ABSTRACT

The increasing interest and research effort devoted to dementia and to other disorders of the latter part of life are a reflection of the longevity of the population in developed countries. Dementia is an acquired syndrome of intellectual impairment produced by brain dysfunction. This paper presents a study exploring wayfinding abilities in dementia of the Alzheimer type (DAT) and suggests possible design interventions. Fourteen patients and a control group of 28 subjects, matched in terms of age, sex and education, were asked to reach a prescribed destination in a large hospital. Subjects had to verbalize all behaviors they engaged in as well as all the information underlying their actions. The verbalizations were recorded and then content analyzed. Results showed most DAT patients to be incapable of developing an overall plan to solve the wayfinding task and incapable of producing decisions involving memory or inferences. Conversely, they were better able to make decisions based on information of explicit architectural nature. Exploratory behavior was more prevalent in DAT patients compared to normal subjects. Patients performed poorly when forced to extract relevant information from graphic displays and tended to be confused by irrelevant information displays. The paper concludes with a discussion of design criteria concerning the spatial organization of settings and the circulation system as well as environmental communication.

INTRODUCTION

The idea to suggest design guidelines for dementia of the Alzheimer type (DAT) might strike many as irrelevant. DAT is a degenerative condition and in the medium and later stages of the disease the affected person will not be autonomous or mobile whatever the environmental support. Design for dementia becomes important if one considers the amplitude of the condition at a regional and national scale. Indeed, it is estimated that between 5-10% of people above the age of 65 are affected and that the incidence of DAT increases by 1% a year thereafter (Mortimer, 1983). Dementia accounts for more admissions and hospital in-patient days than does any other psychiatric condition in the geriatric-age group (Christie, 1982). The United States, for example, spends an estimated 6 billion dollars in nursing home costs for patients with DAT. Appropriately designed residences could delay admission of patients to nursing homes, and appropriately designed nursing homes could render them more cost efficient.

It is a curse of our times having to justify all endeavors in economic terms and, we think, an even stronger argument should be made in respect to the quality of life of the person afflicted by this disease. Kevin Lynch in his classic, The Image of the City (1960), noticed that spatial disorientation not only evokes feelings of insecurity but that a person's whole sense of well-being is deeply attached to his or her sense of space and time. Lynch observes that in our culture, the term "to be lost" also has an existential

meaning and is associated with identity and autonomy. If a setting, be it the patient's home, a nursing home, or even a hospital catering to the elderly, can facilitate spatial orientation and wayfinding, it will contribute to a patient's quality of life. To be able to operate adequately in any field is surely one of the most profound gratifications. In this sense, settings which support wayfinding also have therapeutic qualities.

Some general design criteria for wayfinding in DAT patients might be proposed by adapting knowledge on wayfinding behavior of the general population and the elderly. This approach, though, might easily miss the specific requirements of the target population and might ultimately prove ineffective. Designing for populations with particular behavior and abilities requires an understanding of these characteristics. It has therefore been the aim of this study to identify residual wayfinding abilities and also to identify operations which no longer can be mastered by patients during the early and medium stages of the disease.

DEMENTIA OF THE ALZHEIMER TYPE

DAT is a disorder of the central nervous system occurring in middle or late life. It refers to a progressive and irreversible weakening of all cognitive abilities. As the disease progresses, the cognitive abilities decline to the point of no longer controlling the vital bodily functions. The survival rate can vary considerably. According to Lishmann (1987), it can span from 4 to 25 years, although the average life expectancy is only about 5 to 7 years.

The earliest noticeable sign of intellectual deficit in most, though not all, patients is the impairment of memory. Memories from the past may typically overlay the experiences of the present. DAT at an early stage can also affect language by word-finding difficulties and gradual attrition of complex language capabilities. Language ability deteriorates both in terms of lexicon (Bayles, 1982; Emery, 1985; Ripich and Terrel, 1988) and sentence structure (Blanken, et al., 1987). Speech remains fluent at first, but circumlocutions and paraphasias appear. Other aspects of the cognitive activities are also affected, such as attention (Parasuraman and Haxby, 1993), judgment, and abstract thinking (Cambier, et al., 1982; Cronin-Golomb, 1990; Cummings and Benson, 1992). Changes in social behavior and in expressed emotions are frequently reported.

SPATIAL DISORIENTATION IN DEMENTIA

Spatial disorientation is among the very first signs to appear in DAT, and also one often noted during the progression of the disease (Alexander and Geschwind, 1984; Liu, et al., 1991; Richard, et al., 1979; Semple, et al., 1982). According to the global deterioration scale of Reisberg (Reisberg, 1985; Reisberg, et al., 1982, 1986), orientation difficulties in the earliest stages of the disease (stage 3) affect journeys in unfamiliar environments and at the macro-scale. At stage 4, mobility starts to be impaired and patients experience difficulties at a more local scale, but they are still able to move in familiar places. During stage 5, patients need help in their daily activities and autonomous mobility is further reduced. At stage 6, deterioration of most intellectual activities is severe and patients can only move in very familiar home settings.

