Wayfinding in Cases with Vertical Motion

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ABSTRACT

While numerous studies have investigated environmental influence on wayfinding performance, few researches have investigated wayfinding behavior in cases with inter-floor vertical motion. This study intends to clarify the influence of vertical traveling on spatial cognition and to examine how wayfinding behavior varies with differences in individual strategies and environmental information.

A series of wayfinding experiments were conducted in three different settings: One was a department store which had much visual information provided by display of merchandise and signs along the route ; second was a building on a university campus with less visual information ; the last one was a building on a university campus which had a different corridor plan on each floor. In these experiments several routes with different types of vertical traveling means were included. Each subject was first led from a start point to a destination and asked to go back to the start point by oneself, then to return to the destination. At the final session in the first setting the subject was interviewed to determine the reasons for the route choice, and in the other settings the subject was asked to draw a cognitive map. A pointing task was also conducted in another building on the campus to examine individual orientational skills. Eight male and eight female subjects were employed in these experiments.

An analysis of the results indicates the following five conclusions: (1) vertical traveling disturbs spatial cognition, (2) people tend to lose orientation after vertical traveling, but some of them can recover it from environmental information, (3) the source of information for recovery differs with the person and the space. Successful persons tend to get information not only from such elemental features as objects and signs but also orientation and configuration of space, (4) when people travel from one floor to another, they tend to assume that the new floor plan is similar to the former floor plan, (5) differences in the means of vertical traveling means have no significant influence on wayfinding performance.

Keywords: wayfinding; three-dimensional space; visual information; pointing task; cognitive map

1. INTRODUCTION

In recent years, travel in multilevel buildings is increasing because of the construction of complex and gigantic architecture. In these case, we seem to lose our way in inter-floor travel. Although a large number of studies have been made on the relationship between environmental conditions and wayfinding behavior (Weisman, 1981; Peponis & Choi, 1990; O'Neill, 1991; Golledge & Gale, 1993), most of these studies have discussed wayfinding in horizontal movement. There have been only a few studies dealing with wayfinding including vertical or inter-floor movement. Funahashi (1991) conducted a wayfinding experiment in a route connected two floors but did not discuss the influence of vertical travel. Passini (1984) collected protocols from people wayfinding in multilevel shopping complexes and found that they needed knowledge about vertical relationships to make decisions about the use of stairways and elevators. Montello (1993) studied the acquisition and integration of configuration knowledge of spatial layout using two separate routes which were vertically aligned.

This study considers that vertical traveling disturbs the cognition of a route. It intends to clarify the influence of vertical traveling on spatial cognition and to examine how wayfinding behavior varies with differences in individual strategies and environmental information along the route.

2. METHOD

This study examines the following six hypotheses:

1. Vertical traveling disturbs route cognition.
2. People lose orientation after vertical traveling.
3. People can recover orientation and recognize the right route from environmental information.
4. Visual information along the route influences how people get lost.
5. People tend to lose their way if floor plans are not vertically aligned.
6. Difficulties in wayfinding differ with vertical traveling means as stairs, elevators and escalators.

To examine these hypotheses, a pointing task and three wayfinding experiments were conducted in actual campus buildings and a department store. These buildings were selected according to their environmental conditions: (1) amount of visual information available along the route and (2) vertical floor alignment, that were considered to have influence on wayfinding behavior. Subjects were 16 graduate and undergraduate students (8 females and 8 males, non-architectural students) who had never been to the buildings.

3. A POINTING TASK EXPERIMENT

3.1 Procedure

A Pointing task experiment was conducted along a route containing stairs in a campus building. Subjects first put a mark at the start point and then were led to the destination by the experimenter. They were asked to point the direction of the mark using a pointer made like a compass at three points on the route. The first point (Point Ⅰ) was before going up stairs, the second point (Point Ⅱ) was just after the stairs and the third point (Point Ⅲ) was after turning one corner from former point. Point Ⅰ and Ⅱ are on a corridor which has no window and point Ⅲ is on a corridor with windows on the right and in front.

