

CULTURAL PERSPECTIVE OF WAYFINDING BEHAVIOR- EXPLORING THE SOCIO-SPATIAL VARIABLE IN THREE CHINESE HOSPITALS CASE STUDIES

Yi Lu and Ruzica Bozovic-Stamenovic

Abstract

In the era of rapid economic growth, China is witnessing huge transformations of the built environment, accompanied by the problem of spatial disorientation in large scale buildings, such as hospitals and airports. In search of possible resolutions, we are looking into the relationship between wayfinding performance in hospital environments and the Chinese traditional spatial archetype. This study focuses on a few of the most characteristic properties of traditional Chinese architecture: the axiality and openness. By having subjects carry out various wayfinding tasks in three urban hospitals that differ in terms of the degree of axiality and openness, we examine how socio-spatial variables impact spatial navigation. The result supports the relationship between search performance and spatial properties described from a cultural point of view. It suggests that wayfinding performance could be affected by cultural characteristics immanent in the Chinese society. Acknowledging the deficiencies of this small-scale study we may want to restrict its relevance to inspiring further research in this direction. In the long term, we might expect new prospects leading to important implication for the future of hospital design.

Keywords

Wayfinding; socio-spatial variables; culture; Chinese hospital.

Introduction

From a theoretical point of view, wayfinding performance is the result of a two-way process between a person's cognitive ability and his or her environment (Gaerling, Boeoeek, & Lindberg, 1986; Gaerling & Evans, 1991; Golledge, 1999; Moore & Golledge, 1976) (see Figure 1). The environment suggests distinctions and relations, and the wayfinder makes path choices based on perceived environmental information, with the cognitive ability mediating between the two. A growing body of literature suggests various physical characteristics could facilitate wayfinding. The environment-behavior link is regarded as purely spatio-physical relations in most studies. However, the socio-spatial relations between the environment and wayfinder are also a critical part of the full understanding of wayfinding performance across cultures. Just as Lynch suggests, the systems of orientation used vary widely from one culture to another, from one landscape to another (Lynch, 1960).

In China, and maybe other countries with a rich indigenous culture, the wayfinding environment is much more inclusive. It incorporates both

the spatio-physical aspects expressed through planning and dimensions, but also other permanent features possibly perceived and understood through their cultural dimension. The assumption is based on two reasons. First, Chinese culture and philosophy such as Dao, Confucianism, and Feng-Shui profoundly and directly affect environmental cognition and spatial concepts, even in rapidly modernizing Chinese society. Second, the spatial parameters of Chinese culture have always had vast influences on layout, symbolism and understanding of spaces and settings even until now.

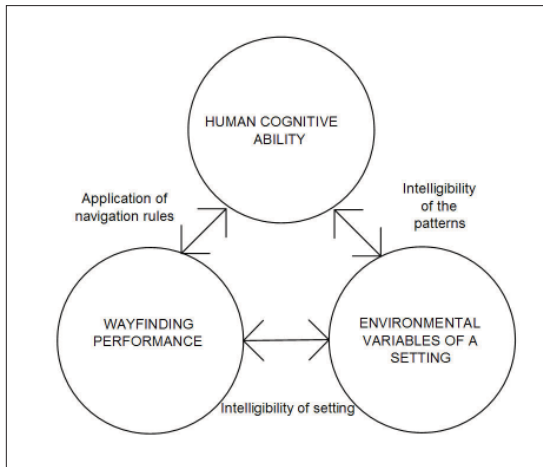


Figure 1: The traditional wayfinding model composed of three parameters: wayfinding performance, the environmental variables of the setting and human cognitive ability. (Source: Authors).