Except for a few recent works on disorientation in DAT (e.g., Liu, et al., 1990), relatively few systematic studies have been undertaken in order to understand the underlying determinants. Often, disorientation is interpreted exclusively as a memory problem or as a spatial representation and cognitive mapping problem. Within the second

framework, specific orientation difficulties have been shown in terms of pointing directions and keeping a sense of direction (Richard, et al., 1979, 1981). Within the Piaget's school of thinking, studies of DATA have shown a deterioration of topological, projective and Euclidean spatial representations (Boehme, 1973; Mietkiewics, 1981; Rainville, 1992; Richard, et al., 1981).

SPATIAL ORIENTATION AND WAYFINDING

Spatial orientation and wayfinding abilities are complementary notions, but they also underline an evolution in the study of purposeful mobility and spatial behavior. A short historical sketch will help to clarify the meaning and the relation between the two notions. The first writings on spatial orientation are case-study descriptions of spatial problems in patients with brain lesions (see Holmes, 1918; Jackson, 1874). Already these early studies pointed to the complex character of spatial orientation and purposeful mobility, that is, the ability to reach desired destinations.

Referring to normal subjects, it is probably Trowbridge, in 1913, who first associated spatial orientation with an imaginary or cognitive map. Tolman (1948), in a classical animal study, explored the notion of cognitive maps empirically and created the base for a new cognitive field of research on spatial representation that became prevalent in the sixties. Lynch (1960), with another milestone in the evolution of the study on spatial orientation, was one of the first to engage in research on cognitive maps in people. Coming from a planning background, he was interested in identifying the physical units people relied upon when mapping the urban environment. He argued that these units had to be emphasized in urban design in order to facilitate spatial orientation. The underlying conceptualization of spatial orientation was the ability of a person to have an adequate cognitive map of the surrounding environment and to be able to situate him or herself within this representation. Two decades of research on the nature of the cognitive map, its typology and the factors affecting it followed the pioneering work by Lynch (see, for example, Appleyard, 1970; Golledge, 1976; Orleans, 1973; Beck and Wood, 1976; Canter, 1975; Weisman, 1981).

Towards the end of the seventies, the study of cognitive maps was questioned on conceptual and methodological grounds (Moore, 1979; Evans, 1980) and the interest shifted from the study of the product (the cognitive map) to the study of the process (cognitive mapping). Downs and Stea (1973) probably most clearly expressed the need to investigate the cognitive process in spatial orientation.

From this conceptual basis emerged a new perspective which, no longer limited to cognitive maps, encompassed all the perceptuo-cognitive operations necessary to purposeful mobility (Kaplan, 1976; Downs and Stea, 1973; Passini, 1977). The term "wayfinding," conceptualized as spatial problem solving, imposed itself as a complementary notion to spatial orientation (Passini, 1984a, 1984b). Wayfinding refers to the problem-solving abilities necessary in reaching destinations. Cognitive maps, in this conceptualization, are seen as one of the sources of information used in the underlying decision making process. Alzheimer patients who can no longer map spaces should still be able to find their way if the setting is designed accordingly (Richard, et al., 1979).

DESIGN FOR DEMENTIA

Disorientation has been documented as being a major factor of social isolation

and dependency leading to increased surveillance and confinement. Most authors agree that a certain level of external stimulation is essential for a patient to remain as functional as possible and not to regress faster than the inevitable evolution of DAT (Jacquemin, et al., 1991). Wayfinding design, taking into account the cognitive abilities of the Alzheimer patient, is a means of diminishing the extraneous weight on cognitive functioning while still providing an acceptable level of stimulation to active patients. Some authors have also suggested design interventions for daily social and environmental enrichment. Cohen and Weisman (1981), for example, propose using familiar objects which had a particular significance in a person's life.

Most specific references to design for dementia emerge from the concept of spatial orientation and are rooted in the work done by Lynch. Suggestions have been made to emphasize landmarks to facilitate circulation and also to use landmarks or color to identify and distinguish destinations (Jacquemin, et al., 1991).

Simple architectural layouts have been proposed by Cohen and Weisman (1988), who also suggest circulation systems for nursing homes to compose with the typical phenomena of aimless wandering (see also Schultz, 1987; McGrowder-Lin and Bhatt, 1988). Wandering is one of the most common errant behaviors in advanced DAT (Aniskiewicz, 1987). It is seen as a source of danger by caretakers. Among the different options to deal with this problem: a) medication, b) restraint, and c) environmental modification; it is the latter that has the fewest adverse consequences and should be exercised whenever possible.

Only limited information is available to guide the planning and design of environments for dementia. We need to know much more about the way DAT patients find their way. We have to understand their abilities to analyze (and understand) relevant wayfinding information, to make wayfinding decisions, to plan their trips, and to retain and cognitively map routes and layouts. Insight into wayfinding needs of DAT patients have to be based on an understanding of their remaining cognitive abilities. A short description of wayfinding will precede the presentation of our study.

WAYFINDING CONCEPTUALIZED IN TERMS OF SPATIAL PROBLEM SOLVING

Wayfinding is the ability to reach desired destinations in the natural and built environment. Defined in terms of spatial problem solving, wayfinding is composed of three interrelated processes: 1) decision-making and the development of a plan of action, 2) decision executing transforming the plan into action and behaviors at the right place and time, and 3) information gathering and treatment which sustains the two decision-related processes (Downs and Stea, 1977; Passini, 1977, 1984a).

