Routes to Remember: Comparing Verbal Instructions and Sketch Maps

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Abstract Sketch maps of routes have been widely used to externalize human spatial knowledge and to study wayfinding behavior. However, specific studies on what information and how people recall route information they obtain from verbal instructions by drawing sketch maps are limited. This chapter aims to know how much information, especially landmarks and streets, people recall after following a wayfinding task. We conducted an experiment and asked participants to draw a sketch map of the route they travelled. Landmarks were classified based on their locations on the route. Sketch maps were compared with verbal instructions to analyze what specific landmarks and street information people recalled as well as what other information was added. Our study showed that (1) landmarks along the route were sketched as often as landmarks located at decision points; (2) participants added landmarks and streets which were not mentioned in the verbal instructions. This chapter provides a better understanding of wayfinding strategies and spatial learning.

Keywords Route · Sketch maps · Verbal instructions · Landmarks · Streets · Wayfinding

1 Introduction

In wayfinding, it is of great interest to know what a wayfinder recalls after following a route instruction from a direction provider. Usually, not all information from the route instruction is remembered. The amount of recollected information

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depends on characteristics of spatial features such as the saliency of landmarks (Raubal and Winter 2002) or how vivid the descriptions are of streets and landmarks (Tom and Tversky 2012). Except for the incompleteness, there are also cases when the wayfinder remembers other information that is not mentioned in the route instruction but rather from his or her travel experiences (Albert et al. 1999). Landmark attributes such as visibility (Denis 1997), prominence (Heft 1979), and location (Denis 1997; Lovelace et al. 1999; Michon and Denis 2001) contribute how quickly people recall information. Even the color of buildings (Jansen-Osmann and Wiedenbauer 2004) has been considered a factor which aids in wayfinding and spatial learning. In this chapter, we focused on the types of landmarks recalled based on their locations on the route. The recall of landmarks of different locations can be more beneficial in studying human spatial orientation and in learning how wayfinders relate objects in space. We also looked at types of landmarks people recalled, and what other sketching information was added which was not mentioned in the verbal instructions. We believe our study contributes to a better understanding of wayfinding strategy and spatial learning.

We used sketch maps to externalize the recollected route information which wayfinders learned from the verbal instructions and their direct travel experiences. We provided wayfinders with a set of verbal route instructions and asked them to perform a wayfinding task in an unfamiliar area. After completing the wayfinding task, we immediately asked wayfinders to draw sketch maps of the routes they had travelled. The sketch mapping activity was video recorded. Landmarks sketched were examined and classified into three groups based on their locations on the route: *along the route*, *at decision point,* and *off the route*. Sketch maps were also compared with verbal instructions to study added and missing landmarks and streets. Analysis on the characteristics of landmarks is beyond the scope of this chapter, but we consider it an interesting aspect for future work.

2 Related Work

Most people can remember the routes they travelled by following verbal instructions. Landmarks and streets play an important role for people to learn and memorize routes and environments. Garling et al. (1982) claimed that people could already learn a path almost perfectly on the first trial while taken on tour by car in an unfamiliar environment. Denis and Zimmer (1992) studied the role of verbal instructions in constructing cognitive maps. The results suggest that people are able to transform linguistic descriptions of configurations into mental representations based on the descriptions in the same way as from a perceptual experience. This also highlighted the fact that a person is able to create good visuo-spatial representations of his or her environment through verbal descriptions. Magliano et al. (1995) stated that a wayfinder was able to learn the environment based on a specific goal. For example, if the task is on landmark-based activity, people are able to follow it but learning is

only concentrated in this specific task. Our study also investigated whether people could learn an unfamiliar environment after following a wayfinding task.

