Individual Differences in Map Reading for Designing Maps

Banqiao, Taiwan as a case study

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Abstract: This study focused on the location map of MRT Banqiao Station as the example. Four addresses are chosen for the task of target searching, route planning, and description. The results are as the following: among the research subjects, males and females use the numbers marked on map to determine the location the most. In gender terms, females use even / odd numbers to determine the location more than males do (26% > 16%). Females choose routes that pass landmarks a lot more frequently than males (16% > 0%). Males, on the other hand, choose routes with fewer turns more often than females (27% > 16%). Male subjects have higher tendency to use names of the street to describe routes than females (34% > 29%). Females, on the other hand, tend to use describe routes with landmarks (16% > 13%). In terms or route describing when describing routes for others, they will choose routes that are simpler in case listeners may get lost. But from the aspect of route planning, males and females yield differences if they plan for themselves. If they are asked to plan a route for others, they will turn to plan a simpler route for others.

Key words: way-finding, maps design, individual differences ,banqiao

1. Introduction

1.1 Way-Finding

The term “way-finding” first occurred in the book, *The Image of the City*, which was authored by an American urban designer, Kevin Lynch, in 1960. This term emphasizes the concept of spatial ability, which refers to the ability to use maps to explore the environment in a given space and to describe space with written words [5]. Lynch, targeting residents of many cities, had investigated urban image for many years. He orderly and thoroughly analyzed what he had observed and experimented on and further generalized five elements for urban organization. The five image elements are (1) Path, referring to streets, transit routes, etc.; (2) Districts, referring to “medium-to-large sections of the city” [1]; (3) Landmark, referring to physical structures such as a buildings, signs, or geographic features; (4) Nodes, referring to the junctions of paths, along which people can travel; and (5) Edge, referring to the boundaries separating one district from another. These five elements are closely connected to one another. Lynch argues that a city is constructed by “image,” whether it is a shared image or a series of shared images. Individual images that come from residents’ cognition are unique. Therefore, it may be difficult for individuals to reach consensus.

Due to individuals' different background and experiences, the ways of way-finding and accuracy may be different too. Thus, designers should take individual differences into consideration so as to help users use maps to do their way-finding.

1.2 Way-Finding and Spatial Cognition

Way-finding is a psycho-cognitive process and will be influenced by both individual purposes and external environments [2]. Modern psychologists find out that human beings will gradually form a cognitive map in their mind during the process of way-finding [3]. According to Passini [4], the common way-finding behavior includes three interplaying steps: (1) drafting and deciding the action plan, (2) carrying out the action plan, and (3) processing the environmental information. Spatial cognition is a theory extended from environmental psychology and can be traced back to field theory proposed by the German psychologist Kurt Lewin. Spatial cognition is the result of exploring the interactions between internal power (personal needs, feelings, and attitudes) and external power (individual's sensation features in a specific place) in a human-environment relation. Therefore, each individual may yield different way-finding decisions due to the influences of personal experiences and abilities.

Getting "lost" may happen during way-finding. The situation of being lost can be classified into two types. The first situation is that those who are experiencing way-finding are not sure about their own position and directions; the other situation of being lost is a psychological reaction of those who have tried way-finding and found out that certain direction or path is wrong. Both of the two types show that people who get lost require extra information, since they are unable to get helped from the surrounding information or their memories. There are three factors that may lead to getting lost: (1) the differences of individual experiences and abilities, (2) the informational problems occurring on the path or at the decision-making point, and (3) the complexity of space layout and path design, which overlooks user's abilities [6].

Humans' understandings toward the environment grow with a series of spatial development, from landmark knowledge, route knowledge to survey knowledge [7]. If individuals know their own orientation on the cognitive map, the cognitive map in their mind can be classified into three types: (1) egocentric type, in which the position of the viewer is taken as the center; (2) fixed type, in which a fixed point is taken as the reference; and (3) coordinate type, in which coordinate system is taken as the reference [8].