Wayfinding decisions are of two orders: (1) decisions leading directly to a behavioral action such as getting up, passing through a door opening, going up the stairs, and (2) higher order decisions like going to a dental clinic, finding the address of the clinic, reaching a given wing of a hospital; these do not lead directly to behavioral actions but require further decisions in order to be executed.

If all the decisions involved in solving a wayfinding problem are linked together according to an "in order" relation (in order to do "a" I have to do "b"), a hierarchical decision plan emerges. The "in order" relationship describes how decisions are linked together; it describes the rational of a wayfinding solution.

In order "to go to the dental clinic," one may decide "to go to the hospital," "to find out the address," "to go to the indicated floor," and "to find the indicated door

number" (if the information is available). Each of these decisions requires further decisions in order to be executed. In order "to go to the hospital" I may have "to follow a path," "to go up the stairs," and "to pass through the entrance doors."

The decision diagram, once completed, presents all wayfinding decisions in a structured form. Indicated at the extreme left of the diagram (Figure 1) is the task decision whereas at the extreme right are shown the decisions leading directly to behavioral actions. In between are to be found the higher order decisions.

Higher order decisions which are directly linked to the task decision describe the overall plan of solving the wayfinding problem. In Figure 1, the decisions "to go to the hospital," "to find the address," "to go to the indicated floor," "to find the indicated door number," describe the overall plan for solving the wayfinding problem "to go to the dental clinic" (for further details on problem-solving in wayfinding see, Passini, 1984). Similar decision structures in goal-directed events have been proposed by Lichtenstein and Brewer (1980).

The average wayfinder does not develop a full and detailed decision plan before starting off on a trip. This makes good sense as not all of the information is usually available at the planning stage.

A decision plan corresponds to the cognitive solution of a wayfinding problem. In order to reach a destination, the plan has to be executed; decisions have to be transformed into behavior which lead to a destination. Miller, Gallanter and Pribram (1960) have proposed a decision execution model (TOTE: Test-Operate-Test-Exit), which can easily be adapted to wayfinding. All decisions, such as "turning right at the intersection," "going up the stairs," and "looking for information" contain a behavioral component ("turning right," "going up," "looking for") and an environmental component ("the intersection," "the stairs," "information"). The model proposes a matching between the expected image as contained in the decision and the perceived image. If the two concur, the behavior is executed; if they do not concur, the person is faced with a problem for which a new plan has to be worked out. The matching process does not require full recall of the image associated with a decision; recognition when faced with the actual stimuli is sufficient.

A familiar route implies essentially decision execution. The necessary decision plan and/or the representation of the path have been developed and recorded on a previous occasion and all that is needed is the execution of the decisions leading directly to behavior. Decision execution, contrary to decision-making, is usually automatic.

Engaging on a return route after having gone to a destination represents a particular problem which, to our knowledge, has not been the object of a systematic description. Basically it can be solved by: 1) inverting the decision plan developed when reaching the destination, 2) following in reverse the path mentally recorded when the original destination was reached, or 3) a combination of both procedures. Recognition of places and decision points might help to break down the return route into smaller segments and, thus, facilitate the described procedures.

Both decision-making and decision execution are based on environmental information. Information has to be identified in the setting. It has to be understood and used in the decision-related processes. It is the nature of the information and the cognitive processing of that information which determine the potential difficulty level of a problem.

Wayfinding differs from most other problem-solving processes in relying on

information that has a macro-spatial dimension. Cognitive mapping is the major psychological process that situates an object, a person, or an event in large scale spaces. It is also the process by which spatial layouts are retained.

GOAL OF THE STUDY

The goal of the present study was to identify the wayfinding abilities of DAT patients at the early and medium stages of the disease in respect to decision-making and information processing. Decision-making was studied both in terms of the subjects' ability to make individual decisions (see the decision typology presented p. 141), and in terms of their ability to plan solutions to the wayfinding problem (overall plan) and its sub-problems (sub-plan). Information processing was studied with respect to the available architectural and graphic information displays typical of large hospitals.

METHOD

SAMPLE

The sample for the experimental group was composed of 14 DAT patients. All subjects underwent a complete neuropsychological evaluation and had to conform with the diagnostic criteria of DSM III (1980) and of NINCDS-ADRDA (McKahn, et al., 1984). They required a score of 4 or less on the Hachinski scale in order to exclude patients with multi infarct dementia and they had to be at stage 3, 4, or 5 of the Reisberg Global deterioration scale. The control group of 28 healthy seniors was matched with the experimental group with respect to age, sex, and education (Table 1).

THE TASK AND THE INFORMATION GATHERING

Each subject had to reach a destination, namely, the dental clinic in a large hospital (H　spital C　tedes-Neiges in Montr　al) from the closest bus stop in front of the hospital. Once the destination was reached, the subject had to return to the bus stop by the same route.