Lynch (1960) emphasized the importance of paths, edges, districts, nodes, and landmarks in helping a person to understand the structural image of a place that guides wayfinding. Some studies considered paths as the skeletal structure in any map drawn first and landmarks encoded afterwards (Appleyard 1970; Garling et al. 1982). With first mapping the paths (or routes) people are able to define where specific landmarks are located (MacEachren 1992). On the other hand, Siegel and White (1975) claimed that people first learn the environment through landmark-based. Related to this claim is the anchor point theory (Golledge and Stimson 1997; Couclelis et al. 1987) stating that landmarks, nodes and regions are linked together creating subregions of organized space. Thus, one is able to create a hierarchical structure of spatial features by relating one landmark to other landmarks which helps in building cognitive map.

Lovelace et al. (1999) looked at elements in route instructions that were relevant for effective wayfinding. The study showed that not only landmarks on choice points were considered important quality of route directions. Michon and Denis (2001) found that participants often referred to landmarks for reorientation. These referred landmarks were located at "critical nodes" where a change of direction happens. The absence of such landmarks makes it difficult for people to progress in a route where reorientation is needed or when there are possible choices of directions. (Raubal and Winter 2002) highlighted the importance of saliency of local landmarks in wayfinding instructions. Landmark saliency has been further analyzed through structurally integrating landmark position on specific route instructions (Klippel and Winter 2005) and in the attempt of modelling salient landmarks in route directions looking at both visual and semantic characteristics (Nothegger et al. 2009). Waller and Lippa (2007) investigated the effectiveness of landmarks both as beacons and associative cues in learning the routes. Our study looked at which types of landmarks people remembered based on its location on the route as investigated by previous studies.

Sketch mapping has been used to externalize and study route knowledge as well as wayfinding performance (Rovine and Weisman 1989; Walmsley and Jenkins 1992; Young 1999) to evaluate how sketch maps can draw individual's environmental knowledge. Similarly, we used sketch maps to study the routes which were recalled and learned from verbal descriptions and direct travel experiences.

3 Wayfinding and Sketch Mapping

This chapter is a follow up study on a previous research on analyzing the wayfinding performance of different reference frames (Anacta and Schwering 2010). The previous wayfinding task design was modeled on the methodology of Ishikawa and Kiyomoto (2008) wherein participants were given route instructions in a shifting reference frame of directions: absolute or relative. The switching reference frame means if the participant is given an "absolute" instruction for one route then he or

