UNDERSTANDING SPATIAL ORIENTATION, COGNITIVE MAPPING AND WAYFINDING

BOOK REVIEW: WAYFINDING BEHAVIOR: COGNITIVE MAPPING AND OTHER SPATIAL PROCESSES

Jiayi Jin, University of Nottingham

Reginald G. Golledge
JHU Press, 1999
ISBN-10: 080185993X
Hardback
Keywords: Cognitive Map; Internal Representation; Navigation; Path Integration; Wayfinding.

The metaphor of a "cognitive map" has attracted wide interest since it was first proposed in the late 1940s. Researchers from fields as diverse as psychology, geography, and urban planning have explored how humans process and use spatial information, often with the view of explaining why people make wayfinding errors or what makes one person a better navigator than another. Cognitive psychologists have broken navigation down into its component steps and shown it to be an interplay of neurocognitive functions, such as "spatial updating “and "reference frames" or "perception-action couplings.” But there has also been an intense debate among biologists over whether animals have cognitive maps or have other forms of internal spatial representations that allow them to behave as if they did. Yet until now, little has been done to relate research on human and non-human subjects in this area. In Wayfinding Behaviour: Cognitive Mapping and Other Spatial Processes Reginald Golledge brings together a distinguished group of scholars to offer a unique and comprehensive survey of current research in these diverse fields. Among the common themes they discover is the psychologists' "black box “approach, in which the internal mechanisms of spatial perception and route planning are modelled or constructed, like metaphors, based on the behavioural evidence.

Cognitive neuroscientists, on the other hand, have attempted to discover the neurocognitive basis for spatial behaviour. (They have shown, for example, that damage in the hippocampus system invariably impairs the ability of animals and humans to learn about, remember, and navigate through environments, and studies in humans show that neurons in this system code for location, direction, and distance, thereby providing the elements needed for a mapping system.) Artificial intelligence and robotics theorists attempt to construct intelligent mapping systems using computer technology. In these areas, there is growing evidence that, as in human wayfinding processes, useful representations cannot be achieved without sacrificing completeness and precision. Wayfinding Behaviour: Cognitive Mapping and Other Spatial Processes offers not only state-of-the-art knowledge about "wayfinding, "but also represents a point of departure for future interdisciplinary studies.” The more we know," concludes volume editor Reginald Golledge, "about how humans or other species can navigate, wayfind, sense, record and use spatial information, the more effective will be the building of future guidance systems, and the more natural it will be for human beings to understand and control those systems."

Wayfinding is a cognitive process to capture maplike information of the environment. Spatial orientation is “a person's ability to mentally determine his position within a representation of the environment made possible by cognitive maps.” When one is determining the position, distances will be compared. “People are not very accurate in estimating routes in metric units, although they may be able to judge relative distances. Even when distances are compared in nonmetric terms, certain complicated but relatively consistent distortions occur.” It is interesting to discover that people tend to refer large spaces into distinct areas. For example, continent will be referred in terms of countries, city will be mentioned into districts, and interior space will be highlighted into functional areas. The process of forming cognitive map is very important. It transforms the physical environment into simplified forms, contains distortions of distance, and organizes in a less schematic way.

In order to understand the origin of wayfinding, it is worth exploring the invention of a labyrinth and the nature of disorientation. The two labyrinths in the ancient cities, Palombara Sabina and Marina Franca, will be examined, which both ancient towns have applied the labyrinth design for defensive purposes. Spatial orientation and wayfinding for sighted people will be to know where one is and to have an adequate cognitive map aside from the cues in the surrounding. Thus, accuracy on orientation will be an issue. The studies on cognitive maps and the nature of distortion will be very interesting.

In many cases, open angles in cognitive maps will eventually mapped out into rectangles, curved lines become straightened, and spatial configurations are simplified into basic geometric forms. There are two common distortions. First, routes appear longer if there are many intersections, barriers, curves and reference points. “The more cluttered a route, the greater the resulting cognitive distance.” Second, a person’s liking or disliking of a place will affect the routes distortion.

