.
2″	distant	*She glanced across the* mountain range.
3	critical reference	*The* grain *was ripe.*
4	filler	*In the evening Karin arrived at the sea.*

We can quickly recognize 'grain' as a part of a 'field', but as a part of the 'mountain range' it has to be additionally inferred. To establish text coherence, an extended spatial focus shift becomes necessary (see 'focus tracking', Sidner, 1983a, b; Schnotz, 1988). In this case it is a spatial specification ('*zooming in*'); a shift from a more extended scenario ('field' vs. 'mountain range') to a spatial detail was necessary for coreference. An additional question in our experiments was: to what extent do we get an increase in reading times also for spatial generalization ('*zooming out*') as the following example represents:

Example 6:
1	setting	*Karin drove her car through the countryside.*
2′	close	*She glanced across the* field.
2″	distant	*She glanced across the* grain.
3	critical reference	*The* mountain range *was impressive.*
4	filler	*In the evening Karin arrived at the sea.*

This analogue example calls for a shift from a spatial detail ('field' vs. 'grain') to a more extended scenario ('mountain range'). The results showed almost no effect between the 'zooming in'/'zooming out' variation. In both variations the reading times increased in the case of the distant referential relations as compared to the close ones. There was a tendency for the 'zooming out' condition to take longer (150 msec difference between close and distant condition in the 'zooming in' version, 250 msec difference in the 'zooming out' version).[6]
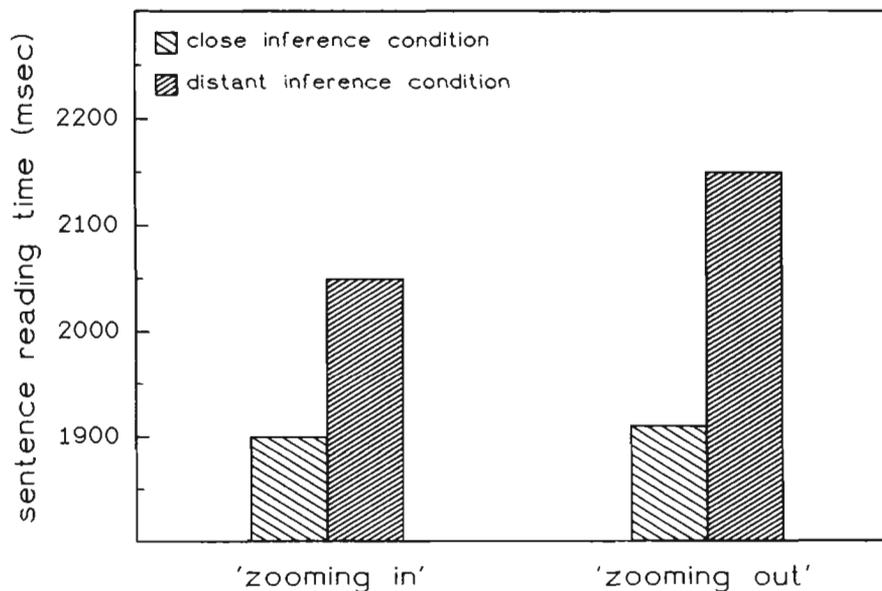

Figure 4: Reading times of the critical third sentence (cf. text examples 5 and 6) determined by the inference condition ('close' vs. 'distant') and the 'zooming' variation ('in' vs. 'out').

There was, however, a difference in the recognition phase: after text presentation recognition items were given which partly represented performed inferences. Such an item represented a text content probably resulting from an inferential process between the second and third sentence. If it was stated that 'Karin glanced across the field' and that 'The grain was ripe', then this implies that 'Karin glanced at the grain'. Subjects had the task to decide whether such a sentence had been given in the text in this form or not. Performed inferences of

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[6] In example 5 *spatial distance* seems to be confounded with *semantic distance:* Associating 'field' with 'grain' is much more probable than associating 'mountain range' with 'grain'. In fact this objection can be applied to most of our texts. On the other hand in example 6 'field' and 'mountain range' seem to be semantically as distant as 'grain' and 'mountain range'. As the reading times for both conditions were similar (with an opposite tendency) the semantic distance does not seem to affect our results. The recognition data give no rise to a semantic distance effect, but only further research can clarify this objection.

the 'zooming out' versions were sooner recognized when the spatial focus was extended as was the case in the distant inference condition. With the 'zooming in' version this did not occur. A possible interpretation is that the 'zooming out' version requires a qualitative shift of the spatial model not equalling the antecedent one. With spatial 'zooming in' this shift is not necessary because the new concept incorporated into the spatial mental model is only more detailed information. In both cases the reading and comprehension times can increase. Nevertheless, the resulting mental models are not necessarily the same.

5. Conclusions

What do the studies mentioned here reveal about focussing in mental models? On the one hand, section 1 shows that the reference to objects and singular persons within a common spatial model is facilitated. Contrary to the experiments by Glenberg, Meyer, and Lindem (1987) we found only little, yet reliable differences in our experiments. The results proved that reference resolution has to do with focussing in a spatial model. Whether someone or something is a part of the model, or not, can apparently be induced by the verb semantic. Nevertheless, the establishment of a spatial mental model is certainly defined by the whole text and not solely by the verb.

On the other hand, as section 2 demonstrated the reference to two persons via a plural pronoun was independent of the associated/dissociated version. It did not make any difference whether *both* or only one person was an explicit part of the spatial representation. One reason for missing effects here could be that the associated and the dissociated complex concept in the experiment did not differ enough to produce reading time differences. In both, at least one person was associated. Another point may have been the ambiguity of the pronoun 'sie'.

In the last section we collected data to prove that for the construction of a mental model subjects refer to spatial information which is not explicitly mentioned in the text (Morrow, Bower, & Greenspan, 1989). These inferences which help to generate a coherent text representation make use of the recipient's world knowledge. In this context also the results for 'zooming out' and 'zooming in' have to be interpreted. Both spatial 'zooming in' and 'zooming out' lead to increased reading times, reflecting the inference effect. If, however, the recognition phase can actually be judged as a criterion for the composition of the mental model, we can conclude that the 'zooming out' requires a qualitative shift of the mental representation. This does not seem to apply to 'zooming in'.

In summary, all the mentioned studies support the assumption that spatial mental models play a role in text comprehension. Focussing has a selective function here by helping to select and adjust the important relations in a mental model out of a multitude of spatial relations. This facilitates text comprehension. The most obvious reason for the focus content to be constantly related and adjusted to the text content is the fact that it can be regarded as part of the

working memory, which again implies that it is subject to capacity limitations (van Dijk & Kintsch, 1983; Glanzer Dorfman, & Kaplan, 1981; Monsell, 1984). However, the relation between capacity limitation and selection has to be considered from a functional point of view: in order to serve the comprehension process, selection mechanisms produce capacity limitations and not vice versa (e.g. Müsseler & Terhorst, 1990; Müsseler, 1995).

However, why should spatial relations play such a prominent role in establishing a mental model? This question evades direct empirical testing and so we are left with speculations. At any rate, the answers should not be isolated from other areas of information processing. One undisputable result is, for example, that spatial aspects are preferably used to control visual focussing (e.g. van der Heijden, 1992). This points to a general mechanism of the human information processing system.

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