

SHORT NOTE

TWO WAYS OF COPING WITH INDETERMINATE
SPATIAL DISCOURSE

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Two experiments investigated the strategy of coping with an indeterminate description in adults. The data suggest the existence of an important inter-individual variation in the way people represent such indeterminacies. In the first experiment 53% of the subjects failed to draw more than one diagram after the reading of an indefinite spatial description. The analysis of reading times nevertheless suggests that these subjects were sensible to the referential problem during reading. In the second experiment, 43% of the subjects recognized only one among several layouts which correspond to a description they had read. In these subjects, a highly modal way to disambiguate the description clearly appears. The possible discrepancy between these results and Mani and Johnson-Laird's (1982) data is discussed.

The mental representation of spatial descriptions has been the topic of several recent papers (Ehrlich & Johnson-Laird, 1982; Foss, 1983; Perrig & Kintsch, 1985). Johnson-Laird (1983) approached the following more specific question: how do people cope with indeterminate discourse? This author listed four different strategies people could use to cope with referential indeterminacy.

1. to stop constructing a mental model of the description as soon as the indeterminacy is encountered. This construction of a mental model is abandoned in favour of a propositional representation. The mental model can be seen as a representation of the state of affairs the description is about. Contrary to mental models, the Johnson-Laird's propositional representations encode the linguistic form of the sentences on which they are based,
2. to construct alternative models representing the different possible layouts corresponding to the description,
3. to represent indeterminacy within a mental model by introducing a propositional element of notation in the analogical representation,
4. to plump for one specific model of the discourse.

Mani and Johnson-Laird (1982) presented empirical data on this question. They observed that although people remembered better the semantic implications of determinate descriptions than those of indeterminate ones, they recalled more easily the verbatim details of the indeterminate descriptions than those of the determinate ones. Mani and Johnson-Laird (1982) and Johnson-Laird (1980, 1981, 1982, 1983) considered that this pattern of results indicates that most of the subjects adopted the first cited strategy to cope with indeterminacy.

In this note, data from two experiments are presented. These data support the idea that subjects are sensitive to the indeterminacy present in a description. However, the data also suggest that a high proportion of subjects do not seem to abandon the construction of a single representation of the description.

EXPERIMENT I

Method

Forty-eight undergraduates participated. Sixteen subjects received a definite description. Thirty-two subjects received an indeterminate description. Three subjects failed to follow the instructions. Their data were rejected from the analysis.

The description consisted of seven sentences. In each sentence the relation between two objects was described. The determinate description contained the following sentences:

1. The cupboard is behind the sofa, 2. The bed is to the right of the cupboard, 3. The chest is to the left of the cupboard, 4. The armchair is to the left of the chest, 5. The bookshelf is in front of the sofa, 6. The chair is in front of the bookshelf, 7. The table is in front of the chair.

The indeterminate description contained the same sentences except the fourth sentence which was "The armchair is to the right of the chest". The shape of the described layout(s) was roughly a T. The indeterminate version of the sentences could describe these three horizontal cross-bar of the T:

1. chest	armchair	cupboard	bed
2. chest	cupboard	armchair	bed
3. chest	cupboard	bed	armchair.

The description was presented one sentence at a time on a monitor screen. The subjects were tested individually, they were told the nature

of their task and could read the description at their own pace. They were instructed to press the space bar of a microcomputer keyboard to print the first sentence on the screen and then to press this space bar each time they were ready to see the next sentence. Each pressing caused the current sentence to disappear and the next sentence to be displayed. These instructions were made clear with an example showing how to use the space bar. The times between the space bar pressures were automatically recorded by the microcomputer. Directly after reading the last sentence, the subjects were asked to draw all the possible layouts that could describe the set of sentences. The instruction was "I do not know how the computer described the room. It is programmed to choose among several different descriptions. If you think the description was unequivocal then draw the corresponding diagram. If you think the description was equivocal then draw the different layouts which could correspond to the description". When the subject drew only one diagram, the experimenter added the following question "O.K. You drew one diagram. Does this mean to you the description was clear?".

Before the reading period, the experimenter and the subject came to an agreement about what was meant by "to the right of", "to the left of", "in front of" and "behind of".

Results

It was examined whether each of the seven presented spatial relations was respected or not. No error at all appeared for the horizontal axis of the T shape. Seven errors, made by five subjects (two from the definite description group and three from the other group), appeared for the vertical axis of the layout. All these errors were inversions between the following elements: the bookshelf, the chair and the table. Most of the subjects in each group succeeded in this task if we only consider their ability to draw one diagram corresponding to the set of presented sentences.

How did the subjects who received the indeterminate description draw the horizontal axis of the layout? In the method section we described the three possible ways to arrange (from left to right) the objects on this horizontal axis. Only nine subjects represented the three arrangements, five subjects drew the following axis "chest armchair cupboard bed" and "chest cupboard armchair bed". Sixteen subjects drew only one diagram in which they placed the armchair between the chest and the cupboard. All sixteen subjects said they found the description clear. Did these subjects process the indeterminacy present in the set of sentences? To

investigate this question, the reading times were analyzed. From now "ONED. subjects" will be used to designate the subjects who received the indefinite description and drew only one diagram, "SEVD. subjects" will designate the subjects who drew several diagrams, and finally "DEF. subjects" will designate the subjects who received the definite description.

The processing of a potential referential ambiguity increases reading time (Ehrlich, 1980; Foss, 1983). Then, it was predicted that the reading times for sentence 4 will be longer for the SEVD. subjects (who were clearly sensitive to the indeterminacy) than for the DEF. subjects. If the ONED. subjects were sensitive to the indeterminacy then their reading times for the sentence 4 should also be significantly longer than those of the DEF. subjects.

We compared reading times, sentence by sentence, with a two way 3 (group) \times 7 (sentence) ANOVA for repeated measures on the last factor and with unequal cell frequencies. The reading times are presented in Table 1. The ANOVA revealed no significant effect of the factor

Tab. 1. — Mean reading times with standard deviation (in brackets) as a function of the sentence and of the group of subjects. DET. subjects received a definite description. ONED. subjects and SEVD. subjects received an indefinite description. The former drew a single diagram whereas the latter drew several layouts.

	DET. Subjects (n = 15)	ONED. Subjects (n = 16)	SEVD. Subjects (n = 14)
Sentence 1	11.73 (3.79)	12.93 (5.12)	11.97 (5.22)
2	16.40 (6.19)	18.76 (5.73)	18.21 (6.15)
3	16.28 (5.04)	16.75 (5.82)	17.11 (4.72)
4	18.38 (6.14)	27.99 (9.52)	29.96 (8.44)
5	17.85 (7.74)	19.51 (5.58)	19.74 (6.15)
6	16.58 (7.09)	20.07 (7.44)	18.80 (8.22)
7	17.85 (9.66)	18.64 (8.67)	20.62 (6.88)

"group" ($F(2,42) = 1.981$) but a clear effect of the factor "sentence" ($F(6,252) = 21.717$; $p < .001$) and an interaction effect ($F(12,252) = 2.098$; $p < .02$). The reading times of the three groups were compared for each sentence with seven separate one-way ANOVAs. No significant effect of the factor was obtained for the sentences 1, 2, 3, 5, 6 and 7 (all $F < 1$). For sentence 4, the ANOVA revealed a significant effect of the group ($F(2,42) = 8.106$; $p < .02$). Complementary analyses revealed that the mean reading time for sentence 4 was significantly lower in DEF. subjects than in the ONED. subjects ($t(29) = 3.237$; $p < .01$) and than in SEVD. subjects ($t(27) = 4.147$; $p < .01$). No significant difference appeared between these two last groups ($t(28) = .577$).

Discussion

More than the half of the subjects drew only one diagram after reading an indeterminate description. The analysis of reading times shows that these subjects, as did the subjects who drew several diagrams, took significantly more time to read the ambiguous sentence than did the control subjects to read a clear sentence at the same place in the description. This result suggests that the ONED. subjects were sensitive to the indeterminacy. Despite this detection, these subjects apparently eliminated the indeterminacy and used sentence 4 as if it meant "The armchair is *directly* to the right of the chest". Finally these subjects explicitly judged the description clear. They did not show any sign that could indicate they abandoned the construction of a single model for the discourse.

These results seem to be different from the data presented by Mani and Johnson-Laird (1982). Nevertheless, if the results of several studies on the processing of partially ordered information are considered, the present results do not appear to be odd at all. In these studies (Griggs, Keen & Warner, 1980; Moeser, 1979; Warner & Griggs, 1980) subjects were presented with sets of sentences describing order structures (for instance a genealogy). It appeared that if subjects are not clearly instructed to check the potential indeterminacies, most of them cannot graphically represent all the indeterminacies present in the descriptions. A not negligible proportion of subjects (about 1/3 in Griggs et al.'s study) did not represent any indeterminacy at all. When the subjects had to answer questions about the relations between the elements of the structure, their answers were consistent with the way they disambiguated the information in their drawings. As Griggs et al. pointed out, these results are quite consistent with a De Soto's statement (De Soto, 1961; De Soto & Albrecht, 1968) that subjects have a predilection to form definite orders even when it is not valid to do so. This predilection of many adults to erase indeterminacies present in a description is precisely what was observed in this study.

Before discussing a possible discrepancy between our data and those of Mani and Johnson-Laird, we present the results of a second experiment. In that experiment the drawing task was replaced by a recognition task. After the reading period, the subjects had to judge whether or not presented diagrams corresponded to the description they had read.

