Gender Differences in Spatial Cognition: Wayfinding Performance and Sketch Mapping Activity of German Speakers

A Master Thesis

by

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Abstract

This study aims to examine the wayfinding performance of men and women in a shifting frame of reference while following an outdoor wayfinding task with instructions given in German language. This is replicating the methodology of Ishikawa and Kiyomoto (2008) but adding gender component in the study. Twenty-four (24) German students composed of 12 men and 12 women in the undergraduate and graduate level who are unfamiliar the study area participated in the experiment. Snowball sampling method was used to gather participants. The participants were divided into the absolute-relative (A-R) and the relative-absolute (R-A) groups. For the A-R group, the first set of instructions were given in the absolute frame and shifted to relative frame of reference. The R-A group, on the other hand, the participants walked the first route set following relative directions before shifting to the absolute directions in the second route set. The wayfinding measures used in analyzing the participant's performance were the number of stops, number of deviations, and the off-route distances they made. Also, included are the time spent and the walking speed of each participant. Mixed ANOVA was used for statistical analysis of the result. It resulted in the experiment that participants in both groups had difficulty following the absolute instructions. The A-R group showed more stops and deviations in the whole experiment for the shifting frame of reference. In terms of gender, women made few stops, few deviations, and did not walk off the route frequently based on the absolute or relative frame. A correlation between the result of Sta. Barbara Sense of Direction Scale and the three wayfinding measures was done to examine the individual differences in terms of their spatial skills based on their performance. There were some uncontrolled situations that occurred while the experiment was being undertaken such as the changing weather condition wherein some experiment days will be rainy and snowy however, it did not affect the participant's wayfinding performance.

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CHAPTER 1

INTRODUCTION

Wayfinding is an interesting area of study as it looks at how people would easily find their routes in both familiar and unfamiliar environment. This is a common problem for most people finding their location given limited knowledge of the place. Oftentimes, people have difficulty finding their way due to several reasons either there is something wrong on how signs and directions are placed in the environment or that people may have problems orienting themselves in the area. A number of studies have been undertaken with regard to knowing gender differences in wayfinding. Many researchers in various fields such as geography, psychology, architecture, engineering, and computer science to name a few have looked at how to make wayfinding easier to people.

There are differences in people's spatial abilities. Some may find it easy to locate a specific place while others could have difficulty. It could be unclear for a person to navigate the route because s/he might have problems understanding instructions. Hence, route directions need to be clear as well. It is necessary to place oneself in the situation of the person unfamiliar to the place and understand that people have their own preferences in finding their way. In this study, people's preferred frame of reference will be examined either in absolute frame which means giving the cardinal directions (North, East, West, and South) and in providing the exact distances in a specific unit of measurement or the relative frame of reference (e.g. right or left) wherein depending themselves with the number of landmarks provided. Thus, many possible ways could be taken into account when giving directions.

Objectives

This study aims:

1) To identify gender differences in following an outdoor wayfinding task in an unfamiliar urban environment based on the frame of reference.
2) To know the wayfinding performance of participants based on the number of stops, deviations and off-route distances with respect to following a shift of frame of reference.

3) To evaluate differences in participant's level of spatial cognition in terms of how much information has been recalled such as the number of landmarks through sketch mapping.

Background of the Study

Several studies have been done with regard to knowing how people use their spatial abilities in navigating. Many experiments have been undertaken to identify reasons of such differences. This ranges from psychometric to navigational tasks. However, it is taken into consideration that the concept of spatial ability and spatial cognition has been seen as vague (Weiss et al, 2003). Many researches have dealt with knowing the spatial abilities of people by way of providing some activities or exercises. Understanding the medical explanations with regard to such differences have also been undertaken.

Gender differences has become a topic of interest to many of these scholars. Studies show that men and women perform differently in various spatial tasks. Hence, the level of spatial understanding differs in both sexes. Iachini et al (2005) looked at differences differences of men and women in object recognition wherein there was no difference but in recalling the spatial layout of the place, it appeared that men performed better than women. Montello et al (1999) highlighted the superiority of female in object location and that they made fewer mistakes in recalling landmarks from the campus route activity. Males, on the other hand, showed better spatial ability by using metric distances and cardinal directions in thinking of an environmental space. Lee et al (2007) also showed a similar result whereby female subjects responded faster in a 2-D matrix navigation task than males when landmark instructions were provided to them. The differences is quite interesting to look at as it follows the idea of women being more confident in relative direction-related tasks while men are more on absolute directions. Hence, this study will perform similar tasks but will focus on the changing frames of reference to understand the level of spatial differences of individuals and to know the preferences of men and women in terms of frame of reference.

Significance

Wayfinding is seen as an important field of study that improves how people could think spatially. This addresses the need for an effective way of sending information to people helping them in finding their destination easily. It is interesting to know how people who are unfamiliar to the place would usually be more inclined of following either absolute or relative directions. In this study, this will be highlighted by identifying any gender difference in wayfinding. Since this study will replicate the methodology done by Ishikawa and Kiyomoto (2008) applying now for German speakers, it would allow further research in looking more on cultural differences in spatial cognition. In comparison with other culture, it will give ideas where differences lie as well as how one culture is able to perceive spatial objects and how they deal with spatial-related activities.

In this way, such result will be a good basis for evaluating the individual's level of geographical knowledge. This could also be used in assessing how they would mostly orient themselves in space and how they would normally refer to spatial models in reaching a specific destination.

Hypotheses

1) There are differences of wayfinding performance between men and women in an unfamiliar environment in terms of the number of stops, number of deviations and off-route route distances traveled.
2) Men are usually better in performing absolute directional instructions whereas women do not only outperform men in relative frame of reference but are also relatively better in absolute directions.
3) Women draw detailed sketch maps than men in terms of the number of landmarks.

Limitation of the Study

Time has been the major constraint in this study. It was no longer possible to choose days with the same weather condition when the experiment started due to the season. Hence, there were days wherein it will be sunny, rainy and snowy.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter reviews some literatures related to the study on gender and wayfinding. The discussion on related works is divided into frames of reference in route instruction, gender differences in wayfinding, and sketch mapping activity.

Understanding how people think spatially is an interesting endeavor in acquiring knowledge on human-environment relationship. Many people put less importance on such discipline however, there are still many things to be learned from this field. The behaviour of people in space provides many possible applications in technological aspect such as usability. What makes spatial cognition interesting is it cuts across various fields of knowledge. Spatial cognition has been intensively studied in the twentieth century by various sciences such as ethology, cognitive and behaviorist psychology, neurology and brain sciences (Levinson, 1996).

One common topic under spatial cognition is wayfinding whereby its application range from humans, animals to intelligent machines. Finding the right path in an unfamiliar environment challenges more an individual's spatial ability. There are cases when a person develop anxiety towards reading maps and following directions specifically in absolute frame of reference.

Several studies on wayfinding have been conducted either in both indoor and outdoor environment. Raubal (1997) studied wayfinding at the airport and developed more related works. Hence, proposing probable techniques on how wayfinding could be efficient in such environment in the form of salient cues, signages and landmarks. Moreso, other related studies suggest that cognitive scientists and architectural designers need to work closely in planning an efficient building especially in designing staircases for multi-level buildings (Vrachliotis, et al, 2007; Hölscher, et al, 2007).

Wayfinding studies also range from looking at differences in culture, gender and age such as one example examining the negative relationship between age and spatial ability (Kirasac, 2000). That the older a person gets, the poorer is his spatial ability such as the case of declining learning of environmental layout.

Frames of Reference in Route Instruction

Levinson (1996) stated that there are three frames of reference – intrinsic, relative, and absolute. For intrinsic, this pertains to the object's coordinate system whereas for relative, this would be with respect to the speaker himself. Absolute reference framework, on the other hand, refers to the cardinal directions. The author emphasized that language plays a major role in cognitive specializations.

Directions are usually given either in relative or absolute frame of reference. People have varying preference of which is easier to follow. Lawton (2001) conducted an internet survey in the US that American women would usually refer to buildings as landmarks and give "right" and "left" directions while men use cardinal directions in giving route instructions. Men are better in both egocentric and allocentric frame of reference (Beatty and Troester, 1987). Drivers who listened to directions were able to drive to the destination in lesser time and fewer miles than those who read maps (Streeter et al, 1985). This compared taped instructions and route maps as navigational aids for drivers. Ishikawa, et al (2007) conducted a study on wayfinding using a GPS device which resulted that participants using GPS traveled more distances and made more stops than those who are using maps and with direct-experience. Thus, it shows the ineffectiveness of GPS as a navigation system method.

Golledge et al (1992) emphasized the need to understand how people acquire knowledge of the environment. Route learning has captured interests to several researchers of various disciplines specifically in the geography field. There is superiority of survey learning in unfamiliar environment at varying geographic background and with gender differences (Golledge et al, 1993). Lawton (2001) looked at how the geography of the place may affect how people would give directions such as the case of the Midwest/West region in the US wherein they would refer to cardinal directions which might be attributed to their grid-like pattern road network.

Lovelace and Montello (1999) looked at various ways of assessing the quality of route directions. The authors discussed theoretical model of creating a route direction in three steps. These are: (1) activation of a spatial knowledge, 2) Choice of a specific route and 3) Translation of environment into a set of verbal instructions. The quality of route directions could be measured

in a number of ways such as the inclusion of landmarks, turns, segments, and descriptive information. These could also be measured subjectively such as asking people to rate the directions. And, finally the quality could be measured in terms of how well they are able to complete the task.

Researchers have seen cultural differences such as the Japanese speakers prefer relative frame of reference (Ishikawa and Kiyomoto, 2008). Such study looked at how Japanese students fared when there is a shift from relative to absolute direction or vice versa. It is also interesting to look at other ethnic groups such as the Mayan culture where the most preferred frame of reference is intrinsic (Levinson, 1996).

On Gender Differences in Wayfinding

It is oftentimes considered as a stereotype that women have more difficulty in any wayfinding task than men (O'Laughlin and Brubaker, 1998). There is a tendency for women to even think that they have a poor sense of direction and they cannot sometimes follow direction specifically absolute frame of reference. Several studies have been conducted to show whether there are gender differences in some spatial skills or not. The results are diverse that would show that men are better than women while others say that there are no differences.

There is male advantage in angular judgement and travel distance elimination (Holding and Holding, 1988) that women tend to show bias towards underestimation and they were guessing in some spatial tasks. In a neuropsychological test conducted, it resulted that men are better on visual-spatial tasks such as spatial orientation, mechanical abilities and mathematics while women outperformed men on most verbal tests (Weiss, et al, 2003). Although, there is a decreasing gender difference in mental rotations test over time (Masters and Sanders, 1993; Colom, et al, 1999).

Eals and Silverman (1994) highlighted the fact that there is female advantage in recalling spatial object. The authors related sex spatial differences from the hunter-gatherer theory wherein men have been tasked for hunting animals and women were engaged in foraging task. Like for women, since they are mostly involved in locating food sources, there might be an effect on how

they are able to retain locations of objects in the environment. Silverman, et al (2007) followed the previous paper using the BBC internet study. The result says that men scored higher in 3-d rotation while women scored higher in object location memory in most of the 40 countries. Following a similar result, Montello et al (1999) said that females are superior on object location memory where they had few mistakes in recalling landmarks in a campus route. The authors emphasized the idea of giving wrong assumptions that males are better than females in terms of spatial abilities because they vary in different level. Males show greater ability to judge distances and more on cardinal directions in thinking of the environmental space and females have shown spatial anxiety thereby reporting poor sense of direction. In an indoor wayfinding, men were more accurate in locating the direction to the destination and women showed more uncertainty in carrying out the task (Lawton et al, 1996).

Lawton (1994) studied that women tend to have spatial anxiety than men. This might be the reason why they mostly have some hesitations in doing spatial tasks such as navigating in a new environment or fear of reading maps. In a cross-cultural study, Hungarian and American women tend to show high spatial anxiety (Lawton and Kallai, 2001). Schmitz (1997) studied gender differences on wayfinding in a three-dimensional maze of some German students. It resulted that girls developed high anxiety and fear than boys when going through the maze. It also turned out that those subjects who were slow in the experiment and scored high in anxiety and fear tend to recall more landmarks than those who were less nervous.

Route strategy and orientation strategy were taken into account as they are important in knowing one's spatial ability. It resulted that men are more into orientation strategy (which refers to cardinal directions) while women use route strategy refering mostly to landmarks. Women prefer route strategies when asking for directions and tracking the distances while going through the routes in an unfamiliar environment whereas men use cardinal directions more often for orientation (Scholl et al, 2000). Females are better in following spatial navigation when landmarks are provided (Kim et al, 2007). It is in dynamic navigation following Euclidean instructions that men outperformed women. Women use topographical rather than Euclidean navigational strategies (Silverman and Choi, 2006).

In a related study, Sandstorm et al (1997) used a computer-generated virtual environment to determine sex differences in navigation. In the experiment where the participants navigated through virtual water maze, females rely mostly in landmarks while males rely on both landmark and geometric information. Ward (1986) showed also that people mostly rely on listing landmarks and turns while giving directions where men would use absolute indicators than women. However, Hund and Minarik (2006) stated in their study that men and women were more fast and accurate when navigating based on cardinal directions than in landmark directions.

There had been an increasing number of studies about no gender differences on spatial cognition specifically learning a spatial a skill. Spence et al (2009) trained selected participants in learning a new video game. Such training method proved that women could equally aquire a basic spatial skill with men. There was no gender difference in sketch mapping task although women reported less confidence in the floor plan's accuracy (O'Laughlin and Brubaker, 1998). Both genders were still able to perform at the same level in the mapping task.

On Sketch Mapping Activity

Sketch mapping is an interesting activity to determine one's mental representation of one's spatial environment. Wise (1990) used sketch maps to assess the student's representation of the world by conducting a pre-test and a post-test. The author emphasized the importance of sketch maps for a geography teacher whereby evaluating student's mental map before and after the course. Metz (1990) also did the same method to assess the progressive levels of learning of the students. Taketa (1996), on the other hand, introduced field sketch mapping to elementary students in order to practice how to use measurements in the map.

Distortions in sketch maps are inevitable. Buttenfield (1986) used multidimensional scaling (MDS) as one technique to measure systematic error and distortions in the representation. There are other techniques now being applied in making sketch maps for educational purposes. This includes SketchMap system as an aid for primary school pupils to draw maps (Ravasio, et al, 2006; Sugimoto et al, 2006). This method has been widely introduced in some elementary schools in Japan.

Although such techniques are interesting to be applied in the sketch maps that will be produced in this experiment, it could not be possibly undertaken due to limited time frame. SketchMap system encourages interest among students in creating sketch maps.

The present study attempts to replicate the methodology done by Ishikawa and Kiyomoto (2008). Although, this study will also consider both the Absolute-Relative and Relative-Absolute groups, wherein also investigating gender effects in terms of the frame of reference. Much is taken into consideration for following their work. It is interesting to find out whether German speakers also prefer relative directions like the Japanese speakers in wayfinding when a shift to another frame of reference is introduced.

CHAPTER III

METHOD

Pre-test

Before the final experiment, a pre-test was conducted with eight international masters students from the Institute for Geoinformatics (IFGI). Three Indonesians, three chinese and two Indian nationales. Their ages ranged from 22-28 years old. The mean age is 24.87 years. The group was composed of three men and five women. They were given instructions in English and they walked through all the routes. While doing the pre-test experiment, many changes in some instructions were made such as changing incorrect turns, the type of landmark which were not visible for most of them, and the structure of some instructions which were not clear to them. Then, these were translated into German language.

Some unexpected problems happened during the pre-test such as technical problems for the video camera used, drawing sketch maps outside a cold weather, missing landmark, and unanticipated time wherein it was getting dark in the middle of the experiment. Hence, the pre-test was a way of studying the environment that the German participants will walk through and some difficulties that might occur when doing the final experiment so that preparations will be made. Indeed, such method was very helpful in creating clearer route instructions. Furthermore, this paved way for conducting a study on cultural differences in wayfinding. This is seen as an interesting topic understanding how various cultural groups find their way in an unfamiliar environment following instructions written in English which is not their native language. It turned out that international participants have different interpretations of some terms used in the instructions, thus, some deviations took place.

Participants

Twenty-four (24) participants unfamiliar to the study area participated in the experiment. They are composed of 12 men and 12 women. The age range is from 19 to 30 years old. The mean age is 23.88 years. The male participants are all Geoinformatics students of IFGI whereas female participants come from different courses in the University of Münster - eight from Geoinformatics, one Political Science major, two from Landscape Ecology and one Geography major. All the student participants are both in the undergraduate and graduate level.

Due to unavailability of funds as compensation for the time spent by the participants in the experiment, a cup of coffee or tea was a good way to treat them after walking under a cold weather. The students voluntarily participated in the experiment .