3.2 Result and Discussions

Subject's performance was evaluated on three levels according to discrepancy from the correct direction. According to this evaluation on each points, subjects were divided into four groups (see Fig. 1 and Table 1). Subjects in Group A and Group B pointed accurate direction or nearly accurate direction at all three points. They could keep direction to some degree even after they travel vertically. Subjects in Group D couldn't keep orientation as they pointed wrong direction at all points. Subjects in Group C pointed nearly correct direction at Point Ⅰ but pointed wrong direction at Point Ⅱ, however they pointed correct direction again at Point Ⅲ. This means that they once lost direction after vertical travelling, but they recovered orientation by acquiring information from the scenery viewed from the windows while traveling from Point Ⅱ to Ⅲ. Although recognition of orientation differs with individuals, this experiment clarified that vertical traveling cause a loss of orientation and some people can recover it by acquiring environmental information around the route.

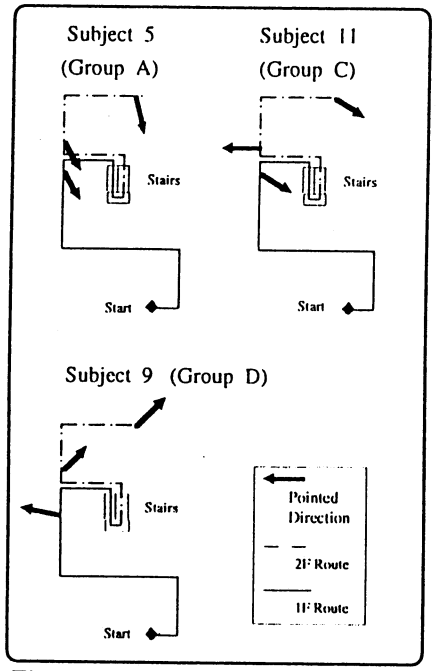

Fig. 1 Results of Pointing Task

Table 1. Classification of subjects

Subject	Pointing Task			Sketch Map	Group
	Point I	Point II	Point III		
1	○	○	○		
2	○	○	○	Overlap	
3	○	○	○	Overlap	A
4	○	○	○		
5	○	○	○		
6	○	○	○	Overlap	
7	△	△	△	Overlap	
8	△	△	△		B
9	△	△	○	Overlap	
10	△	×	△	Overlap	
11	△	×	△	Overlap	C
12	△	×	○	Overlap	
13	△	×	○	Reverce 2	
14	×	×	×	Reverce 1	
15	×	×	×	Overlap	D
16	×	×	△		

○	Accurate	△	Nealy Accurate	×	Wrong

4. WAYFINDING IN A BUILDING WITH VERTICALLY NONALIGNED FLOOR PLANS

4.1 Procedure

A wayfinding experiment was conducted in a campus building which had a different corridor plan in each three floors with less visual information (see Fig. 2). The route consists of a straight corridor on the center of the first floor and loop corridors on both second and third floor which are not aligned vertically. Subjects were first led from a start to a destination by the experimenter and asked to return the start by themselves. After drawing a sketch map of the route at the start, they were asked to go back to the destination again. This task was conducted in two routes (from start to Point A on the second floor and to Point B on the third floor).

4.2 Result and Discussions

Nine of all 16 subjects (56%) drew sketch maps as if the corridor on the first floor were aligned vertically with corridors on the second and the third floor. Subjects who drew such maps were not necessarily show poor performance in the pointing task experiment. In most of such aligned sketch maps, the staircase was drawn in distorted form or ambiguously drawn to correspond to upper floor plan as shown in Fig. 3. These results indicate that it is difficult to recognize the correspondence between upper and lower floor plan after vertical travelling, and that most people understand the route configuration based on the image of "plans of upper and lower floor are the same and vertically aligned". It is also indicated that the length and the turning direction of stairs are perceived more ambiguously than corridors.

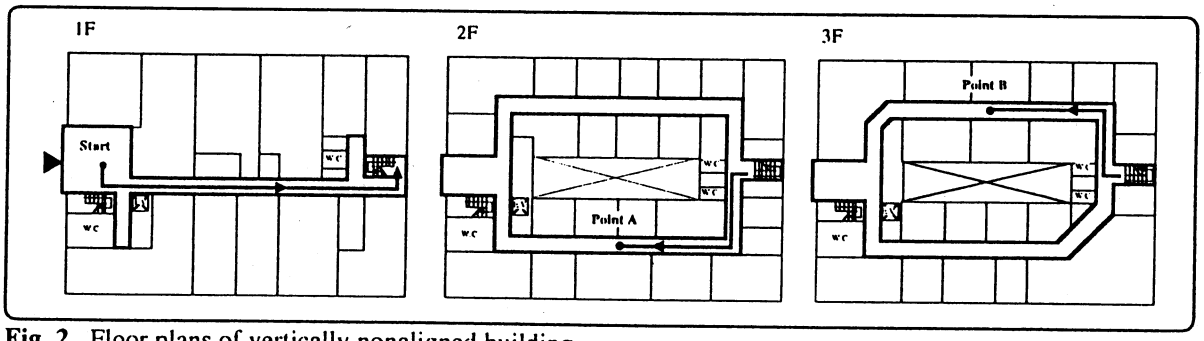

Fig. 2 Floor plans of vertically nonaligned building

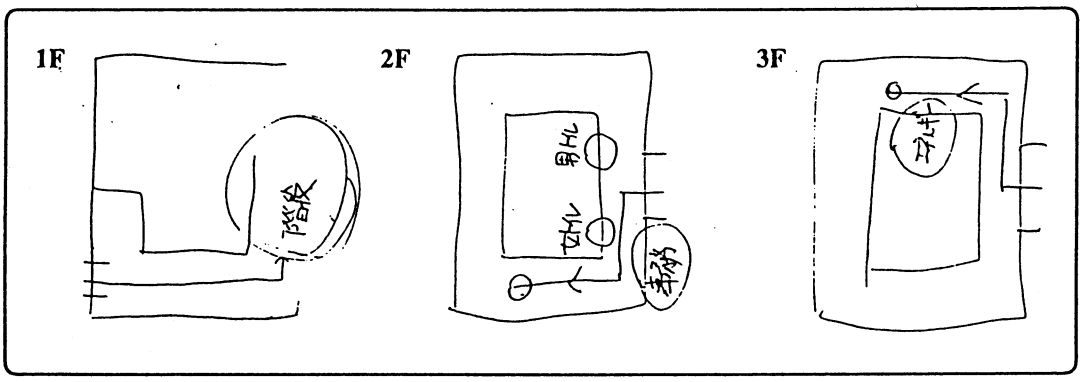

Fig.3 An example of sketch maps drawn by subjects

5. WAYFINDING IN THE SPACE WITH LIMITED VISUAL INFORMATION

5.1 Procedure

A wayfinding experiment was conducted in a campus building which had limited visual information with few signs and uniform finishes of floors and walls (see Fig. 4). Three routes, each contains different vertical travel means; stairs 1, stairs 2 and a elevator, were examined in this experiment. Subjects were first led from the start to the goal by the experimenter and then were given a sham task to go to the start and then back to the goal by themselves. At the end of the experiment, subjects were asked to draw a sketch map of the route.

5.2 Result and Discussions

Wayfinding performance was recorded in terms of "lost" behavior, which means stopping and looking around on the route, and "mistake" behavior which means selecting a wrong way at intersections (see Fig. 5). Each subject is classified by the result of pointing task indicated by circle types. This shows that subjects in Group A who pointed the correct direction at all points rarely became "lost" or made a "mistake" (except one subject), and the number of "lost" and "mistake" behaviors rises as performance in pointing task get worse as shown in Group C and Group D.

In this experiment, some subjects chose the right route in wayfinding even though they drew a wrong sketch map or couldn't draw a sketch map (see Table 2, subject 4,11,13,16). This suggests that we need not have complete knowledge about routes in advance, and that we can choose the right route acquiring information from sequences of visual scenes as we move. However, it is not always true because some subjects drew wrong maps and failed to choose the right route (subject 3,9,14).