To control for the possible interference from a memory deficit, the subjects were given a card containing the name of the destination at the beginning of the experiment. They were asked to express verbally and aloud everything that went through their mind while reaching the destination. In order to assure full verbalization, an observer accompanied the subject. If the verbalization was not forthcoming, the observer inquired what the subject was doing (identifying decisions) and why the subject was taking a given action (identifying the underlying information). The conversation was taped and then transcribed (wayfinding protocol).

The equipment used to record the verbalization was light and unobtrusive. In order to ensure ecological validity, the subject and the observer had to appear like two people walking and conversing. The interrogating role of the observer was crucial in assuring complete wayfinding data. At the same time, the observer had to be careful not to suggest solutions by giving verbal or behavioral cues. The observer had to ask the what/why questions when the subject failed to verbalize. The value of this method depended on the DAT patients' abilities to express themselves even if only in a simple fashion. Subjects had to be able to say what they saw and heard, and what they were doing.

THE SETTING AND THE ROUTE

The Hôspital Côte-des-Neiges is a geriatric institute to which demented patients frequently come for outpatient consultation. The route of the experimental task is shown in Figure 2.

The subjects had to reach the hospital by the main entrance which is clearly visible from the point of departure: the bus stop. After going up a flight of exterior stairs the subjects reached the entrance doors of the hospital and entered a lobby. The lobby features a directory from which the address of the dental clinic had to be obtained: "dental clinic" R de C 0356 (R de C is an abbreviation for Rez-de-Chaussée, meaning ground floor in French).

From the entrance lobby (which is the first floor), the subjects could only go up one floor by a choice of two stairs to reach the second floor. On the second floor, the subjects followed a corridor to reach an intersection, turned to the right and followed a corridor until reaching the elevators. Once the ground floor was reached by the elevator, the subjects followed the corridor to the left to reach the destination: the dental clinic.

The reason for choosing a fairly complex task was to confront the subjects with a diversity of decisions and a need to plan. If the subject was lost and did not know what to do, the observer intervened by giving the appropriate decision.

RESULTS

WAYFINDING PERFORMANCE

A combination of measures can be used to establish a nuanced estimate of wayfinding performance. At the high performance end of a continuum is the error-free completion of wayfinding; this is followed by the completion with errors corrected by the person's own initiative; on the low performance side, we identify completions of the task necessitating one, two, or more interventions from the observer.

Table 2, referring to the original trip from the bus stop to the dental clinic, shows a clear difference between the performance profile of DAT and the control group. Twelve of the 14 DAT patients needed more than 3 interventions while 21 out of the 28 subjects of the control group were able to complete the task without any interventions. The best of the DAT group were only as good as the worst of the control group. This difference in performance had to be expected and is concordant with disorientation problems as reported in the literature.

The data for the return trip from the dental clinic to the bus stop (Table 3) shows that the performance of the DAT group did not improve for the 12 subjects who needed three or more interventions while 24 out of the 28 control subjects did not need any interventions. The explanation of this observation emerges from a more detailed analysis of the decision-making process in the return trip.

DECISION TYPES ANALYSIS

All decisions require some mental or cognitive abilities but to different degrees. Our hypothesis was that patients in early and intermediate stages of DAT would still be able to make certain types of decisions but that other types of decisions would no longer be in the range of their abilities.

In order to classify the decisions made by the subjects, a decision typology is introduced. A first distinction was made between a wayfinding condition when: 1)

relevant information was available (type A decisions) and 2) no relevant information was available (type B decisions). Type B decisions are of an exploratory nature.

In wayfinding, people are often confronted with situations in which little or no information is available. They still have to make decisions even if no relevant information is immediately available. These types of decisions were labeled Type B decisions.

This typology was applied to the wayfinding behavior of the experimental and the control subjects. Table 4 shows a large quantity of B type decisions for both groups. The amount of exploration necessary to complete the wayfinding task is an indication of the effort needed to obtain relevant information. In respect to the control group, the finding can be interpreted as being a sign of the mediocre quality of the existing wayfinding support.

In order to obtain a statistical measure of comparison between the two groups, the multivariate analysis by Hotelling (Hotelling's T2) was applied. The test, which analyzes the overall difference between the two groups, was significant at p < 0.0000. A Student T-test was then applied to identify which of the variables were responsible for the difference between the two groups.

It has to be noted that A3 (decisions based on memory), although more present in the control group, were too few to be taken into consideration, and the difference between the groups on the B1 decision type was so drastic that no analyses were performed on these two variables. The comparison between the two groups for type A decisions showed no marked differences with the exception of A4 (decisions based on an inference) which were prevalent in the control group.

The most remarkable results pertain to the distribution of the B type decisions. B1 was only made by DAT patients. Almost a quarter of all decisions for the DAT group were B1 (looking or walking without explicit aim), a decision type which was totally absent from the control group. Similarly, B2 (exploring in order to find the destination directly) was predominant in the DAT group. B4 (exploring in order to find a specific information) were decisions made by both groups but more so by the control group. B3 (exploring to find any useful information), was not discriminative although the difference lies on the limit of significance.