Two participants (one female and one male) had to be replaced because of their familiarity of the place already. It was asked in the first part of experiment whether the person was unfamiliar with the area but, unfortunately in the middle of the experiment, it occurred that he already had enough knowledge of the place. Thus, I have to look for more participants as replacements.

Snowball sampling method was used to gather participants for this experiment. This is a good sampling method considering the limited time allotted for the study.

Materials

Study Area

The study area is a small residential area in the city of Muenster. This is a university town located in the Northrhine Westphalia in Germany. The selected area is the eastern surrounding environment of IFGI of the University of Münster (Westfälische Wilhems-Universität Münster) located in the RvE building at the corner of Weseler Strasse and Inselbogen Strasse. The starting point of the experiment is only 150 meters away from the institute. The study site is a residential area which was purposely chosen in order to get more unfamiliar students instead of the university block near the city centre wherein all of them are familiar with. The University of Münster is not situated in a specific campus rather school buildings are dispersed within the city.

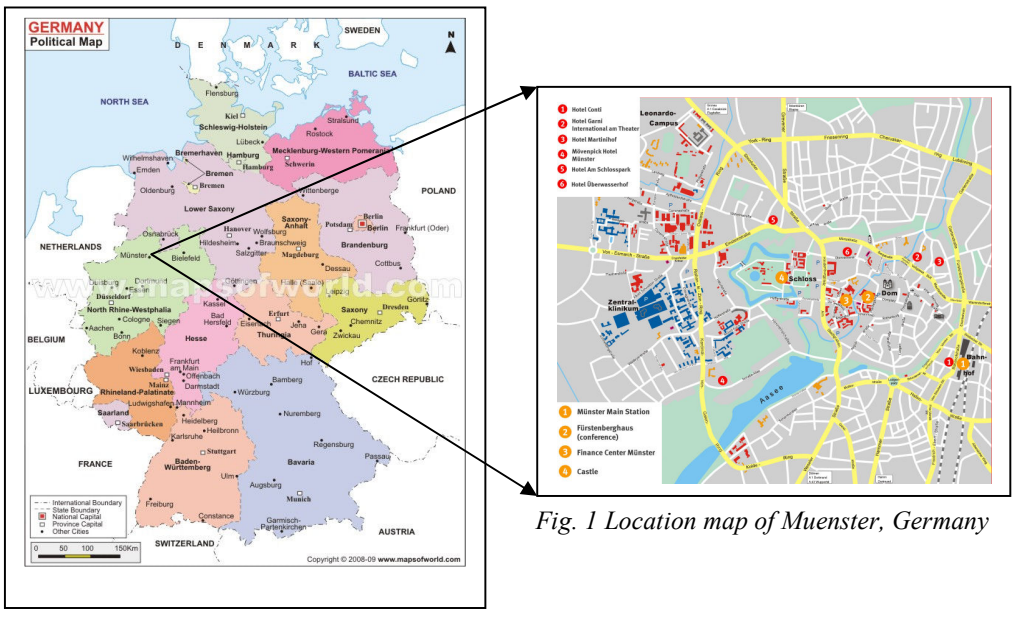

Fig. 1 Location map of Muenster, Germany

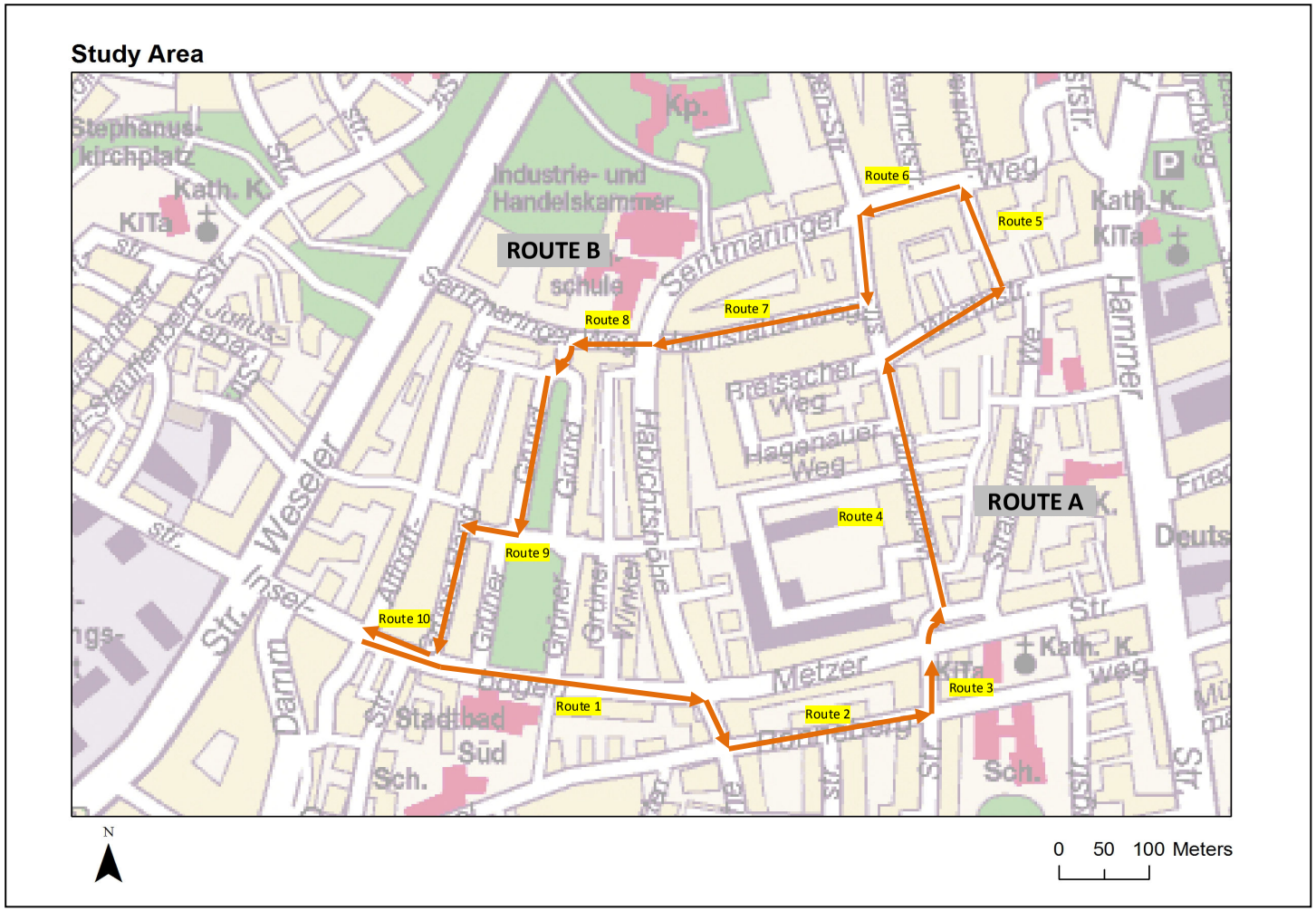

Fig. 2 Study Area

The Route Instructions

There are 10 routes in this experiment which are divided into Route A and Route B (See Fig. 2). Route A follows the first set of five routes while Route B is composed of the remaining five routes. Each route has a distance ranging between 62-400 meters long. The entire route is 2.3 km. In every route, there is a specific goal for the participant. For relative reference, egocentric representations were used for directions. However, for the absolute part, cardinal directions and distances in meters were used. The landmarks used as sub-goals for each route are the same for the two frames of reference.

In such verbal route directions, the participant is given an instruction card with a size of 11x15 cm where the routes are described either in relative or absolute instructions. An example of a relative route instruction is Route 3 which is written as: "Turn left from the pharmacy and walk straight. You see the Ulf Import Fahrschule to your right. Cross the street, you see the Haus Niemann 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." This was translated into German language as: "*Bitte biegen Sie an der Apotheke links ab und laufen geradeaus. Sie sehen die Ulf Import Fahrschule zu Ihrer Rechten. Überqueren Sie eine Straße. Zu Ihrer Linken sehen Sie das Restaurant Haus Niemann [**Ziel**]. Vor Ihnen sehen Sie die Johanniter Akademie Gästehaus. Außerdem sehen Sie eine Kirche und einen Schlecker Supermarkt zu Ihrer Rechten."*

In absolute instruction of the same route, it was stated as "Walk 70 meters north. You see the Ulf Import Farschule to the east. Cross the east-west running road, you see a Haus Niemann 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." The German instruction is stated as: "*Bitte laufen Sie 70 Meter in Richtung Norden. Sie sehen die Ulf Import Fahrschule im Osten. Überqueren Sie nun eine Ost-West verlaufende Straße. Sie sehen das Restaurant Haus Niemann [**Ziel**] im Westen. Sie sehen die Johanniter Akademie Gästehaus im Norden. Außerdem sehen Sie eine Kirche im OSO und einen Schlecker Supermarkt im Osten."* (see Appendix for all the route instructions both in English and German languages).

Self-report Sense of Direction

The participants filled out the Sta. Barbara Sense of Direction Scale (http://www.psych.ucsb.edu/~hegarty/instruments/sbsod.pdf) consisting of 15 questions to be used in correlating to individual's performance in the wayfinding task. Seven questions are stated in a positive statement such as "My "sense of direction" is very good." On the other hand, eight questions were negatively stated like - "I don't remember routes very well while riding as a passenger in a car." This questionnaire examines the spatial and navigational abilities, preferences and experiences of every individual.

Experiment Design

The participants are divided into the Group A-R (Absolute-Relative) and Group R-A (Relative-Absolute) with an equal distribution of men and women. The first group walks the first set of five routes (Route A) which starts with absolute directions and shifted to relative directions (Route B). The second group, on the other hand, walks with relative directions first and then shifts to absolute directions. The participant is asked to draw a sketch map of the route s/he took right after each major route (Route A and Route B). An A3 size paper and a pen are provided by the experimenter.

Procedure

Before the participants start with the experiment, they are asked to fill out the Sta. Barbara Sense of Direction Scale Questionnaire. The experimenter explains the whole procedure to the participant including taking the video of him/her while doing experiment. Also, the cardinal directions are explained. The experimenter now leads the participant to the starting point of the first set of 5 routes. S/he is directed where the north direction is before the first task is given. The experimenter walks behind the participant and no conversations are made. If the participant walked the wrong route, the experimenter leads him/her to the right direction only if s/he doubled the time that the experimenter travelled the entire route. This is also estimating the off-route distance they travelled which doubled the actual distance of the route. The whole wayfinding experiment is videotaped. This helps the researcher in recording the time, deviations

of the route and the number of stops. A stop is recorded if the participant spent 15 seconds or longer (per stop). This also includes how they draw the sketch map and recording the time spent.

After the end of the fifth route (Route A), I take the participant to the nearest bakery for a cup of coffee or tea and where s/he draws the first sketch map. Then, for Route B, the participant draws the second sketch map usually at the institute. The maximum time to draw each sketch map is fifteen (15) minutes.

CHAPTER IV

RESULTS

This chapter discusses the results of the outdoor wayfinding experiment using the Mixed ANOVA (Analysis of Variance) in SPSS. This statistical analysis tests the mean differences between two or more independent variables while subjecting participants in repeated measures. The indicators that were analyzed to examine the participant's wayfinding performance are travel time, speed, number of stops, number of deviations and the off-route distance travelled. The results for both the groups A-R and R-A as well as the performance of men and women in both frames of reference.

Travel Time, Distance and Speed

Travel Time for A-R and R-A

In the Mixed ANOVA result shown in Table 1 where the time spent in the first five set of routes was the within-subject factor and the group (A-R and R-A) as the between-subject factor, it shows that the main effect of time was significant as well as time and group interaction, $F(1,22) = 47.65$, $p < 0.001$ and $F(1,22) = 15.52$, $p < .01$, respectively. Hence, this means that there are differences in the travel time between groups. Although, as shown in the result for the between-subjects which is the group, the effect is less significant having (.097), $p < .05$.

Table 1. Test Within-and Between-Subjects Effects of Groups A-R and R-A Travel Time

Measure: MEASURE_1

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	546.008	1	546.008	47.654	0	0.684
	Greenhouse-Geisser	546.008	1	546.008	47.654	0	0.684
	Huynh-Feldt	546.008	1	546.008	47.654	0	0.684
	Lower-bound	546.008	1	546.008	47.654	0	0.684
time * Group	Sphericity Assumed	177.832	1	177.832	15.521	0.001	0.414
	Greenhouse-Geisser	177.832	1	177.832	15.521	0.001	0.414
	Huynh-Feldt	177.832	1	177.832	15.521	0.001	0.414
	Lower-bound	177.832	1	177.832	15.521	0.001	0.414

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Error(time)	Sphericity Assumed	252.069	22	11.458			
	Greenhouse-Geisser	252.069	22	11.458			
	Huynh-Feldt	252.069	22	11.458			
	Lower-bound	252.069	22	11.458			

Test Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		18374.274	1	18374.27	1321.392	0	0.984
Group		41.869	1	41.869	3.011	0.097	0.12
Error		305.915	22	13.905			

Fig. 3 shows the plotted travel time for both the A-R and R-A groups. It would take a longer time for participants to follow absolute instructions in both goups. The A-R group took an average of 40.99 minutes to finish the experiment while it took 36.89 minutes for the R-A group. The average time spent for R-A and A-R groups in Route A is 19.87 and 25.8 minutes, respectively. For Route B, on the other hand, it took an average time of 17.02 minutes for R-A group and 15.19 minutes, respectively.

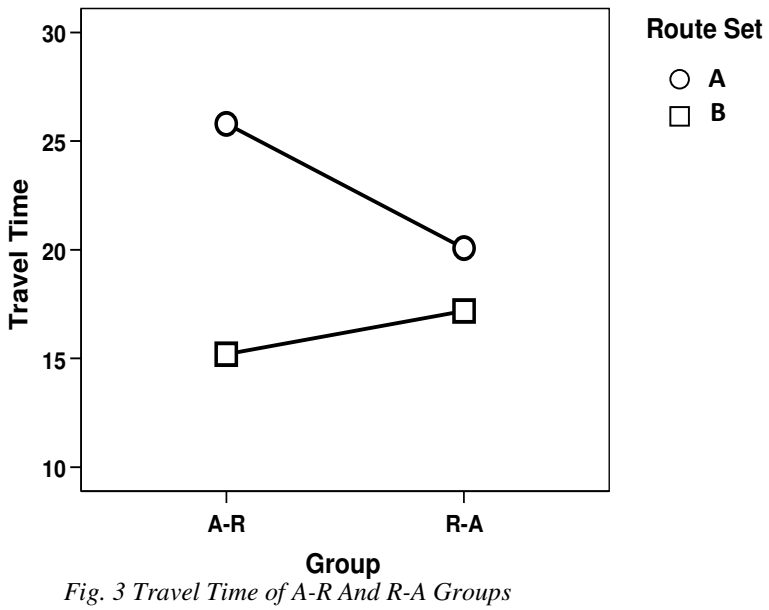

Fig. 3 Travel Time of A-R And R-A Groups

Travel Time for Gender

Table 2 shows that there is a significant effect of the travel time of route set with $F(1,22) = 5.031$, $p < .05$. This means that there are differences of time spent by men and women for each route set. Although, the effect for the interaction of gender and the interaction is not significant.

Table 2. Test Within-and Between-Subjects Effects of Gender

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_time	Sphericity Assumed	180.226	1	180.226	5.031	0.035	0.186
Routeset_time * Gender	Sphericity Assumed	5.556	1	5.556	0.155	0.698	0.007
Error(Routeset_time)	Sphericity Assumed	788.059	22	35.821			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		18197.83	1	18197.83	1092.289	0	0.98
Gender		1.916	1	1.916	0.115	0.738	0.005
Error		366.526	22	16.66			

For the whole experiment, the average time spent by both men and women is 38.54 and 39.69 minutes, respectively. Fig. 4 shows the comparison of the time spent for both men and women. It shows that there is more time spent in travelling the absolute instructions than in relative directions.

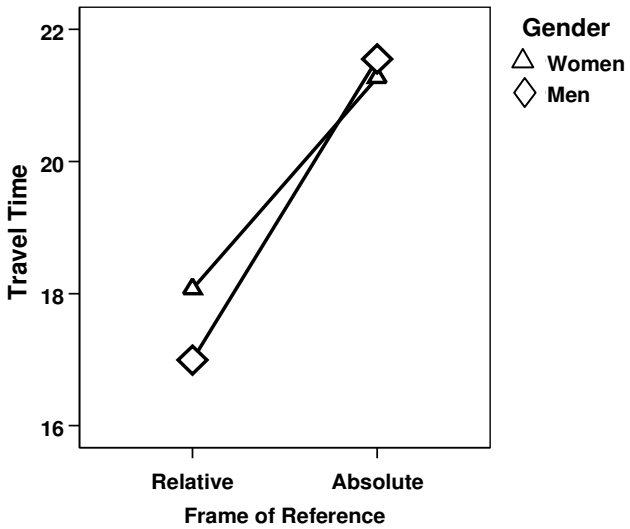

Fig. 4 Travel Time of Men and Women

Distance travelled by A-R and R-A (focus on off-route)

There is a significant effect of off-route distance and group interaction, $F(1,22) = 4.96$, $p < .05$ (see Table 3). Although, there is no significant effect seen in distance and between-subject variable, Group since $p > .05$.