This cultural dimension is reflected in the main principles of configurations, including axially, cardinal orientation, and open spaces (Li, 2002; Lu & Bozovic-Stamenovic, 2004; Shen,

1994; Steinhardt & China House Gallery., 1984; Wheatley, 1971; Xu, 2000). The first distinguished feature is cardinal orientation and axially (Figure 2). It is shared by almost every city, resident house and public building. In China, this pattern appeared “in the plans of some of earliest cities, but even the smaller cities and towns usually exhibited the rule of cardinal axially and orientation” (Shen, 1994). In Chinese cities, the principal street running from south to north was of much greater significance than any venue running from east to west. In cities and settlements, the most important official buildings were ranged along this axis (Wheatley, 1971). This feature dominates layouts of almost all built environments, ranging from the Old City of Beijing to single residences.

The second obvious feature is the layout of courtyard (Figure 3). Buildings, usually rectangular in plan, were established around a courtyard or series of courtyards. Despite the different forms of individual buildings, the courtyard composition is the most common. Even compact houses of two or more floors will often be found to be planned around a small courtyard. This is to obtain the balance of yin and yang (Lee, 1989; Lung, 1978). Yin signifies the shadowy slopes, the cold and rainy season, and everything that is passive and female; Yang signifies the sunny slopes, warmth and dryness and everything that is active and male. According to yin-yang school, yin and yang are interdependent, for there is no yang without yin and no yin without yang.

This discourse suggests that the built environment may seem to be easily understood by the traditional Chinese due to the striking physical features that denote particular inherent spatial

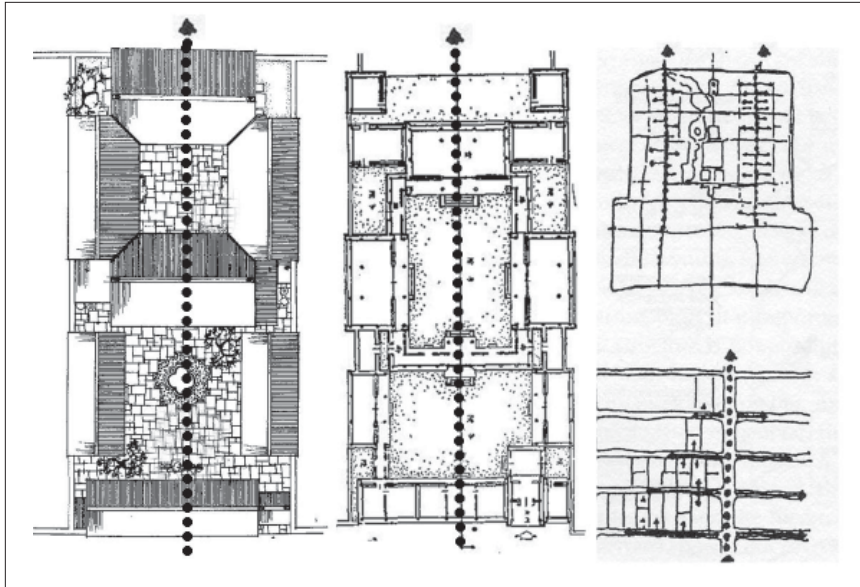


Figure 2: The physical feature of axiality and cardinal orientation. (Source: Authors).

patterns. Cultural conditions influence the environmental cognition of traditional spatial concepts, as well as traditional environments. Therefore, socio-spatial variables might impose an important constraint on wayfinding behavior, otherwise solely guided by universal spatial concepts and navigational rules. Hence, we assume that the environmental properties like axiality and open spaces might be relevant for wayfinding in Chinese hospital layouts.

Methods

Overview

Various studies have already confirmed the influence of spatial characteristics on wayfinding and spatial cognition, though most of them focus on the spatio-physical link. As

early as 1960, Lynch (1960) pointed out five elements - landmark, path, node, edge, and district - as important for the legibility of a city. Later, Gaerling and others (1983) pointed out three environmental variables could influence wayfinding: degree of differentiation, degree of visual access, and complexity of spatial layout. Similarly, Weisman (1979) believes that visual access to cues and landmarks, architectural difference, signs, and plan configuration are important factors likely influencing wayfinding behavior. O'Neill (1991) found both cognitive mapping and wayfinding performance increased when the 'Inter-Connection Density' decreased, which is defined by the average number of connections per choice in a floor plan. Later, Peponis and others used space syntax theory and methodology to examine



Figure 3: The physical feature of courtyard. _
(Source: Authors).

the spatial variables. The researchers reported that subjects' searching patterns were strongly predicted by a space syntax measure of the accessibility of a particular space (Haq, 2003; Peponis, Zimring, & Choi, 1990).