In the return trip, a major shift from the exploratory B type to A type decisions occurred for the control group. In fact, 88.45% of all decisions were of the A type and more than a third (38.85%) of all decisions were A3 (decisions based on memory). The distribution for the DAT group was quite similar to their distribution in the original trip. The Hotelling test analyzing the overall difference between the two groups was again significant at p < 0.0000. The Student T-test between pairs of variables showed significant differences for A2, A3, and B2. B1, again was only made by DAT patients (Table 5).

B1 (looking and walking without specific aim) and B2 (exploring to find the destination directly) remained unchanged while the higher order exploration B3 and B4 diminished and accounted for the small drift to A type decisions. A3 (decisions based on memory) increased to 10.4%.

The analysis of decision types shows that people at early and medium stages of DAT can still cope quite well with A1 and to a certain extent, A2 decisions. They also make many exploratory decisions, mostly of the lower orders.

However, the most striking result is probably DAT subjects' difficulties for the return trip. The relative poor presence of A3 (decisions based on memory) suggests memory to be responsible for the difficulties, but care should be taken not to limit the explanation to a simple loss of general memory. Being able to make a return trip is a more complicated issue. On a theoretical level it is possible to conceptualize the return trip as 1) the inversion of a decision plan or 2) the reliance on a cognitive map. Most people probably operate on the combination of decision plans and cognitive maps. A3 (decision based on memory) does not distinguish between the two, as cognitive maps are not easily expressed in verbal form. The poor wayfinding performance for the return trip suggests, though, that DAT patients have difficulties in respect to both inverting a decision plan and forming or using a cognitive map of the path taken on the original trip.

THE ABILITY TO SOLVE WAYFINDING PROBLEMS

The key notion in this analysis is "to plan," that is the ability not only to make individual decisions but to establish an interrelated sequence of decisions aimed at solving a wayfinding problem. An important differentiation can be made between the overall plan to complete a complex wayfinding task like going from the bus stop to the dental clinic, and plans to solve sub-problems like using the elevators, finding a room number once a person is in the correct corridor, etc. The hypothesis in this respect was that Alzheimer patients at the early and medium stages would still be able to solve some sub-problems but would have difficulties in developing an overall solution to a complex wayfinding problem.

In order to analyze the abilities to solve wayfinding problems, the task was broken down into easily circumscribed sub-tasks. For each sub-task we identified the possible plans to solve it. In order to reach the destination at the ground floor, for example, it was possible to a) rely on a directional sign and walk in the correct direction until the destination was identified or b) to rely on the door numbers, to identify by inference the appropriate direction and walk until the desired door number was reached. Similarly it was possible to identify the plans to solve the overall task. All wayfinding protocols were thus analyzed by referring to a pre-established list of all possible solutions and sub-solutions. In the following section, the overall plan and each sub-plan will be individually analyzed.

THE ABILITY TO DEVELOP AN OVERALL PLAN

The overall plan for the task would typically comprise the following decisions: 1) to go from the bus stop to the entrance hall of the hospital, 2) to find the address of the dental clinic, 3) to go to the ground floor (by passing through the second floor), and 4) to find the destination at the ground floor.

As shown in Table 6, only 2 out of 14 DAT patients were able to develop an overall plan to go from the bus stop to the dental clinic. In comparison, 26 out of the 28 control subjects were able to develop the overall plan. This difference fully supports our hypothesis.

Sub-plan: Going from the bus stop to the entrance hall of the hospital. Almost every DAT patient (13 out of 14) was able to complete this task. The score was 100% for the control group. The task required identifying the entrance to the hospital, walking along a footpath, going up stairs and going through the entrance doors. All these decisions were of the A1 type and were based on architectural information.

This observation may be seen as trivial at first view, but it will be crucial in suggesting design guidelines. The decisions associated with these architectural elements are almost implicit: stairs are to go up, doors are to go through, etc. In fact, the decisions associated with these elements are so strongly evident that they invite behavior which might not always be appropriate. A patient, seeing a doorbell (for night use) at the hospital immediately decided to ring. Architectural elements might well have such a strong impact that they determine to a certain extent the behavior of less independent patients.

Sub-plan: Finding the address of the dental clinic in the entrance hall. Obtaining the address from the directory at the entrance hall is a difficult task confounded by the poor design of the directory. Although 10 Alzheimer patients tried to find the address on their own initiative, only 1 succeeded. In the control group 27 tried to find the address and 25 succeeded.

Some subjects just did not find the information on the directory, some did not understand the meaning of the symbols, in particular the abbreviation R de C for ground floor (Rez-de-Chauss e). Another confusion was caused by the close proximity of information pertaining to other destinations but which were associated with the address of the dental clinic.

Sub-plan: Going to the ground floor from the entrance hall or the upper level. The entrance hall is situated on the first floor. From the entrance hall one has to go up one level to the second floor and only then can one find the elevator to go down to the ground floor. This task is rather complex in that it requires an overall plan. Although 8 DAT patients at one moment or another formulated the decision to go to the ground floor, none succeeded to develop the appropriate plan. All of the 23 subjects of the control group who decided to go to the ground floor succeeded in developing the appropriate plan.