Table 3. Test Within-and Between-Subjects Effects of Distance (A-R and R-A)

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_distance	Sphericity Assumed	11718.75	1	11718.75	1.486	0.236	0.063
Routeset_distance * Group	Sphericity Assumed	39102.083	1	39102.08	4.958	0.037	0.184
Error(Routeset_distance)	Sphericity Assumed	173498.167	22	7886.28			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		101200.333	1	101200.3	9.277	0.006	0.297
GROUP		3960.333	1	3960.333	0.363	0.553	0.016
Error		239986.333	22	10908.47			

Fig. 5 shows the plot for the off-route distance travelled by each group. It shows that their is a big difference for A-R group in terms of the off-route distance travelled as compared to the R-A group. For A-R group in the absolute frame, participants travelled 1,190 m but in the relative frame, they only went off-route for 130 m. The R-A group, on the other hand, traveled 287 m off-route in the relative frame while 597 m in the absolute direction.

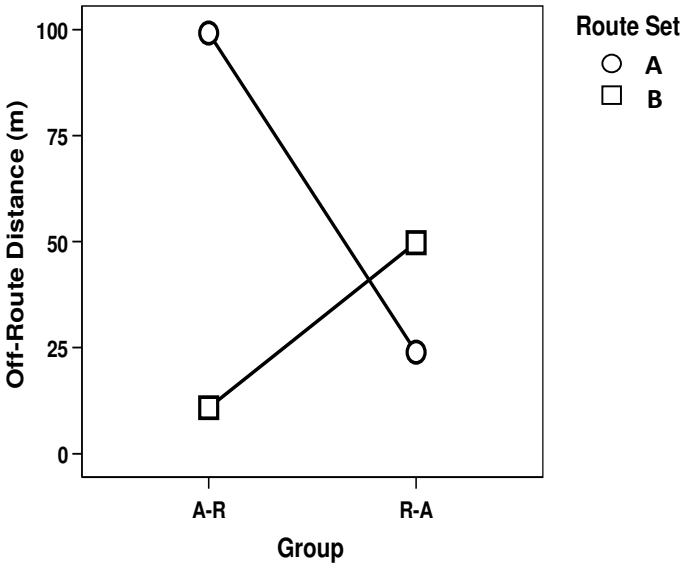

Fig. 5 Off-route distance of A-R and R-A groups

Distance of Gender

In terms of the off-route distance for gender, the main effect of frame of reference set was significant, $F(1, 22) = 5.15$, $p < .05$. Both men and women walked longer off-route distances in the absolute frame of reference. However, it shows that there is no significant effect of the interaction of gender and route set and gender per se.

Table 4. Test Within-and Between-Subjects Effects for Gender

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_distance	Sphericity Assumed	42525.158	1	42525.16	5.155	0.034	0.197
Routeset_distance * Gender	Sphericity Assumed	10296.55	1	10296.55	1.248	0.277	0.056
Error(Routeset_distance)	Sphericity Assumed	173220.277	21	8248.585			
Test Between-Subjects Effects							
Source		**Type III**	**df**	**Mean**	**F**	**Sig.**	**Partial Eta**

		Sum of Squares		Square			Squared
Intercept		108971.135	1	108971.1	10.224	0.004	0.327
Gender		15729.83	1	15729.83	1.476	0.238	0.066
Error		223816.822	21	10657.94			

As seen in Fig. 6, it shows that men walked longer distances when they went off the route in both frames of reference. Men walked 1.24 km off-route in the absolute frame while women traveled 548 m off-route distance. In the relative frame, on one hand, men walked 240 m off-route while women walked 177 m.

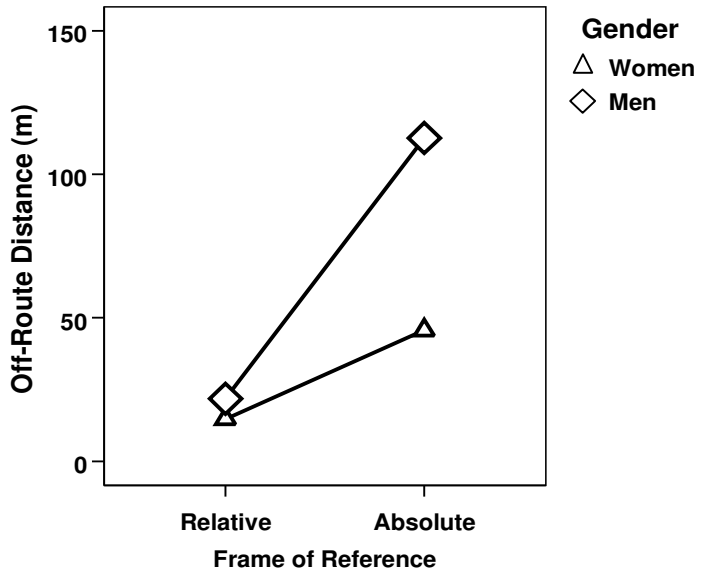

Fig. 6 Off-route distance of Men and Women

Speed of A-R and R-A

The walking speed was recorded in terms of steps per minute of each participant in every route. It was averaged for both Route A and Route B to examine whether there had a been a change in their speed. Route set was the within-subject factor and the group was the between-subject factor. In Table 5, It showed that there is no significant effect in terms of walking speed for both groups, $F(1, 22) = 2.78$, $p > .05$. This means that participants maintained their normal walking speed

when a shift to another frame of reference was given. But, for the route set and group interaction, there is a significant difference with $F(1, 22) = 6.23$, $p < .05$.

Table 5. Test Within-and Between-Subjects Effects of Walking Speed (A-R and R-A)

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_speed	Sphericity Assumed	26.181	1	26.181	2.781	0.11	0.112
Routeset_speed * Group	Sphericity Assumed	58.631	1	58.631	6.227	0.021	0.221
Error(Routeset_speed)	Sphericity Assumed	207.139	22	9.415			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		552863.273	1	552863.3	6451.893	0	0.997
Group		19.956	1	19.956	0.233	0.634	0.01
Error		1885.182	22	85.69			

Fig.7 shows the plotted result of group's walking speed. For A-R group, the participants had an average of 104.83 steps per minute in the absolute frame of reference whereas, in the relative frame of reference, the average walking speed was 108.52 steps per minute. In the R-A group, there was not much of a difference as they had walked an average of 108 steps per minute for each major route.

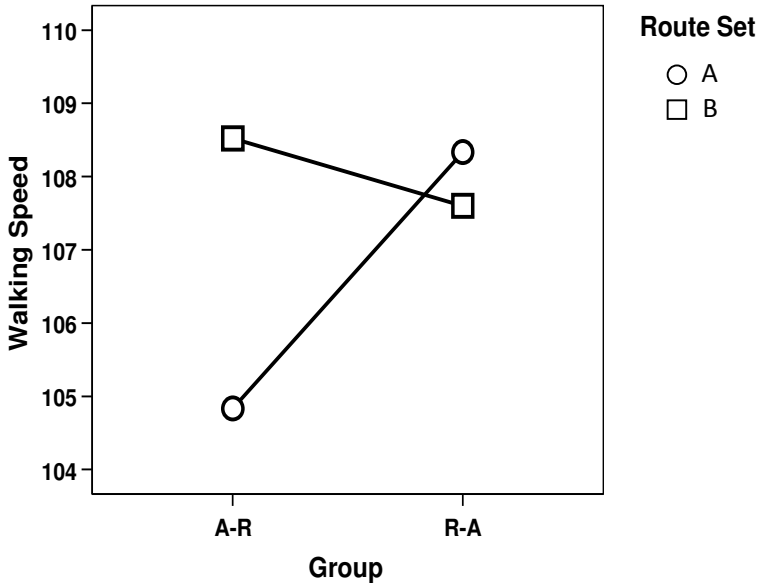

Fig. 7 Walking speed of R-A and A-R groups

Speed of Gender

There was a significant effect of the frame of reference set, $F(1,22) = 4.86$, $p < .05$. There was a difference of the walking speed in the absolute and relative frame of reference of men and women. Although, for the interaction and the gender, there was no significant effect.

Table 6. Test Within-and Between-Subjects Effects of Walking Speed of Gender

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_speed	Sphericity Assumed	52.605	1	52.605	4.863	.038	.181
Routeset_speed * Gender	Sphericity Assumed	.788	1	.788	.073	.790	.003
Error(Routeset_speed)	Sphericity Assumed	237.998	22	10.818			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		556302.906	1	556302.906	5992.703	.000	.996
Gender		333.644	1	333.644	3.594	.071	.140
Error		2042.261	22	92.830			

Fig. 8 shows the walking speed of men and women in both absolute and relative frames of reference. Women walked an average of 109.12 steps per minute in the absolute frame and in the relative frame, they walked an average of 111.47 steps per minute. Men, on the other hand, they walked an average of 104.steps per minute in the absolute frame while in the relative frame is 105.94 steps per minute. It clearly showed in the figure that when a change to absolute frame of reference was made, there was a decreasing walking speed for both men and women.

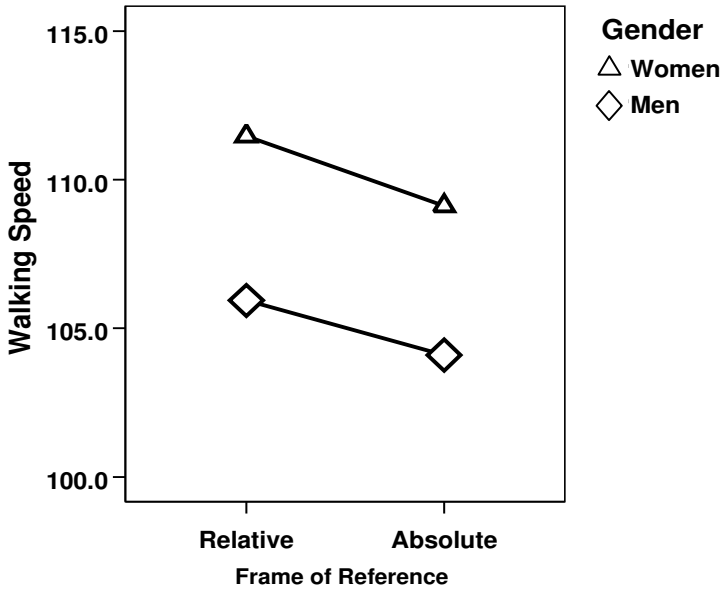

Fig. 8 Walking speed of Men and Women

Number of Stops

A-R and R-A

The number of stops was recorded for each route when the participant stopped for 15 seconds or longer. The video was the basis in reviewing the wayfinding performance of each participant. The stops mean that s/he is trying to understand the verbal route instructions and to figure out whether s/he is heading the right path.

In Table 7, there was a significant effect of Route set(stops) and Route set (stops) x Group interaction with $F(1,22) = 7.615$, $p < .05$ and $F(1,22) = 10.36$, $p < .01$, respectively. This means that participants made many stops on one set of five routes. Also, there was a significant main effect of Group with $F(1,22) = 4.25$, $p = .05$. Hence, there was a difference with the number of stops each group made.

Table 7. Test Within-and Between-Subjects Effects of Number of Stops (A-R and R-A)

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_stops	Sphericity Assumed	12	1	12	7.615	0.011	0.257
Routeset_stops * Group	Sphericity Assumed	16.333	1	16.333	10.365	0.004	0.32
Error(Routeset_stops)	Sphericity Assumed	34.667	22	1.576			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		60.75	1	60.75	25.62	0	0.538
GROUP		10.083	1	10.083	4.252	0.051	0.162
Error		52.167	22	2.371			

Fig. 9 shows the plotted result for A-R group, the participants made more stops in the first set of routes with absolute instructions and made fewer stops in the second set with relative instructions. For R-A group the participants made more stops in the second set of routes with the absolute directions.

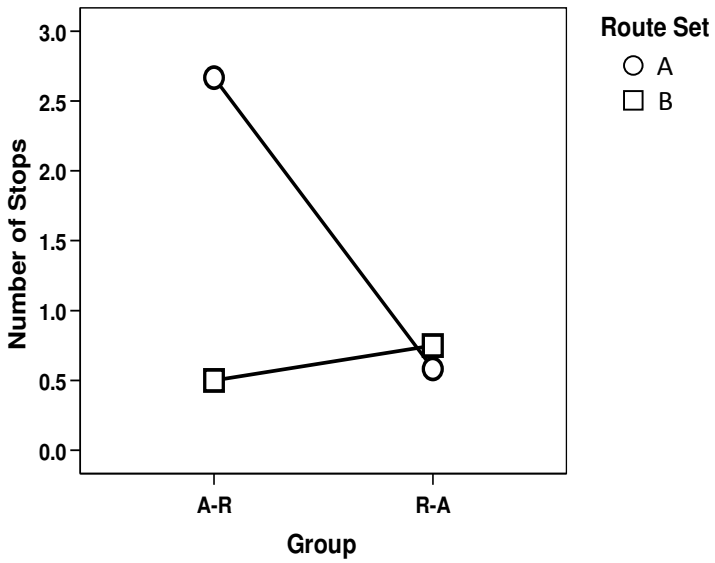

Fig. 9 Number of stops of A-R and R-A groups

Gender

The main effect of frame of reference set was significant, $F(1, 22) = 7.42$, $p < .05$. This means that there is difference on how men and women perform in absolute and relative frame of reference. That they tend to make more stops in absolute directions. There was no significant effect shown for the route set and gender interaction as well as the gender showing $p > .05$.

Table 8. Test Within-and Between-Subjects Effects of Number of Stops of Gender

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_stops	Sphericity Assumed	17.521	1	17.521	7.419	.012	.252
Routeset_stops * Gender	Sphericity Assumed	.021	1	.021	.009	.926	.000
Error(Routeset_stops)	Sphericity Assumed	51.958	22	2.362			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		58.521	1	58.521	19.719	.000	.473
Gender		1.688	1	1.688	.569	.459	.025
Error		65.292	22	2.968			

Fig. 10 shows the number of stops for both men and women in the absolute and relative frames. It shows that men tend to make more stops than women both in absolute and relative frame of reference. There were lesser stops in the relative directions in both gender and men made more stops than women showing that there are more stops in absolute directions for both gender.

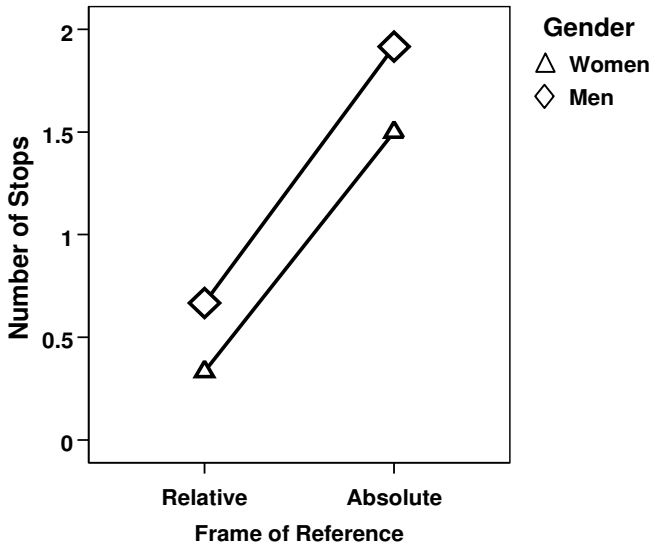

Fig. 10 Number of stops of Men and Women

Deviation of Routes

A-R and R-A

Deviation of the route whether just few meters were recorded in each route. Also, the off-route distances were taken into account to determine how far each participant deviated from a particular route. Similar to the number of stops, mixed ANOVA was used for analysis. Table 9 shows that the main effect of group was not significant $F(1,22) = 4.25$, $p > .05$. Also, there was no significant effect of route set with $F(1,22) = 1.165$, $p > .05$ whereas route set x group interaction showed less significant effect, $F(1,22) = 3.235$, $p < .1$. However, it should be pointed out that although, there is no resulting significant effect, it does not mean that it is not important to studyany differences in the performance. Looking at the estimated mean for the group deviations, it could be observed that there is a difference of the mean for the A-R group in both route set which means that participants deviated more in the absolute frame of reference.