These studies have brought attention to the various properties of the environment and techniques for their measurement. However, further discussions and investigation on environmental specificities from specific cultural perspectives are needed. Apparently, the hypothesis of this study could benefit from applying the theory and methods of space syntax (Hillier & Hanson, 1984). In this case space syntax will be used for analyzing particular spatial patterns which reflect, and could be recognized, quantitatively measured, and

labeled as part of the wider cultural pattern (Hillier & Hanson, 1984).

Settings

The research was carried out in three complex urban hospitals in Nanjing, a major Chinese city. The selected hospitals are diverse in regard to their principles of configuration. One is to a great extent based on principles of traditional Chinese architecture, due to obvious axis running from south to north, and many open spaces in front of the main buildings (Figure 4). On the other hand, the second one has a strongly compact layout, with few characteristics of Chinese traditional buildings (Figure 5). The third hospital shows an in-between situation in respect to the previous ones. It also has some open spaces and an axis running from north to south. However,

these characteristics do not dominate spatial organization (Figure 6). It is assumed that these different layout principles could be of some

relevance to wayfinding behavior in these three hospitals.

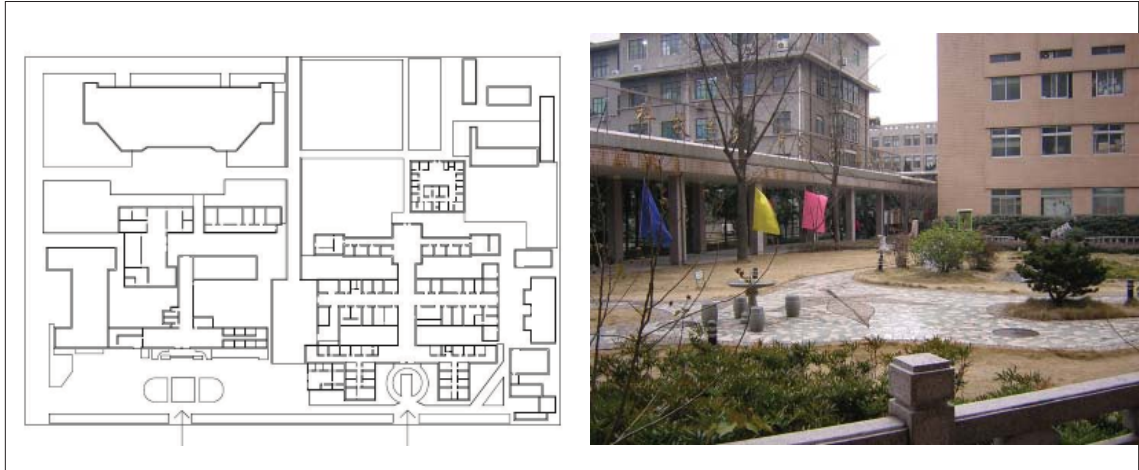


Figure 4: Floor plan and picture of General hospital, which has obvious characteristics of axially and open spaces. (Source: Authors).



Figure 5: Floor plan and picture of 81 Hospital; a compact layout, without open space. (Source: Authors).