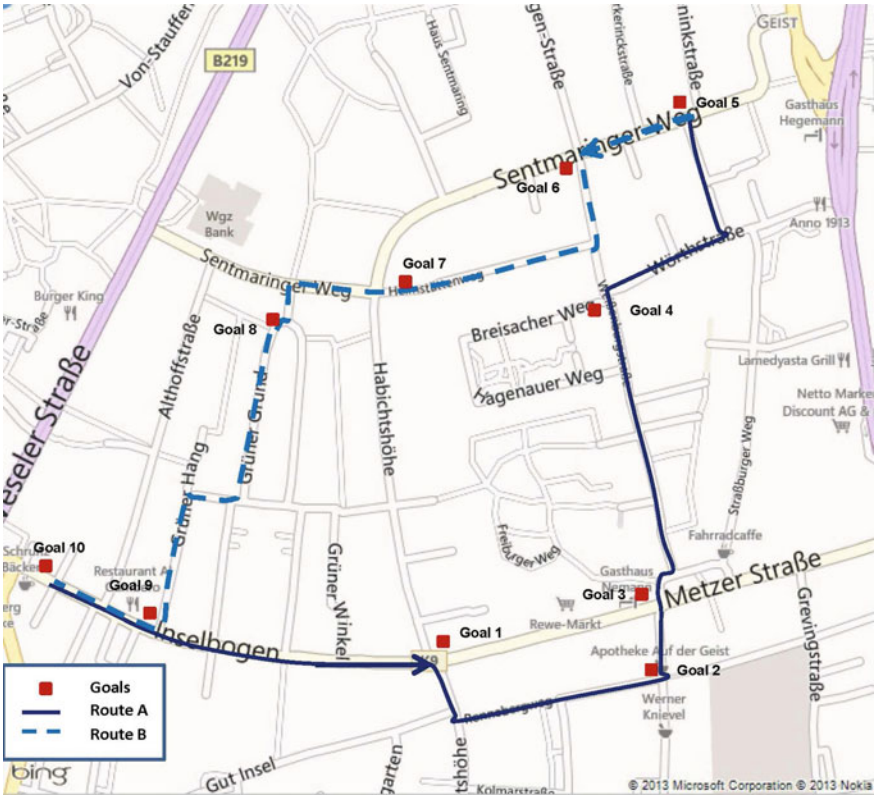

Fig. 1 The study area with the two major routes, *Route A* and *Route B*, and the 10 *goals* (*Source* Bing map)

she continues the next route by following a "relative" instruction. In the current study, we added another sketch mapping task to externalize the routes travelled.

Participants and study areas A total of 18 university students (nine female) with an average age of 23.5 years ($SD = 2.28$) participated in the experiment. These students were from diverse disciplines. The study area (Fig. 1) is a residential district in the city of Muenster and we chose two routes in this area. Route A has a total length of 1,380 m while Route B is 920 m long. The blue route is Route A and the orange route represents Route B. Both routes have a total length of 2,300 m with each sub-route ranging from 62 to 400 m. There were 10 goals specified in the verbal instructions which the participant had to reach before going to the next route. All participants claimed that they were unfamiliar with the study area and the routes.

Material and procedure We provided each participant a set of 10 verbal instructions and asked them to perform a wayfinding task. The verbal instructions were in German and they describe two major routes, Route A and Route B, with each composed of connected sub-routes. Route A is composed of sub-routes from 1 to 5 and route B

Table 1 Route A verbal instructions in both reference frames

Absolute frame of reference	Relative frame of reference
Route 1. Walk straight to ESE for 400 m. You see a block of houses to the north and to the south of the street. You see a restaurant and a hair salon to the north. You see a bakery with an automobile shop beside it to the south. You see a traffic light. You see a park to the north. After the park, you see a kiosk. When you hit an intersection, you see the bakery located ESE. You see a Teleport telephone booth [goal] to the east	Route 1. Walk straight ahead. You see a block of houses on both sides of the street. You see a restaurant and a hair salon to your left. You see a bakery with an automobile shop beside it to your right. Then, you see a traffic light. You see a park to your left. After the park, you see a kiosk. When you hit an intersection, you see a bakery located in the corner of the other side of the street. You see a Teleport telephone booth [goal] to your left
Route 2. Turn to the south and cross the street. Walk straight for 62 m. Turn to the ENE when you hit a shared pathway for bicycle and pedestrian. Walk for 220 m. You pass through a residential area where you see a white building to the north. You pass by an open space to the south. You see a parking space of a restaurant to the south. When you hit a north-south running road, you see a pharmacy [goal] to the north and a restaurant to the south	Route 2.Turn to the right and cross the street. Walk straight. Turn left when you hit a shared pathway for bicycle and pedestrian. You pass through a residential area where you see a white building to your left. You pass by an open space to your right. Then, you see a parking space of a restaurant to your right. When you hit the end of the road, you see a pharmacy [goal] to your left and a restaurant to your right
Route 3. Walk 70 m north. You see the Ulf Import Farschule to the east. Cross the east-west running road, you see a Haus Nemann restaurant [goal] to the west. You see Johanniter Akademie Gästehaus to the north. You also see Schlecker store to the east and a church to the ESE	Route 3. Turn left from the pharmacy and walk straight. You see the Ulf Import Fahrschule to your right. Cross the street, you see the Haus Nehmann restaurant [goal] to your left. You see Johanniter Akademie Gästehaus in front of you. You also see Schlecker store and a church to your right
Route 4. Walk to the NNE for 40 m and then walk 290 m NNW. You pass by the whole block of Johanniter Akademie Gästehaus to the west. You see a shop for decorations to the east. You pass by the Johanniter-Stift Seniorenhäuser Münster to the west. You cross two streets to the west. You see a whole block of brick building [goal] to the west	Route 4. Turn to the right beyond the island. Turn to the left in the first street and walk straight. You pass by the whole block of Johanniter Akademie Gästehaus to your left. You see a shop for decorations to your right. You pass the Johanitter-Stift Seniorenhäuser Münster to your left. You cross two streets to your left. You see a whole block of brick building [goal] to your left
Route 5. Turn to the NE and walk for 150 m. When you hit a shared bicycle and pedestrian pathway to the north, turn to the NNW and walk for 120 m. You pass through a residential block with a white-colored house to the west. At the end of the pathway [goal], You see a brick building to the north with a kiosk and a shop for girls on both ends of the building	Route 5. Turn to the right and walk straight. When you hit a shared bicycle and pedestrian pathway to the left, turn to the left and walk straight. You pass through a residential block with white-colored house to your left. At the end of the pathway [goal], you see a brick building in front of you with a kiosk and a shop for girls on both ends of the building