Table 9. Test Within-and Between-Subjects Effects of Number of Deviations (A-R and R-A)

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_deviations	Sphericity Assumed	0.75	1	0.75	1.165	0.292	0.05
Routeset_deviations * Group	Sphericity Assumed	2.083	1	2.083	3.235	0.086	0.128
Error(Routeset_deviations)	Sphericity Assumed	14.167	22	0.644			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		12	1	12	15.529	0.001	0.414
Group		0	1	0	0	1	0
Error		17	22	0.773			

Looking at Fig. 11, it could be observed that the A-R group had many deviations when the instructions started in the absolute frame and they improved when it shifted to relative directions. In a similar observation for the R-A group, the participants made few deviations in the relative frame but incurred many deviations when the absolute direction was given.

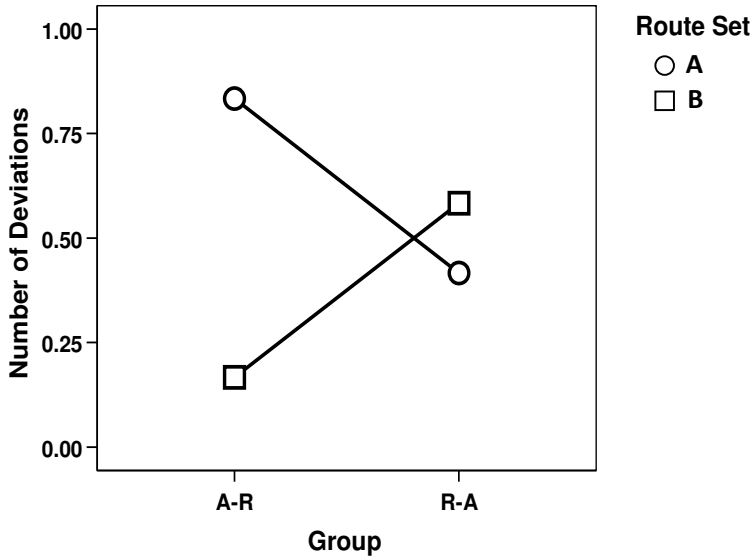

Fig. 11 Number of route deviations of R-A and A-R Groups

Gender

Table 10 shows that the difference of route set for the gender with $F(1,22) = 3.14$, $p < .05$. This means that there was there was an effect of both absolute frames of reference with how the participants fared in the task. Although, it showed that there was no significant effect for the interaction of route set and gender as well as gender showing $F(1,22) = .503$, $p > .1$ and $F(1,22) = 1.01$ $p > .1$, respectively.

Table 10. Test Within-and Between-Subjects Effects of Number of Deviations (Gender)

Test Within-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Routeset_deviations	Sphericity Assumed	2.083	1	2.083	3.143	0.09	0.125
Routeset_deviations * Gender	Sphericity Assumed	0.333	1	0.333	0.503	0.486	0.022
Error(Routeset_deviations)	Sphericity Assumed	14.583	22	0.663			
Test Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept		12	1	12	16.246	0.001	0.425
Gender		0.75	1	0.75	1.015	0.325	0.044
Error		16.25	22	0.739			

Looking at Fig. 12, it shows that there had been many deviations in the absolute as compared to the relative frame of reference. It also shows that men made more deviations than women. It shows that there were more deviations in the absolute directions than the relative frame of reference. It also shows that women did not make deviations when routes shifted to absolute directions. Whereas men tend to incur more deviations with shifting instructions.

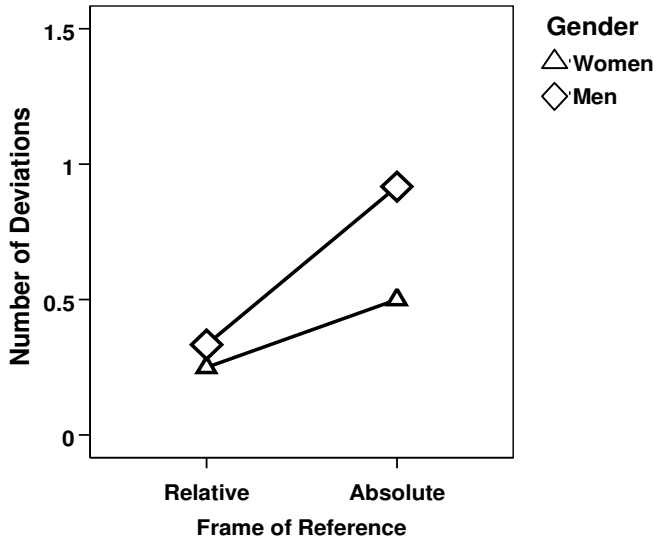

Fig. 12 Number of route deviations of Men and Women

Sense of Direction Self-Report and Relationship with the Wayfinding measures

In the Sta. Barbara sense of direction questionnaire, the mean was calculated for each participant. However, the negative questions were translated into positively type statement so that the higher the number means that they have high sense-of-direction. The result was then correlated with the number of stops, deviations, and off-route distances taking into account the absolute frame of reference only.

To evaluate the correlation between the participants and the wayfinding performance, the result in the absolute instructions was used following the previous study. Table 11 shows the correlation of Sense of Direction (SOD) of both A-R and R-A participants to the wayfinding measures. It means that there was a negative correlation of for the number of stops which means participants with high SOD tend to make more stops. Whereas, for deviations and off-route distances, a positive correlation resulted, which means that participants with high SOD tend to make fewer deviations and did not go off the route more frequently.

Table 11. Correlation Table for Groups A-R and R-A

A-R and R-A GROUP					
		SOD	Stops	Deviations	Off-Route
SOD	Pearson Correlation	1	-0.373	0.108	0.128
	Sig. (2-tailed)		0.072	0.615	0.551
	N	24	24	24	24

Table 12 shows the result of the SOD of each participant in the A-R group. As shown in the result, the participant who rated himself to have a high SOD did not make any stop, deviation and did not travel longer off-route distance.

Table 12. Sense of Direction (SOD), Stops, Deviations, and Off-route distance result of A-R Group*

SOD	Stops	Deviations	Off-route distance
3.13	3	0	0
3.13	8	2	154
3.53	5	2	232
3.67	0	0	0
3.73	2	1	113
3.8	4	0	0
3.87	2	1	210
3.93	3	1	345
3.93	3	1	65
3.93	0	0	0
3.93	4	2	71
4.13	0	0	0

**in absolute frame of reference*

In the case of the R-A group, it shows that not only those who judged themselves having a better SOD tend to make few stops, deviations and off-route distances but also those with poor SOD. It is interesting to note that there are more participants who rated themselves with poor SOD but they did not make any mistake in wayfinding.

Table 13. Sense of Direction, Stops, Deviations, and Off-route distance result of R-A Group*

SOD	Stops	Deviations	Off-route distance
3.1	0	0	0
3.4	0	0	0
3.53	0	0	0
3.8	0	0	0
3.87	1	0	0
4.1	1	1	15
4.1	2	0	0
4.13	0	0	0
4.27	1	2	60
4.33	3	4	522
4.33	0	0	0
4.4	0	0	0

**in absolute frame of reference*

The descriptive statistics in Table 14 shows that there is higher mean for most of the performance measures of men than women. There is a big difference in terms of the mean for the off-route distances made in the absolute frame.

Table 14. Descriptive Statistics of Men and Women

		Men		Women	
	N	*Mean*	*Std. Deviation*	*Mean*	*Std. Deviation*
SOD	12	3.8767	0.38431	3.7958	0.38587
Stops	12	2.08	1.676	1.42	2.429
Deviations	12	0.92	1.24	0.5	0.798
Off-Route	12	103.25	172.009	45.67	74.224

Table 15 shows the correlation of the Sense of direction result and the wayfinding performance measures for men and women. In only the absolute frame of reference, women who had better

sense of direction made less stops, less deviations, as well as off-route distances. Whereas, men who had better sense of direction made less stops but with more deviations, and travelled long off-route distances.

Table 15. Correlation Table for Men and Women

Men					
		SOD	Stops	Deviations	Off-Route
SOD	Pearson Correlation	1	-0.217	0.427	0.282
	Sig. (2-tailed)		0.498	0.167	0.375
	N	12	12	12	12
Women					
		SOD	Stops	Deviations	Off-Route
SOD	Pearson Correlation	1	-0.456	-0.312	-0.269
	Sig. (2-tailed)		0.137	0.324	0.397
	N	12	12	12	12

Table 16 shows the result of the SOD scale for men. It shows that most participants who have better SOD tend to have more stops, deviations, and travelled longer off-route distances. Although, there was one who was able to judge himself to have a better SOD who did not incur any stop, deviation and off-route distance.

Table 16. Sense of Direction, Stops, Deviations, and Off-route distance result of Men*

SOD	Stops	Deviations	Off-route distance
3.13	3	0	0
3.4	0	0	0
3.53	5	2	232
3.67	0	0	0
3.8	4	0	0
3.93	3	1	345
3.93	3	1	65
4.1	1	1	15
4.1	2	0	0

SOD	Stops	Deviations	Off-route distance
4.27	1	2	60
4.33	3	4	522
4.33	0	0	0
3.88	**25**	**11**	**1239**

**in absolute frame of reference*

In the case of women, those who rated themselves to have better SOD did not make any stop, deviation and did not travel off the route. Although, there was one participant who judged herself to have poor SOD but ended up not making any stop, deviation and off-route distance.

Table 17. Sense of Direction, Stops, Deviations, and Off-route distance result of Women*

SOD	Stops	Deviations	Off-route distance
3.1	0	0	0
3.13	8	2	154
3.53	0	0	0
3.73	2	1	113
3.8	0	0	0
3.87	2	1	210
3.87	1	0	0
3.93	0	0	0
3.93	4	2	71
4.13	0	0	0
4.13	0	0	0
4.4	0	0	0
3.796	**17**	**6**	**548**

**in absolute frame of reference*

Sketch Mapping Activity

When the participant was asked to draw a sketch map of the route they travelled, different sketch maps were produced as well as individual differences were observed while creating it. The measures used to assess how much information has been retained in the individual's memory

after walking through the two sets of route were the landmarks, the correct turns, and the number of streets drawn. The number of landmarks taken into account were those written in the instructions whether they were still able to remember it. This is regardless of how they draw the landmarks on the sketch map. The correct turns show the path the participant took whether s/he remembers how to have reached the goals. The number of streets drawn does not only pertain to those written in the instructions rather including other path they noticed while they were walking through the route.

Landmarks

For the A-R group, participants were not able to remember all the landmarks for Route 1. This also shows with the R-A group as shown in Fig. 13 although, the participants from this group were able to draw more landmarks in this route.

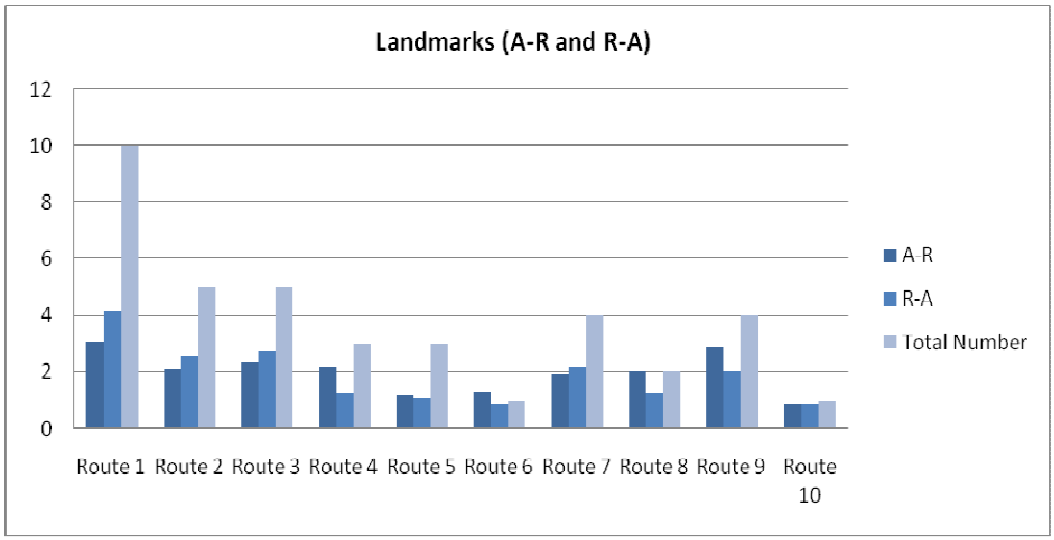

Fig. 13 Landmarks drawn of A-R and R-A group

Men drew less number of landmarks than women. An accumulated number of landmarks drawn by men totaled 210 while for women a total of 252 landmarks were drawn. However, there was not much big difference when drawing the other landmarks for the other routes as shown in the

graphs. Fig. 14 shows the landmarks drawn by men and women in relation to the total number of landmarks.

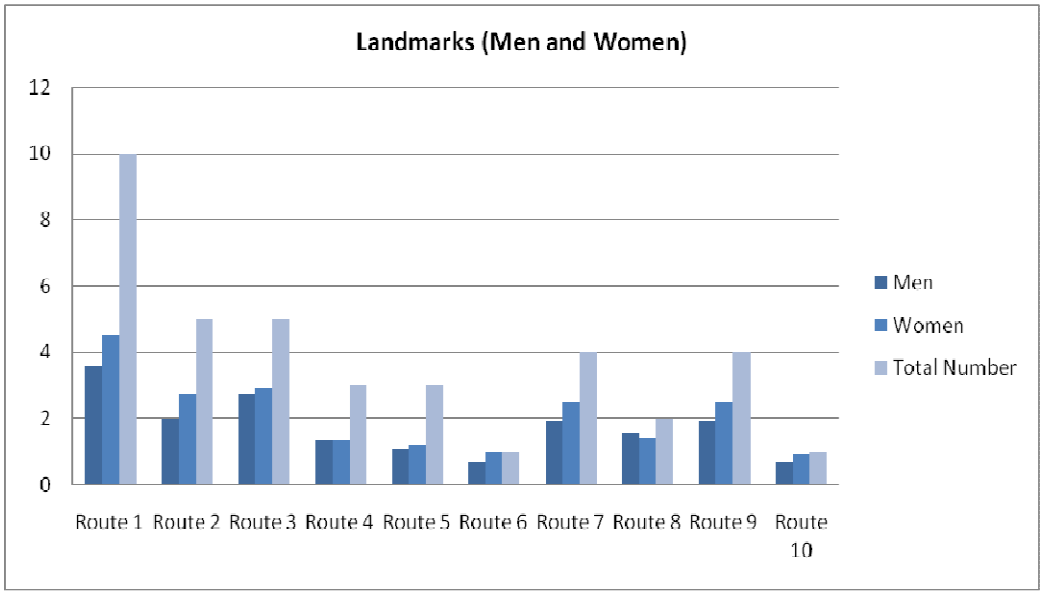

Fig. 14 Number of Landmarks drawn by Men and Women

Turns

There was a total of 16 turns for the whole experiment. Participants in both A-R and R-A group were able to draw the correct number of turns. Although, Route 4 was a little bit confusing to draw as shown in the result in Fig. 15 for the correct turn of both groups.

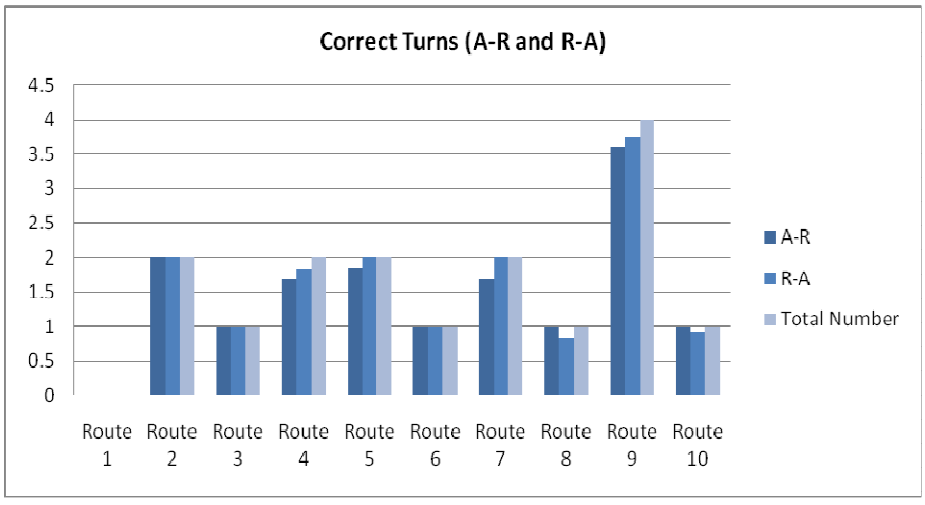

Fig. 15 Correct turns drawn by A-R and R-A group

Both men and women drew the same total number of correct turns with Route 4 as one confusing route where they had missed a turn. In Route 7, most women also missed s turn going to the next goal. Fig. 16 shows a comparison of the correct turns drawn by men and women vis-a-vis the total number of turns.