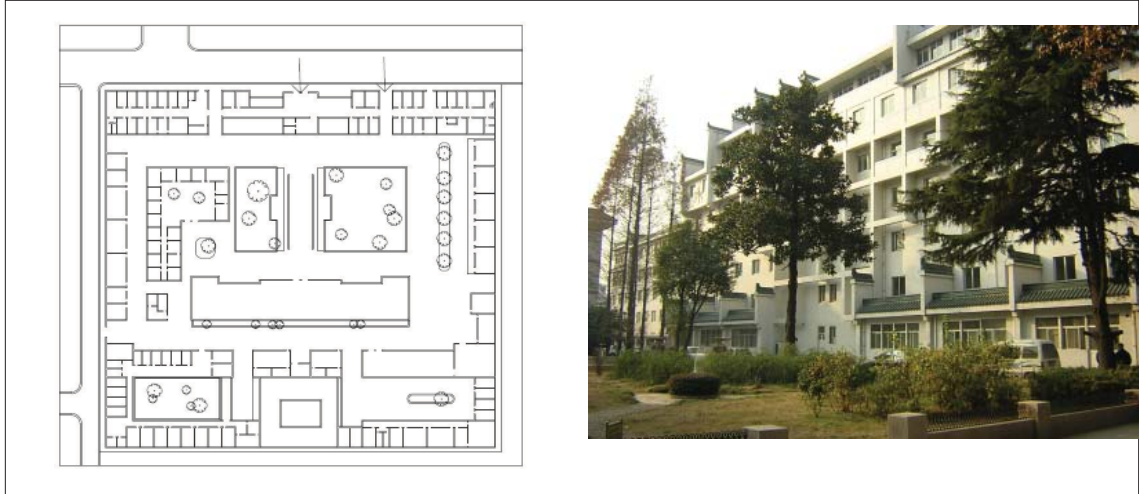


Figure 6: Floor plan and picture of Nanjing Hospital; some open spaces and axis running from north to south. However, these characteristics do not dominate. (Source: Authors).

Subjects

In these three settings, 31 participants carried out a variety of tasks related to wayfinding behavior and cognitive spatial understanding. The subjects were 17 male and 14 female college students aged 18 to 25. They were carefully screened so that none had visited a large hospital complex more than once in the 12 months prior to the study.

Procedures

The subjects were individually met on campus and led to one of the hospitals. Every participant carried out two wayfinding tasks, an open exploration of the setting, and a directed search for certain destinations within it (1).

For the open exploration, the subjects were led to the main entry point of the hospital and were asked to freely explore the ground floor of the

complex. They were instructed to learn about its layout and locations as best as they could, so that they would be able to carry out specific search within the environment later. They were instructed not to talk to anyone but to try and fulfill their tasks only from the environmental information, including signage received from the actual setting. The subjects were followed by a researcher, and search paths were recorded on the plans of the hospitals.

After the completion of the open search phase, subjects were asked to perform directed searches for specific locations. As before, subjects were allowed to proceed as they wanted and to read any signs that were available, but were prohibited from asking questions. The directed search paths were recorded on the plans of the hospitals.

Environmental Variables

In order to systematically analyze the tracking records we first looked into the layout of selected hospitals applying methods from the space syntax theory, we assumed that the environmental properties, axiality and open space, reflect cultural parameters, and are critical for wayfinding performance, as they are easily understood by people from this particular culture. Hence, the environmental properties of axiality and open spaces were selected as being important for predicting Chinese people's wayfinding performance, in this case, of local hospitals.

In terms of technique of space syntax, the layout of axiality can be reflected in the environmental variable of integration. The spaces located along the axes have higher integration values than the others, due to their easy access. The measure of integration, or its reciprocal, segregation, is expressed by Real Relative Asymmetry or RRA value. This value is obtained by the analysis of a graph representing the number of changes in direction between one axial line or space to all other lines or spaces, in a given building.

On the other hand, the open spaces can be defined in terms of the environmental variable of visual access. The existence of open spaces could increase the degree to which other spaces could be seen from a given space. The measure of 'visual access' is established by a trained observer who stood in particular nodes of various hospitals and estimated how many other decision nodes he could identify.

Behavioral Variables

As discussed above, this study considered two kinds of behavioral variables: use of lines and

nodes in the two tasks, open exploration and directed search, and redundant nodes use in directed search. The total frequency of use of each axial lines and each node was counted for statistical purposes. It was calculated from the times of total use of each unit by the 31 subjects during their exploration within the setting. For the purposes of such computation, the backtrackings other than those which covered a considerable length were ignored in this study.