Sub-plan: Taking the elevator. Three DAT patients out of the 14 developed the necessary decisions to take the elevator and only 2 succeeded without help. In contrast, the success rate for the control group was 100%. Decisions involved in the use of the elevator were generally of the A2 type. The difficulty with the elevator was the very short time span in which a decision had to be made and executed. Frequently, the door closed before the patient was able to get out of the elevator cabin. The distinction between the "up" and "down" buttons to call the elevators, which were indicated by arrows, also seemed to create difficulties.

Sub-plan: Finding the destination on the ground floor. Once arrived to the ground floor, the task again became manageable. Twelve out of the 14 DAT patients developed an appropriate plan to find the destination and 9 succeeded without help from the observer. Some plans consisted of mainly A1 decisions based on directional signs. Some other plans, though, involved A4 decisions when using the door numbering system to establish the direction of the destination. The success rate for the control group was 100%.

Sub-plan: Stopping to search once the destination is reached. A rather bizarre behavior was observed in 5 DAT patients who, after having perceived the destination, continued to search. Similar observations of perseveration have been made when DAT patients perform other tasks like drawing. It suggests some problems with the inhibition of the currently ongoing task. Such a possible lack in inhibition should be taken into consideration by appropriate environmental interventions.

OBSERVATIONS ON INFORMATION PROCESSING

The difficulties DAT patients had with signs and directories have already been outlined. Based on our previous work, we are tempted to say that most normal people have difficulties with signage, a condition which has not so much to do with inadequate information processing as with bad signing. This is not quite true for DAT patients, even though the difficulties are exacerbated by poor design.

One aspect of information processing seems to cause particular difficulties to DAT patients: the ability to distinguish relevant from irrelevant information. Situations occurred when patients were reading all that was written on signs and directories and everything they could find on their way. This included information about the functioning of the hospital, the services offered, but also posters, commemorative plaques, even advertising.

Most DAT patients in our studies did have moments of this non-discriminatory reading behavior. Two short translated excerpts from the protocol illustrate this. The first patient, after having obtained the address in the entrance hall was going up the stairs and walking along the corridor of the second floor:

Patient: I have to go to the dental clinic.
Observer: Waht are you reading?
Pat: Its direction for health ..., infirm ..., incamper ...
Obs: Infirmary.
Pat: Yes.
Obs: Direction of dental services.
Pat: The medical ... (continues reading)
Obs: Ok, now what shall we do?
Pat: We ... uh, return from where ...
Obs: You would like us to return?
Pat: Yes.
Obs: Ok.
(silence)
Obs: Where are we going now?

Another subject found himself at the ground floor shortly before reaching the destination. The subject, having decided to follow the door numbers in the correct descending order, had developed an appropriate plan but he constantly got side-tracked by the displayed written information:

Observer: You are reading the notice board?
Patient: Have they the desire to ... boil the ... hey, essential ..., I don't know, I don't know ...
Obs: What are you looking for?
Pat: Unknown ..., I am looking for the dental clinic, ... their number ..., so that I communicate with them for the appointment ...
Obs: Ok.
Pat: Meeting room 303 ..., meeting room 303, 356 (looks at the address on his card), it's close, we can go and have a look to see what happens.
Obs: Ok.
Pat: Ha ha ha, 309, 309-5-5, we have seen it before, before the laundromat, it's lucky to find ... wash, there is car wash, you know.
Obs: Yes.

Pat: Information, let's go from here.

Obs: We are in front of a directory before the elevators.

Pat: Room for formation, food services, food service, here we see the essential recognized, the essential, they often talk about it; it's fashionable -- the essential.

Obs: You are reading a sign on a door.

Pat: Ah aye ... essential.

Obs: You are now reading a sign: "communication to everybody."

Pat: Dinner, dinner, I think they don't have many dinners organized here, (etc.).

This non-discriminatory reading is not only useless but is exhausting and misleading for the user. As the excerpts show, the patients may lose sight of the reason for the search, and they may even forget the destination of the wayfinding task. After a period of non-discriminatory reading, the observer typically intervened to remind the subject of the destination.

Hospital settings tend to display a lot of written information. The average user might well be able to ignore that which is irrelevant. The situation for the DAT patient is more confusing and, in trying to cope with the mass of information, conditions of overload ensue.

IMPLICATIONS FOR DESIGN CONSIDERATIONS

Wayfinding design involves two distinct aspects: spatial organization and environmental communication. Spatial organization refers to the ordering of functions and facilities and the creation of a circulation system which, in a general sense, determines the wayfinding problems users have to solve. Environmental communication refers to the architectural and graphic expression of information necessary to solve the wayfinding problems.

Spatial organization. As was suggested earlier in the literature, the configuration of space in settings catering to DAT patients should be simple. The setting, ideally, should not be large, and the solutions to the wayfinding problems posed by the spatial configuration should not necessitate A3 decisions (based on memory) and A4 decisions (based on inference). Moreover, the configuration should not require the development of higher order plans. Patients should be able to proceed from one decision point to the next as they walk along without having to plan for future decisions.