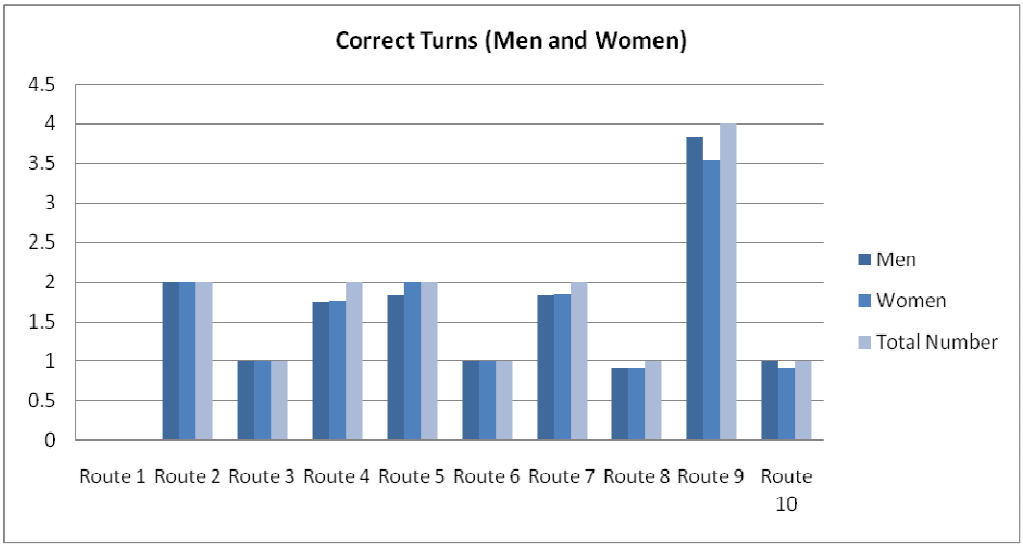

Fig. 16 Correct turns drawn by Men and Women

Streets drawn

In Route 1, the participants crossed many streets yet, few of them were drawn. Looking at Fig. 17, there is not much difference on the number of streets drawn by both groups. Apart from Route 1, participants also missed to include some streets they crossed in Route 4.

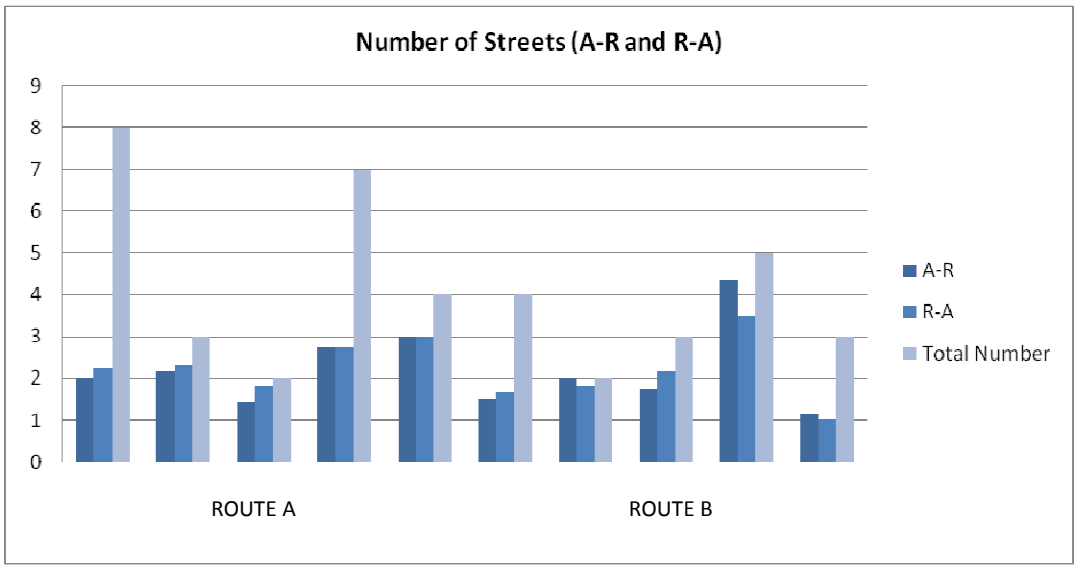

Fig. 17 Streets drawn drawn by A-R and R-A group

There was not much big difference on the number of streets drawn by men and women (Fig. 18). Routes 1 and 4 showed that many streets were missed by most participants.

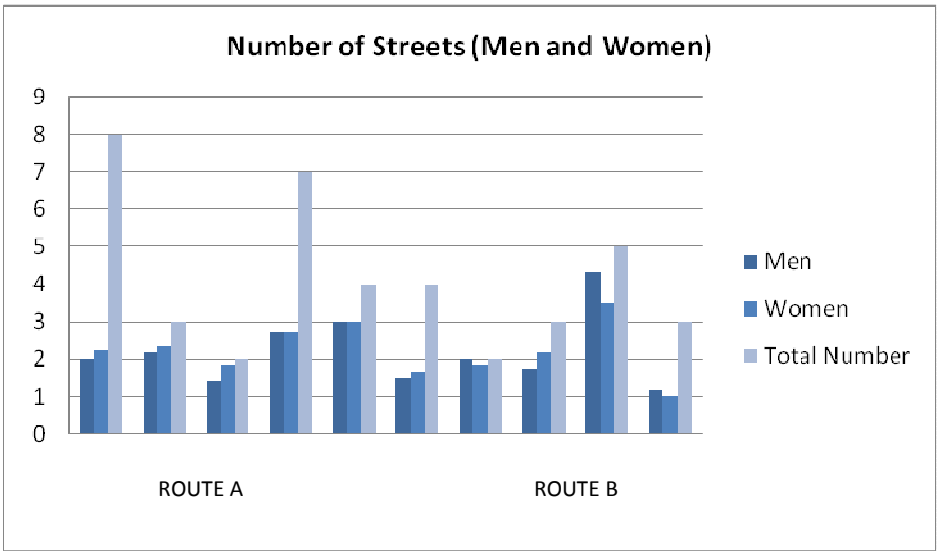

Fig. 18 Streets drawn drawn by Men

CHAPTER V

DISCUSSION

This chapter provides an in-depth discussion of the results from the statistical analysis following the same outline in the previous chapter. This also includes a brief description of problems encountered while doing the experiment.

Travel Time, Distance and Speed

Travel Time

A-R and R-A

The time spent by each participant for each route was recorded so with the distance they travelled. There were differences in the time spent for groups A-R and R-A wherein it would usually take a longer time in following absolute frame of reference for each group. Comparing both instructions, it will usually take lesser time to follow when directions are given in relative frame.

Gender

There is a significant difference in comparing the time spent by men and women in both absolute and relative frames of reference. When instructions are in absolute frame, they tend to spend longer time than relative directions. For women, it took them an average of 21.27 minutes for the absolute frame while in the relative frame, it took them 18.07 minutes. For men, on the other hand, it took them 21.55 minutes in the absolute frame and in the relative frame, it took them 17 minutes.

Distance

R-A and A-R

There are differences of the distances travelled by each group. The A-R group travelled more distances than the R-A group which means that there had been many deviations in this group and they walked longer off-route distances.

Gender

Men travelled more distances than women. This was shown in the result of the off-route distances they made and mostly in the absolute frame of reference. Women tend to travel more distances when they are given the first route set of instructions. But, when it shifted to another set of instruction whether absolute or relative, they did not walk off the route.

Speed

A-R and R-A

There was no big difference in terms of the walking speed for both groups when there was a shift to another frame of reference. This means that the participants walked smoothly through the routes verbally described. Also, regardless of the weather.

Gender

There are no differences of the walking speed for men and women as they tend to maintain the walking speed when a shift from relative to absolute frame of reference or vice versa. In the relative frame, they would usually walk in a fast pace.

Number of Stops

A-R and R-A

From the result, it showed that group A-R made more stops than the R-A group. But, looking at both groups, it is usually in the absolute frame of reference where most of the participants stopped several times. When absolute instructions are given first, Group A-R would have more stops than the R-A group. There were several stops in Route 5 which was stated in an absolute frame of reference. Route 5 was a little bit tricky because the landmark was a whole block of a brick building. The exact distance to such goal was specified in the instruction yet, all participants in the A-R group underestimated it. Although, there were many stops in this route, not much deviations occurred. For the R-A group, there were more stops in Routes 7 and 9 which are in the absolute instructions. In total, there were 34 stops made by participants of A-R

group in Route A (absolute frame) and 5 stops only in Route B (relative). For the R-A group, 7 stops were recorded for both absolute and relative frames of reference. Fig. 19 shows the number of stops for both groups.

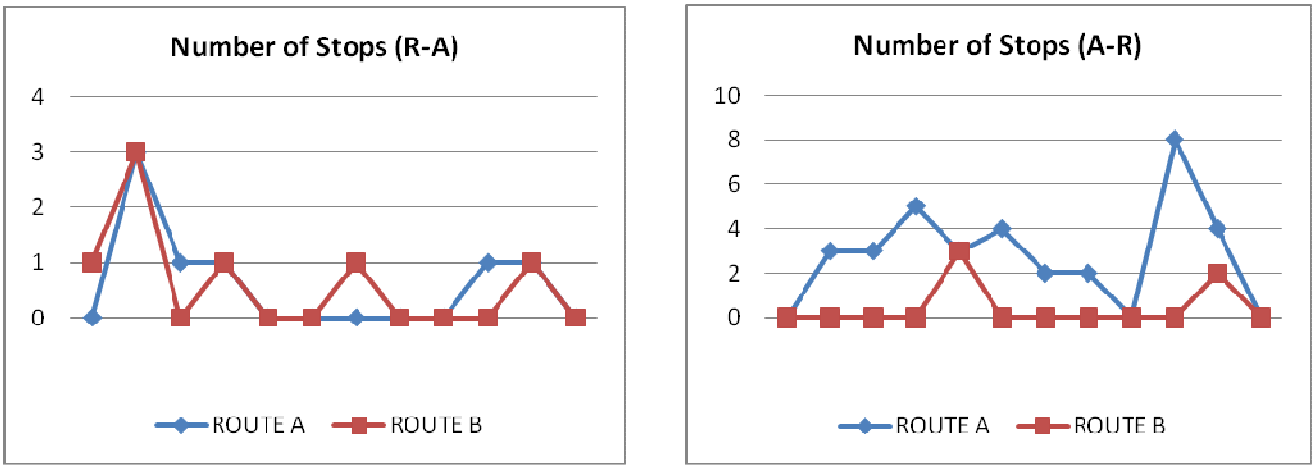

Fig. 19 Number of stops of A-R and R-A groups

Gender

From the results, it showed that there was a significant effect of the number of stops for both frames of reference. Although, it was not significant in the other statistical result such as gender and the interaction, yet it is still interesting to consider that there were differences in the number of stops made by both men and women. It is in the absolute frame of reference that both genders had many stops. It was a bit confusing for men to follow Routes 3 and Routes 4. Although Route 3 was quite easy to find because it is situated in a corner street, perhaps the name was not quite visible that they had to stop several times. Route 4, on the other hand, was a little bit difficult for men to follow as compared to women. The route was quite hard to describe because of a presence of an island along the main street. In the case of women, Route 2 was a bit confusing for two participants thus, they made two or more stops in this route. Women did not make any stop in Routes 7 and 8 even if the instructions shifted to absolute frame of reference. The number of stops made by women in absolute and relative frames of reference is 18 and 4,

respectively. While men made 23 stops in the absolute direction and 8 in the relative frame. Fig. 20 shows the number of stops of all the participants in both A-R and R-A groups.

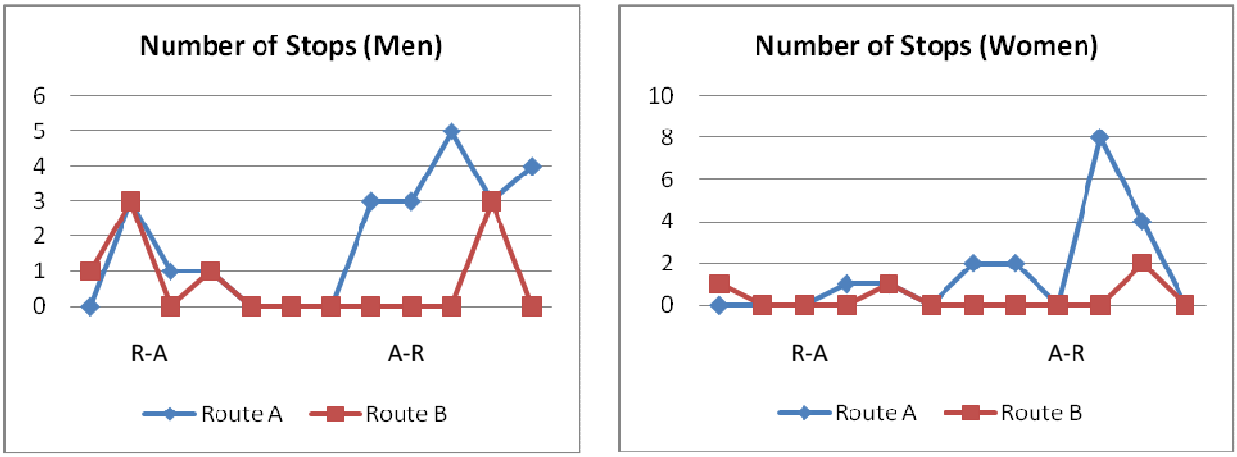

Fig. 20 Number of stops of men and women

Deviation of Routes

A-R and R-A

For both A-R and R-A group, it showed that the route set with more deviations was the absolute frame of reference. Once the instructions shifted to a relative frame of reference, participants made few or no deviations. For the A-R group, Routes 1, 3 and 4 incurred more deviations. In Route 1, the major reason why some participants deviated was a different perception of a landmark. The goal for the first route was a telephone booth. It happened that they were still looking for a yellow booth which was recently changed into a pink open telephone stand. Although, the former could still be seen in other areas of the region but the telephone company has already changed the design and deployed them in many locations in the city. (see photos 1 and 2)

In Route 3, participants showed different behavior in walking towards the goal which is a restaurant. This was one of the major reasons why deviations occurred in this route. It was stated in the instruction to "cross the east-west running road", what others decided was go to the stoplight first and from there crossed the street and went to the goal.

Photo 1. Yellow telephone booth

Photo 2. The new telephone stand (goal)

As stated in the previous discussion, Route 4 has a difficult path to follow. Some of the participants misinterpreted instructions. Also, it would take awhile for some of them to orient themselves from Route 3 to Route 4 because of a unique street network.

In the A-R group, Route 7 incurred many deviations. Those who deviated in this route overestimated the distance from the last goal.

A total of 10 deviations for Route A (absolute directions) was incurred by A-R group whereas for the R-A group, only 3 deviations were made by the participants for the same route set. It was in the absolute frame of reference where more of the deviations occurred. Fig. 21 shows the number of deviations of participants for both R-A and A-R groups.

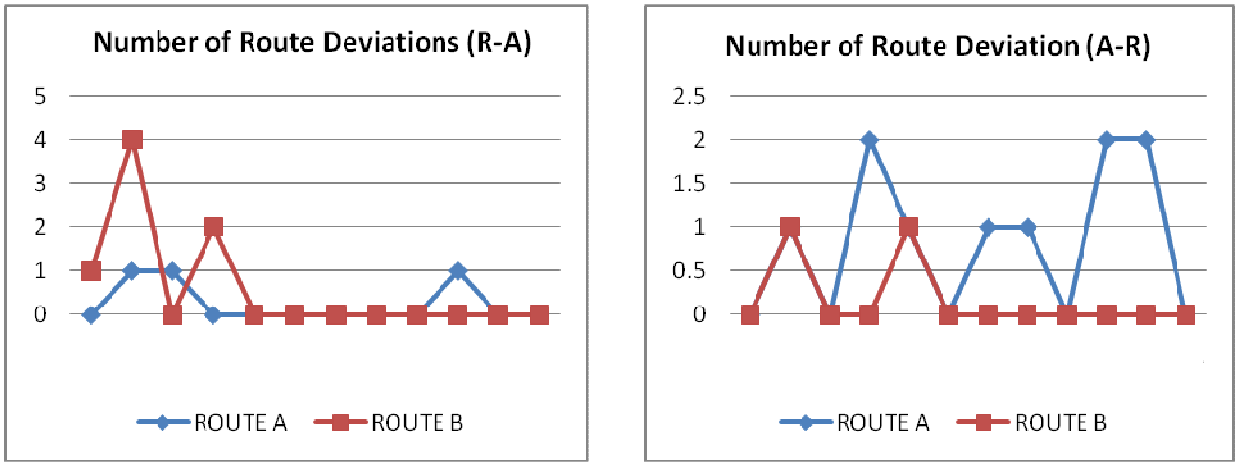

Fig. 21 Number of route deviations of R-A and A-R Groups

Gender

From the result, men made many deviations than women. The number of deviations men incurred for the relative frame is 4 while in the absolute frame, they incurred 11 deviations. For women, they made 3 deviations in the relative frame and 6 deviations following the absolute direction. It is interesting to know that women had many deviations only in the first set of routes but no deviation occurred when there was a shift to another frame of reference whereas, men deviated several times.