For each directed search task, the shortest topological route was determined. The nodes that lie on such routes were called 'path node'. More than on use of these path nodes and use of other nodes were considered as redundant use. It is important because it gives a measure of wayfinding difficulty. Redundant node use was calculated from subjects' performance in directed search. In terms of the environment, this provides an important value of attraction for any node and space, and in cognitive terms this provides a sense of environmental understanding (3).

Results

The data set includes both environmental variables, which are analyzed from a cultural point of view, and behavioral variables, which are obtained from the recorded search tracks of the subjects in three hospitals. Basic information about the respondents, such as age, sex and background were also collected.

Open search and environmental variables
In order to discover whether the pattern of integration or visual access was relevant to the way in which the buildings were searched, we

studied the correlation between the degree of integration of different axial spaces and the frequency of use of each space by the 31 subjects during the open search (Figure 7). For the purposes of such computation we ignored backtrackings, other than those covering a considerable length from one corridor junction, or end point, to another.

During open search period, the correlations between integration value and frequency of use of each axial line turned out to be quite strong, whether we consider integration with respect to the circulation system only (Pearson's correlation $r=0.789, 0.766, 0.716, p<0.001$ in General, Nanjing, 81 Hospital receptively) or with all rooms on the main floor, including those only available to staff ($r=0.643, 0.545, 0.671, p<0.001$ in General, Nanjing, 81 Hospital receptively).

Similarly, the correlations of usage of decision nodes to node integration value were also high, both when we consider integration with respect to the circulation system only ($r=0.747, 0.784, 0.736, p<0.001$ in General, Nanjing, 81 Hospital receptively) and with all rooms on the main floor, including those only available to staff ($r=0.651, 0.594, 0.586, p<0.001$ in General, Nanjing, 81 Hospital receptively).

A preliminary inspection indicates that both the line use and node use were relevant to the integration value of each unit. However, as we expected, the correlation value was higher when the integration value is obtained with respect to the circulation system than that obtained with respect to all rooms on the main floor. For example, the correlation value between line integration value and frequency

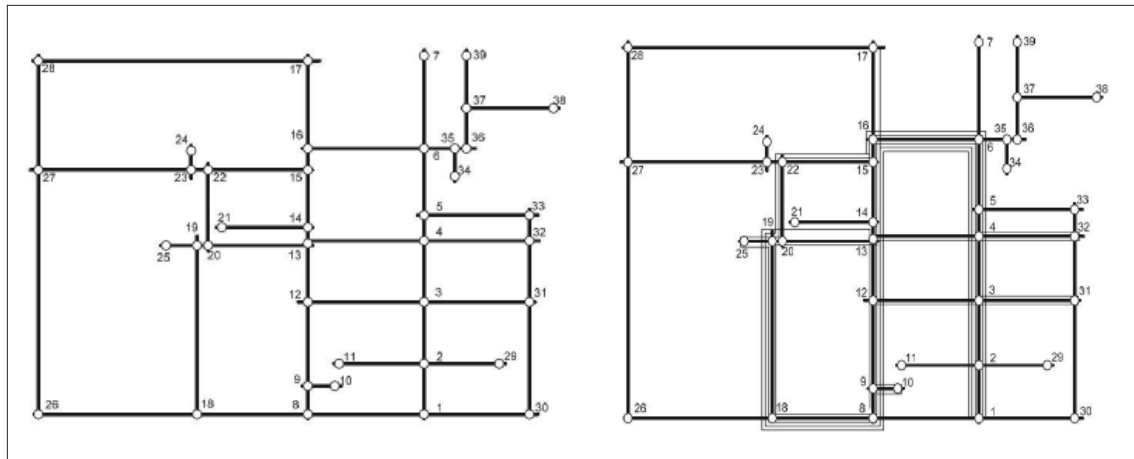


Figure 7: the left figure represents the network of basic choice nodes defined within the circulation system in General Hospital. The right figure represents the recorded tracks of the subjects who searched the hospital. Some nodes and spaces are more frequently visited by subjects than others. (Each thin line represents the tracks of three people. Some minor deviation was ignored in this figure.) (Source: Authors).

of line use in General hospital is 0.789 with respect to circulation system only, while the value decreases to 0.643 with respect to all rooms including some restricted areas.

During the open search period, the correlation between visual access value and the frequency of use of each decision node were also significant. Hospital 81 has an r-value of 0.659, $p < 0.05$, while the values of General hospital and Nanjing hospital are 0.631, 0.565, $p < 0.05$ respectively.

Finally, the mathematical analysis confirmed that the multi-co-linearity was not clear; there is no high ($r = 0.80$ or greater) inter-correlations between the independent variables of node integration value and node visual access value. This result indicates the feasibility of multiple regression analysis.

In accordance with the mathematical analysis, an interaction term comprises all independent variables, which yields significant correlations with frequency of node use. This was used in the multiple regression analysis. To our surprise, the two independent variables entered into the regression, node integration value and node visual access value, yielded an adjusted R-squared value of 0.670, 0.675, and 0.597 ($p < 0.05$) in General Hospital, Nanjing Hospital and 81 Hospital respectively.

Directed Search and Environmental Variables

In the phase of directed search, the way we analyzed behavioral data was as follows: each search path was transcribed as a set of decision nodes. For each task, we determined what was the path, or the set of paths, that could lead to the destination with the shortest metric distance. The nodes used in excess of this shortest path

were defined as redundant.

The correlations between frequency of redundant use of each node and integration and visual access were calculated. It was found that there is a statistically significant correlation between the redundant frequency of node use and the degree of integration of that node with respect to the circulation system only ($r = 0.606$, 0.625, and 0.545, $p < 0.05$ in General Hospital, Nanjing Hospital and 81 Hospital respectively).

On the other hand, the correlation between the average frequency of redundant use of each node and its degree of visual access was not significant in General Hospital and Nanjing Hospital, though there is still a consistent trend. However, this correlation remains significant ($r = 0.620$, $p < 0.05$) in the case of 81 Hospital.

Discussion

In the open search, the combination of the integration value and visual access value of a given node determines to a great degree of the variation of the use of this node. It suggests that open exploration in a hospital was bias toward some spaces more than towards others, in proportion to their degree of integration and visual access. It seems that the results suggest the existence of search pattern which is highly dependent on specifiable and measurable qualities related to environmental properties of axiality and open spaces.

In the directed search, the redundant search for particular destinations is also biased so that more integrated or more easily observed nodes are more frequently traversed, almost irrespective of what the point of origin or destination may be. Those subjects, who did not reach their

destination efficiently, seemed to walk more along integrated spaces. On the other hand, in the 81 Hospital, subjects seemed to still heavily rely on the degree of visual access. Perhaps the difficulty in developing configurational knowledge in the early exploration causes the subjects to become more dependent on visual cues in the directed search.

The empirical results favor a more comprehensive wayfinding model, involving four kinds of parameters. The first is the cultural properties of the built environment which could be understood as system of abstract relational patterns. The second parameter is the observed search and wayfinding paths recorded in the

tracking, which have been shown not only to be correlated to the pattern of axially and open spaces, but also to display specific regularities which could be predicted according to parameters of the specific culture. The third is the Chinese culture, which tries to maintain the harmony of the human and nature. Culture has great influence on the building configuration and the people's cognitive ability, and hence is of great significance for the wayfinding performance. The fourth is human's cognitive ability, including some navigation rules which seem to mediate the relationship of the above three variables. The relationships between them are summarized in Figure 8.