Labyrinths and Disorientation

Spatial orientation allows “people an idea of surrounding space, of their positions in that space, and they allow purposeful movement within that space.” In daily basis, people are also aware of one’s position in space. However, if everything is working according to plan, then he or she will not be able to notice the mental orientation process. On the other hand, when one gets lost, then the experience of searching for the way will be a memorable experience. Thus, the invention of a labyrinth is very well-known to disorientate and, or entertain people, which has appeared at least 5000 years and used in different cultures.

There are two types of labyrinth designs. The first type is called unicursal, which is created from an older origin. It is like a spiral form that has a unique path that leads one to the centre and then out again. The aim is to let the visitors to understand the spatial arrangement and one’s position in it. The second type is called multicursal, which is developed after the Italian Renaissance as the hedge mazes. This type of design is “composed of a number of paths, forking, intersecting, and possibly leading to impasses or dead ends.” The aim of this design is to challenge one’s orientation skill in order to find the exit. Even the simplest form of a labyrinth creates a spatially complex path. Complexity is by definition not easily grasped; it is associated with unpredictability, the unknown, and the mysterious.

Another usage of the labyrinth is to evoke the fear of disorientation, which can be very effective to exclude the unwanted. For example, the entrances to Egyptian pyramids were organized with complex designed underground passages (as fig. 1):“As can be seen from the plan of the entrance to the pyramid of Mazghuna (twelfth dynasty), the use of meandering paths and heavy granite plugs weighing up to 100 tons were among the devices to delude intruders.” The layout of the plan is approximately 200 by 170 meters that can successfully disorientate any visitors without the help from the guides.

Figure 1: Egyptian labyrinth according to Canina.

On the other hand, hedge mazes are designed for entertaining purposes. However, many visitors, including children and adults, are confused with the feeling between anxiety and excitement. Although it will be just the idea of momentarily lost, the garden labyrinths can have the power to provoke excitement, motivation and curiosity.

Complex environments that challenge wayfinding can be highly valued by the user. Even the sensations associated with being lost or with not finding the way can be an exciting experience. It has to be specified that in the labyrinth example certain conditions that might be crucial are met. The person is prepared and chooses to undergo such an experience. He or she knows that the time during which they will feel lost will be limited, and that no real danger awaits.  


Labyrinths in Ancient Cities

Palombara Sabina, an ancient Italian town with 10,000 inhabitants, has developed along the hill where a castle is located at the top. It is founded in the eleventh century, and is composed of “concentric or spiral street system winding around a hill.” (See fig.2) the streets are all situated in an irregular pattern, which travels up and down the hill in a clockwise direction. The houses are built in a dense manner, where streets are too narrow for a view up to the castle.

Another ancient Italian town with the labyrinth design is Martina Franca in Puglia. It is founded in the tenth century with approximately 20,000 inhabitants. (See fig.3 and fig.4) Similar to Palombara Sabina, the houses are constructed very close together, along with chaotic street network. “The streets are often narrow, always crooked, and usually end in impasses.” Because of the irregular pattern of the streets, the experience of getting lost is expected. As the Italian historian Montuori has stated:

Getting lost in this labyrinth is a natural occurrence. Only a few reference points mark the urban fabric there is only one square, two major churches. The door and window decorations of residences belonging to the bourgeoisie, although different from one another, seem all to be made by the same family of artisans.

The feeling of disorientation can be disastrous along with frustration and anxiety. As Kevin Lynch has stated in Image of the City:

Let the mishap of disorientation occur and the sense of anxiety and even terror that accompanies it reveals to us how closely it is linked to our sense of balance and wellbeing. The very word “lost” in our language means much more than simple geographical uncertainty: it carries a tone of utter disaster.

Both ancient towns have applied the labyrinth design for defensive purposes. At the present, this characteristic has gained some excitement in the exploration. “The irregular curves and open-angled intersections make it very difficult for the visitor to situate himself. At moments he will wonder where the streets will lead him and, when finally recognizing one landmark or another, there is the thrill of the puzzle solved or the surprise of the unexpected.
Spatial Orientation and Wayfinding

The sense of orientation has the same meaning as to have the sense of direction. It is “an ability to maintain a direction while moving, or to point to a direction independently of one’s location in space and independently of cues originating from the environment.” In other words, it is about “knowing where one is and with having an adequate cognitive map.” In general speaking, it is quite difficult for many people to have that kind of ability. It is also impossible to have “pure” sense of direction, which means to maintain the sense of direction independent from any information in the environment. One of the studies in Shemyakin’s Orientation in Space has proven that “pure” sense of direction is impossible.