Men tend to travel more distances than women when they went off the route. It is observed that most participants would not pay much attention to distances stated in the instructions, rather they woud refer to the landmarks mentioned. People tend not to use distance information when it implied a target location which means within the landmark configuration (Waller et al, 2002). However, there was a woman participant who said that she would prefer the absolute instructions better because she could estimate where to make a turn based on the distance indicated. For relative reference frame, it is sometimes difficult to estimate where to take the next turn especially when few landmarks are given.

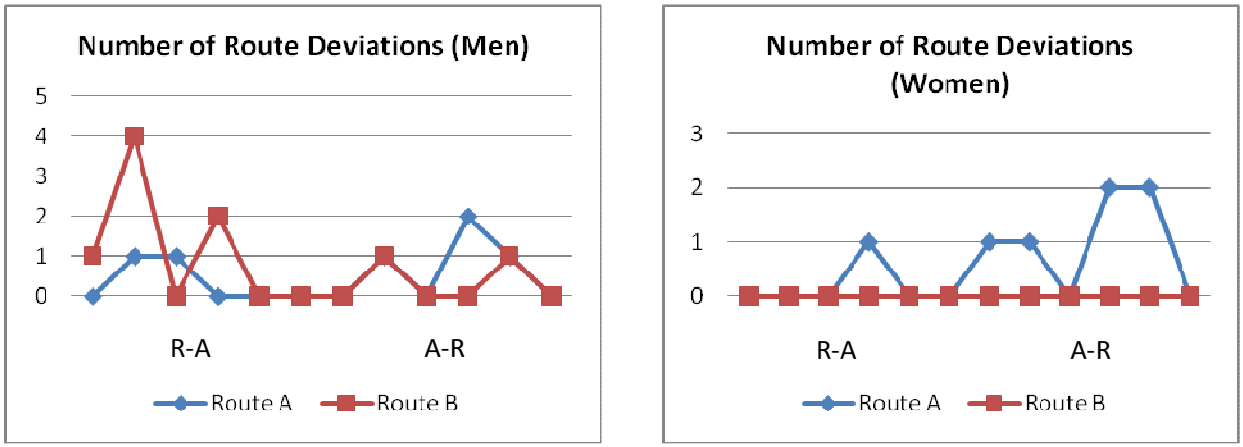

Fig. 22 Number of route deviations of Men and Women

Off-Route Distance

A-R and R-A

For A-R group in the absolute frame, participants travelled a total of 1,190 m but in the relative frame, they only went off-route for 130 m. The R-A group, on the other hand, traveled 287 m off-route in the relative frame while 597 m in the absolute direction. Fig. 23 shows the off-route distances travelled by participants in both groups.

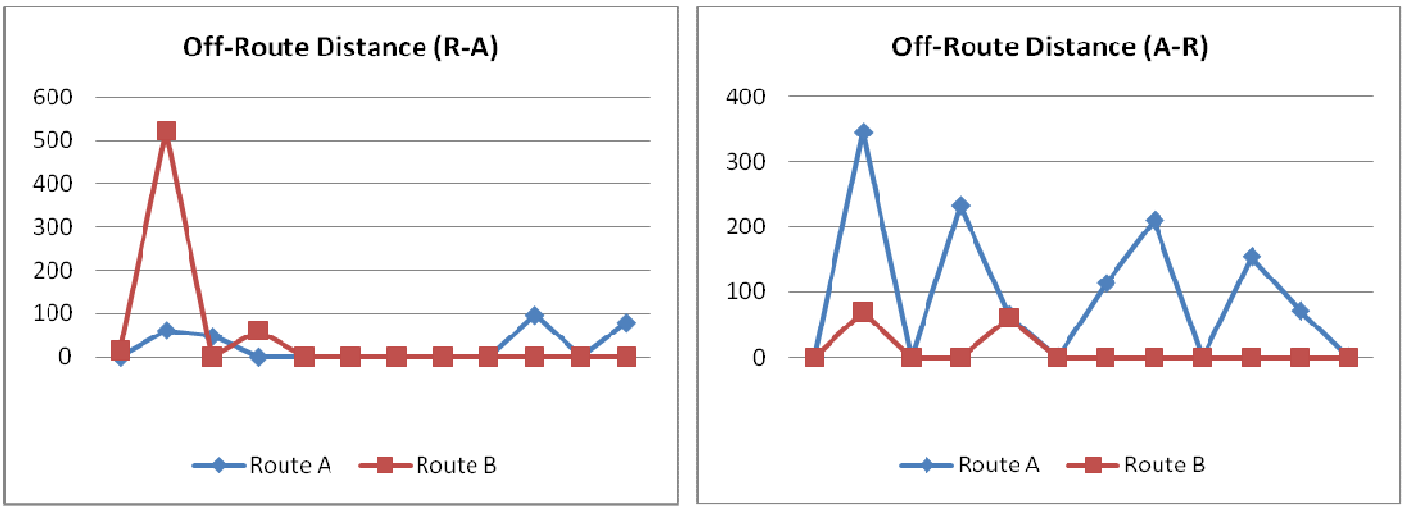

Fig. 23 Off-route distance of R-A and A-R group

Gender

Both men and women walked longer off-route distances in the absolute frame of reference. Men walked 1.24 km off-route in the absolute frame while women traveled 548 m off-route distance. In the relative frame, on one hand, men walked 240 m off-route while women walked 177 m. It also shows that women tend not to walk off the route in second set of the route instructions. Whereas men travelled 727 m off-route distance for the second set of routes which are either in a relative or absolute frame of reference.

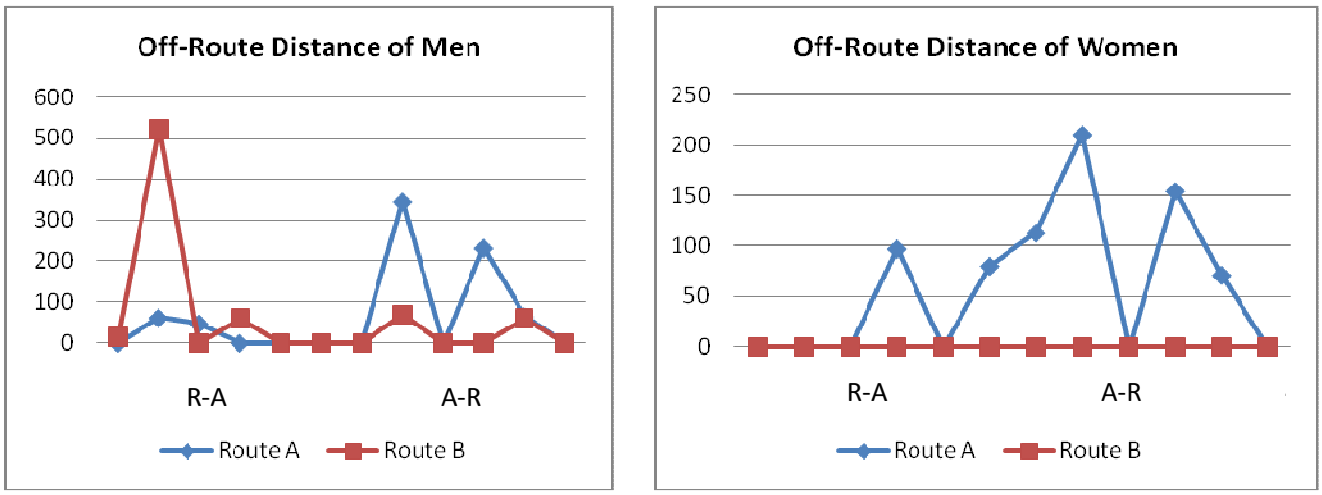

Fig. 24 Off-route distance of men and women

Fig. 25 shows the off-route distance travelled by men and women in every route regardless of whether in absolute or relative frame of reference. It shows that women walked longer off-route distance in Route 1 while for men it is Route 7. Although, only one person made so many deviations in this route. It is in Routes 3 and 4 where most of the men walked off the route.

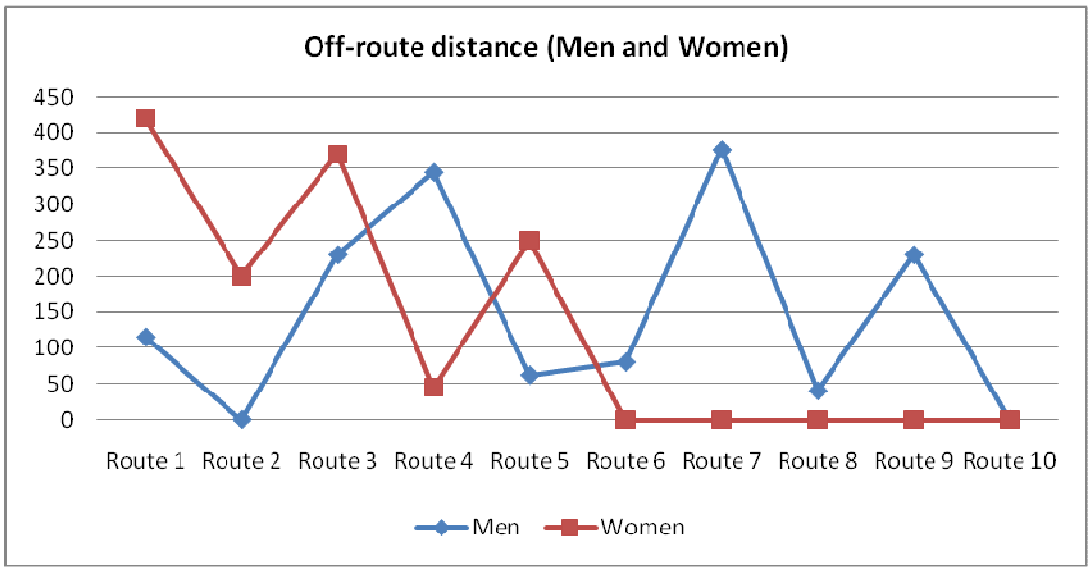

Fig. 25 Off-route distance of Men and Women per route

Sense of Direction Self-Report and Relationship with the Wayfinding measures

The Sta. Barbara sense-of-direction questionnaire was an indicator of how well the participant judged his spatial and navigational abilities, preferences, and experiences. The questions ranged from assessing how poor his memory is and how well he enjoys reading maps and giving directions. The (see Appendix for the sample questionnaire)

A-R and R-A

Participants in the A-R group who have good sense of direction tend to make less stops, less deviations, and less off-route distances in the absolute frame of reference. It is interesting to see that three participants who assessed that they have good sense of direction made more stops, deviations, and travelled longer off-route distance. The participant who incurred a high score in the sense-of-direction scale did well in the whole experiment without making any mistake.

For the R-A group, it showed that the participant with better sense of direction tend to make more stops, more deviations, and went off the routes. Although, it was only one participant in this group that assessed himself to have a better sense of direction yet took more deviations and frequently went off the route. Also, it is interesting to find out that some participants who

assessed themselves having a poor sense of direction fared well in the wayfinding experiment for the absolute frame of reference.

Gender

From the correlation result, it occured that men who assessed themselves to have good sense of direction made less stops but more deviations, and walked longer distances when they went off the route. From tabular data, it shows that there are two men who rated themselves having better sense of direction but each differed in the wayfinding performance.

Women who evaluated themselves having better sense of direction made less stops, less deviations and travelled less off-route distances. It could also be observed that the participant who had poor sense of direction did well in the task for the absolute instructions.

Hence, in looking at the mean of the SOD for men and women, it shows that men had rated themselves to have better sense of direction than women. However, in correlating it with the wayfinding performance measures, they made more stops, more deviations and travelled longer off-route distances.

Sketch Mapping Activity

Different individuals have varying ways of creating sketch maps. Some will take into account the paper size so they would be able to estimate the scale of the map. Whereas, others will draw until they will lack space and then try to disregard the distance of one landmark to another landmark as well as the length of the road.

Landmarks drawn

Landmarks are important features in wayfinding. Raubal and Winter (2002) addressed the importance of enriching wayfinding instructions with local landmarks by providing measures to identify the saliency of a specific feature. This includes visual attraction (facade area, shape, color, visibility), semantic attraction (cultural and historic importance of object), and structural attraction (nodes, boundaries, and regions). Without landmarks, it will be hard for people to find their way especially those who do not prefer following absolute directions. However, it is important to take into consideration that landmarks could not be reliable as they might change

overtime unlike using orientation strategy where there are fixed reference points (Lawton and Kallai, 2002). In the experiment following the absolute frame of reference, participants were paying more attention to the landmarks they saw rather than estimating the distance they have travelled. But, when drawing the sketch map, it is difficult for most people to remember all the landmarks s/he saw along the way. In Route 1, since there were ten (10) landmarks mentioned, perhaps it was quite impossible to remember all of them especially when going to four more routes before drawing the first sketch map. Only one participant was able to remember 9 out of the 10 landmarks for Route 1. Also, the participants from the R-A group drew more landmarks than A-R group where the instructions were given first in relative frame.

Men tend to draw lesser number of landmarks. As shown in the result of the sketch maps drawn by the participants, it occurred that women were able to remember and draw more landmarks. Although, there were two male participants who was able to draw a detailed sketch map.

It is also observed that some participants would draw other landmarks not indicated in the verbal instruction. Some of those they have seen while going to the starting point specifically placing the institute (IfGI) as a reference point. Also, another observation was that they would usually draw the bakery where they draw the first sketch map.

There are cases wherein most landmarks are not drawn in the correct position. Most of the time they would either overestimate or underestimate the placement in the sketch map for as long as they are in correct order such as which landmark came first. Also, there are instances when a visible landmark such as a park was not drawn in the sketch map. In terms of orientation, few participants included the north arrow sign.

Turns

Most of the participants were able to draw the correct number of turns of the route they walked. However, some turns were missed out in confusing routes such as Route 4 where the island was located. Both the A-R and the R-A groups did not perfectly draw the correct turn for this route.

Men and women did not show much difference in remembering the correct turns. They were able to draw the same number of turns in total. Although, there were few who made mistakes such as confusing a right turn or a left turn to drawing straight path. In Route 9, mostly women missed a

turn going to the next goal. This is where the park was located and they had to make a little turn and walk on the right side of it.

Streets drawn

The number of streets that a participant could remember is not only referring to the turns he made but other streets he saw while going through all the routes. Similar to drawing the landmark for Route 1, almost all of the participants were not able to identify the other streets they crossed along the way. Also, with Route 4, where few of them were able to remember the pathways they crossed which were indicated in the instruction.

Streets were drawn differently by participants. Some of them drew a single line for all the street network while others created double lines to represent both major and minor roads. Participants tend to disconnect streets such as the main road they first walked where they had to turn Right-Left-Left. Most of them did not realize they just went back to the main street.

One obsevation in drawing the road is that participants tend to draw a curved road into a straight line such as the first main road they took. Few were able to discern how the street network looks like.

It is also observed that participants who deviated tend to include the streets or path he took whch are not included in the instruction.

There was no difference on the total number of streets drawn by men and women. The result showed that they missed several streets in the same routes. If there were incomplete mention of turns or segments, this might be those where such information is unnecessary due to the presence of cues in the real environment (Lovelace and Montello, 1999).

Problems Encountered

Participants

There had been problems encountered in gathering participants due to several reasons. One, is the difficulty to get women respondents since the institute is dominated by men. Hence, it was a common practice to ask men whether they have female friends who could participate in the experiment which was following the snowball sampling method. Although, I sent e-mails to a

group of students from a mailing list given by former tutors coming from various courses in the university but, nobody responded. This was the period when most students are taking many exams already, hence, this might be one possible reason for not having time to participate. Another problem encountered was when there were participants who turned out to be familiar of the place in the middle of the experiment. Although, it was asked before the experiment was conducted whether they are familiar of the area. Hence, I looked for replacements when I encountered participants who were quite familiar to the study site already. The third problem is conflicting schedules of some participants that is why there had been negotiations with them during their free time. Also, there were instances when rescheduling of the experiment was done because participants could not make it to the assigned schedule.

Season

The experiment started in the last week of November and ended in the last week of December (days before Christmas time). In this season, the days are shorter and the nights are longer. Hence, it was taken into account the time when the experiment should start. Although, I wanted to have three or more respondents a day but, it would be dark already by the time I have my last participant. So, only two respondents a day were possible for the experiment. One in the morning (10 AM) and one in the afternoon (2 PM). The experiment would usually last for approximately 60 to 90 minutes depending on the speed of the participant. It took 17 days to finish with all 24 participants as well as some replacements. All experiment was done on weekdays except for one which was done on a weekend.