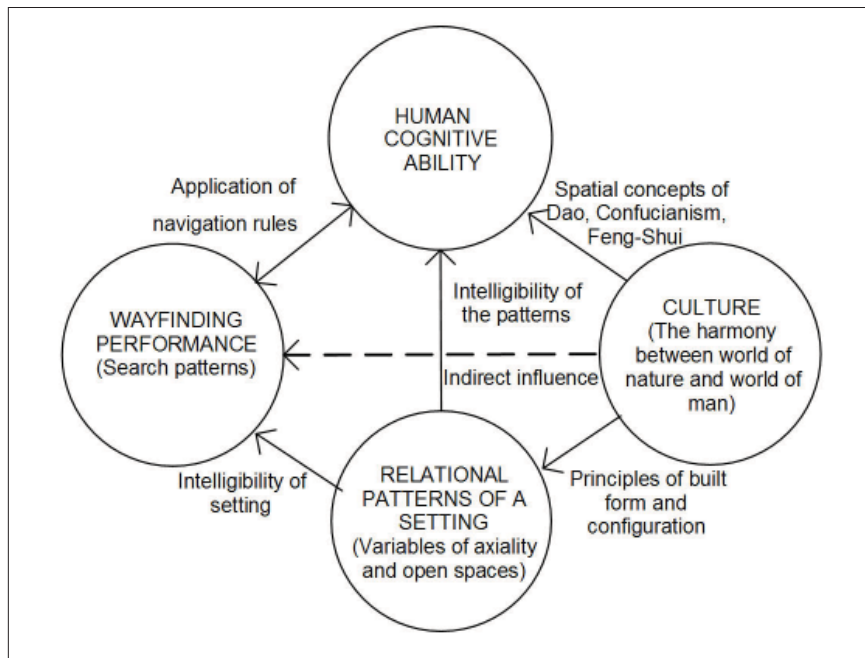


Figure 8: The wayfinding model composed of four parameters: wayfinding performance, the configurational variables of the setting, human cognitive ability, and a cultural dimension. (Source: Authors).

Our research findings imply that there is a relationship between the cultural aspects of environmental variables and our subjects' wayfinding performance in these hospitals. The cultural parameter may impose stress on the environmental cue selection and wayfinding performances of our subjects in the settings. One environment may be well-understood because it conforms to a stereotype already constructed by the wayfinder even when it is visited for the first time. Alternatively, one environment may be regarded as disorderly by a person if it has no physical features that match one's own generic recognizable spatial pattern.

Conclusion

Based on this study, we may suggest that in the mind of our subjects, there was a certain spatial pattern used to identify and to structure the environment. These environmental properties were identified as integration and openness or visual accessibility; the combination of integration value and openness value of a given space appears relevant to the frequency of use of this space during the phase of open search and directed search. It indicates that the environment-behavior link might be more than pure spatio-physical relations.

If the abovementioned points are true, we can draw some important design applications. Designers should redirect their attentions from an exclusive focus on universal wayfinding principles, to one that also considers the cultural aspects of spatial concepts. By integrating proper attention to the latter, we can create environment to facilitate wayfinding and better match the inherent cultural preferences of the users.

Some limitations of this study and recommendations for future research follow. First, it is certain that even in the context of Chinese culture the cultural properties of environment could not be simplified and expressed through axiality and open spaces only. In fact, much more research is certainly needed to identify all important Chinese cultural aspects of wayfinding. Second, the environmental properties of open spaces discussed in this study still need further investigation and application using a stricter methodology. Third, further works should be aimed at a computational model and wayfinding rules set to predict human wayfinding performances as discussed above. It is beyond the scope of this research to discuss how wayfinding rules can interface with computational navigation models in the future. Ultimately, further wayfinding studies would examine the role of the socio-spatial dimension in different cultures or countries, using either space syntax methods or other innovative research methods.

Notes

(1) These methods were known from previous research done by Peponis (Peponis, et al., 1990).

(2) This value is also used earlier by Peponis (Peponis, et al., 1990) and later Haq (Haq & Zimring, 2003).

Source of illustrations: Yi Lu.

References

- Gaerling, T., Boeok, A., & Lindberg, E. (1986). Spatial orientation and wayfinding in the designed environment: A conceptual analysis and some suggestions for postoccupancy evaluation. *Journal of Architectural and Planning Research*, 3(1), 55-64.
- Gaerling, T., & Evans, G. W. (Eds.). (1991). *Environment, cognition, and action: An integrated approach* London: Oxford University Press.