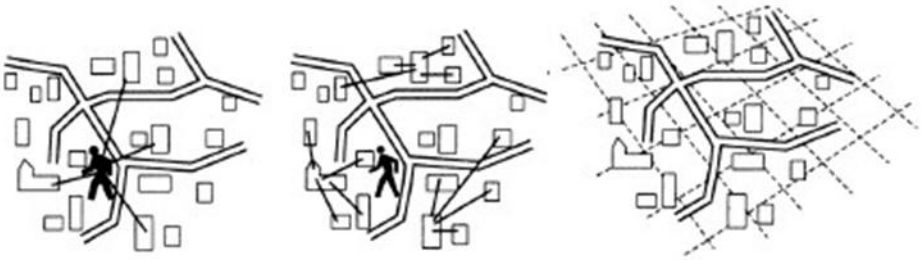

Figure 1 Reference of cognitive map: (1) egocentric, (2) fixed, and (3) coordinate.

When entering an unknown environment, one will analyze the information and deal with the problems based on the cognitive map drawn in their mind [9]. Based on the above-mentioned studies, cognitive maps may show individual differences due to personal and environmental differences, which may result in different judgments. This research hence will explore the relationship between environment and cognitive maps generated from individual differences.

1.3 Designs of Way-finding Maps

Human beings often emphasize the importance of spatial distance coming from personal impression. Therefore, it can be argued that there is no precise map in human's mind [10]; the cognitive map in a person's mind tends to be thematic and include topical expressions and personal interpretation. The research on maps explains the relationship between distance and cognitive maps. Lu points out that when constructing a cognitive map, the concept of distance comes out earlier than that of direction under the premise that the given spatial information can help the individual construct a better cognitive map [11]. Chang conducted a research targeting elementary school students, aiming to find out their spatial concept [12]. It is found that in terms of "landmarks" and "paths," girls have more "landmarks" in their cognitive maps than boys do; boys, on the other hand, show more key features on their maps. Overall, boys have better performance than girls do. This research also concludes that when designing a map for children, designers should focus more on how to present "landmarks" on maps.

A map is a tool for transmitting geographic information; a map symbol is a means of showing the content of the map. Appropriately adopting map symbols is one basic feature of maps [13]. Papenek (1971) argues that when creating an expected image, all the drawings and simulations are resulted from the process of making concrete space into abstract flat images and surface steric factor needs to be taken into consideration in order to make sure the transformed map information still possesses the original features. The very purpose of using maps is to transmit certain geographic information to the reader; any editing, symbolization, scale-reducing, projecting, etc. should all be based on the purpose.

Devlin and Bernstein conducted a research of way-finding theory and propose 3 factors of the use of maps [14]: (1) color; using different colors and figures on maps may create potential differences on transmitting information. Many statistical charts are presented with different colors; "color" is considered as the most influential factor marking or presenting visual information [15]; (2) level and detail; downtown maps may be more real due to the specificity, but specificity does not affect the functions, such as the basic ability of evaluating information. And (3) label position; according to Paivio [16], if the texts on the map are appropriately placed, they can be easily recalled. Placing pictures directly on the right side of the landmark can increase the visual speed than on the section of index [17].

It is obvious that the process of constructing cognitive map is experience-driven. Both the location of the maps and urban image are factors influencing way-finding performance. Hence, individuals may have different spatial cognitions.

1.4 Current Designs of Way-Finding Maps

The British government started setting up maps exclusively designed for pedestrians in Bond Street area in London in 2007, which are named Legible London. Legible London was set up at the entrance of underground, bus stop signs, and bicycle ducking stations. According to Department of Transport in London, 83% map users can find their way to the destination and the willingness of people's using maps to do the way-finding increased by 22%. Also, the rate of getting lost has significantly dropped 65%. The followings are the design features of Legible London:

1. It is drawn and created based on cognitive map. Studies show that during way-finding, our mind will form a cognitive map based on the place or path we are familiar with. Cognitive map can easily influence our confidence to walk to the destination.
2. It promotes walking. Walking is much freer and healthier. Although underground stations are everywhere in London, sometimes walking may be faster than taking the underground.
3. It points out key buildings and scenic spots. It helps users find their ways and people can naturally connect cognitive map to the real environment.
4. Some buildings are drawn in three-dimension. These 3D pictures of buildings facilitate users to read the map. The texts on the map tell the names of the buildings, which make the map much closer to users' cognitive map and help them to plan the route.