Changing weather condition

Muenster weather is described as oftentimes changing. The experiment started on November 25, 2009 and ended on December 21, 2009, the start of the winter season. As seen in Table 24, the highest mean temperature (11.0˚C) was on the first day of the experiment while the lowest temperature (-12.0˚C) happened on December 19, the coldest day of the year. During the first few days, the weather seemed fine even though there were times when it will suddenly rain in the middle of the experiment (see photos 6, 7, and 8 for changing weather). Despite such varying temperature, it did not affect the wayfinding performance of the participants.

Table 18. Meteorological Data of the 17 Experiment Days

Day	Date	Mean Temp.	Max. Temp	Max. Wind Gust	Remark
1	25-11-2009	11.0˚C	9.0˚C	13.0 m/s	
2	26-11-2009	8.0˚C	6.0˚C	10.0 m/s	
3	30-11-2009	6.0˚C	3.0˚C	8.0 m/s	
4	01-12-2009	4.0˚C	1.0˚C	7.0 m/s	
5	02-12-2009	3.0˚C	0.0˚C	7.0 m/s	
6	03-12-2009	8.0˚C	5.0˚C	10.0 m/s	
7	07-12-2009	6.0˚C	4.0˚C	9.0 m/s	
8	08-12-2009	6.0˚C	4.0˚C	7.0 m/s	
9	09-12-2009	6.0˚C	4.0˚C	8.0 m/s	
10	10-12-2009	8.0˚C	7.0˚C	9.0 m/s	
11	14-12-2009	-1.0˚C	-1.0˚C	0.0 m/s	
12	15-12-2009	-1.0˚C	-3.0˚C	0.0 m/s	
13	16-12-2009	-1.0˚C	-3.0˚C	0.0 m/s	
14	17-12-2009	-2.0˚C	-4.0˚C	-1.0 m/s	Started snowing
15	18-12-2009	-4.0˚C	-11.0˚C	-2.0 m/s	
16	18-12-2009	-12.0˚C	-13.0˚C	-1.0 m/s	Coldest day of the year
17	21-12-2009	-2.0˚C	-3.0˚C	0.0 m/s	

Source: http://kli.uni-muenster.de/en/weather/stats/index.html

It is interesting to note that since it was quite difficult to find enough women to participate earlier, most of them were scheduled in the last days when the weather was so cold and when it started to snow. Yet, it did not affect their performance. As one female participant commented: "*...it's not the weather, but the clothes you wear*." Hence, people living in Muenster are well-prepared of such varying weather condition.

Another interesting problem encountered was when the bakery was unexpectedly closed (on a weekend) that the participant had to draw the first sketch map outside. It happend on the coldest day of the year. Perhaps, the weather condition affected how he drew the first sketch map. It showed in the result after he finished drawing the second sketch map in a conducive environment wherein he included some landmarks already. (see Appendix Map 6 for R-A group of Men)

Photo 5. A sunny day (Day 4)

Photo 6. A rainy day (Day 8)

Photo 7. The snowy weather, coldest day of the year (Day 16)

CHAPTER VI

CONCLUSION

The study provided interesting results contributing to the set of related studies about gender differences. Recalling the objectives of this research whereby: (1) to identify gender differences in following an outdoor wayfinding task with respect to the absolute or relative frame of reference taking into account the number of stops, deviations and off-route distances; (2) to know the wayfinding performance of participants in A-R and R-A groups based on the number of stops, deviations and off-route distances with respect to following a shift of frame of reference; and (3) to evaluate differences in participant's level of spatial cognition in terms of how much information has been recalled such as the number of landmarks drawn through sketch mapping, the following observations were identified from the experiment in reaching such aims:

Shift and comparison of Results to Ishikawa and Kiyomoto (2008)

This research followed the methodology of Ishikawa and Kiyomoto (2008) whereby examining how people would adapt to switching frames of reference in verbal route instructions. Comparing the results to their study, it also shows that German speakers prefer relative frame of reference just like the Japanese speakers. There are differences of how people perform the outdoor wayfinding experiment depending on which frame of reference was used.

In similar result, this study also shows that people would find it easier to switch from a non-preferred frame of reference (absolute) to a preferred frame (relative) which is from absolute to relative instructions. It shows that there were more stops and deviations in the absolute directions but, somehow the participants were still able to adapt to their non-preferred frame of reference. The authors emphasized that the processing of two kinds of instructions are different but it does not mean that absolute frame would create larger cognitive loads than the relative frame of reference. However, in this experiment, a significant difference was observed with the A-R group performance wherein it was quite difficult for all of them to follow absolute instructions first considering the number of stops and deviations made. This

could be due to the difficulty of route set as compared to the second route set. Shifting to a non-preferred frame of reference was not as difficult for the participants who are starting in the non-preferred frame of reference. In Ishikawa and Kiyomoto's result, the R-A group tends to make more deviations and travelled longer off-routes.

It is interesting to note that there had been varying results of how participants with better and poor sense of direction fared in the wayfinding task. In the previous study, it occurred that the participants were able to rate well their own navigational skills. However, in this study, there were cases wherein some participants who said they have better sense of direction made more stops and more deviations than those participants who claimed they have poor sense of direction who fared better. This was shown in correlating the performance measures and the sense of direction scale questionnaire. When looking at their performance, it was easier for them to change from a non-preferred frame of reference, absolute, to the preferred frame which is relative. This is attributed to the time they spent and the number of stops and deviations they made. In terms of the walking speed, the same result was attained comparing with Ishikawa and Kiyomoto's experiment wherein there was no difference of the participant's speed when it changed to another instruction. Hence, it is highly considerable that people could still achieve the same level of performance regardless of the frame of reference used.

Gender Differences

Based on the wayfinding performance measures, it resulted that women were able perform better than men whereby making less number of stops, deviations and went off the route less frequently based on the frames of reference. Although, there were studies stating that men usually perform better than women in many spatial activities especially in wayfinding (O'Laughlin and Brubaker, 1998; Lawton, 1994).

In terms of the frame of reference, several studies have shown that men are better in following absolute frame of reference (Holding and Holding, 1988; Scholl et al, 2000; Silverman and Choi, 2006;). However, from the result of the experiment, it showed that women are able to follow absolute directions as well. An interesting observation is when the instruction shifted from relative to absolute frame of reference, wherein the women participants did not make any deviations whereas men did more deviations. It was observed that women tend to adapt

easily to a changing route instructions and showed a quick processing of information. Holding and Holding (1998) stated in their study that women tend to show bias towards underestimation and that they were guessing in some spatial tasks, but in this research, women were able to estimate their distances by not going off the route. However in this case, men tend to overestimate their distances by travelling longer off-route distances. In terms of the sense-of-direction report, it resulted that women were able to evaluate their spatial skills better based on the wayfinding performance measures although not seen as significant. From the result, it showed that women who think they have poor sense of direction tend to make more stops, more deviations, and walked off-route frequently.

In terms of recalling objects, several studies found that women perform better in object location memory (Montello et al, 1999; Eals and Silverman, 1994) thus, this could be one reason that women are able to draw detailed sketch maps based on the number of landmarks they could remember. But, Iachini et al (2005) observed that men performed better in indoor spatial task such as object location memory than women. However, in this study while evaluating the sketch maps, women were able to draw more landmarks than men but in overall sketch map activity, it showed that there is no gender difference in sketch mapping as both genders were able to perform the same level of mapping task based (O'Laughlin and Brubaker, 1998) based as well on the sketch map indicators such as landmarks, turns, and the streets drawn.

In general, since there had been problems encountered specifically the changing weather condition, it resulted that it did not affect the wayfinding performance of the participants. However, this area of study need to be further examined.

Therefore, based on the results, it is concluded that:

a) Women performed better than men taking into account the wayfinding indicators on the frames of reference. They made few stops, few deviations and did not walk off the route more frequently.

b) In terms of the shifting frame of reference, participants in the A-R group made more stops, more deviations, and walked longer off-route distances than those in the R-A group. It is in the absolute frame of reference wherein it was quite difficult for the participants to follow.

c) Women drew sketch maps more detailed than men based on the number of landmarks.

Future Work

This study presented interesting results in gender studies showing the varying spatial abilities of men and women in wayfinding. The shifting frame of reference is seen as an important activity to determine how people would follow navigational instructions efficiently whether it is in relative or absolute frame of reference. Clear route instructions for both preferred and non-preferred frame of reference is deemed important for people to easily follow wayfinding tasks. It is also interesting to note that women could equally perform better with men in terms of following absolute directions where they are seen as poor in wayfinding task in many studies.

In this research, many possible topics for future work were realized. These were the following:

- Study on cultural differences in wayfinding is an interesting topic using English language as a route instruction. One may be able to discover how each culture would interpret instructions following another language which is not their native tongue.
- It is also interesting to look at the individual differences of unfamiliar people to familiar people to the environment. This includes how s/he follows directions and how they also draw sketch maps.
- Quantitative analysis of sketch maps.
- In terms of gender, it would be interesting if similar study will be conducted but following the shifting frame of reference.
- It would also be interesting to look at differences of students coming from a spatial and non-spatial discipline in following wayfinding task.
- Changing weather condition effect on outdoor wayfinding is also seen as an interesting topic as this is seen as unexplored area of study since there had been no existing literature or related researches found.

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APPENDIX

Route Verbal Instructions (English and German Language)

Route 1

Absolute:

Walk straight to ESE for 400 meters. 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.

*Gehen Sie 400 Meter geradeaus in Richtung OSO. Sie sehen Häuserblocks im Norden und Süden der Straße. Im Norden sehen Sie ein Restaurant und einen Friseur. In Richtung SSO sehen Sie eine Bäckerei neben einem Geschäft für Modellautos. Sie sehen eine Ampel und einen Park in Richtung Norden. Nach dem Park sehen Sie einen Kiosk. Wenn Sie an einer Straßenkreuzung angekommen sind, sehen Sie eine Bäckerei im OSO und eine Telefonzelle **[Ziel]** im Osten.*

Relative:

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.

*Laufen Sie geradeaus. Sie sehen Häuserblocks auf beiden Seiten der Straße. Zu Ihrer Linken sehen Sie ein Restaurant und einen Friseur. Zu Ihrer Rechten sehen Sie eine Bäckerei neben einem Geschäft für Modellautos. Danach sehen Sie eine Ampel und zu Ihrer Linken einen Park. Nach dem Park sehen Sie einen Kiosk. Wenn Sie an einer Straßenkreuzung angekommen sind, sehen Sie eine Bäckerei an der Ecke auf der anderen Straßenseite und eine Telefonzelle **[Ziel]** zu Ihrer Linken.*

Route 2

Absolute:

Turn to the south and cross the street. Walk straight for 62 meters. Turn to the ENE when you hit a shared pathway for bicycle and pedestrian. Walk for 220 meters. 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.

Bitte drehen Sie sich in Richtung Süden und überqueren Sie die Straße. Gehen Sie nun 62 Meter geradeaus. Wenn Sie an einem gemeinsamen Geh- und Radweg ankommen, drehen Sie in

Richtung ONO. Gehen Sie nun 220 Meter geradeaus. Sie laufen durch ein Wohngebiet, wo Sie Richtung Norden ein weißes Gebäude sehen. Sie laufen an einer Grünfläche in Richtung Süden vorbei. Sie sehen einen Parkplatz von einem Restaurant in Richtung Süden. Wenn Sie an einer Nord-Süd verlaufenden Straße ankommen, sehen Sie eine Apotheke [Ziel] in Richtung Norden und ein Restaurant in Richtung Süden.

Relative:

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.

*Bitte drehen Sie sich nach rechts und überqueren Sie die Straße. Gehen Sie nun geradeaus. Wenn Sie an einem gemeinsamen Geh- und Radweg ankommen, biegen Sie links ab. Sie laufen nun durch ein Wohngebiet, wo Sie zu Ihrer Linken ein weißes Gebäude sehen. Zu Ihrer Rechten laufen Sie an einer Grünfläche in vorbei. Danach sehen Sie einen Parkplatz von einem Restaurant zu Ihrer Rechten. Wenn Sie am Ende der Straße ankommen sind, sehen Sie eine Apotheke [**Ziel**] zu Ihrer Linken und ein Restaurant zu Ihrer Rechten.*

Route 3

Absolute:

Walk 70 meters 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.

*Bitte laufen Sie 70 Meter in Richtung Norden. Sie sehen die Ulf Import Fahrschule im Osten. Überqueren Sie nun eine Ost-West verlaufende Straße. Sie sehen das Restaurant Haus Nemann [**Ziel**] im Westen. Sie sehen die Johanniter Akademie Gästehaus im Norden. Außerdem sehen Sie eine Kirche im OSO und einen Schlecker Supermarkt im Osten.*

Relative:

Turn left from the pharmacy and walk straight. You see the Ulf Import Fahrschule to your right. Cross the street, you see the Haus Nemann 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.

*Bitte biegen Sie an der Apotheke links ab und laufen geradeaus. Sie sehen die Ulf Import Fahrschule zu Ihrer Rechten. Überqueren Sie eine Straße. Zu Ihrer Linken sehen Sie das Restaurant Haus Nemann [**Ziel**]. Vor Ihnen sehen Sie die Johanniter Akademie Gästehaus. Außerdem sehen Sie eine Kirche und einen Schlecker Supermarkt zu Ihrer Rechten.*

Route 4

Absolute:

Walk to the NNE for 40 meters and then walk 290 meters 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.

*Laufen Sie nun 40 Meter in Richtung NNO und dann 290 Meter in Richtung NNW. Sie laufen an dem Gebäudekomplex Johanniter Akademie Gästehaus im Westen vorbei. Sie sehen ein Deko-Geschäft im Osten. Nun laufen Sie am Johanniter-Stift Seniorenhäuser Münster im Westen vorbei. Sie überqueren zwei Stichstraßen im Westen. Im Westen sehen Sie einen Häuserblock mit geklinkerten Gebäuden **[Ziel].***

Relative:

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.

*Biegen Sie nach der Straßeninsel rechts ab. Danach biegen Sie links in die erste Straße und laufen geradeaus weiter. Zu Ihrer Linken laufen Sie an dem Gebäudekomplex Johanniter Akademie Gästehaus vorbei. Sie sehen ein Deko-Geschäft zu Ihrer Rechten. Nun laufen Sie am Johanniter-Stift Seniorenhäuser Münster zu Ihrer Linken vorbei. Sie überqueren zwei Stichstraßen zu Ihrer Linken. Zu Ihrer Linken sehen Sie einen Häuserblock mit geklinkerten Gebäuden **[Ziel].***

Route 5

Absolute:

Turn to the NE and walk for 150 meters. When you hit a shared bicycle and pedestrian pathway to the north, turn to the NNW and walk for 120 meters. 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.

Biegen Sie in Richtung NO ab und laufen Sie 150 Meter. Wenn Sie bei einem gemeinsamen Geh- und Radweg (im Norden) angekommen sind, drehen Sie sich in Richtung NNW und laufen 120 Meter. Sie laufen durch ein Wohngebiet mit weißen Häusern im Westen. Am Ende des Weges [Ziel] sehen Sie ein geklinkertes Gebäude im Norden mit einem Kiosk und auf beiden Seiten Geschäfte.

Relative:

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.

Biegen Sie in die Straße nach rechts ein und laufen Sie geradeaus. Wenn Sie bei einem gemeinsamen Geh- und Radweg (links) angekommen sind, biegen Sie links ab und laufen Sie geradeaus. Sie laufen durch ein Wohngebiet mit weißen Häusern zu Ihrer linken. Am Ende des Weges [Ziel] sehen Sie vor Ihnen ein geklinkertes Gebäude mit einem Kiosk und auf beiden Seiten Geschäfte.

Route 6

Absolute:

Turn to the WSW and walk straight for 110 meters. In the intersection, you see a big yellow building **[goal]** to the west.

*Biegen Sie in Richtung WSW ab und laufen Sie 110 Meter. An der nächsten Kreuzung sehen Sie im Westen ein großes gelbes Gebäude **[Ziel].***

Relative:

Turn to the left and walk straight until the intersection. You see a big yellow building **[goal]** in front of you in the other side of the street.

*Biegen Sie nach links ab und laufen geradeaus bis zur nächsten Kreuzung. Sie sehen vor Ihnen auf der gegenüberliegenden Straßenseite ein großes gelbes Gebäude **[Ziel].***

Route 7

Absolute:

Turn south and walk 100 meters. Turn WSW and walk 220 meters. You pass by a row of houses usually with colors yellow and white on both sides of the street. You see a shoe shop (Lodweg Schuhfachgeschäft) to the north. You see Protte Lohmann Fahrschule to the south. You see a big post for advertisement **[goal]** .