Gaerling, T., Lindberg, E., & Mantyla, T. (1983). Orientation in Buildings - Effects of Familiarity, Visual Access, and Orientation Aids. *Journal of Applied Psychology*, 68(1), 177-186.

Golledge, R. G. (1999). *Wayfinding behavior : Cognitive mapping and other spatial processes*. Baltimore: Johns Hopkins University Press.

Haq, S. (2003). Investigating the syntax line: configurational properties and cognitive correlates. *Environment & Planning B: Planning & Design*, 30(6), 841-863.

Haq, S., & Zimring, C. (2003). Just down the road a piece: The development of topological knowledge of building layouts. *Environment and Behavior*, 35(1), 132-160.

Hillier, B., & Hanson, J. (1984). *The social logic of space*: Cambridge: Cambridge University Press.

Lee, S. H. (1989). *Feng-shui: Its context and meaning* (Doctoral dissertation, Cornell University, 1989).

Li, X. D. (2002). The aesthetic of the absent The Chinese conception of space. *Journal of Architecture*, 7, 87

Lu, Y., & Bozovic-Stamenovic, R. (2004). The spatial concept of Chinese architecture. *International Journal of Architectural Theory*, 9(1),

Lung, D. P.-y. (1978). *Heaven, earth and man: concepts and processes of Chinese architecture and city planning*. Eugene, Oregon: University of Oregon.

Lynch, K. (1960). *The image of the city*. Cambridge, Massachusetts: Technology Press.

Moore, G. T., & Golledge, R. G. (1976). *Environmental knowing: Theories, research and methods*. Oxford, England: Dowden.

O'Neill, M. J. (1991). Evaluation of a conceptual model of architectural legibility. *Environment and Behavior*, 23(3), 259-284.

Peponis, J., Zimring, C., & Choi, Y. K. (1990). Finding the building in wayfinding. *Environment and Behavior*, 22(5), 555-590.

Shen, Y. (1994). *The ordering of the Chinese city*. Cambridge, Massachusetts: Harvard University Press.

Steinhardt, N. S., & China House Gallery. (1984). *Chinese traditional architecture*. New York: China Institute in America China House Gallery.

Weisman, G. D. (1979). *Way-finding in the built environment: A study in architectural legibility*. *Dissertation Abstracts International*, 40(2-A), 505.

Wheatley, P. (1971). *The pivot of the four quarters: a preliminary enquiry into the origins and character of the ancient Chinese city*. Edinburgh, UK: Edinburgh University Press.

Xu, Y. (2000). *The Chinese city in space and time: the development of urban form in Suzhou*. Honolulu: University of Hawaii Press.

Yi Lu

Yi Lu is a PhD student in the department of architecture, Georgia Institute of Technology, USA. He received his bachelor degree of architecture in 2002 from Southeast University, China and his master degree of architecture in 2005 from National University of Singapore. He has practiced in large architectural firm DP Architects in Singapore. His projects include single family houses, public housings, and large commercial complexes. He is interested in several research areas: spatial syntax, architectural theory, environmental behavior studies, and GIS. After joining the PhD program in Gatech, he has worked in two research projects: 1) web-walking on campus, which studies how the physical attributes of paths influence people's walking behavior in corporate campuses. 2) Visibility Analysis in built environment, which explores the effect of visibility structure of environment on people's perception, movement and distribution within the environment, by developing new measures of visibility analysis in GIS platform.

Ruzica Bozovic Stamenovic

Dr Bozovic Stamenovic is Assistant Professor of design at the Department of Architecture, National

University of Singapore. The theory of health and space and their interconnectivity is at the core of her teaching and research interests with her current programs focusing on foreseen changes and new paradigms in the area. She has published two books and a number of research papers promoting the idea of healing spaces. As a practising architect, Dr Bozovic Stamenovic won major architectural prizes in the former Yugoslavia and over fifteen national and international competition awards. She has also participated in over thirty exhibitions including the prestigious "The Biennale of Venice", Italy (1985, 2002).