Figure.1 A 3D building

Figure.2 building entrances is represented on maps

Legible London, the maps exclusively made for pedestrians in London, was created according to its urban image, which matches people's mental process of route planning and meets the need of way-finding. According to the surveys made before and after the installment of Legible London, users have high degrees of satisfaction towards this design of map. It is, therefore, suggested that future map designs can take Legible London as reference so as to increase people's willingness to use maps and explore the local environment.

1.5 Experiment Area

Banqiao District, one of the major satellite cities in Taipei metropolitan area, is located in mid-west of New Taipei City, north of Taiwan. Its Banqiao Station is a union (HSR, TRA, and MRT) and a complex station where people can easily travel in and out. In recent years, Banqiao District has become the Central Business District

(CBD) of New Taipei City. Banqiao, literally meaning "wooden board bridge," was once called Fang Qiao. In the 17th century, when ship transport was still flourishing, businessmen and travelers built a wooden board bridge there for the sake of convenience. During the time of Japan's rule, Japanese was assigned as the official langauge in Taiwan. Due to the fact that Fang Qiao and Wang Xiang (missing hometown) have the same pronunciation in Japanese language, Fang Qiao was, then, replaced by Banqiao in order to ease those Japanese who stayed in Taiwan from nostalgia. The local government has been working hard on preserving local cultures. The Lin Family Mansion and Garden is one famous and historical site in this area. A stele called Fang Qiao Tablet in Banqiao Elementary School for the achievement of the expansion of Banqiao Public School is also well preserved. In addition, the local government has rebuilt and renovated a deserted training site for reserve force and turned it into a new place for arts called 435 Art Zone. In addition to the scheduled International Art Village, some part of the Military dependents' village is also reserved. People who come here are able to see both modern concrete buildings and ancient brick buildings. In this urban district where historical sites and modern economy co-exist, one can experience the prosperity of business and emerge him/herself in the atmosphere of ancient times. Such increases the value of way-finding.

Figure.3 Fang Qiao Tablet

Figure.4 The Lin Family Mansion and Garden

Figure.5 435 Art Zone

Summery

From previous studies, we could conclude that: when searching for a target or planning routes in an unfamiliar area, people will have different ways of way-finding, different decisions, and different routes due to the fact that people have personal experiences, spatial ability, information of the present environment, and diversified personal background. Besides, how much information contained in a map and the presentation of the map will not only influence people's decision and the planned route when they are doing way-finding, but also people's willingness to use the map. When more people are willing to use the map, the percentage of exploring urban space will rise. Besides, the image of the city and residents' cognition are also important factors that are needed to be considered when designing the map. If the image of the city could be blended into the design, it will help to highlight the uniqueness of one area. Compared to Taipei City, Banqiao has a special urban image by embracing both cultural heritage and modern technological development. This research attempts to design a way-finding map for Banqiao District; therefore, it is essential that the problems people may encounter when using current Banqiao map be found. Think-aloud protocol (TAP) is adopted to explore the cognitive differences produced by subjects when they are using current Banqiao map. Finally, suggestions for the design of cognitive maps will be proposed.