Note Original verbal instructions were written in German language

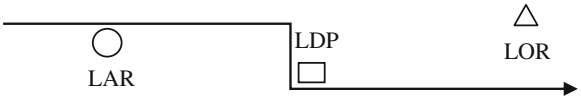

Fig. 2 A schematic view of the classification of landmarks based on locations

is composed of sub-routes from 6 to 10. Table 1 shows an example of the verbal instruction of the first set of five routes in Route A in both absolute and relative frames of reference. The experimenter walked behind the participant without any conversation.

After completing the wayfinding task for Route A, we retrieved the verbal instructions from the participants and immediately asked them to draw sketch maps of the routes they had travelled. The participants were provided with an A3 sized chapter and a pen. We asked them to complete sketching the map within 15 min. The drawing activity was recorded using a video camera. After finishing the drawing task, the participants proceed with Route B. The same procedure was followed in the sketch mapping task.

Method of landmark classification Landmarks classification was based on their locations with respect to the route proposed by Lovelace et al. (1999). These are landmarks along the route, at decision points and landmarks off the route. Landmarks along the route (LAR) refer to the landmarks located on the route which the wayfinder encounters when he or she travels along the route. LAR type of landmarks is located at either one or both sides of the route being travelled. Landmarks at decision points (LDP) are landmarks that are located at junctions or intersections where a turning action is required. Landmarks off the route (LOR) are the landmarks that are not directly along the route and they can be visible or not. Oftentimes, LOR are distant landmarks but their locations relative to the participant are known. Figure 2 is a schematic view of the classification of landmarks: circle represents LAR, rectangle represents LDP and triangle represents LOR.

4 Results

We collected in total 18 sketched route maps. The average time spent to complete sketch maps was around 8 min for Route A and 6 min for Route B. We used mixed analysis of variance, with time as within subject factor and the route group as between subject factor. There was a significant effect of time in drawing the sketch maps for the two groups. This means that it took time for participants to draw longer routes, $F(1, 16) = 11.42$, $p < .01$. The changing reference frame was not a factor for the number of landmarks drawn.

Table 2 Percentage of the landmarks recalled and missed from verbal instructions

Route	LAR (%)	LAR (missed) (%)	LDP (%)	LDP (missed) (%)	LOR
Route A	37.58	62.42	64.82	35.18	35.19%
Route B	51.59	48.41	72.22	27.78	No data[a]

[a]No landmark off the route mentioned in the verbal instruction for Route B

Table 3 Percentage of all landmarks drawn in sketch maps

Routes	LAR (%)	LDP (%)	LOR (%)
Route A	42.81	37.33	19.86
Route B	41.53	42.62	15.85

4.1 Landmarks

Landmarks recalled and missed from verbal instructions In verbal instructions, Route A has 24 landmarks and Route B has 15 landmarks. The numbers of the different types of landmarks included in the verbal instructions differ for two routes. In Route A, there are 17 landmarks along the route (LAR), nine landmarks at decision points (LDP) and six landmarks off the route (LOR). In Route B, there are seven landmarks along the route (LAR), six landmarks at decision points (LDP) and no landmarks off the route (LOR). We compared the collected sketch maps with the verbal instructions in landmark information. Table 2 shows the percentage of landmarks that participants recalled and drew and the percentage of landmarks that were missed in sketch maps.

