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The Production of Route Directions: Investigating Conditions That Favour Conciseness in Spatial Discourse

MARIE-PAULE DANIEL* and MICHEL DENIS

Groupe Cognition Humaine, LIMSI-CNRS, Université de Paris-Sud, Orsay, France

SUMMARY

The study reported here investigated the effects of conditions expected to favour conciseness in the production of route directions. In Experiment 1, two groups of undergraduates were invited to give written descriptions of the route connecting two well-known places on their university campus. The control group received standard instructions, and the other group was instructed to produce route directions that were as concise as possible, while remaining sufficiently informative to guide a pedestrian to the goal. Not surprisingly, instructions to be concise resulted in an overall shortening of descriptions, but this occurred in a selective manner. In particular, actions and action-landmark combinations were the least affected, whereas the number of landmarks mentioned without being associated with actions, as well as of details describing landmarks, was considerably reduced. Furthermore, landmarks situated at points on the route involving a decision about changing direction underwent less reduction than other landmarks. In Experiment 2, conditions were created where conciseness was brought into play without any explicit instructions to be concise. Undergraduates were asked to work in groups of three, and each group was assigned the task of producing a single description. The results showed that the descriptions produced by a group were shorter than those produced by individuals. This was interpreted as reflecting that in the absence of any conciseness instructions, the feedback developed within groups during the production of route directions led to effective selection of the information content. Interestingly, the items relating actions and landmarks were almost fully preserved in the group descriptions. In Experiment 3, conciseness was shown to be further increased by combining instructions for conciseness and group production. Altogether, the three experiments revealed the primary role of propositions linking action prescriptions and landmarks at points on the route where key actions have to be taken. Copyright © 2003 John Wiley & Sons, Ltd.

INTRODUCTION

The last decade of text and discourse research has been marked by the development of considerable interest in the production and comprehension of spatial descriptions. Among the variety of forms of spatial discourse, a special concern has emerged for the description of routes in direction-giving situations. This form of spatial discourse is of great value in any effort of psychology to understand human cognition, since it relies on intimate interfacing between two cognitive systems, the system that codes spatial knowledge and

*Correspondence to: Marie-Paule Daniel, Groupe Cognition Humaine, LIMSI-CNRS, Université de Paris-Sud, BP 133, 91403 Orsay Cedex, France. E-mail: mpd@limsi.fr

the linguistic system by which that knowledge is expressed in communicative situations (cf. Bloom, Peterson, Nadel, & Garrett, 1996; Bryant, 1997; Landau & Jackendoff, 1993; Munnich, Landau, & Dosher, 2001; Tversky & Lee, 1998). Research in this domain has important implications for the development of navigational aid systems (cf. Chown, Kaplan, & Kortenkamp, 1995; Jackson, 1998; Streeter, Vitello, & Wonsiewicz, 1985).

In natural contexts, direction-giving situations typically involve two people. One person expresses a request to another person in order to obtain information on the procedure required to navigate from a starting point to a goal in an unfamiliar environment. The person who receives such a request is expected to implement a sequence of operations which it is hoped will satisfy the request. It is generally agreed that the first operation consists of the speaker *activating an internal representation* of the environment in which the displacement to be described will take place. This representation presumably contains procedural information, but also visual information reflecting the environment as seen from the perspective of a person traversing it (cf. Giraudo & Pailhous, 1994; McNamara, Halpin, & Hardy, 1992; Schneider & Taylor, 1999). The next operation consists of *planning a route* in the subspace of the representation currently activated. Defining a route means defining a sequence of segments that connect the starting to the end point, with the constraint of meeting criteria such as taking the shortest route, or the route with the smallest angular discrepancy with respect to the target at each intersection, and so on (cf. Cornell, Heth, & Alberts, 1994; Gärling, 1989; Golledge, 1995). The last operation consists of *formulating the procedure* that the person will have to execute to move along the route and eventually reach the goal. This operation results in a verbal output, which combines a set of instructions and a set of descriptions of landmarks to be encountered along the route. This three-step procedure is postulated either under this form or some close variant of it in every psychological or linguistic account of the production of route directions (cf. Couclelis, 1996; Denis, 1997; Klein, 1982; Lovelace, Hegarty, & Montello, 1999; Wunderlich & Reinelt, 1982).

The resulting discourse (or written text) is characterized by several features. An essential characteristic of this type of discourse is that it is basically *procedural* in nature. Even though it contains a number of descriptive components (streets, intersections, buildings, etc.), the production is guided by the intention of offering an addressee a set of *actions* to be done in a specific order. Thus, route directions include a strong *prescriptive dimension*, which is expressed by instructions referring to progression, direction change, following roads for a given distance, and so on. A second important feature is that as well as delivering a procedure, route directions generally provide information intended to allow an addressee to construct a *visual model* of the environment in which progression will take place in advance. To give substance to this model, the speaker or writer typically describes *scenes* that will be seen at specific points of the route. The description of these scenes includes reference to *visual landmarks*, the location of which is made explicit in order to specify where critical actions will take place. Descriptions, however, refer only to a limited subset of the numerous elements composing an environment, a feature that introduces us to the third important feature of route directions, that is, their *selective character.* This characteristic makes it possible for the speaker or writer to limit the amount of information to be processed and kept in the transient memory by the addressee or reader. Most speakers show an ability to take into account the limited processing capacities of their addressees. If speakers are insensitive to such limitations, they may produce an excessively long, redundant discourse, which is detrimental to comprehension and, subsequently, to navigation.