2. Method

This research takes the location map of MRT Banqiao Station as the example. Four addresses are chosen for the task of target searching, route planning, and description. These four locations are each situated in the east, south, west, and north side of Banqiao Station. Think-aloud protocol is adopted to record subjects' reasons of any decisions making. The recorded contents are then further coded in order to find out (1) the characteristics of the cognitive process of route planning and (2) the differences among subjects. At last, improvements and suggestions are proposed for future map design. In this research, 10 males and 10 females are chosen as the subject; the average of their age is 25. In average, they went to Banqiqo twice a year. The experiment addresses are as the followings:

Address 1: No. 9, Ximen St. (The Lin Family Mansion and Garden)

Address 2: No. 278, Hansheng East Rd. (Banqiao First Sports Ground)

Address 3: No. 44, Lane 188, Wenhua Rd. Section 1 (an Oyster vermicelli stand)

Address 4: No. 65, Guoguang Rd. (Da Ting New Village)

The experiment will be conducted as the followings:

(1) Please read the following address and point out where it is on the map.

By asking subjects to look for the target position, the reasons why the public make their decisions can be known.

(2) Assuming that you were reading this map at the entrance of the MRT station, could you plan a route to the place you wanted to go?

By asking subjects to choose or plan a route, the reasons for route planning can be known.

(3) Assuming that you had a friend who had to go to the given address from MRT station by foot, how would you instruct him or her to get to the destination?

By asking subjects to describe the route, how they use the information from the map can be known.

3. Results

The results of the experiment can be classified into three types: (1) target searching, (2) route planning, and (3) route describing. In this research, the recorded talks were all coded and further analyzed to explore the relationship between individual differences and between codes.

3.1 Target searching

The codes for "target searching" are the followings:

TS-1: numbers: determining the location according to the numbers marked on the map

TS-2: landmarks: determining the location according to the landmarks marked on the map, such as post office, schools , banks, temples, stores, shopping malls, and government entities

TS-3 left / right hand: determining the location based on the use of left or right hand

TS-4: length of street sections: determining the location according to the length of the street section marked by two numbers

TS-5: intersections: determining the location according to intersections

TS-6: even / odd numbers: determining the location according to the even or odd numbers marked on the map

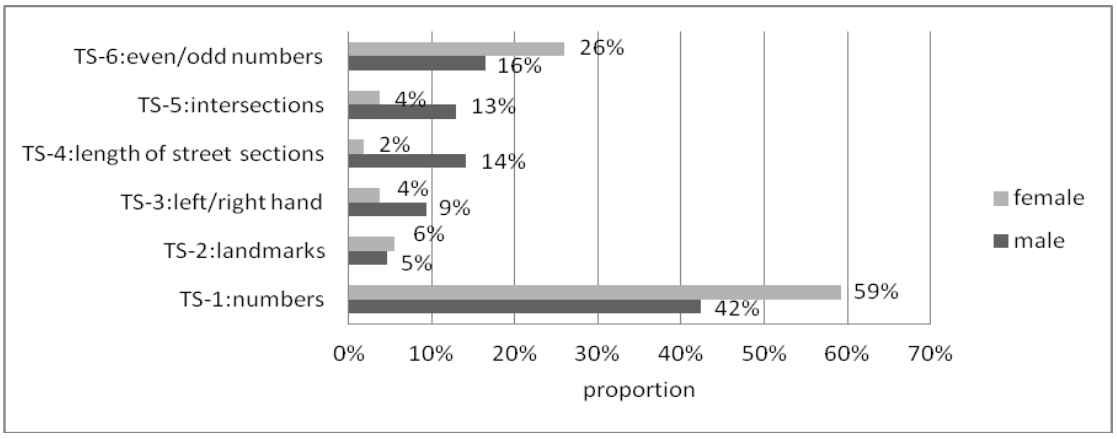

Figure .6 Gender and target searching task

According to the analyses, it is found that both males and females use (TS-1) the numbers marked on map to determine the location the most. In gender terms, females use (TS-6) even / odd numbers to determine the location more than males do (26% > 16%). Such tendency also occurs on (TS-2) using landmarks to determine the location (6% > 5%). Male subjects, on the other hand, use (TS-3) left / right hand (9% > 4%), (TS-4) the length of street sections (14% > 2%), and (TS-5) intersections (13% > 4%) more than female subjects. Overall, female subjects often use even / odd numbers to determine the location, whereas males often use different ways for route searching. Generally speaking, males and females search the target location based on their own habits and experiences. For example, they may think that the numbers marked on the map and the address are related; even or odd numbers may influence the target location. Therefore, it can be concluded that personal experiences does influence the ways of target searching.

3.2 Route planning

The codes for the reasons for route planning are the followings:

RP-1: shorter route: Choosing the route that is shorter

RP-2: major road: Choosing major roads

RP-3: landmarks: Choosing the route that passes landmarks

RP-4: fewer turns: Choosing the route with fewer turns

RP-5: simpler route: Choosing the route that is simpler

RP-6: straight route: Choosing the route that is straight

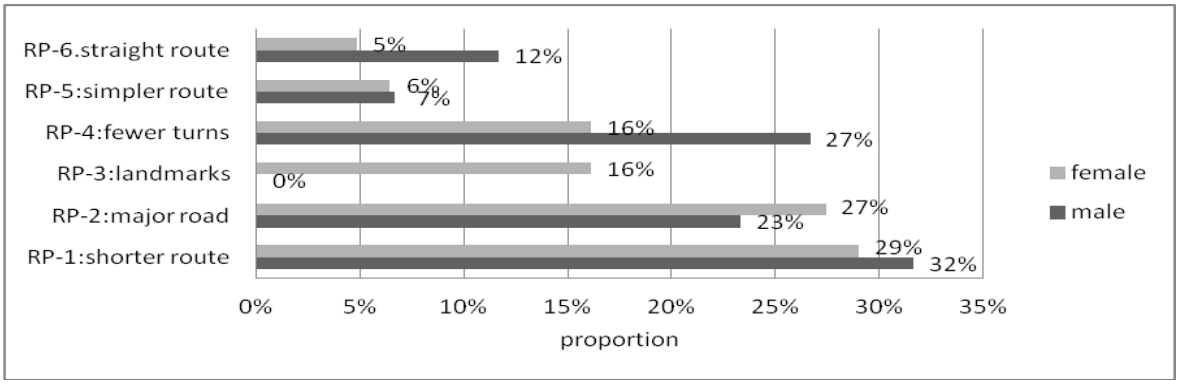

Figure .7 Gender and the reasons for route planning

The results show that both male and female subjects choose (RP-1) routes that are shorter the most. (RP-5) Routes that are simpler are also frequently chosen by both. However, in terms of gender, females choose (RP-3) routes that pass landmarks a lot more frequently than males (16% > 0%). Males, on the other hand, choose (RP-4) routes with fewer turns more often than females (27% > 16%). Overall, female choose (RP-2) major roads or (RP-3) routes that passes landmarks or (RP-4) with fewer turns more often, while males choose (RP-2) major roads or routes that are (RP-6) straight or (RP-4) with fewer turns. Hence, it can be argued that individual differences may result in difference choices of routes.

3.3 Route describing

The codes for route describing are the followings:

RD-1: Current position: pointing out the starting point

RD-2: Names of the street: using names of the street to describe the route

RD-3: Making turns: using turns to describe the route

RD-4: Intersections: using intersections to describe the route

RD-5: Lanes / Allies: using the number of lanes or allies to describe the route

RD-6: Landmarks: using landmarks to describe the route

RD-7: Directions: using four directions (north, west, south, and east) to describe the route

RD-8: Destination: pointing out the target or destination

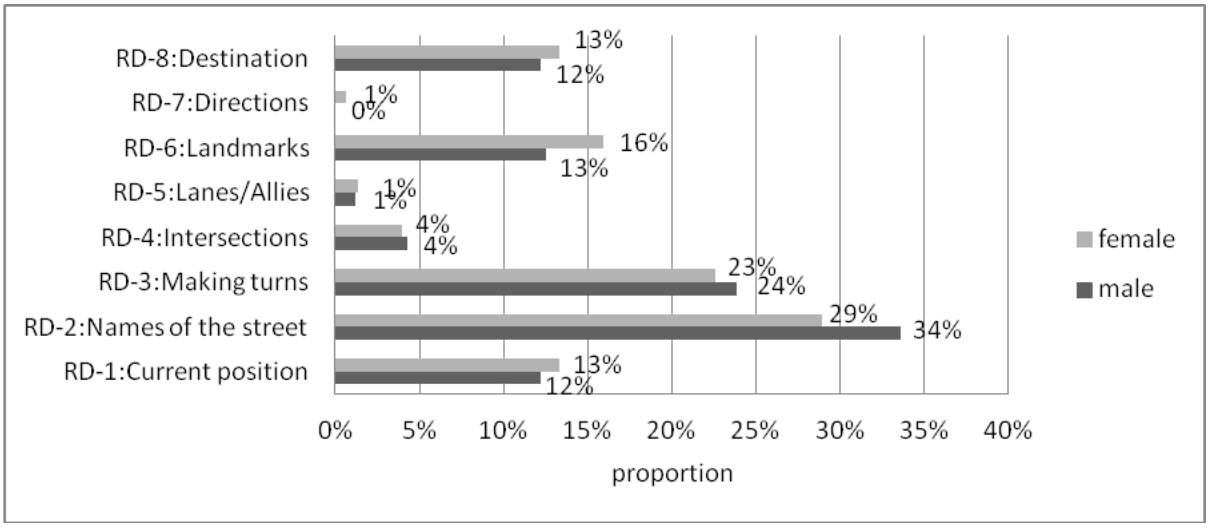

Figure .8 Gender and route describing

Results of this task reveal that both male and female subjects use (RD-4) directions, (RD-5) lanes and allies, and (RD-7 directions less to describe routes. Male subjects have higher tendency to use (RD-2) names of the street to describe routes than females (34% > 29%). Females, on the other hand, tend to describe routes with (RD-6) landmarks (16% > 13%). In overall, both males and females often use (RD-2) names of the street, (RD-3) turns and (RD-6) landmarks to describe routes.

4. Discussions

The planned routes of the participants were drawn on the map. Darker color of the route represents more people chose the same route. (See Figure 9. and 10.)

From the protocol of target searching, the majority of users use map symbols to determine the location. In address 1, subjects are influenced by the way numbers are marked and ordered; many subjects presume that the destination may be close to the continuous numbers marked on the map and think that The Lin Family Mansion and Garden could be the beginning of the address due to its wide surface. In address 2, many subjects may locate the target location with the help of the numbers of the blocks. In address 3, due to the fact that enough clues and information can be found from the map, most subjects can easily find the destination, in spite of the lack of lane numbers. In address 4, subjects are influenced by the numbers of the roads that go to different directions, which increases the time of route planning; in fact, most subjects are unable to plan the route to the destination. Therefore, how the numbers are marked on the map is one essential factor influencing map reading. In gender terms, female subjects use landmarks to plan routes more frequently (16% > 0%) than males. In route planning of address 2, we could clearly see that more female participants plan the route with landmarks than males do. In route planning of address 3, females plan more different routes than males do. Therefore, it can be concluded that both gender and map symbols may influence route planning and the judgments to the destination.