The above table shows that participants included all three types of landmarks in their sketch maps. It was not only the landmarks of LDP were frequently drawn but also the landmarks of LAR were recalled and sketched. For Route A, participants also recalled and represented around 35 % of LOR in their sketch maps. In Route B, there is a high percentage of landmarks recalled and drawn from the verbal instructions. The table also shows the information of missing landmarks. There is a high percentage of LAR missed in Route A and less percentage of LDP missed in Route B.

Types of landmarks drawn in sketch maps We examined now all types of landmarks including missing and extra ones drawn in sketch maps. Our aim was to explore what types of landmarks people commonly sketch in route maps. Table 3 includes all the landmark information generated from sketch maps regardless of being mentioned in route instructions. The table shows that landmarks along the route were drawn as frequently as landmarks at decision points. Landmarks off the route were also evident in both routes. It occurred that all participants have included landmarks off the route in Route A which comprised almost 20 % of the total landmarks drawn and almost 16 % in Route B.

Figure 3 shows all three types of landmarks in a sketch map from one of our participants. The figure shows the first five route segments of Route A with landmarks along the route (circle), at decision points (rectangle), and off the route (triangle) (refer to Fig. 1 for the map and Table 1 for the route instructions).

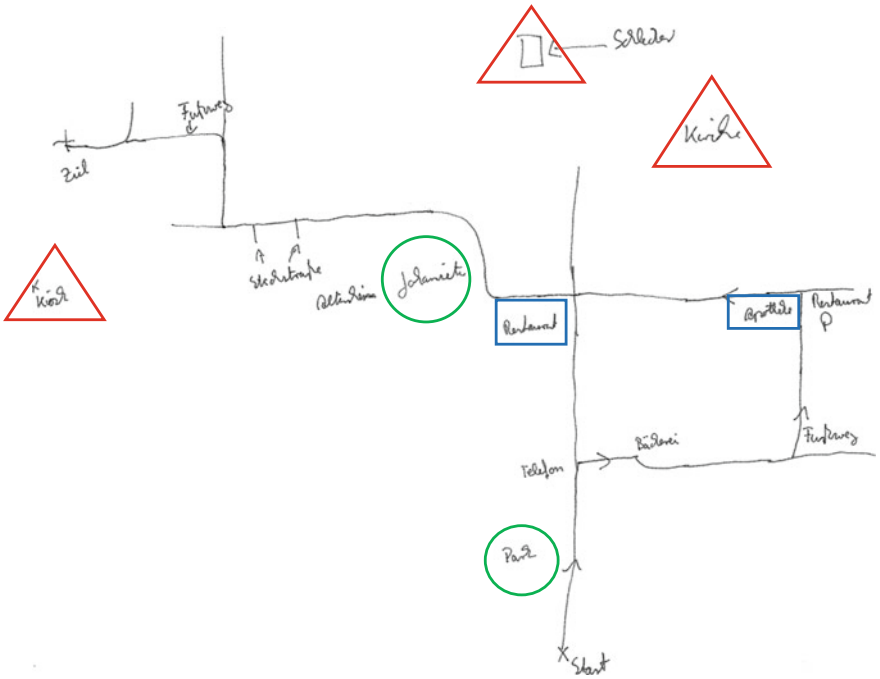

Fig. 3 Sketch map showing all types of landmark classification

Table 4 Percentage of all landmarks recalled in individual sketch maps

Landmarks	LAR (%)	LDP (%)	LOR (%)
Recalled from verbal instructions	45.89	48.02	6.08
Added in sketch maps	41.66	40.51	17.82

Landmarks drawn per participant In this analysis, we tried to examine landmarks drawn by each participant. We investigated all three types of landmarks in sketch maps comparing them with the verbal instructions. Similar to the previous results from Tables 2 and 3, Table 4 shows that landmarks along the route were drawn as often as landmarks at decision points in individual sketch maps for both routes. Regarding LOR type of landmarks, participants tended to draw extra ones that were not mentioned (17.82 %) than the ones that were mentioned in verbal instructions (6.08 %). Half of the participants added landmarks along the route for both routes.