To summarize, delivering route directions consists essentially of *selecting salient features in the environment* which should allow the user to *create a visual model* by which he/she will be able to anticipate those points where *crucial decisions about action* will be made (such as changing direction). This view is supported by the finding that describers refer more frequently to landmarks located at decision points (intersections) than to those to be found along segments (cf. Denis, 1997; Michon & Denis, 2001).

In addition to the general features documented by most studies of route directions (e.g. Allen, 2000; Denis, 1997; Fontaine & Denis, 1999; Golding, Graesser, & Hauselt, 1996; Lovelace et al., 1999; Wright, Lickorish, Hull, & Ummelen, 1995), the most impressive characteristic of this type of discourse is the wide variety of descriptions of a given route by a sample of participants. Even in fairly homogeneous samples of respondents, objective measures, such as the length of the descriptions, the number of landmarks mentioned, or the specific subset of landmarks included in the descriptions, reveal how diverse the linguistic productions can be from several people describing exactly the same sequence of steps in an environment. Some of these measures have been related to individual characteristics, such as gender and visuo-spatial ability (cf. Denis, 1997; Galea & Kimura, 1993; McGuinness & Sparks, 1983; Miller & Santoni, 1986; Vanetti & Allen, 1988). These individual characteristics, however, do not exhaust the wide range of factors likely to account for the differences observed.

The diversity of expressions in route directions leads the scientist to look for the common structure (or 'guiding thread') which underlies the various descriptions beyond that diversity. Denis (1997; Daniel & Denis, 1998) introduced the concept of the 'skeletal description', a construct intended to reflect the essential information needed for adequate navigation. The method used to build a skeletal description is based on a simple statistical procedure which takes the propositionalized individual descriptions given by a sample of respondents as inputs, and ratings of each proposition for its informative value. Skeletal descriptions have been shown to concentrate features that are generally recognized as characteristic of 'optimal' descriptions by both experts and ordinary users of spatial descriptions. They are concise packages of information that do not contain any superfluous or redundant items, and are organized around a limited set of relevant landmarks. Such abstract descriptions are characterized by clarity of navigational instructions and unambiguous spatial descriptions of landmarks. Behavioural validation of skeletal descriptions has been obtained by testing navigational performance of participants using these descriptions in unfamiliar environments (cf. Denis, Pazzaglia, Cornoldi, & Bertolo, 1999).

It is generally agreed that conciseness is a characteristic to be promoted in discourse production. In many forms of communication, concise expression has been shown to have significant beneficial effects on the processing and memory of texts (cf. Cremmins, 1996; Endres-Niggemeyer, 1998; van Dijk & Kintsch, 1983). In general, the objective of a concise discourse or text is not only to obtain shorter, more compact material, but conciseness is also thought to affect the structure of discourse in a positive manner. In particular, generating abstracts from extended pieces of discourse is a way of making the macrostructure of that discourse clearer. In the case of spatial discourse, can conciseness be expected to be of any special virtue? From the user's point of view, an obvious advantage of concise messages is to reduce the amount of processing and memory load. A further advantage is that it helps the user to access the core information more directly, by avoiding having to process redundant or superfluous information. From the point of view of the describer (the point of view that we consider here), we expect that a context inviting a speaker or writer to be concise will enhance the amount of attention devoted to *selecting*

the information to be included in descriptions. It should also promote recourse to discourse routines that more tightly articulate landmarks and actions.

There is no published research on the effects of conciseness instructions in the specific domain of route directions and the present study was designed to investigate these effects. We investigated not only the overall effects of conciseness instructions, but also looked at their impact on the different parts of the spatial discourse. In particular, it seemed reasonable to expect that conciseness would only moderately affect the crucial units, those which are supposed to convey the most valuable information, whereas it would have its greatest effects on passages that are less crucial in terms of navigational assistance.

One should also note that any methodology exclusively based on instructions is of limited value. A helpful complementary approach consists of favouring conciseness indirectly, by placing the participants in a situation expected to increase selectivity and induce concise statements. Our reasoning was that a context favouring such pressure for selectivity and conciseness could be created by generating route instructions in groups of participants, instead of individually. Doing a common task in a social context should favour the exchange and confrontation of solutions, and therefore facilitate assessment of the relevance of selected information. Studies in social psychology have highlighted that tasks performed by small groups of cooperating people generally result in better outputs, probably due to mutual checking and immediate feedback about any proposed solution, and consequently earlier rejection of inadequate solutions (cf. Brodbeck, 2000; Hill, 1982; Laughlin, 1999; Laughlin & Ellis, 1986; Levine & Moreland, 1998; Michaelsen, Watson, & Black, 1989; Resnick, Levine, & Teastely, 1991; Watson, Michaelsen, & Sharp, 1991). We then hypothesized that inviting people to work together in small groups might create a social context likely to generate better descriptions, containing more carefully selected information, and therefore more concise descriptions.

EXPERIMENT 1

Inducing conciseness by explicit instructions

The objective of Experiment 1 was to measure the impact of conciseness instructions on the production of route directions. The protocols obtained from participants instructed to be concise were compared to those in which the participants worked under standard, unconstrained conditions. First, conciseness instructions were investigated by considering their effects on the various types of statements that compose route directions. We considered five classes of statements based on the classification proposed in previous works: prescription of an action with no reference to a landmark; prescription of an action with reference to a landmark; introduction of a landmark; description of a landmark; commentary (cf. Daniel & Denis, 1998; Denis, 1997). It seems reasonable to expect that some items will be more affected than others by conciseness instructions. In particular, we expected that the number of statements related to landmarks would be reduced substantially. Previous research has shown that about 80% of statements of route directions are to some extent concerned with landmark information. Thus, if describers are invited to spare some amount of information and exclude it from their descriptions, they are more likely to shorten those passages that are more saturated with the introduction or description of landmarks (primarily those of secondary importance).

The second question was about how participants would distribute their effort to be concise over the whole description. Two attitudes can be contrasted in this respect. One

consists of beginning the task with a moderately selective attitude, then becoming increasingly selective as the task progresses. The other consists of applying conciseness evenly to all segments of the route. The latter approach would reflect the ability of describers to engage in a sustained effort to be concise throughout the description, and not only during portions of it.

The third question concerned more specifically how participants would distribute their reference to landmarks within their descriptions. Previous research has indicated that mentions of landmarks tended to be more frequent at points on a route where reorientations are likely to occur (cf. Denis, 1997; Michon & Denis, 2001). Other studies reported the opposite finding, that is, landmarks would be more frequently cited along straight portions of a route (Lovelace et al., 1999). However, reference to landmarks is expected to be more useful at points of a route where the describer will have to make sure that any ambiguity is avoided, namely, places where a change in direction is called for. This is why we expected that more landmarks would be cited at points connecting segments, and those landmarks would survive better than others when participants were invited to provide concise descriptions.

The last aspect investigated was related to the structure of the descriptions. Skeletal descriptions are constructs abstracted from individual protocols. They consist of the essential points in route directions underlying the diversity of their expression. The data collected in Experiment 1 made it possible to construct skeletal descriptions both from the protocols produced under the control condition, and from the protocols produced in response to instructions to be concise. These two skeletal descriptions could then be compared. If the second one was based on a genuinely selective attitude, then its content could be expected to be a subset of the content of the first description.

Method

Participants

The participants were 40 undergraduates (35 male, five female) attending courses at the Technological Institute of the Orsay campus (Institut Universitaire de Technologie, commonly known as IUT) and between 18 and 21 years of age. All were very familiar with the environment traversed by the route to be described.

Materials

A route connecting the main hall of the IUT to the students' cafeteria was selected. This itinerary was very familiar to all the students of the IUT. The route could be divided into four main sections, by reference to critical sites (or intermediary nodes) where a change of direction was required. The departure point was inside the main hall of the IUT. The first segment (A), 37-m long, involved getting out of the hall and walking in a patio-like environment until going under a porch (first intermediary node). The second segment (B) extended from this archway to a parking lot (second intermediary node) and consisted of a 100-m long walkway with distinctive white paving stones. The third segment (C) was a 210-m long road, which connected the exit from the parking lot to the main entrance of the Supelec building (third intermediary node). The cafeteria was located inside this building. The fourth segment (D), 70 m in length, extended through the Supelec building from the entrance (at the top of outside steps) to the cafeteria, located in the basement. Thus, from the starting point to the target point, the route extended over a total of 417 m.

Procedure

The participants were given the following instructions:

> Suppose that you have to describe to someone, a future student at the IUT, the route from the IUT to the Supelec cafeteria. Your description should start from the main hall of the IUT and include the whole route all the way to the entrance to the restaurant. This description is intended for publication in the next IUT brochure. It should therefore be as helpful as possible, and designed to allow each new student to reach the cafeteria without making any mistakes and having to ask anyone the way.

The participants were invited to write down their descriptions. Half of them were provided with two sheets of paper and did not receive any further instructions (control condition). The other half received one sheet of paper on which five lines were drawn in a space (constrained condition). They also received the following additional instructions:

> Please pay attention to the following important constraint. There will only be five lines available in the brochure for the description. Please only mention what is really most relevant for people using the description.

The participants were randomly assigned to the two conditions.

Results and discussion

The content of each individual description was coded by the authors in a proposition-like format following the method used by Denis (1997). This procedure was considered to guarantee equivalent processing of the items produced by various participants. Propositions were designed as minimal informational units combining a predicate and one or two arguments.

The next step consisted of classifying the statements. Five classes were considered.

—Class 1: prescription of an action without any reference to a landmark. This class included propositions that expressed a prescribed action without referring to any landmark. Examples: 'Go ahead', 'Go straight ahead', 'Turn right'.
—Class 2: prescription of an action with reference to a landmark. In this class, propositions explicitly connected an action to a landmark. Examples: 'At the parking lot, turn right', 'Take the main road', 'Cross the parking lot', 'Walk up the white steps'.
—Class 3: introduction of a landmark. A new landmark is mentioned without any associated reference to an action to be executed. A spatial localization is sometimes specified. Examples: 'There is a phone cabin', 'On your right, there is a building', 'The door is to the right of the notice-board'.
—Class 4: description of a landmark. In this case, the landmark is mentioned without mentioning its localization or prescribing an action, but its characteristic features are described. Examples: 'It is a big grey building', 'The path is made of white paving stones'.
—Class 5: commentary. This class contained comments that referred to the route without providing any relevant information. Examples: 'It is not too far', 'Be careful, the path is not well paved', 'Good luck'.

Length and content of descriptions

Inspection of the protocols revealed the considerable variability of their length. In the protocols collected under the control condition, the number of propositions ranged from 17 to 65. Under the constrained condition, the number ranged from 7 to 20. The wide range

of lengths of the descriptions confirmed a feature already documented in previous studies on the generation of route directions (cf. Daniel & Denis, 1998; Denis, 1997).

An analysis of variance with conditions and proposition types as factors was conducted. There was a significant effect of conditions, $F(1, 38) = 42.95$, $p < 0.001$. Under the control condition, the average number of propositions per participant was 34.8, whereas it was 14.4 under the constrained condition. This difference shows that the instructions to be concise were effectively taken into account by the participants in the constrained condition. The standard deviations of the number of propositions were 13.5 under the control condition, and 3.6 under the constrained condition. The difference between the two values attests that the conciseness instructions not only reduced the number of statements, but also resulted in individual descriptions that were more uniform in size.