EXPERIMENT 2

Method

Thirty undergraduates participated. The description consisted of the seven following sentences:

1. The cupboard is behind the sofa, 2. The bed is to the right of the cupboard, 3. The chest is to the right of the bed, 4. The armchair is to the right of the cupboard, 5. The bookshelf is in front of the sofa,

6. The chair is in front of the bookshelf, 7. The table is in front of the chair. The shape of the described layout(s) was a right angle. The sentences could describe the three following horizontal part of the angle:

- | | | | |
|-------------|----------|----------|----------|
| 1. cupboard | armchair | bed | chest |
| 2. cupboard | bed | armchair | chest |
| 3. cupboard | bed | chest | armchair |

The seven sentences were presented together on a monitor screen. The subjects were tested individually and were told the nature of their task which was to decide whether or not diagrams were consistent with the description they read. They were allowed to study a description for as long as they liked. They were instructed to tell the experimenter when they were ready for the recognition test. The three previously described diagrams and three erroneous diagrams were presented one at a time on a monitor screen. Two of the erroneous diagrams contained an error on the horizontal axis (chest to the left of the bed). The last one contained an error on the vertical axis (table between the bookshelf and the chair). These six diagrams were presented in a random order. The subjects' response was to say aloud their judgments.

Results and discussion

Two major results appear. First, the subjects rarely answered "yes" when confronted with a non-consistent diagram. Only five errors were observed. Second, 13 subjects answered "yes" for one diagram only. They did not recognize the two other layouts which were consistent with the description. All these subjects but one chose a diagram in which the armchair was placed between the cupboard and the chest, that is directly to the right of the cupboard.

These data are rather consistent with those of the first experiment. They also suggest a predilection of many subjects to disambiguate the indeterminate relation. The way these subjects (except one) apparently erased the indeterminacy is the same as the one used by the subjects involved in the first experiment: they took the relation "right of (x,y)" as if it was "directly to the right of (x,y)".

GENERAL DISCUSSION

In the first experiment about 53% of the subjects failed to draw several layouts after the reading of an indeterminate spatial description. Nevertheless, the subjects were sensitive to the indeterminacy present in the description: they took more time to read this indeterminate relation than control subjects took to read an analogous determinate relation. Despite this detection, these subjects finally judged the description clear and drew only one diagram. In the second experiment, about 43% of the subjects judged that only one diagram could correspond to the description they had read. They failed to recognize the two other layouts consistent with the description. From the data of both experiments, it is clear that there is an highly preferred way to erase the indeterminacy. All the subjects who drew only one diagram and all but one of the subjects who recognized only one diagram apparently used the indeterminate relation (in this context) "right of (x,y)" as "directly to the right of (x,y)".

Our results reveal nothing about how these subjects came to disambiguate the description in such a way. Perhaps these subjects did not consider the possibility of being deliberately misled by the experimenter. Perhaps they found a way to disambiguate the relation expressed in the fourth sentence, i.e., in considering that sentence 4 had been used to insert something between already mentioned elements. This strategy was spontaneously described by five subjects involved in the first experiment. Such a reaction can be seen as an example of adhesion to a cooperative principle (Grice, 1975). Such an adhesion has precisely been viewed by Johnson-Laird (1983, p. 164-165) as a reason for which people sometimes do not abandon the construction of a single mental model when confronted with a potential indeterminacy. At this stage, further experiments are needed to test such a hypothesis.

The results of the experiments presented in the present paper do not fit with the idea that adults generally cope with what Mani and Johnson-Laird (1982) call grossly indeterminate descriptions, by abandoning the construction of a single mental model.

Many subjects have apparently constructed a single model of the indeterminate description. In fact, grossly two types of subjects were observed: Those who constructed a representation of only one of the possible layouts and those who encoded the multireference. Mani and Johnson-Laird did not point out such an interindividual variability. Then the question is: Is there a discrepancy between our results and those of Mani and Johnson-Laird? A closer examination of their results

suggests there is probably no discrepancy. Mani and Johnson-Laird concluded that when subjects detect an indeterminacy, they abandon the construction of a single model, on the basis of two indexes: The first index was that subjects were more able to rank the original description prior to a consistent paraphrase when the description was determinate than when it was indeterminate. However, this observed difference was not significant (see Mani and Johnson-Laird, 1982, p. 183). The second index was that subjects could more easily rank the original description prior to a consistent description presenting inferrable relations (i.e., relations between elements which had not been explicitly related in the original description) when the description was indeterminate. This time, the statistical analysis (Wilcoxon test) revealed a significant difference. But the N of the Wilcoxon test was 13 although the data of 20 subjects were analyzed.

As one knows, according to the Wilcoxon procedure the subjects whose scores are identical for both conditions are dropped from the initial N (Siegel, 1956). Then, since the authors do not signal the elimination of subjects before the statistical analysis, it can be deduced that seven subjects (i.e., 35 percent of the initial sample) obtained the same recognition scores for the determinate descriptions and for the indeterminate ones. Secondly, the observed Wilcoxon T was equal to 9. Since theoretically the minimal value of T is 0, this means that the scores were not better for the indeterminate descriptions in all the subjects.

Then, it is not at all clear that the representation of the discourse was different in the case of definite descriptions than in the case of indefinite descriptions for many subjects, probably at least 40 percent, of the Mani and Johnson-Laird's sample.

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