Figure 4 shows two sketch maps with added landmarks. These added landmarks were commonly LOR type and were not mentioned in the verbal route instructions.

Taking all the landmarks drawn on sketch maps, there is a significant difference of the landmarks along the route, $F(1, 16) = 24.63$, $p < .001$; decision points $F(1, 16) = 19.06$, $p < .001$; and off the route $F(1, 16) = 19.06$, $p < .001$ using

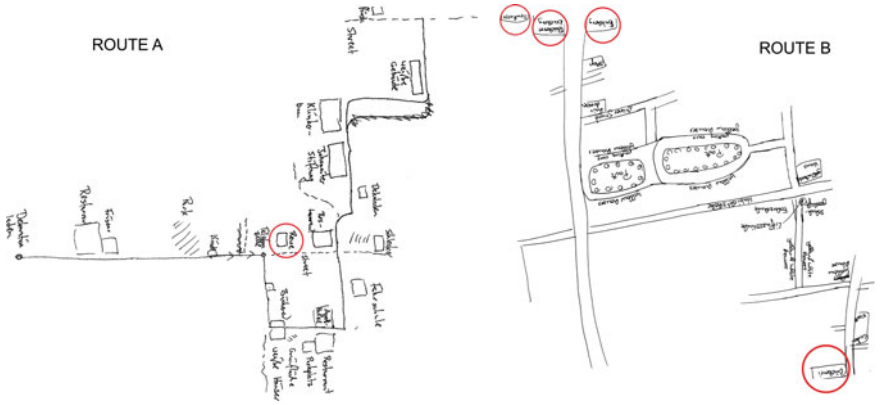

Fig. 4 Landmarks (*encircled*) are the ones added to sketch maps

Table 5 Percentage of streets from verbal instruction and extra streets

Route	From verbal instructions (%)	Not from verbal instructions (%)
Route A	79.91	13.95
Route B	85.35	12.13

mixed analysis of variance. The changing reference frame does not have an effect on the number of landmarks drawn on sketch maps.

Relationships of the types of landmarks A significant correlation occurred in the landmark types of Route B. LAR and LDP were positively correlated ($r = .66$, $p < .01$). This means that if participants draw LAR, they tend to also draw LDP. LOR, on the other hand, was negatively correlated with LAR, ($r = -.66$, $p < .01$) and LDP, ($r = -1$, $p < .01$). The more LAR and LDP were drawn, the less LOR was included in the sketch map. Regarding both Route A and Route B, there is a significant negative correlation between LOR and LDP ($r = -1$, $p < .01$). This means that if participants draw more LOR, they include less LDP in their sketch maps.

4.2 Streets

There were 13 streets mentioned in the verbal instruction of Route A and 11 streets mentioned in the verbal instruction of Route B. Table 5 shows that participants were able to recall and draw most of the streets mentioned in the route instructions. For Route A, almost 80 % of the streets were recalled and drawn. For Route B, 85 % of the streets were recalled and represented in sketch maps.

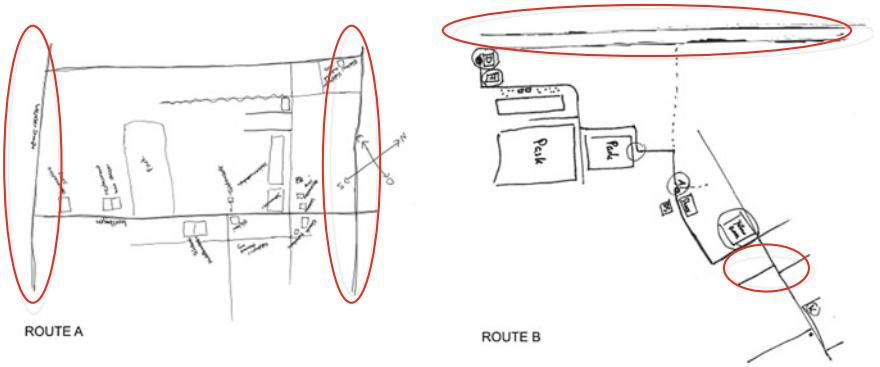

Fig. 5 Extra streets (*encircled*) added to sketch maps

Almost 78 % of all participants added streets that were not mentioned in verbal instructions in their sketch maps for both routes. Participants added and labeled mostly distant street they recognized (Fig. 5).

5 Discussion and Conclusion

This study shows what information people remember after following verbal instructions of a route. Sketch maps cannot tell everything what people learned from verbal instructions as well as travel experiences but they can provide insights into what people may recall from verbal instructions and other information of landmarks and streets that are excluded from verbal instructions. With regard to types of landmarks, people did not include all landmarks mentioned in the route instructions to their sketch maps. The importance of landmarks at decision points have been widely studied specifically in wayfinding. Denis (1997) stated that landmarks where action is required are considered the most essential type of landmark to be included in verbal route descriptions. However, we found that landmarks along the route were drawn as frequently as landmarks at decision points. This shows that participants found the landmarks without turning action made were also relevant in representing the study area. Schwering et al. (2013) also showed a similar result wherein landmarks along the route are frequently mentioned in the route descriptions and sketch maps. Our result of the types of landmarks agrees with Lovelace et al. (1999) stating that landmarks along the route are also important elements to be considered in route instructions. In the results, there was a positive correlation in one major route which suggests that when participants drew LDP, they also draw LAR. It shows that the landmarks that they mostly remember and represent in the sketch map were not only located at decision points but also along the route. When participants draw more LAR and LDP, they tend to draw less LOR. This shows that all these landmark types are commonly remembered and are considered important to be represented in the

sketch maps. Participants also remembered landmarks that are not mentioned in the instructions as well as streets. This tells us that people are not confined in landmarks and streets that they read in verbal instructions but are also interested in providing added information they have seen along the route. The landmarks that were added vary among participants wherein most of these appeared to be visually recognizable. With regard to streets, participants recalled more than half of it and included recognizable streets that are distant from the study area. These were mostly major roads.

To conclude, this chapter addresses the following aspects. Firstly, we looked at the types of landmarks based on their locations on the route. Results showed that these landmarks were not only located at decision points but also along the route. Landmarks off the route were also common types of landmarks drawn. Secondly, this chapter addresses the added information found in sketch maps. Our results showed that participants included extra landmarks and streets to sketch maps, which were not mentioned in verbal instructions. This shows that participants paid attention to the study area during wayfinding and they were able to learn extra spatial knowledge directly from their travel experiences.

This study is helpful to cognitive psychologists who try to understand how human externalize spatial knowledge both from verbal instructions and real travel experiences. This provides an idea of which type of landmarks people remember considering the location on the route. When giving directions, landmarks at decision points may be more commonly used but in this study, landmarks along the route appeared to be important as well. Participants also recalled landmarks off the route which were included in the sketch maps. Providing better orientation in an unfamiliar environment could be one reason why participants remember adding information in the sketch maps especially those landmarks located off the route. In addition, this study showed that people are able to learn an unfamiliar environment which is evident in the sketch maps showing a natural way of how people represent the environment. For future work, we intend to investigate how participants sketched route maps to determine importance of landmarks drawn. Also, it would be interesting to know how participants provide verbal instructions after following a wayfinding task.

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