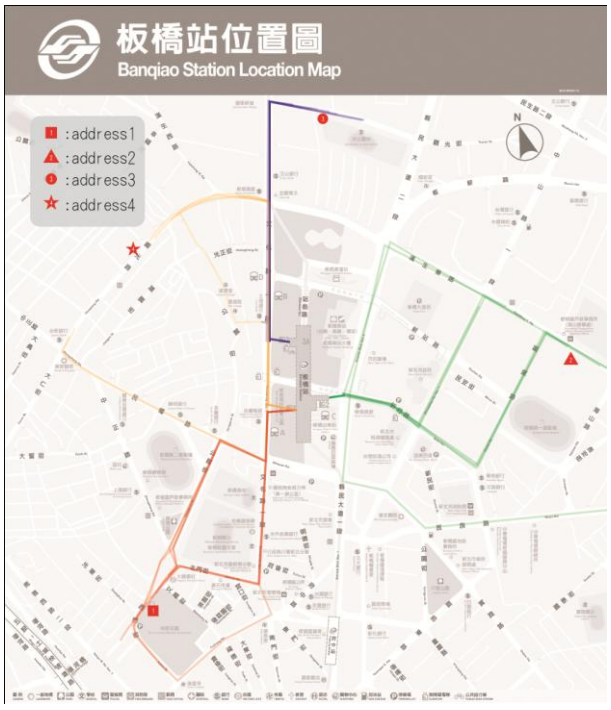

Figure.9 route planning –males

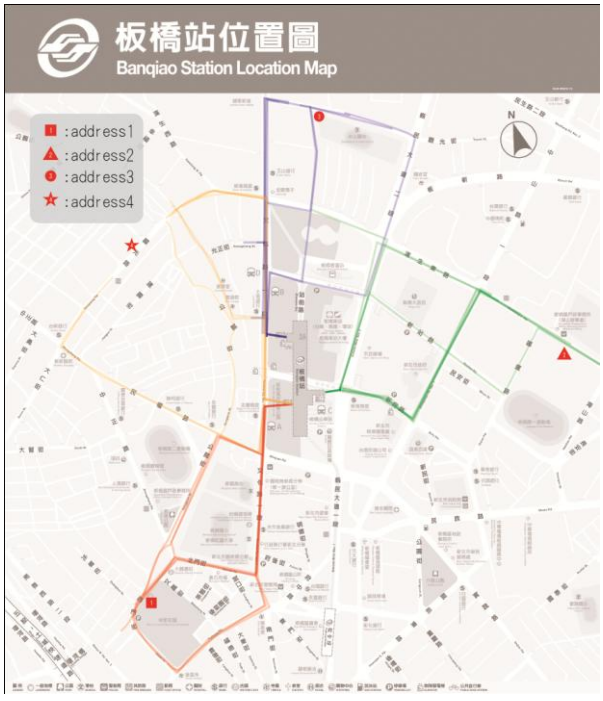

Figure.10 route planning - female

5. Conclusions

From the experiment, it is found that target searching can be affected by both the information shown on the map and personal experiences. For instance, subjects may determine the location based on the numbers marked on the map or the habits of using left or right hand. Such personal preferences may lead to totally different judgments. Therefore, the design of maps should reduce the errors generated from cognitive differences. In the future, misleading information should be avoided when designing. In terms of route planning, the two genders result in significant differences. For example, female subjects frequently use landmarks as the reference, but for males, none of them has ever used such strategy. In addition, males are found to choose routes with more straight roads than females although there is only a slightly difference in the numbers of each gender. Subjects who are not familiar with the local environment will choose major roads more often than those who are. However, with the help of the signs of landmarks, those who are not familiar with the environment may be willing to choose non-major roads. For females, safety is one prior reason for them during route planning. When engaged in somewhere they are not familiar with, they will tend to walk on major roads.

In overall, landmark is an important factor when it comes to route planning. Map designers should use landmarks as references to give information for the places that might cause confusion so as to meet users' needs. Police stations or information center should be marked on maps, so that people who need assistance could easily locate these service institutes. In terms or route describing, the two genders show similar patterns. When describing routes for others, they will choose routes that are simpler in case listeners may get lost. However, from the aspect of route planning, males and females yield differences if they plan for themselves. If they are asked to plan a route for others, they will turn to plan a simpler route for others. Hence, individual differences and the targets to whom routes are described will lead to different route planning and route describing.

This research found out the differences between target searching and individual cognitive differences. Through route planning and route describing, the way personal experiences affect users' target searching is clarified. The results found in this research can be taken as the reference for the future designing of Banqiao way-finding map. With proper adjustment, individual cognitive differences can be reduced; the efficiency to get to the destination, on the other hand, can be increased. These can lead to more effective route planning and route describing and a higher willingness to use maps.

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