There was a significant overall effect of proposition types, $F(4, 152) = 115.30$, $p < 0.001$, reflecting that the distribution of propositions was unequal across the five classes. The interaction between conditions and proposition types was significant, $F(4, 152) = 14.56$, $p < 0.001$, indicating that the reduction in the number of propositions from the control to the constrained condition did not apply evenly to all classes of propositions. Table 1 shows the average number of propositions of each class in the protocols for each condition. The reduction of the number of propositions from the control to the constrained condition affected all classes of items, but the extent of the reduction differed, as evidenced by Tukey *post hoc* analysis. Actions were the least affected ($p < 0.05$), followed by action-landmark combinations ($p < 0.001$). The number of landmarks introduced without being associated with actions was reduced to a very large extent ($p < 0.001$). Non-essential details describing the landmarks were also extensively deleted in the constrained descriptions ($p < 0.001$). Lastly, the few commentaries that had been given by participants under the control condition virtually disappeared under the constrained condition.

Thus, the data clearly confirmed our expectations that the shortening of the descriptions after instructions to be concise would essentially affect the statements related to landmarks. Because landmarks tend to be commonly introduced in route directions, possibly beyond what is strictly necessary to assist navigation proper, they are likely candidates to be the most severely eliminated when space or time constraints have to be taken into account. Similarly, participants subject to such constraints probably perceive descriptions of landmark details as non-essential information. Thus, it is not surprising that participants

Table 1. Average number of propositions of each class and corresponding frequencies (in brackets) for individual and group protocols under unconstrained and constrained conditions (Experiments 1, 2, and 3)

	Individual protocols		Group protocols	
	Unconstrained (Expt 1)	Constrained (Expt 1)	Unconstrained (Expt 2)	Constrained (Expt 3)
Prescription of an action	5.7 (*16.4*)	3.4 (*23.6*)	3.0 (*14.2*)	1.8 (*14.9*)
Prescription of an action with reference to a landmark	14.2 (*40.8*)	7.4 (*51.4*)	13.6 (*64.5*)	8.4 (*69.4*)
Introduction of a landmark	9.6 (*27.6*)	2.6 (*18.1*)	3.3 (*15.6*)	1.7 (*14.0*)
Description of a landmark	4.4 (*12.6*)	0.8 (*5.6*)	0.5 (*2.4*)	0.1 (*0.8*)
Commentary	0.9 (*2.6*)	0.2 (*1.4*)	0.7 (*3.3*)	0.1 (*0.8*)
Total	34.8 (*100.0*)	14.4 (*100.0*)	21.1 (*100.0*)	12.1 (*100.0*)

Table 2. Average number of propositions per segment of the route and corresponding frequencies (in brackets) under each condition (Experiment 1)

Segment of route	Control condition	Constrained condition
A	7.4 (*21.3*)	3.2 (*22.2*)
B	8.3 (*23.9*)	2.9 (*20.1*)
C	9.7 (*27.9*)	4.7 (*32.6*)
D	9.4 (*27.0*)	3.6 (*25.0*)
Total	34.8 (*100.0*)	14.4 (*100.0*)

invited to be concise primarily shortened passages related to landmarks and their descriptions.

Conciseness over the four segments

Table 2 shows the average number of statements made by participants for each of the four segments of the route. The value of these data is to inform us about one aspect of the strategy elicited by the instructions to be concise. The data reflect the fact that when the participants reduced the number of statements, they did so uniformly, with the reductions evenly spread over the four parts of the route. This is an indication that participants subject to the constrained condition applied their strategy across the whole description, and not only to some portions of it. This can also be taken as an indication that participants planned their responses sufficiently in advance to avoid unbalanced descriptions of the early segments relative to the later ones.

Reference to landmarks

Because landmarks are key components of route descriptions, we conducted more detailed analysis of their citations in the protocols, in order to identify the points of the route where they may have a special functional role. The list of all the landmarks mentioned by the whole sample of participants was established, amounting to a total of 50 landmarks. Not surprisingly, there was a significant difference between the average number of landmarks mentioned by the participants under the control and constrained conditions (16.3 vs. 8.1, respectively, $F(1, 38) = 75.81$, $p < 0.001$).

The next step consisted of defining a level of frequency of citation likely to reflect that the corresponding landmarks were critical to navigational assistance. The critical frequency was set at 50%, that is, we considered as especially relevant those landmarks cited by more than half of the participants under the control condition. A total of 11 landmarks met this criterion, all of which were in fact located in the immediate vicinity of the most critical points on the route (the starting point, the three intermediary nodes, and the arrival point). This confirmed that landmarks tended to be cited more frequently at points where segments connected to one another (i.e. where reorientations were likely to occur).

A further sign of the special relevance of landmarks at connecting points was found in the fact that the number of these landmarks mentioned by the participants (hereafter, 'critical landmarks') was reduced to a lesser extent than that of other landmarks under the constrained condition. The interaction between conditions and landmark types was significant, $F(1, 38) = 10.82$, $p < 0.005$. Table 3 shows the average number of landmarks of each category cited in the protocols for each condition. The average number of critical landmarks was 8.5 under the control condition vs. 5.6 under the constrained condition.

Table 3. Average number of landmarks of each category per protocol and corresponding frequencies (in brackets) for individual and group protocols in unconstrained and constrained conditions (Experiments 1, 2, and 3)

	Individual protocols		Group protocols	
	Unconstrained (Expt 1)	Constrained (Expt 1)	Unconstrained (Expt 2)	Constrained (Expt 3)
Critical landmarks	8.5 (*52.1*)	5.6 (*69.1*)	7.8 (*61.4*)	7.1 (*78.0*)
Other landmarks	7.8 (*47.9*)	2.5 (*30.9*)	4.9 (*38.6*)	2.0 (*22.0*)
Total	16.3 (*100.0*)	8.1 (*100.0*)	12.7 (*100.0*)	9.1 (*100.0*)

Tukey *post hoc* analysis showed that this difference was significant ($p < 0.001$). However, the number of remaining landmarks mentioned, all of which were remote from the reorientation nodes, dropped dramatically from 7.8 under the control condition to 2.5 under the constrained condition. The difference was significant ($p < 0.001$). This reflects that the withdrawal of landmarks under the constrained condition was not a random process, but more selectively involved the landmarks not thought to be critical for assisting navigation.

Skeletal descriptions

In order to build skeletal descriptions, as constructs containing the essential points in the prescriptions and landmarks related to the route, the procedure developed by Denis (1997) was used. For the set of protocols under the control condition, an extended list of all the statements produced by the 20 participants was established. This constituted the 'mega-description', which included every statement made by every participant. Items given by several participants were entered only once and all items mentioned by even a single participant were also included. The resulting megadescription contained 126 propositions.

The megadescription was submitted to 20 new participants familiar with the environment described, who were asked to judge the relevance of each item for guiding a traveller along the route. All the pieces of information in the megadescription were said to be accurate, but to provide far more information than was strictly necessary to guide a traveller. Judges were invited to remove all the items that they considered superfluous in this respect and to keep only the items they considered necessary and sufficient to effectively assist a traveller. The items that were selected by at least 80% of the judges (16 out of 20) were used to form the skeletal description.

Table 4 shows the skeletal description derived under the control condition. It contains 37 items. This collection of items results in a perfectly interpretable package of information for assisting people navigating along the route. The items interconnect well with no necessity for 'smoothing' or including additional information. Among the landmarks cited were all the 11 items that had been given by more than 50% of the participants, that is, most of the crucial landmarks located at or in the vicinity of reorientation points. The skeletal description also contained a large proportion of action-landmark associations (62.2%), which was higher than the average proportion of such items in the original descriptions (40.8%). In this sense, the skeletal description appeared to be well designed to serve the functions expected from it, that is, to concentrate the essentials of a navigational procedure, without any irrelevant or redundant information.

Table 4. Skeletal description based on protocols obtained under the control condition (Experiment 1). The class to which each proposition belongs is indicated (A: action; AL: action connected to landmark; L: landmark; DL: description of landmark; C: commentary)

Segment A
1. You are in the central hall (*L*)
2. Go out of the hall by the door (*AL*)
3. Cross the courtyard (*AL*)
4. Follow an alley for 20 meters (*AL*)
5. Go as far as a junction (*AL*)
6. At the junction, turn right (*AL*)
Segment B
7. Go under a little archway (*AL*)
8. There is a walkway in front of you (*L*)
9. Take the walkway (*AL*)
10. Walk along the cafeteria building (*AL*)
11. You reach the stone-paved walkway (*L*)
12. Go along this walkway (*AL*)
13. There is another walkway (*L*)
14. It is perpendicular (*DL*)
15. Turn right (*A*)
16. You reach the Technical Institute parking lot (*L*)
17. Cross the parking lot (*AL*)
Segment C
18. Go on to the road (*AL*)
19. Outside the parking lot, turn right (*AL*)
20. Go straight ahead (*A*)
21. Go to a cross junction (*AL*)
22. Go to the entrance of Supelec Building (*AL*)
23. This is an entrance for pedestrians (*DL*)
24. Go up the stairs of the building (*AL*)
Segment D
25. Go inside the hall (*AL*)
26. There is a corridor in front of you (*L*)
27. Take the corridor (*AL*)
28. Go on to another hall (*AL*)
29. Go straight ahead (*A*)
30. Walk to the cafeteria (*AL*)
31. Turn right after the drink-vending machine (*AL*)
32. There is a bar (*L*)
33. Walk in front of the bar (*AL*)
34. Just after the bar, turn left (*AL*)
35. You can see some more stairs (*L*)
36. Go down these stairs (*AL*)
37. At the bottom, you have reached the restaurant (*L*)

The same set of operations was performed using the protocols obtained under the constrained condition. A megadescription was constructed, and then a new group of 20 judges was asked to evaluate the relevance of every item. The megadescription based on the protocols under the constrained condition contained 58 propositions. Because these operations were conducted separately for the two conditions, the detailed wording of the

items was not exactly the same in the two megadescriptions, but there was no difficulty in matching corresponding items. Items selected by 80% of the judges formed the skeletal description, which contained 22 propositions (Table 5). Again, the majority of items were action-landmark associations (54.5%).

Comparison of the skeletal descriptions produced under the two conditions revealed the very high proportion of items in the skeletal description under the constrained condition that were also contained in the skeletal description under the control condition. In fact, the skeletal description based on the constrained condition consisted almost entirely of part of the skeletal description obtained under the control condition. Of the 22 items in this description, 21 were included in the description obtained under the control condition, and only one was unique to the constrained condition (Item 13). The skeletal description obtained under the constrained condition can therefore be considered to be a subset of the other, representing the core structure of directions for the route under consideration. It concentrates on prescriptions tightly articulated to critical landmarks, a feature generally considered of primordial functional value in route directions. A detailed examination of the two skeletal descriptions shows that the shorter one still contains all the essential information (in particular, all items prescribing changes in direction). Both skeletal descriptions contain the critical landmarks cited by more than half of the participants

Table 5. Skeletal description based on protocols obtained under the constrained condition (Experiment 1). The class to which each proposition belongs is indicated (A: action; AL: action connected to landmark; L: landmark; DL: description of landmark; C: commentary)

Segment A
1. You are in the central hall (*L*)
2. Walk out in the courtyard (*AL*)
3. At the first junction, turn right (*AL*)
Segment B
4. Go under a little archway (*AL*)
5. Walk along the cafeteria building (*AL*)
6. Take the pedestrian walkway (*AL*)
7. Go to the end of this walkway (*AL*)
8. Turn right (*A*)
9. You come to a small parking lot (*L*)
Segment C
10. Get to the road (*AL*)
11. Turn right (*A*)
12. Go straight on for 150 meters (*A*)
13. There is a rugby ground on the right (*L*)
14. Cross the road (*AL*)
15. The name Supelec is inscribed on the left (*DL*)
16. There is a gate (*L*)
17. Go up the first staircase on the right (*AL*)
Segment D
18. Go inside the hall (*AL*)
19. It is straight ahead (*DL*)
20. Walk round the bar (*AL*)
21. Go down the stairs (*AL*)
22. The restaurant is down there (*L*)

under the control condition. Thus, the saturation of skeletal descriptions by essential landmarks is not diminished by conciseness instructions.

EXPERIMENT 2

The production of route directions as a group task

Experiment 1 has shown that under conditions designed to favour conciseness, people do create more concise outputs than in a control condition. It was also shown that conciseness operates selectively on the different components of the messages. In particular, a large proportion of secondary landmarks were deliberately excluded from the descriptions, while the most critical landmarks were preserved. The effort to be concise also appeared to be spread over the whole route. Still more importantly, the skeletal description was affected by conciseness instructions, but its remaining content was found to reflect the essential core of the skeletal description obtained in standard (unconstrained) conditions.

The issue investigated in Experiment 2 was whether conditions could be created where conciseness is brought into play with measurable effects, without the experimenter imposing it by the way of explicit instructions. The generation of texts in a social context offers conditions under which we expected to see a favourable effect on the quality of productions, mainly their conciseness. Participants in this experiment were asked to work in groups of three people, and each group was assigned the task of producing a single description based on interactive cooperation. We thought that, compared with an individual condition, the feedback developed within groups would lead to more stringent selection of the units included in the final description. Thus, we expected to find an effect of the same type as in the previous experiment, possibly with more preservation of the most significant items. This expectation was based on the hypothesis that the social context generally creates conditions where the monitoring of crucial pieces of information is more efficiently achieved than when people are working alone (cf. Brodbeck, 2000; Hill, 1982; Watson et al., 1991).

The essential new feature of Experiment 2 was that the selective process was expected to be operating in the absence of any explicit requirement on the part of the experimenter. As in Experiment 1, the impact of conciseness was investigated on the frequency of the various components of the descriptions.

Method

Participants

Forty-five IUT undergraduates, between 18 and 21 years of age, took part in this experiment. None had participated in the previous one. As before, all of them knew the route to be described very well.

Materials

The same route was used as in the previous experiment.

Procedure

The participants, who were students attending the same classes, were first invited to form groups of three based on their prior acquaintance with each other. They were then given the same instructions as under the control condition of Experiment 1 (which had been

applied to individual participants). They discussed the itinerary together without any time constraint. The times actually devoted to discussions ranged from 5 to 10 minutes. At the end of the discussion, when participants felt that they had agreed about the description of the route, one of them wrote it down, and the other two looked at the text being produced. If needed, they corrected the information. Thus, one description was generated per group.

Results and discussion

We collected 15 descriptions. Each of them was analysed according to the same procedure as in the previous experiment. The analyses presented below are based on the data from the control condition of Experiment 1, hereafter called the 'individual condition', and those obtained under the condition examined in the present experiment, hereafter called the 'group condition'.

Length and content of descriptions

As expected, the social context affected the production of route directions, by reducing the total number of propositions. While the average number of propositions per protocol was 34.8 under the individual condition, this number dropped to 21.1 under the group condition. The analysis of variance attested that this difference was significant, $F(1, 33) = 13.40$, $p < 0.001$. The data are consistent with the hypothesis that the feedback within the groups led to more stringent selection, as compared with an individual condition. Furthermore, the standard deviation of the number of propositions was 13.5 under the individual condition vs. 5.6 under the group condition, showing that, as had been the case with explicit instructions, performing the task as a group resulted in greater homogeneity in terms of description length. The results also showed that the reduction in the number of propositions from the individual to the group condition was variable. Table 1 shows the average number of each class of items in the protocols for each condition.

There was a significant overall effect of proposition types, $F(4, 132) = 122.44$, $p < 0.001$, as well as a significant interaction between conditions and proposition types, $F(4, 132) = 7.26$, $p < 0.001$. This interaction reflected that when the participants reduced the number of statements, they paid attention to the kind of information that had to be retained in the descriptions. While the number of instructions which prescribed actions without or with reference to landmarks was virtually unaffected by the group context ($p < 0.10$, in the case of action prescriptions), the number of landmarks and landmark descriptions markedly decreased in the group condition ($p < 0.001$ and $p < 0.005$, respectively). The participants in the group condition seemed to consider landmark information as essential for the effectiveness of the route directions. Specifically, action-landmark items corresponded to 64.5% of the total number of propositions (13.6 out of 21.1), whereas under the individual condition, it only corresponded to 40.8% (14.2 out of 34.8). The high frequency of this class of propositions confirms the proportion observed in the skeletal description, where the actions prescribed with reference to landmarks accounted for 62.2% of the whole (23 out of 37 propositions).

Reference to landmarks

Table 3 shows the average number of landmarks cited in each condition. There was a significant difference between the number of landmarks cited by the participants under individual and group conditions (16.3 vs. 12.7, respectively, $F(1, 33) = 9.11$, $p < 0.005$). The differences in the frequency of citation of landmarks supported the assumption that in

the absence of any explicit conciseness instructions, the social context would lead to effective selection of information to include in route directions. In spite of the overall reduction in the total number of landmarks in the group context, the special relevance of the 11 critical landmarks was clearly identified by the participants. The frequency of citation of these landmarks did not decrease significantly (8.5 vs. 7.8, respectively), while a significant decrease was found for the other landmarks (7.8 vs. 4.9, respectively, $p < 0.001$).

Taken together, the results of Experiments 1 and 2 indicate that both conciseness constraints and working in a group produce decreasing effects on the length of route descriptions. But the group condition displayed several specific features as regards the content of the descriptions. First, the amount of preserved information was larger in the group condition than in the individual condition with conciseness instructions. While generating significantly shorter descriptions, the participants of the group condition nevertheless tended to produce more extended descriptions than did individual participants invited to be concise. Secondly, compared to the individual condition with standard instructions, the two conditions expected to induce concise descriptions resulted in similar decrease for all the types of propositions, except for those relating actions and landmarks. Within a general context of reduction of information, the participants involved in groups treated the action-landmark items in a very privileged way. This special treatment of items combining instructional and descriptive information can be accounted for by the fact that the group context favoured more critical monitoring and selection of information, with more efficient preservation of those items of primary value to assist navigation.

EXPERIMENT 3

Combining instructions for conciseness and group production

Experiment 1 showed that explicit instructions to be concise did result in more concise outputs from individual participants. Experiment 2 showed that in the absence of such instructions, working in a group also helped to produce shorter descriptions than working individually. Not surprisingly, the effects were more marked in Experiment 1, where the variable was the subject of explicit instructions. As a further step, we tested the extent to which conciseness could be further increased by combining instructions for conciseness and the requirement for participants to work in a group context.

The status of the action-landmark items was of special interest here. While these items were largely eliminated after explicit conciseness instructions in Experiment 1, they survived in the group condition of Experiment 2 (in the absence of such instructions). Delivering conciseness instructions in Experiment 3 should result in a decrease of these items, although they should remain the most frequent type of propositions in the descriptions. In a mostly constrained context combining two factors intended to shorten the descriptions, the primary value of action-landmark items should thus be confirmed, and the functional role of critical landmarks should be further evidenced.

Method

Participants

Forty-two IUT undergraduate students took part in this experiment. They knew each other very well, and all of them were very familiar with the route to be described.

Materials
The same route was used as in Experiments 1 and 2.

Procedure
First, as in Experiment 2, the participants were asked to form groups of three. They were given the same instructions as the constrained condition participants in Experiment 1, and were invited to write down their descriptions. They were provided with a sheet of paper on which five lines were drawn in a space and which contained printed instructions to produce concise descriptions. One description per group was produced.

Results and discussion

A total of 14 descriptions were collected. They were analysed and compared to those collected in Experiment 1 from individual participants given the conciseness instructions (the constrained condition of Experiment 1).

Length and content of descriptions
When exposed to conciseness instructions, participants working in a group tended to produce shorter descriptions than when they worked individually. The average number of propositions decreased from 14.4 to 12.1, an effect that fell just below significance, $F(1, 32) = 3.63$, $p < 0.07$. Standard deviations were 3.6 and 2.7, respectively. The constraint of conciseness and the group context thus combined their effects to produce very concise route directions. Table 1 shows the average number of each type of proposition under both conditions. There was a significant overall effect of proposition types, $F(4, 128) = 180.27$, $p < 0.001$, as well as a significant interaction between conditions and proposition types, $F(4, 128) = 4.59$, $p < 0.002$. While the number of action prescriptions decreased by a substantial amount ($p < 0.02$), there was no such effect for the other types of propositions. Interestingly, the number of action-landmark propositions did not decrease, but even slightly increased, although nonsignificantly. This finding reflects that the conciseness constraint highlighted the primary role of the propositions that have the greatest capacity to integrate navigational instructions in a compact informational package.

Table 1 summarizes the frequency of each class of propositions under the four situations investigated in these experiments. If we consider the frequency of each class of propositions, in all cases action-landmark propositions were the most frequent, and this frequency increased progressively from the condition where individual participants produced directions without any conciseness constraint (40.8%) to that where groups of participants worked with conciseness instructions (69.4%).

Reference to landmarks
Table 3 shows the average number of critical and other landmarks cited in protocols under each condition examined in these experiments. Compared to individual participants exposed to conciseness instructions, the participants working in groups under the same instructions mentioned slightly more landmarks (8.1 vs. 9.1, respectively, but this effect was not significant). Interestingly, the number of critical landmarks significantly *increased* between the two conditions (5.6 vs. 7.1, $p < 0.05$), whereas non-critical landmarks were not differently recalled (2.5 vs. 2.0). The data from Experiment 3 show that under the greatest pressure for conciseness (working in groups with explicit instructions to be

concise), the participants produced the largest proportion of critical landmarks and, correlatively, made the greatest effort to eliminate non-essential landmarks.