Cognitive mapping abilities are probably quite reduced in DAT patients. Nothing indicates, though, that they do not understand architectural elements when they see them. This suggests that visual accessibility of spaces and functions can facilitate the understanding of a given setting. Open cores (interior squares, streets, etc) in multi-story buildings are means of giving visual access and allowing a certain understanding of space without having to integrate into an ensemble that is perceived in parts, which is the most difficult aspect of cognitive mapping.

The spatial organization and the circulation system should also allow for wandering when designing well-articulated safe paths. This recommendation reduces the necessary control by the nursing staff and provides for greater freedom of movement by the patients.

Environmental communication. Architectural communication is a major ingredient to wayfinding design and it also seems to be important for dementia. Entrances to buildings should be well-articulated and should not need to be signed. People do not only enter buildings, but they also enter identifiable zones in the building. In a hospital

one may, for example, identify a recreation zone, a medical zone, an in-patients and out-patients zone. Entrances to these zones could also be created and each zone entrance could be given its appropriate display and meaning. This interior articulation of areas, referred to as destination zones, will reduce the necessary amount of signage.

As already indicated, DAT patients tend to have difficulties retracing their steps. This implies that they have to solve the problem of getting out of a destination zone (or the building), as if it were a new problem. This means that information to solve the problem has to be provided. Architects, therefore, also have to be thinking about the expression of exits. However, it might be desirable for a nursing home not to express building exits too clearly in order to prevent patients from leaving the setting.

It is not only the entrances to destination zones which should be given a distinct expression but the zone itself. Even assuming the limited cognitive mapping abilities of the typical DAT patient, a zone with a strong character might favor a certain spatial identification, if only in the sense of being somewhere distinct. Uniformity, after all, is the secret of labyrinths and getting people lost.

Horizontal and vertical circulations are also part of architectural wayfinding communication. Signs indicating the location of stairs or elevators only show that the architectural expression is insufficient. They are strong architectural elements that do not need being pointed to. The clear articulation of the circulation is an issue concerning all types of buildings and users but would seem to be particularly important in respect to dementia.

A final major item in architectural communication is landmarks used as reference points. In a well-articulated environment, entrances, destination zones, and even the elements of the circulation system such as stairs or elevators can serve as reference points. It might be of interest, though, to introduce landmarks that have a special meaning to the user as was suggested by Cohen and Weisman (1988). This might be achieved in providing a view to a landmark feature outside the building, or to key features inside the building such as a fountain or even to objects with a particular meaning to patients. Graphic and architectural communication should be complementary. All too often graphic information tries to compensate for poor architectural communication and mostly with insignificant results (Arthur and Passini, 1993). Graphic information, though, will still be needed even if the building is architecturally well-articulated.

One of the major recommendations emerging from this research is to clean up information clutter on circulation routes. The non-discriminatory reading of information by DAT patients is among the most confusing interferences in the wayfinding process. Graphic wayfinding information notices along circulation routes should be clear and limited in number and other information should be placed somewhere else. It is quite feasible to create little alcoves specifically designed for posting public announcements, invitations, and publicity, and these areas could even become small gathering places encouraging social interaction.

The graphic information provided should be of consistent design and systematically located so that the user knows what to look for and where to look for information. This rule facilitates graphic communication and also reduces chances of the user being overloaded by information.

Our study was not aimed at analyzing graphic communication, but from the few directories and signs used we can make some simple recommendations. Arrows in

directional signs have to be in close spatial proximity with the name of the destination; otherwise, the connection is not made. Furthermore, each message has to be spatially separated from the other messages on the same display; otherwise, nonsense links are made between messages. If ever possible, abbreviations such as "R de C" should not be used. All signs and messages should be simple. The letter B, for example, which in the address of the dental clinic indicated a zone of the hospital and preceded the door number, has probably not helped anybody and certainly confused many.

Wayfinding design not only makes settings more efficient, safer in case of emergencies, and accessible to a larger section of the population, it also can bring about an architecture that is well-articulated, rich in spatial experience, and, why not, aesthetically pleasing. Wayfinding design, we believe, is an antithesis of uniformity and boredom.

ADDED MATERIAL

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TABLE 1. Average and dispersion of age and education for DAT and control groups.

Group	N	Age Average	Age Std. Dev.	Education Average	Education Std. Dev.
DAT	14	72.07	4.71	10.07	4.00
Control	28	71.43	4.73	10.50	3.11

TABLE 2. Performance of the DAT and control group in the original trip.

Group	without errors	errors corrected	one intervention	two interventions	three or more interventions	total
DAT	0	0	0	2	12	14
%	0	0	0	14.4	85.6	100
Control	13	8	6	1	0	28
%	46.4	28.6	21.3	3.7	0	100

TABLE 3. Performance of the DAT and control group in the return trip.

Group	without errors	errors corrected	one intervention	two interventions	three or more interventions	total
DAT	0	1	0	0	12	14
%	0	7.1	7.1	0	85.6	100
Control	19	5	0	0	1	28
%	67.9	17.8	10.7	0	3.6	100

TABLE 4. Distribution of decision types in percentage for the original trip.