Another interesting fact about the awareness of one’s wayfinding and the sense of orientation is that they are affected by the level of relieve and efficiency to the final destination. For example, during the first driving lesson, one will be fully aware of the complexity to function properly with the mechanical parts in order to reach the destination. However, once experienced, then the complicity will be eliminated, and one can freely talk and drive at the same time. During that moment, the process of wayfinding will not be noticeable.
Accuracy on Orientation

There is an error margin of 5 degrees when one point out the location and then compare the result on the map. (See fig.8) However, 5 degrees in error may seem very little, but it actually “misses the destination by about 100 meters for one kilometre and by 1000 meters for 10 kilometres.”

Figure 8: A directional error of 5 degrees

Cognitive Maps

There are two important publications that put a lot of effort into exploring the importance of cognitive maps: The Image by Boulding in 1958 and The Image of the City by Lynch in 1960. Boulding has stated that “in order to understand what people do, one has to understand what people know, or, more precisely, what they believe they know.” An image is the product of how people understand their physical and non-physical environment. “Clear images of an environment contribute to a person’s efficient functioning, in particular to his wayfinding performances.”

There are two types of cognitive maps: linear and spatial linear cognitive map (as fig.9 & 10) shows one’s movement in space, which is often created by recalling the walking route. Thus it is also called as route map. “Time provides a means of ordering environmental information (one thing after another) and of dealing with complexities (one at a time).” On the other hand, spatial cognitive map is free from one’s specific position and movement. The setting is seen as a spatial subject, and it is referred as a survey map.

There are three ways of obtaining information from the spatial environment: egocentric frame, fixed frame and coordinate frame. In an egocentric frame, elements are relative to one’s position; in a fixed frame, elements and the viewer are related to a specific location; and finally in the coordinate frame, “elements in the environment are positioned in relation to some abstract system.” It is also related to the order of cognitive thinking during the development of the child. From the age up to seven, a child tends to see things in a linear manner. As the age increases along with more active exploration, spatial thinking will eventually develop.

Figure 9: Linearly and spatially organized map at building scale.

Figure 10: Linearly and spatially organized map at the urban scale.

Cognitive Distortion

Cognitive maps contain lots of distortions which are affected by one’s familiarity of the place. As one knows the place more, the size of it will become more important. In the example of the shopping complex Bonaventure, the square along with the entrance leading to the metro system are understood as the most important place, thus it is unintentionally drawn out of scale. It is proven that “metric distortions in cognitive maps manifest
themselves in differences between cognitive and real distances.” There are two major conditions that cause cognitive distortions: clutter effect and valence. The clutter effect is referred when there are so many obstacles on the route that increase the distance. The term valence means the degree of one’s liking or disliking of a place. As one likes a place it will seem shorter in cognitive distance. Another interesting reference is “large spaces are often mapped by regrouping spatial elements into distinct areas.” For example, a continent will be referred to countries, a city to districts, and an interior space to functional areas. “If two elements are situated within the same area, the distance will tend to be assessed as being shorter than if the elements are in two distinct areas.” The indication of distance and time are used interchangeably. For example, when one asks how far a place is, in normal cases, people tend to refer that by the amount of time to get there. “Time expresses the experience of moving through space, and distance is an abstraction thereof.”

Conclusion

At the end of the book, mobile robots are mentioned as a suitable tool for bringing a new perspective to the understanding of cognitive maps. The use of mobile robots deserves more attention: most of the models brought up in the previous chapters could be tested on mobile robots serving as testing platforms. Robots’ huge advantage over simulated computer models, or even purely theoretical constructs, is their real-world aspect. Animal and human cognitive maps are not restricted to perfect environments either. Some models just do not account for physical laws like gravity or acceleration, or changing light conditions. As robots are embedded into the ‘real world’, an applied model must be able to cope with all such irregularities.

In conclusion, "Wayfinding Behavior" is definitely worth reading, despite some of the foregoing criticism. By setting aside the resolution to read it from page one to page 428, but instead browsing it and attentively reading the parts of current interest, many answers are provided, and, at the same time, a further "Pandora’s box" of questions is opened.

REFERENCES:


