Can You Follow Your Own Route Directions: How Familiarity and Spatial Abilities Influence Spatial Performance and Sketch Maps

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Abstract. Verbal route descriptions are common in our daily lives that give us wayfinding directions. They also are important in cognitive research as they lend insight on processes associated with wayfinding. This paper reports a study that investigates the influence of familiarity and spatial abilities on acquiring spatial knowledge from verbal route directions. The familiarity of the participant was removed by replacing all names of spatial entities in the route instructions given by the same person. Specifically, the types of acquired spatial knowledge addressed are direction, distance, and configurational aspects of sketched maps. Results show that familiarity plays a crucial role on acquisition of spatial knowledge at the survey level. In particular, familiarity leads to fewer errors in directional estimation, but overestimation of distance. Spatial abilities further influence one's knowledge of distance such that higher spatial abilities lead to more accurate distance estimation in new environments. With that said, lower spatial abilities do not contribute to distance estimation in both familiar and new environments. Furthermore, measures on sketch maps show that familiarity does not lead to dramatically different sketch maps while variation exist. These results also point out the necessity of follow-up studies to address the orientation specificity in familiar and unfamiliar environment.

Keywords: Route descriptions · Familiarity · Sketch maps · Spatial abilities · Orientation

1 Introduction

When a person navigates in a new environment, asking someone for directions seems like the most convenient way of finding one's path from point A to point B. Sometimes, this is even more convenient than using one's mobile device. Verbal route directions have served as important sources for researchers to understand the planning, cognitive processing, and spatial knowledge acquisition associated with wayfinding [1, 2]. Earlier studies [3, 4] assessed the elements that would contribute

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to good route directions. We all have likely had the experience of receiving verbal descriptions from someone else where these descriptions may not be easy to follow due to their style and navigational preference being different from our own. Researchers have questioned the effectiveness of given verbal descriptions on accuracy or other performances of wayfinding and examined the factors that would influence the composition of route directions [5]. Furthermore, verbal descriptions can be categorized based on their intended purposes. It is pointed out that depending on the intended addresses (direction givers or receivers) significantly impact the ways that route directions were given. It is easy to assume that when a person uses his or her own given route directions, the embedded structure and characteristics are familiar to him or her. While a person has to use the direction given by others, the effectiveness of those given directions is in question. On the other hand, verbal descriptions can also be differentiated based on the type of spatial information included. For example, A study [6] assesses the differences in acquired spatial knowledge based on types of spatial information included in verbal descriptions. Route directions containing spatial information based on landmarks, skeletal descriptions (see [7]), or metric distance would lead to different spatial knowledge acquisition. Results from this study show that various types of spatial information can lead to different forms of sketch maps, as well as, contrasting types of spatial knowledge.

Motivated by these findings on verbal route directions associated with different purposes or included spatial information, we are interested to investigate if personal factors such as familiarity and spatial abilities would play a role on acquiring spatial knowledge. If so, how do they influence spatial performance that utilizes acquired spatial knowledge? In order to address these questions, we carry out this study aiming to investigate the effects of familiarity and spatial abilities on spatial performance that requires acquired spatial knowledge involving direction and distance. This report is organized as follows: Sect. 2 introduces the related work that is keen to the background and influential factors that we investigate in this study. The methods section (Sect. 3) elaborates the design of our study. In particular, we introduce the design of verbal descriptions for both familiar and unfamiliar scenarios controlled with the same style, syntax, and amount of information specific to each participant. The following sections report the results, discussions, and a summary to conclude current study.

2 Related Work

2.1 Verbal Descriptions

Analyzing verbal descriptions to find an effective way for communicating wayfinding instructions has drawn researchers' attention from different fields. Denis and Zimmer [8] investigate the importance of verbal instructions for constructing cognitive maps. Their study shows that people are capable of transforming linguistic descriptions involving configurations into mental representations, both in text and other information. They also highlight that a person is able to construct a good visuospatial representation of the environment based on the verbal descriptions. To further understand the cognitive aspects behind the construction of spatial descriptions, Denis [9] collects several route descriptions that result in the development of skeletal descriptions. Skeletal descriptions consist of a minimal set of informative route instructions with particular importance to landmarks at decision points. Such descriptions have been tested in several wayfinding studies (see [10, 11]). On the one hand, these results show the effectiveness of skeletal descriptions as good verbal descriptions. On the other hand, other researchers analyze the contextual aspects of route instructions based on different modes of transportation and a traveler's perspective [12]. This is because people may vary their route descriptions based on several factors. Klippel and colleagues [13] emphasize the importance that such directions are cognitively adequate which could be easily comprehended by persons in need. These studies indicate that several factors would influence the generation of verbal descriptions for various people. A set of verbal descriptions that is sufficient for one person may not be helpful for another due to different cognitive capacity or information sufficiency. They also point out the importance of constructing verbal descriptions in experiments that is cognitively sufficient and efficient for an individual person. We further introduce our design of constructing verbal descriptions in the section regarding methods.

2.2 Familiarity

Familiarity is an influential factor in wayfinding and the acquisition of spatial knowledge. It indicates the level of previously acquired knowledge about an environment. Therefore, it is not only positively correlated with a person's development of cognitive maps [14], but also positively correlated with a person's wayfinding performance [15, 16]. Weisman (1981) suggests differentiating between three aspects of familiarity: the frequency, recency, and context of spatial knowledge that contribute to the familiarity of an environment. Gale and colleagues [17] suggest four different aspects: locational knowledge, visual recognition, name identification, and interaction frequency which contribute to the familiarity of an environment. Instead of considering familiarity at different levels, the purpose of this study is to investigate familiarity as a single factor that contributes to the acquisition of spatial knowledge: the estimation of direction, the estimation of distance, and the configurational change of sketch maps. As the first step in assessing the role of familiarity, we only consider two different classes of familiarity: very familiar and not familiar at all, in this study.

2.3 Spatial Orientation

Spatial orientation is an important cognitive process, especially when a person is planning routes or performing actual wayfinding. It is a vital mechanism that directly relates to the correct execution of the planned routes based on the spatial knowledge of the environment that a person acquires. A person uses reference systems to estimate his/her location and specify relationships between the current location and other places [18]. The use of reference systems differentiates spatial orientation into two types. Hart and Moore [19] classify these references systems as egocentric and geocentric. Egocentric reference systems use a wayfinder's position and heading (line of sight) to assign spatial predicates such as left or right to objects in relation to the wayfinder. It is similar to the concept of piloting introduced by Sholl and colleagues [20]. The use of egocentric reference systems involves using a wayfinder's velocity and acceleration information about self-movement [21]. In contrast, the use of geocentric (absolute) reference systems is in how a person relates to the features of an environment and determines the relative locations of a feature to other features in the environment. Sholl and colleagues [20] define spatial orientation as a process of orienting to landmarks that are hidden from view using visible landmarks and a cognitive map. In this definition, the outcome of cognitive mapping, the cognitive map, is used. It is similar to the type of spatial orientation that uses an egocentric reference system as introduced above. It can occur in both familiar and unfamiliar environments in which landmarks provide wayfinders information on their location and confirmation while executing routes [22]. In this study, we use the errors of direction and distance estimation as ways to reflect one's performance related to spatial orientation.

2.4 Cognitive Maps

When an environment is so large that one needs to travel in order to learn the space through multiple vantage points, cognitive maps or mental representations are the outcome of a process called cognitive mapping. The developed cognitive maps integrate spatial knowledge of the large environment with configurational knowledge. Regarding the acquired spatial knowledge in cognitive maps, researchers such as Downs and Stea [23] suggest that knowledge in cognitive maps includes the relative locations and attributes of phenomena in one's every day spatial environment that a person can acquire, store, recall, and decode. Levine and colleagues [24] also suggest that cognitive maps are mental copies of the environment including not only sequentially experienced landmarks but also the metric information of landmarks. In short, cognitive maps are mental models where acquired spatial knowledge is stored. In the context of wayfinding, people are able to access cognitive maps to support decision making such as which direction one should head or the spatial relationship between a location and others. Using externalized representations such as sketched maps [25, 26] is one of the common methods to assess one's cognitive map. This is evident in many studies that participants are asked to sketch a route they are familiar with [27, 28] or after following a task in an unfamiliar environment [29, 30]. Analysis of sketch maps include either qualitative [31, 32] or quantitative [33–35]. As the results of qualitative evaluation suggest, sketch maps yield high accuracy in depicting topological relationship. Therefore, in this study we adapt quantitative measures on sketch maps to assess if familiarity would affect aspects associated with configuration such as distortion, scaling, and rotation.

3 Methods

To evaluate the role of familiarity and spatial abilities of a participant on their spatial knowledge and mental representations, we design our experiment to control participants' familiarity and to assess their spatial abilities. The following sections detail the information of participants, experimental materials and procedure employed in this study.

3.1 Participants

Participants were recruited through a campus wide listserv administrated by the student association. Students who received our flyer and were interested in this study contacted the experimenter to sign up. The only requirement was that a participant should have lived in the city for more a year. In total 26 students (15 male and 11 female) participated in this study. The mean age of participants is 24.58 ($SD = 1.40$). Participants received monetary reimbursement for their participation in this study.

3.2 Materials

As one of the most important aspects in this study, creating comparable verbal descriptions for familiar and unfamiliar environments was the first task. When a participant confirmed to take part in this experiment, he or she was asked to provide verbal descriptions from the *central train station* to the *student cafeteria* in the city of Muenster. All participants were given the same scenario that someone was coming to the city for their first time and wanted to go to the student cafeteria from the central train station. Each participant should provide verbal descriptions to help this person get from the central train station to the student cafeteria easily. These provided descriptions were the basis for the authors to create instructions in the unfamiliar scenario. In particular, when a participant contacted the experimenter to schedule an experiment, the confirmation email with experiment time and location also included a task requesting the participant to give verbal descriptions from the central train station to the student cafeteria in the aforementioned scenario. Each participant's experiment took place at least a few days after signing up. During this period, we altered each participant's provided instructions to create verbal descriptions for the unfamiliar scenario. To do so, we first identified all mentioned entities in the original descriptions and replaced them with foreign street names. For the start and ending point, the *central train station* was changed to *theatre*, the *student cafeteria* was changed to *library*. The street names were replaced by the most frequently used street names in the United States [36] in order to create an unfamiliar scenario for this participant. In this way, only the spatial entities' names were changed, but the syntax, style, or information sufficiency remained the same to each participant based on their provided verbal descriptions.

In addition to familiarity, participant's spatial abilities was the other factor we investigated in this study. To do so, we selected one psychometric test mental rotation task (MRT) and the self-rated spatial strategies scale [37]. The MRT was adapted from Vandenberg's test [38] that participants had to find two out of four 3D rotated objects that was identical to a given object. Only correctly selecting both two matching objects would qualify for earning one point. Partial or non correct selection resulted in zero points. Participants' scores in this task were further adjusted for chance of random guess by deducting 25% of the number of incorrectly answered questions. The self-rated questionnaire for assessing spatial strategies consisted of 19 statements addressing egocentric strategies, cardinal strategies, and general confidence and sense of direction. Participants could rate on 7 scales from strongly disagree (1) to strongly agree (7). Participant's scores were normalized and later mean split in order to create two groups of spatial abilities: high and low in later analysis.

3.3 Procedure

When a participant contacted the experimenter expressing interest in joining this experiment through email, the experimenter provided available timeslots and asked the participant to choose his/her preferred slot, which would take place a few days later. In the email sent to a participant confirming the time and location of the experiment, the participant was also asked to provide directions in the form of verbal descriptions to help someone who is new to the city to get from the central train station to the student's cafeteria (Fig. 1). These instructions were written and sent to the experimenter. During the days before each participant's scheduled experiment, the experimenter then replaced all names of mentioned spatial entities to create the verbal descriptions in the unfamiliar scenario.

Fig. 1. Selected starting and ending locations in Muenster (NRW), Germany.

Days later the participants came to the scheduled experiment where he or she started working on the remaining tasks. All participants were not reminded that days ago they provided the verbal descriptions of getting from central train station to the student cafeteria. Instead, they were told to draw a sketch map to show the directions for someone new to the city to get from the central train station to the student cafeteria. In addition, they were asked to estimate the distance and direction to the cafeteria, while imagining they were standing at the front of the train station facing north. After that, each participant received a set of verbal descriptions that was altered based on his or her original directions. They were asked to assume that they arrived in a city they had never been to and received the directions from some locals to get from the theatre to the library. They were told to read the directions carefully and then complete a map sketching task and the estimation tasks of direction and distance. During this task, there were two participants who thought the instructions were similar to what they wrote a while ago. The experimenters then stated that it might be due to coincidence as the instructions were given for an American city, in order to distract the participant to relate this instructions with their written ones, This session ended with participant's completion of the psychometric tests including MRT and the self-rated spatial strategies scale.

4 Results

The errors of each estimation task were used as the dependent variables in a mixed design. Participants were categorized into two groups using a mean split of scores of their MRT and self-rated scores. The spatial abilities group was entered in a repeated ANOVA as a between-subject variable while familiarity was entered as a within-subject variable. Regarding direction estimation, participant's absolute errors between 0^{o} and 180^{o} were used as the dependent variable. Familiarity was found to be a significant factor that participants made fewer errors in the familiar condition ($M = 60.42$, $SD = 55.60$) than in the unfamiliar condition ($M = 88.08$, $SD = 50.53$), $F(1, 24) = 8.15$, $p < .01$, partial $\eta 2 = .25$). Spatial abilities and the interaction between familiarity and spatial abilities were not found significant factors ($p = .58$ and $p = .38$, respectively). The results are shown in Fig. 2.

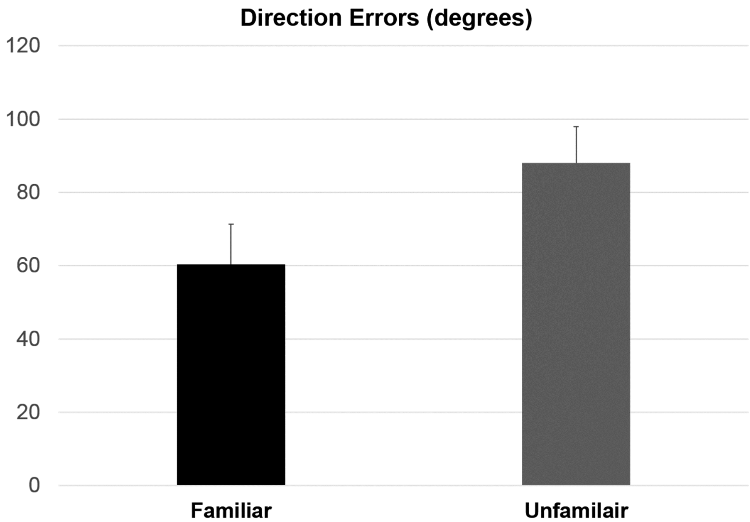

Fig. 2. Absolute errors of direction estimation in both experimental scenarios.

Regarding the distance estimation, we did not use the absolute errors in this measure as the positive and negative errors could provide us valuable information about the influence of familiarity and spatial abilities on distance overestimation or underestimation. Using the same mixed design in which familiarity was entered as a within-subject variable while spatial abilities group based on mean split was entered as a between-subject variable, results showed that the familiarity had main effect on the distance estimation errors ($F(1, 24) = 8.32$, $p < .01$, partial $\eta 2 = .26$) while the interaction of familiarity and spatial abilities also contributed to the influence significantly ($F(1, 24) = 6.50$, $p < .05$, partial $\eta 2 = .21$). The spatial abilities were not found a significant factor of distance estimation errors ($p = .67$). In particular, familiarity seems non influential to participants in the low spatial abilities group, as their estimation in both familiar and unfamiliar scenarios are similar ($M = 1.69$, $SD = 3.28$; $M = 1.56$, $SD = 3.14$, respectively). Spatial abilities seem non influential on participants in the familiar scenario as well ($p = .68$). Familiarity, however, plays a significant role influencing participants in the high spatial abilities group, as their estimation errors in the familiar scenario is higher ($M = 2.21$, $SD = 2.93$) than those in the unfamiliar scenario ($M = .11$, $SD = 1.90$). Figure 3, below, shows these results in details. We further discuss participants' distance estimation in Sect. 5.2.

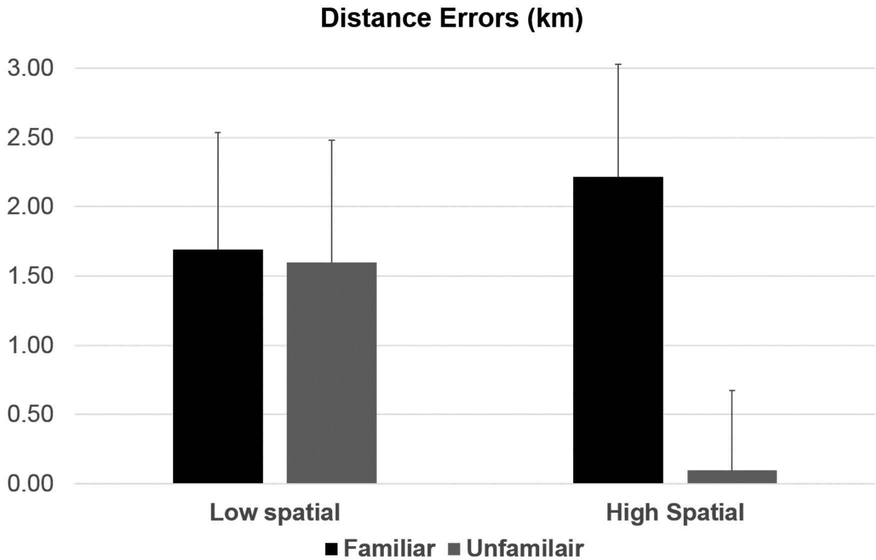

Fig. 3. Distance estimation errors influenced by familiarity and spatial abilities.

Due to the fact that participants were asked to draw the sketch map showing direction from the central train station (theatre) to the student cafeteria (library) without the requirement of including the same landmarks, the sketch maps provided by participants include various types and numbers of landmarks. This diversity made the comparison between each participant's sketch maps with a cartographic map less informative. Therefore, we only applied the spatial abilities as the between-subject factor to compare participants' sketch maps between the two spatial abilities groups. To do so, we used Gardony Map Drawing Analyzer [39] to quantify all drawn sketch maps. Once a coordinate file was created based on the first sketch map and landmarks (drawn in the familiar scenario), the second sketch map (drawn in the unfamiliar scenario) was imported to measure several aspects including configurational accuracy (r), scaling (ϕ), and rotation

(θ). The reason for choosing these measures is because they provide valuable information about configurational changes of sketch maps between familiar and unfamiliar scenarios. Each aspect of these measures was entered in a one-way ANOVA. Results showed that spatial abilities did not significantly differentiate sketch maps' configurational distortion, size, or rotation (p = .88*;* p = .98*;* p = .42*, respectively)*. However, the results from these bi-dimensional measures provide valuable information for us to understand the change of sketch maps drawn by each participant from familiar scenario to unfamiliar scenario. In particular, the descriptive statistics of configuration accuracy, scaling, and rotation of participants in both spatial abilities groups are shown in Table 1. We further address these measures in our discussion on sketch maps in Sect. 5.3.

Table 1. Descriptive statistics of participants' sketch map measures

Participants	Configurational accuracy (r)	Scaling (ϕ)	Rotation (θ)
Low spatial	.85	.78	13.56°
High spatial	.84	.78	45.64°
Average	.85	.78	27.13°

5 Discussion

Based on the results that we described above, the discussion is structured as following three sections: errors of directional estimation, errors of distance estimation, and measures of sketch maps.

5.1 Directional Estimation

The first important notion is the influence of familiarity on directional estimation. Not surprisingly, this finding confirms earlier suggestions that contribution of verbal description to survey knowledge is weak [40, 41] as the refinement of survey knowledge is sensitive to time and experience of a person [42]. Furthermore, this study further reveals that familiarity to an environment has a more dominant role on refining survey knowledge. This finding further supplements the suggestion of a previous study that development of spatial orientation which helps one to estimate direction in one environment is mostly associated with the person's familiarity [43, 44]. These previous studies suggest that the influence of familiarity on spatial orientation is more dominant than that of the environment. Although this study does not address the role of the environment, it is worthwhile in future studies to clarify the roles between environment and spatial abilities while counting the major influence of familiarity. It is likely that familiarity helps a person embed a planned route in a larger context, which contributes to globally orienting the route in an environment. Therefore, when a person has no familiarity of larger context in the environment, he or she is likely to be less spatially oriented.

It is also important to note the large errors of estimation by participants in both familiar and unfamiliar scenarios. Even in the familiar scenario, participants' estimation had errors over 60°. The error is greater when the instructions were altered to appear as an unfamiliar environment to participants. This further indicates that the refinement of spatial knowledge is a lengthy process, especially if one does not acquire spatial knowledge of the environment through representation such as maps.

5.2 Distance Estimation

Participants' estimation of distance in this study shows large variation. In general, the influence of familiarity and spatial abilities seems more intricate. It is easy to note that familiarity seems non influential on participants with lower spatial abilities, as their errors of distance estimation are very similar between the familiar and the unfamiliar scenario. It is interesting to find that in the unfamiliar scenario, participants with high spatial abilities are benefited the most. Their estimation of distance based on the altered route descriptions yield very small errors. Furthermore, if only considering the main effect of familiarity, all participants overestimate the distance in the familiar scenario rather than in the unfamiliar scenario. The findings here are parallel to the suggestion from a few previous studies. For example, Sadalla and Magel [45] suggested that a higher number of turns in an environment leads to overestimation of distance. This suggestion explains our findings in this study as well. When participants were estimating the distance from the central train station to the student cafeteria, they mentally walk through the route in order to estimate the distance. The mentally walked route involved small turns or slight changes of direction, which were not exactly represented in their verbal descriptions or sketch maps. Those provided verbal descriptions and sketch maps show the route in a simpler fashion to make the directions easier for a person to follow. Therefore, when they were given the altered verbal descriptions, the number of turns is directly controlled by the information provided in those directions, which leads to less number of turns, hence less overestimation. This finding was later verified and replicated using a virtual environment (see [46]). Furthermore, an early study by Cohen and colleagues [47] discussed the roles of task demand and familiarity on estimation of distance that showed estimation of distance is more accurate in an unfamiliar environment than in a familiar environment. A recent study by Jackson and colleagues [48] also demonstrated that spatial experience such as time spent in an environment does not lead to improvement of estimation but overestimation. The factor that contributes the refinement of distance estimation is not time in an environment but the evolutionary navigation costs. These theories also explained participants' performance of distance estimation in this study. When participants are given altered directions, they have to actively engage and process the provided information during the experiment to estimate. While during their daily activities in the city, their acquisition of spatial knowledge and learning of the environment could be subconscious and not so purpose oriented.

5.3 Sketch Map Measures

Results of sketch map measures further confirm that the influence of spatial abilities on configuration of sketch maps is not dominant. Based on our measures of the configurational aspects of sketch maps, including distortion and scaling, participants in both spatial abilities group have almost the same ratio indicating that the distortion of sketch map configuration is not affected by spatial abilities. Looking at the configurational accuracy, sketch maps drawn based on altered verbal descriptions only have about 15% distortion. Similarly, the scaling indicates how much a sketch map is resized when participants draw them based on altered verbal descriptions. Participants in both spatial abilities groups tend to draw sketch maps 22% smaller than the ones drawn based on their own spatial knowledge. This could be an indicator that familiarity may have played a role influencing the size of sketched maps. When participants are familiar with an environment, they are likely to think of more details. According to our earlier discussion on the overestimation of distance, they tend to draw longer lines and more segments of street. They can both lead to a larger configuration of a sketch map. When participants read through the altered verbal descriptions which provides the only available spatial information, their estimation of distance seems less, hence the drawn segments of streets would be shorter.

The third aspect of sketch map measures on rotation, worth further exploration. As the rotation is related to participant's orientation, our findings in directional estimation are also associated with this aspect. We introduced earlier that due to the familiarity of a person, the participant can orient the planned route within a global context of environment, which can be orientation specific. Depending on the position of the participant when taking this task, participants could rotate the page to draw their orientation-specific sketch maps. When processing the altered verbal descriptions, participants no longer have an orientation-specific context to embed the route, so most of them tend to draw a sketch map align their map north with the upright orientation of the given sheet. It is necessary to point out that the accurate angle between the start-end locations and north is -68^{o} (68^{o} anti-clockwise). All participants tend to rotate their orientation-specific sketch maps clockwise towards a north-upright alignment in the unfamiliar scenario. In particular, higher spatial abilities participants rotate sketch maps 45.64^{o} clockwise and lower spatial abilities participants rotate sketch maps 13.56^{o}. Because we did not specify the sitting position of each participant, it is unknown if their facing direction during the sketching task would influence this sketch map measure. We plan to carry out a follow-up study, in particular, to address the influences of familiarity, spatial abilities, and actual sitting position on the configurational rotation of sketch maps.

6 Conclusion

Verbal descriptions are common in our daily lives helping one get from one location to another in a new environment. We acknowledge the large individual variation among people's given directions, creating only one version may not meet the need of individual's information sufficiency and style. To avoid this bias, we design to create the familiar and unfamiliar conditions based on ones' own given directions. We only replace the names of entities such as street names and landmarks in the directions and keep the syntax and amount of information the same. Therefore, each individual would be acquainted with the style that verbal descriptions are given. Besides the familiarity as a considered factor, we employ psychometric tests and self-rated spatial strategies to place participants into two groups: high spatial abilities and low spatial abilities. Participants' performance such as estimation of direction and distance and measures on sketch maps were used as dependent variables, while these introduced factors were entered as independent variables in our analyses to investigate the different roles that they play. However, it is important for use to acknowledge that we have only asked each participant to estimate only once in each condition regarding direction and distance. The estimations may have not fully represented a participant's full scale of spatial knowledge but mainly the survey-level knowledge of direction and distance, Further studies are needed to investigate more comprehensively about one's spatial knowledge.

It is important to summarize the impact of familiarity on spatial performance together with spatial abilities. The most important finding of this study is that it shows different impacts that familiarity and spatial abilities have on various aspects of spatial performance. Familiarity plays a dominant role on spatial orientation that involves direction regardless of spatial abilities. Regarding spatial knowledge associated with distance, familiarity tends to have a negative role on accuracy of distance estimation. This is because of the mentally navigated route in an familiar environments involves more details and small turns which are normally eliminated when expressing routes for others for navigation purpose, these details and higher number of turns lead to overestimation of distance. However, when given descriptions of an unfamiliar environment, participants with higher spatial abilities seem to benefit the most. Their higher spatial abilities lead to more accurate estimation of distance when they actively engage and process the provided descriptions. Participants with lower spatial abilities estimate almost the same in both familiar and unfamiliar scenarios. The measure of participant's sketch maps confirm the findings in estimation of direction and distance. Like the estimation of distance, familiarity tends to lead one person to draw a slightly less distorted and larger sketch map. The orientation of sketch maps seems to be perspective specific when one is familiar with an environment. In unfamiliar environments, the sketch map seems to be orientation free that north of the map is aligned with the upright direction of page. The information may provide some more evidence to characteristics regarding cognitive maps developed in familiar and novel environments. These results provide useful information regarding the design of navigation systems that can contribute to one's spatial orientation compared to the poor contribution of existing navigation systems regarding this aspect (see example in [49]).

It is also important to acknowledge the limits of this study. First of all, due to its relatively small sample size, our results show necessity for further investigation on the roles of familiarity and spatial abilities on acquiring spatial knowledge with more participants. Second, we instruct participants to perform free sketching task without requiring them to include identical spatial entities in their verbal descriptions and sketch maps, which provides difficulty when comparing each participant's two maps with a cartographic map. In order to clarify the role of familiarity on sketch maps, we aim to design an experiment that controls the number of landmarks to be sketched in order to provide a comparable basis. In this way, sketch maps will be further compared with metric maps for more qualitative assessments. Third, our finding of the orientation specific and orientation free trend in drawn sketch maps of familiar and unfamiliar environments motivates us to further investigate if the siting position and facing direction would play a role on the orientation specificity of sketched maps. To do so, we will conduct an experiment with a siting condition factor, together with the factors of familiarity and spatial abilities to shed light on their impacts.

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