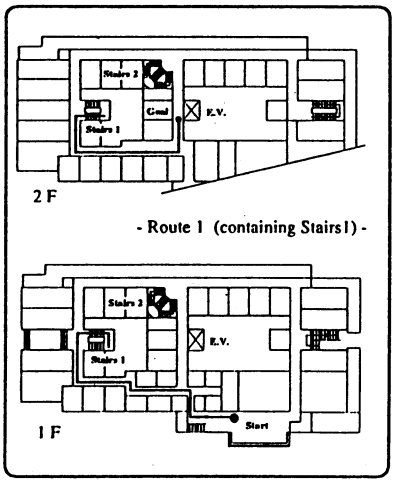

Fig. 4 Floor plans of a building with limited visual information

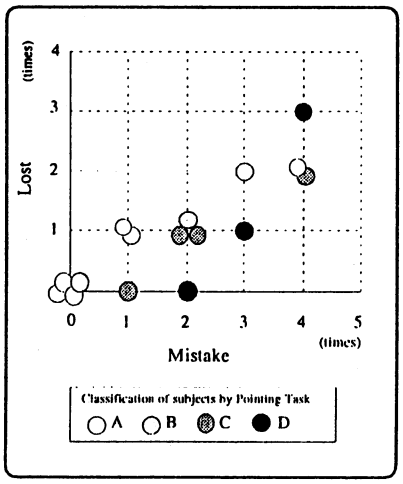

Fig. 5 The number of times of "lost" and "mistake" behavior in wayfinding

Table 2 Errors in sketch maps and wayfinding behavior

Subject	Errors in Sketch Map	Wayfinding Behavior	Group
1			
2			
3	Wrong turning order	Mistake	A
4	Reverse in 2F route		
5			
6			
7			
8			B
9	Lack of a corner	Mistake	
10			
11	Lack of a corner		C
12		Mistake	
13	Reverse direction		
14	Lack of a corner	Mistake	
15		Lost	D
16	Can't sketch a map		

6. WAYFINDING IN THE SPACE WITH MUCH VISUAL INFORMATION

6.1 Procedure

A wayfinding experiment was also conducted in a department store which had much visual information provided by different signs, display of merchandise and various finishes of floors and walls along the route. Subjects were tested through a series of routes which consisted of five settings : a route with a elevator, a route with a escalator, two routes each contained stairs but were different in the scene seen after going up and a route in one floor without vertical traveling. At the end of this experiment, subjects were interviewed about the reason for their route choices at every intersection.

6.2 Result and Discussions

Fig. 6 shows that subjects' "lost" and "mistake" behaviors were observed more frequently in routes with vertical traveling than horizontal traveling, and indicated that vertical traveling disturbs route cognition. Since no significant difference was found between vertical travel means, they have less influence on wayfinding than other environmental conditions.

Reasons for route choice were classified according to the characteristics of source of information as Table 3. The relation between subjects performance and mentioned reasons was analyzed. Fig. 7 shows that subjects who

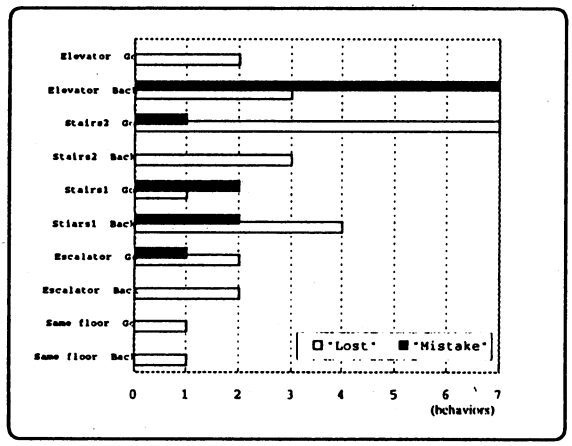

Fig. 6 The numbers of "lost" and "mistake" behavior in each route

Table 3 Classification of reasons for route choice

	Classification of Information	Samples of reasons for route choise
Environmental Information	Orientation	Overthere, Left direction
	Scenary	Scenary, Atomosphere
	Direction based on Objects	Over the escalator, Right of the stairs
	Characteristics of Space	Winding corridor, Hight of ceiling
	Finish	Floor color, Finish of ceiling
	Areas	Sports shop, Children's clothes shop
Elemental Information	Signs	C.D., CHANEL
	Objects	Boots, Dishes