	Table A						Table B				
Groups	A1	A2	A3	A4	Total A	B1	B2	B3	B4	Total B	Total
DAT	122	44	1	33	200	122	70	65	82	342	539
%	22.63	8.16	0.2	6.12	37.11	22.63	12.99	12.06	15.21	62.89	100
Control	241	89	4	133	467	0	9	176	327	512	979
%	24.62	9.09	0.40	13.59	47.70	0	0.92	17.98	33.40	52.30	100
T-Test	N.S.	N.S		*		*	*	N.S.	*		

Note: Given that six tests were performed, the p level had to be adjusted to $*p \leq .0083$ (.05/6)

TABLE 5. Distribution of decision types for the return trip.

	Type A						Type B				
Groups	A1	A2	A3	A4	Total A	B1	B2	B3	B4	Total B	Total
DAT	76	17	26	9	128	63	37	15	7	122	250
%	30.4	6.80	10.4	3.6	51.2	22.3	13.1	5.3	2.5	48.8	100
Control	121	102	195	26	444	0	9	27	22	58	502
%	24.1	20.32	38.85	5.18	88.45	0.0	1.79	5.38	4.38	11.55	100
T-Test	N.S.	*	*	N.S.			*	N.S.	N.S		

Note: Given that seven tests were performed, the p level had to be adjusted to $*p \leq .0071$ (.05/7).

TABLE 6. The ability to develop plans and sub-plans.

Groups

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Problem description                              DAT        Control
Planning to go from the bus stop to          2 (14%  )      26 (93%  )
the dental clinic; this task requires
the development of an overall plan
Planning to go from the bus stop to the     13 (93%  )      28 (100%  )
entrance of the hospital
Succeeding                                   13 (93%  )      28 (100%  )
To look for the address of the dental clinic 10 (71%  )      27 (96%  )
Succeeding                                    1 (7%  )       25 (89%  )
Planning to go to the ground floor            8 (57%  )      23 (82%  )
Succeeding                                    0              23 (82%  )
Planning to take the elevator                 3 (21%  )      28 (100%  )
Succeeding                                    2 (14%  )      28 (100%  )
Planning to find the destination at the      12 (86%  )      28 (100%  )
ground floor
Succeeding                                    9 (64%  )      28 (100%  )
To stop searching once the destination has    9 (64%  )      28 (100%  )
been reached
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FIGURE 1. A simplified decision diagram reflecting a decision plan developed by a wayfinding subject.

FIGURE 2. The hospital setting: C te-des-Neiges and the route to go to the dental clinic.

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TYPOLOGY OF DECISIONS BASED ON ENVIRONMENTAL INFORMATION (TYPE A)

Type A1 (decisions based on explicit environmental information). These are situations which have been experienced by a person on a routine basis and which involve a unit of explicit information leading to a decision without any additional cognitive requirements. These include: entering through a door, using stairs, following a directional sign. People have continuously been using doors and stairs; the decisions of entering, exiting or going up or down are intrinsic to these objects. To the wayfinding person the use is, thus, contained or implied by the available information. Similarly, a directional sign has been experienced by most people on a routine basis; it also leads directly to the wayfinding decision: the name, in fact, indicates destination and the arrow the action or the movement necessary to reach it.

Type A2 (decisions based on routine sets of behaviors). The decisions necessary in using an elevator are of this order. A2 type decisions are interrelated and represent a sub-plan contrary to A1 type decisions which are made on an individual basis. Both types of decision are closely associated with behavioral routines and probably represent low cognitive involvement. On a purely formal basis, A2 type decisions are more complex because of their structural links. To take an elevator, for example, appears more complex an operation than just opening a door because it involves a series of actions coordinated in time and space.

Type A3 (decisions based on memory). These are situations requiring the memorization of information. Decisions based on the memorization of an address (formal memory), or decisions based on a verbal process description such as "go to the end of the corridor, turn left, take the first door on your right ..." (procedural memory), and decisions based on recognition memory are of this order. This type also includes decisions based on information retained on the basis of a cognitive map.

Type A4 (decisions based on an inference). These are situations requiring an inference, that is, the use of at least two units of information to generate new information. An example of a decision based on inference is the use of two adjacent door numbers in order to identify the direction of the ascending or descending order of the numbering system and to decide to walk in the appropriate direction. A4 type decisions also include more general planification statements, or anticipation of further action, such as the decision to go at the end of the alley in order to look (then) if the doors' numbers are descending (in the right direction). These kinds of decisions are in fact very similar in a broad sense: both can be classified as reasoning.

TYPOLOGY OF EXPLORATORY DECISIONS (TYPE B)

Type B1 (looking or walking without aim). The decision is to look around or walk without explicit purpose; the person in this situation is not looking for the destination.

Type B2 (exploring in order to find the destinations directly). The decision to walk on a chance basis until hitting upon destination; in this case, contrary to the previous situation, the person will keep the goal of reaching the destination in mind.

Type B3 (exploring in order to find any useful information). The decision to explore on a chance basis in order to find some relevant information; in this case the aim of the exploration is to return to goal-directed decision-making as soon as relevant information is obtained.

Type B4 (exploring in order to find a specific information). The decision to look for specific information in a semi-directed way; the person may explore a section of a building in order to find an information desk or study a map to find the location of destination.