Table 3 summarizes the frequencies of landmarks of each category cited in the four situations investigated. The proportion of critical landmarks to the total number of landmarks cited increased from 52.1% to 61.4 % from the individual to the group condition in the absence of conciseness instructions. When instructions were given to the participants, the proportion still increased from 69.1% to 78.0%. Thus, the group context increased the selection of landmarks according to their crucial location and prevented the reducing effect of the conciseness constraint. Whether constrained or not, the participants mentioned quite similar numbers of critical landmarks (7.1 and 7.8, respectively), whereas the total number of landmarks decreased. This stability in the number of critical landmarks was not found when participants were tested individually. In this case, the conciseness constraint led the participants to decrease significantly the citation of all landmarks, wherever they were located.

GENERAL DISCUSSION

The purpose of the research reported here was to test the effects of conditions expected to encourage conciseness in the production of route directions. This research takes place in the context of the continuing interest of psychology for the cognitive mechanisms responsible for the generation of spatial discourse. Before summarizing the results and discussing their relevance to the issue of language as a navigational aid, we underline the findings of the present research that confirm those previously collected in experiments on the production of route directions (e.g. Allen, 2000; Daniel & Denis, 1998; Denis, 1997; Lovelace et al., 1999; Tversky & Lee, 1998).

The first aspect to consider here is the wide variability of verbal outputs generated by people when they describe routes. Such variability justifies our attempts to catch the 'guiding thread' that underlies the various individual descriptions of a route beyond their diversity. The value of such an effort is obvious not only from a theoretical point of view, by helping to abstract the essential points from a very complex type of message, but also when considering the applicability of the findings to the ergonomics of spatial instructions. The value of the concept of the 'skeletal description' advocated in previous research (cf. Daniel & Denis, 1998; Denis et al., 1999) was confirmed here. We feel encouraged to consider the descriptions produced by a sample of individual respondents as variants on a core structure, the skeletal description, which captures the essential points of a navigational procedure.

Another feature of the present study that confirms previous research is the composite nature of route directions. In such materials, the procedural component is essential, as expressed by instructions to proceed, turn left, turn right, and so on, but the descriptive statements embedded in these instructions are also of crucial importance. Not only are landmarks numerically abundant in all individual descriptions, but they also seem to be assigned quite a major role by the describers. They are used as elements intended to help listeners or readers to build visual representations in advance of the environments to be traversed. More specifically, they are mentioned more frequently at the critical nodes of the route where significant actions (in particular, changes of direction) have to be executed. They also tend to be integrated with a reference to an action, thus contributing

to specifying the locations where significant actions must take place, in the form of compact action-landmark packets of information.

The present experiments consisted of manipulating variables that were likely to favour a concise discourse, either directly (through explicit instructions) or indirectly (by having people generate descriptions in small interactive groups). It was expected that such conditions would produce more concise descriptions. Interestingly, although not surprisingly, this was actually the case. This output is interesting for its applicability to real situations, suggesting that greater conciseness is a feature that increases the comprehensibility and memorability of the message, and therefore its helpfulness during navigation. Moreover, some qualitative effects of conciseness on the frequency of mentioning specific components of route directions were detected.

The first of these effects is that conciseness instructions reduced the amount of information present in the individual protocols, but the selective process also resulted in the fact that the skeletal description stemming from the protocols produced under conciseness instructions was itself shorter than the control skeletal description. Moreover, this shortening occurred in a non-random fashion, since the resulting skeletal description was practically a subset of the control description. This suggests that skeletal descriptions collected in standard conditions (as in Denis, 1997) are amenable to substantially greater reduction when respondents are invited to be more concise, without any critical loss of their informative value (unless an unreasonable degree of conciseness is imposed).

Under constrained conditions, the selection of salient features of the environment that normally applies under standard conditions is implemented to an even greater extent. This process mainly concerns references to visual landmarks, and the selectivity that applies to them is still more marked. Only the landmarks in the vicinity of the reorientation nodes are retained in the descriptions, whereas secondary landmarks (not essential to reorientations) are deleted. This confirms the special role of landmarks at the approach to critical nodes (cf. Michon & Denis, 2001). On the other hand, reference to actions is not affected by conciseness instructions to the same extent as that to landmarks. Lastly, while group production induces more concise descriptions, propositions tightly connecting specific actions to specific landmarks are not reduced at all. These items become even more prominent when conciseness instructions are associated with a group production context, where they correspond to about two thirds of all propositional statements.

Converging findings were obtained in all three experiments reported here. In Experiment 1, conciseness effects were obtained by simply asking participants to be more concise. In Experiment 2, inviting people to work in groups resulted in similar conciseness effects, although presumably the underlying mechanisms were somewhat different (here, the fact that feedback developed in group work resulted in stringent selection of items). In Experiment 3, combining both these aspects resulted in still more concise productions. The participants considerably reduced the number of landmarks not associated with actions. They also reduced the frequency of mentioning non-essential details describing the landmarks, as well as commentaries. The priority given to action-landmark combinations was an appropriate way to provide integrated instructions in the form of compact informational packets.

Generating descriptions in groups was favourable to the resulting protocols. Social context was found to encourage conciseness without any explicit instructions to that effect. Plausibly, group discussion of the details of route directions provides people with a more concrete idea of the possible reactions of their addressees. By offering opportunities to anticipate these reactions, they can immediately repair any infelicities pointed out by other

members of the group. Note also that another effect of the group condition is to reduce inter-protocol variability substantially.

Conciseness can be considered to be a characteristic to be promoted in many communication situations, such as those investigated in cognitive ergonomics. This is true, in particular, when people (or intelligent systems) have to provide others with information to assist their navigation in an unfamiliar environment. Because the size of such verbal messages must remain compatible with the memory capacities of the addressee, it is important that describers (or systems) avoid forcing their addressees to process redundant or superfluous information. In our experiments, we placed describers under highly constrained conditions, but the application of these findings extends beyond these special conditions, and provides information about some basic features of spatial discourse.

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