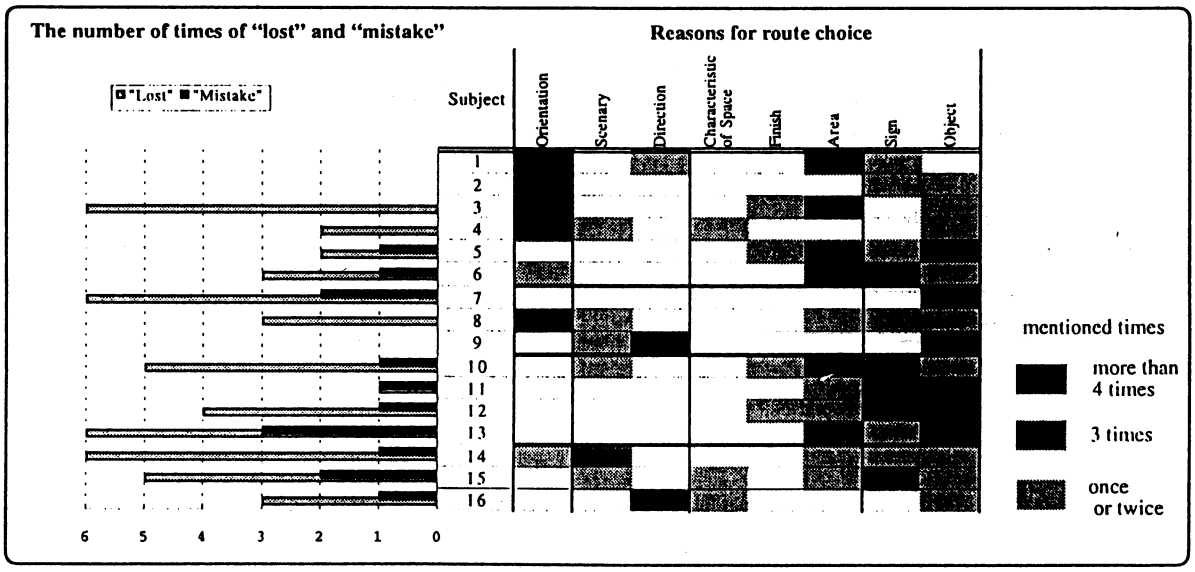

Fig. 7 The number of times of "lost" and "mistake" behavior, and reasons for route choice

frequently were "lost" and make "mistakes" mentioned elemental information while others who showed better performance mentioned environmental features as well as elemental ones. This suggest that it is effective to use a wider range of information from the environment to facilitate correct route choices.

7. CONCLUSION

This study resulted in the following five conclusions.

1. Vertical traveling disturbs spatial cognition more than horizontal traveling.
2. People tend to lose orientation after vertical traveling, but some of them can recover it by environmental information.
3. The source of information for recovery differs with the person and the space. Successful persons tend to get information not only from such elemental features as objects and signs but also orientation and configuration of spaces.
4. When people travel from one floor to another, they tend to assume the new floor plan is similar to the former floor plan.
5. Differences in the means of vertical traveling have no significant influence on wayfinding performance.

REFERENCES

Funahashi, K., (1991). Experimental study of wayfinding behavior in and spatial cognition of circulation spaces, *Journal of AIJ, No.429,* pp.61-72.

Golledge, R.G. & Gale, N.D., (1993). Integrating route knowledge in an unfamiliar neighborhood: Along and across route experiments, *Journal of Environmental Psychology, 13,* pp.293-307.

Montello, D.R., (1993). Integrating knowledge of vertically aligned large-scale spaces, *Environment and Behavior, Vol. 25 No.4,* pp.457-484.

O'Neill, M.J., (1991). Effects of signage and floor plan configuration on wayfinding accuracy, *Environment and Behavior, Vol. 23 No.5,* pp.553-574.

Passini, R., (1984). *Wayfinding in Architecture,* New York: Van Nostrand Reinhold.

Peponis, J. & Choi, Y.K., (1990). Finding the building in wayfinding, *Environment and Behavior, Vol. 22 No.5,* pp.555-590.

Weisman, J., (1981). Evaluating architectural legibility : Wayfinding in the built environment, *Environment and Behavior, Vol 13,* pp189-204.