*Gehen Sie in Richtung Süden und laufen Sie 100 Meter. Biegen Sie nun Richtung WSW ab und laufen Sie 220 Meter. Auf beiden Straßenseiten laufen Sie an Häuserreihen vorbei, von denen die meisten Häuser gelb und weiß gestrichen sind. Sie sehen ein Schuhgeschäft (Lodweg Schuhfachgeschäft) im Norden und Protte Lohmann Fahrschule im Süden. Sie sehen eine große Litfaßsäule für Werbung **[Ziel].***

Relative:

Turn left and walk straight. Turn right on the first street. You pass by a row of houses usually with colors yellow and white on both sides of the street. You see a shoe shop (Lodweg Schuhfachgeschäft) to the right. You see Protte Lohmann Fahrschule to the left. You see a big post for advertisement **[goal]** at the end of the street.

*Biegen Sie links ab und laufen geradeaus. Biegen Sie an der ersten Straße rechts ab. Auf beiden Straßenseiten laufen Sie an Häuserreihen vorbei, von denen die meisten Häuser gelb und weiß gestrichen sind. Sie sehen ein Schuhgeschäft (Lodweg Schuhfachgeschäft) zu Ihrer Rechten und Protte Lohmann Fahrschule zu Ihrer Linken. Sie sehen eine große Litfaßsäule für Werbung **[Ziel]** am Ende der Straße.*

Route 8

Absolute:

Walk straight to the west for 90 meters. You see a brick building to the north. When you hit a road, turn south and walk for 30 meters to the park **[goal].** Choose the road west of the park for the next route.

*Laufen Sie 90 Meter geradeaus in Richtung Westen. Sie sehen ein geklinkertes Gebäude in Richtung Norden. Wenn Sie an der nächsten Straße ankommen, biegen Sie in Richtung Süden ab und laufen 30 Meter zum Park [**Ziel].** Für den weiteren Weg wählen Sie die Straße, die westlich vom Park ist.*

Relative:

Walk straight ahead. You see a brick building to the right. When you hit a road that leads to a park, turn to the left and walk straight to the park **[goal].** Choose the road to your right for the next route.

*Laufen Sie geradeaus. Sie sehen ein geklinkertes Gebäude zu Ihrer Rechten. Wenn Sie an der Straße, die in Richtung Park führt, ankommen sind, biegen Sie nach links ab und laufen geradeaus zum Park **[Ziel].** Für den weiteren Weg wählen Sie die Straße, die rechts vom Park ist.*

Route 9

Absolute:

Turn to the SSW and walk for 180 meters. You pass through the park and a residential block in yellow color. Turn to the WNW and walk for 50 meters. When you hit the street running toward

south, turn to the south. You see the backyard of a residential block to the east with some garden sheds. If you hit the east-west running street, you see the Hair salon **[goal]** to the west.

*Biegen Sie in Richtung SSW ab und laufen Sie 180 Meter geradeaus. Sie laufen an einem Park und einem Wohngebiet vorbei, in dem die Häuser gelb gestrichen sind. Biegen Sie in Richtung WNW ab und laufen Sie 50 Meter. Biegen Sie in die nach Süden abgehende Stichstraße ein. Sie sehen die Gärten mehrerer Häuser teilweise mit Gartenhäusern in Richtung Osten. Wenn Sie bei einer Straße, die Ost-West verläuft, ankommen, sehen Sie einen Friseursalon im Westen **[Ziel].***

Relative:

Turn to the right and walk straight. You pass through the park and a residential block in yellow color. Before you reach another park, turn to the right and walk straight. When you hit the street running toward the left, turn to the left. You see the backyard a residential block to your left with some garden houses. If you hit the end of the street, you see the Hair salon **[goal]** to your right.

*Biegen Sie nach rechts ab und laufen geradeaus. Sie laufen an einem Park und einem Wohngebiet vorbei, in dem die Häuser gelb gestrichen sind. Bevor Sie einen zweiten Park erreichen, biegen Sie rechts ab und laufen geradeaus. Biegen Sie in die nach links abgehende Stichstraße ein. Sie sehen die Gärten mehrerer Häuser teilweise mit Gartenhäusern zu Ihrer Linken. Am Ende der Straße sehen Sie einen Friseursalon **[Ziel]** zu Ihrer Rechten.*

Route 10

Absolute:

Turn to the WNW and pass through the grayish building. You see the hair salon and the restaurant to the north. Walk straight for 80 meters. You see the decoration shop **[goal]** which is the starting point.

*Biegen Sie in Richtung WNW ab und laufen unter einem grauen Gebäude lang. Sie sehen ein Friseursalon und ein Restaurant im Norden. Laufen Sie 80 Meter geradeaus. Sie sehen ein Deko-Geschäft **[Ziel],** welches auch Ihr Startpunkt war.*

Relative:

Turn to the right and pass through a grayish building. You see the hair salon and the restaurant to your right. Walk straight ahead. You see the decoration shop **[goal]** which is the starting point.

*Biegen Sie nach rechts ab und laufen unter einem grauen Gebäude lang. Sie sehen ein Friseursalon und ein Restaurant zu Ihrer Rechten. Laufen Sie geradeaus. Sie sehen ein Deko-Geschäft **[Ziel],** welches auch Ihr Startpunkt war.*

SANTA BARBARA SENSE-OF-DIRECTION SCALE

Sex: F/M
Age:

Today's Date:
V.2

The questionnaire consists of several statements about your spatial and navigational abilities, preferences, and experiences. After each statement, you should circle a number to indicate your level of agreement with the statement. Circle "1" if you strongly agree that the statement applies, "7" if you strongly disagree, or some number in between if your agreement is intermediate. Circle "4" if you neither agree nor disagree.

1. I am very good at giving directions.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

2. I have a good memory for where I left my things.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

3. I am very good at judging distances.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

4. My "sense of direction" is very good.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

5. I tend to think of my environment in terms of cardinal directions (N,S,E,W)

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

6. I don't get lost very easily in a new city.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

7. I enjoy reading maps.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

8. I don't have trouble understanding maps.

   Strongly agree 1 2 3 4 5 6 7 strongly disagree

9. I am very good at reading maps.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

10. I remember routes very well while riding as a passenger in a car.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

11. I enjoy giving directions.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

12. It is important to me to know where I am.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

13. I do not usually let someone else do the navigational planning for long trips.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

14. I can usually remember a new route after I have traveled it only once.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

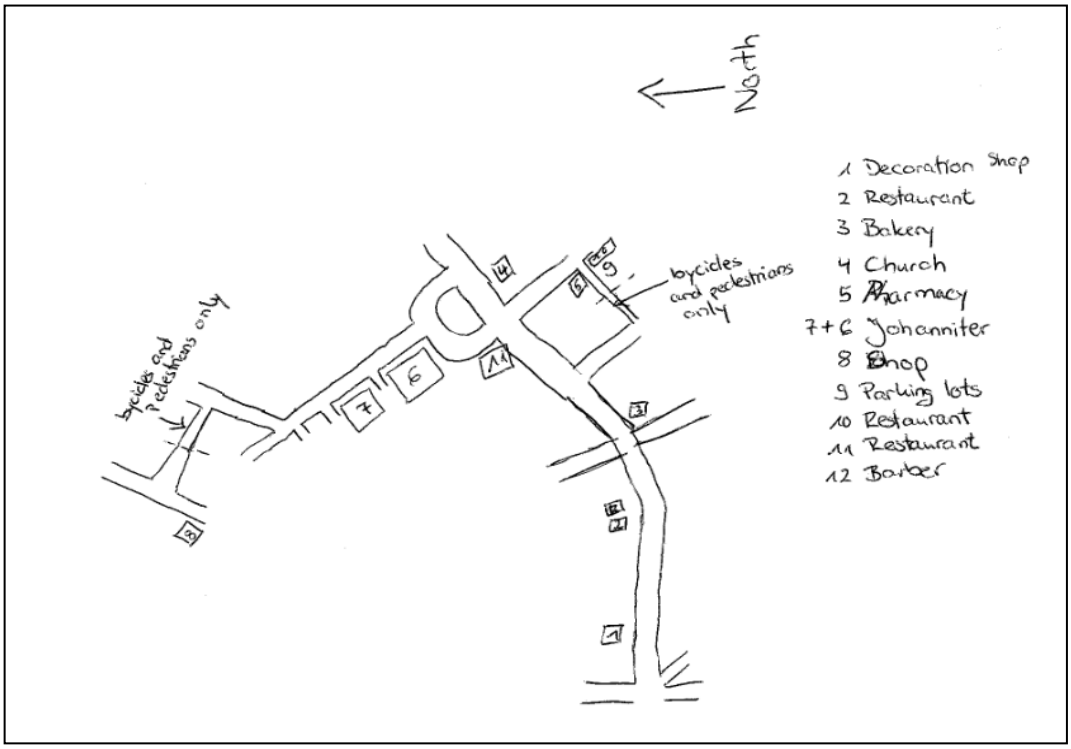
15. I have a very good “mental map” of my environment.

Strongly agree 1 2 3 4 5 6 7 strongly disagree

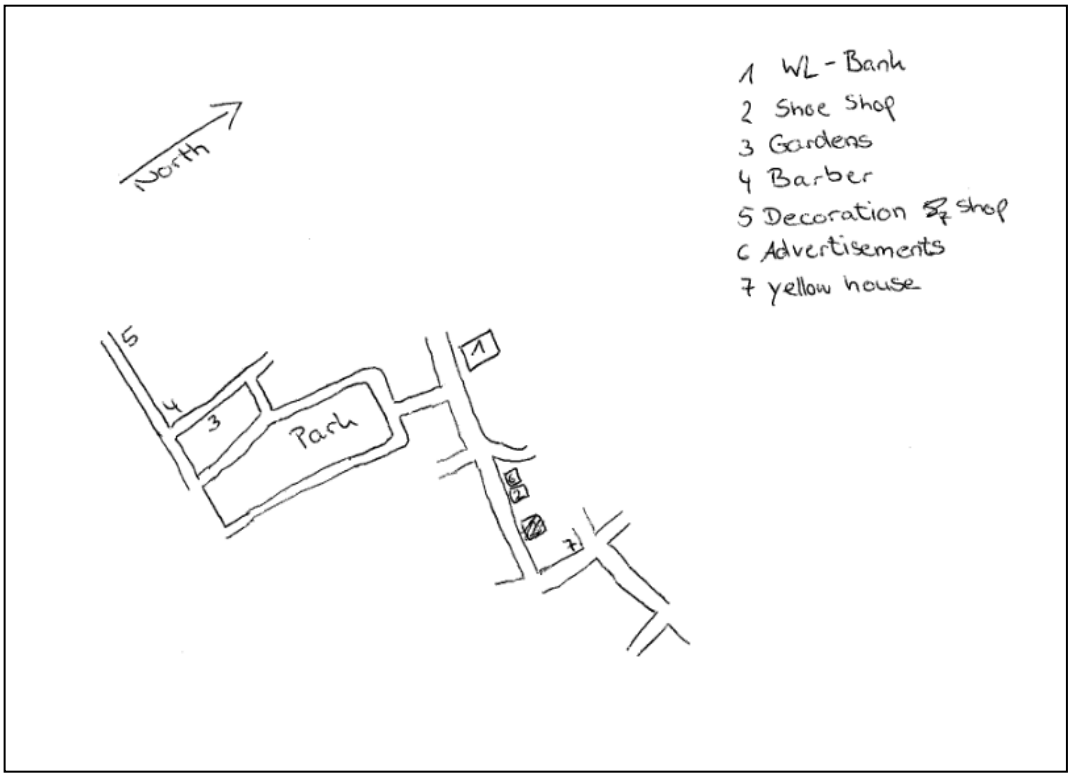
SKETCH MAPS

Men and Women

Sketch Map 1 (WOMEN in R-A Group)

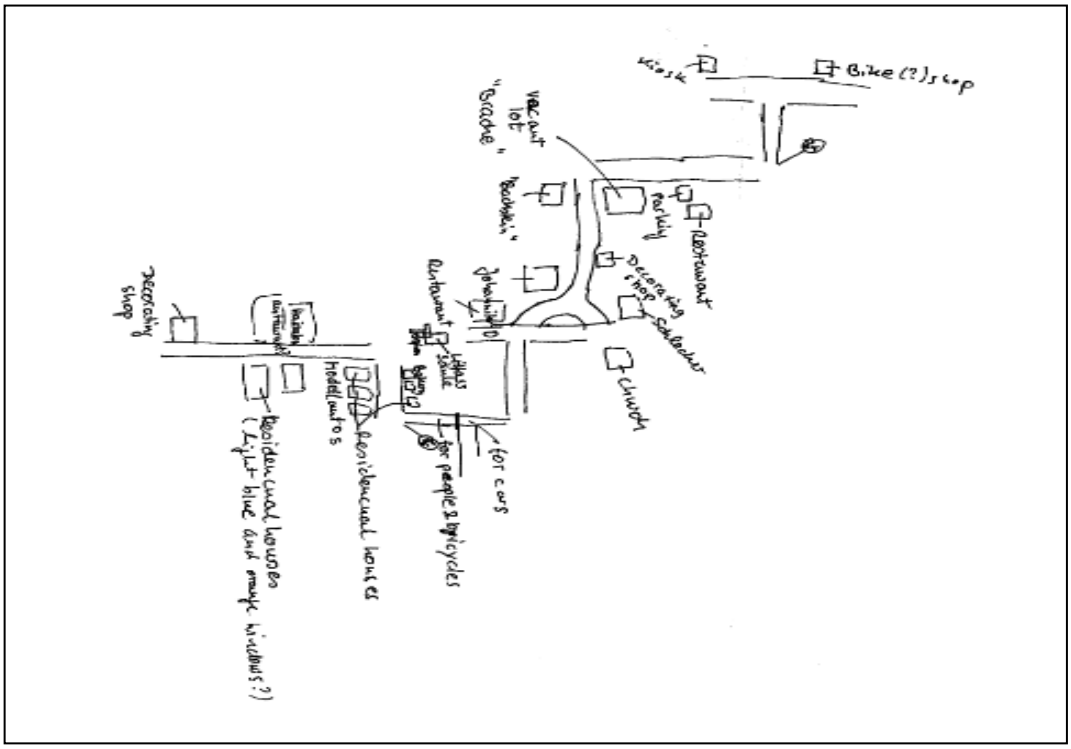


ROUTE A

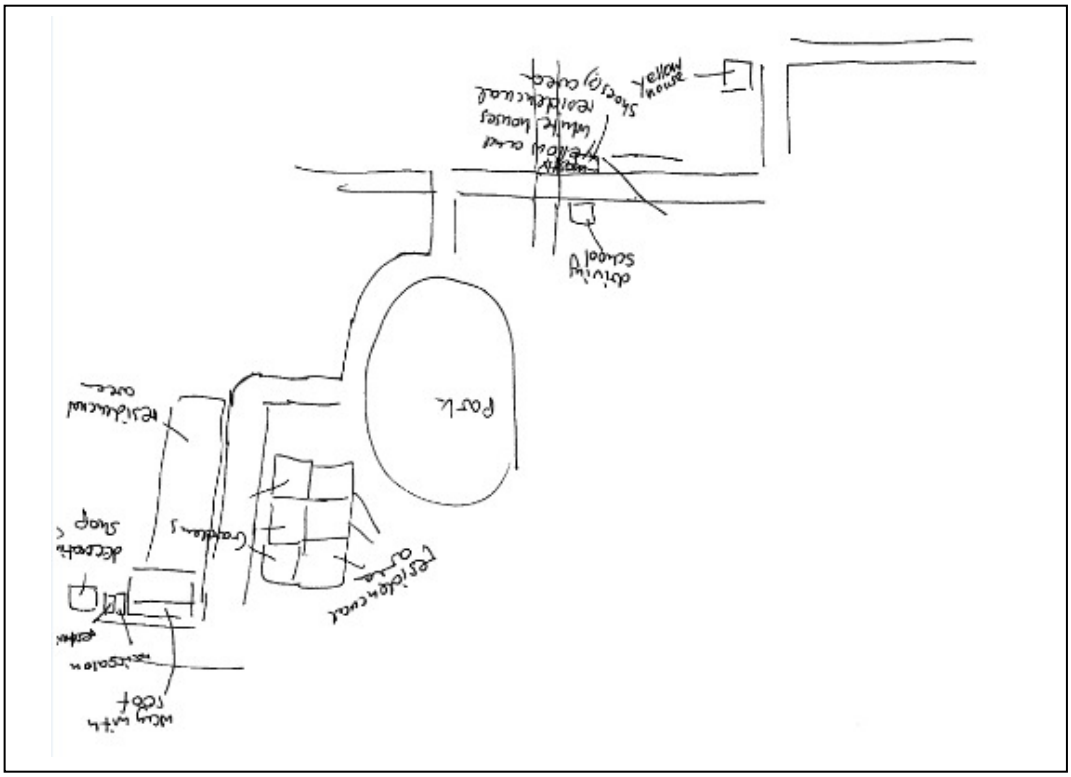


ROUTE B

Sketch Map 2

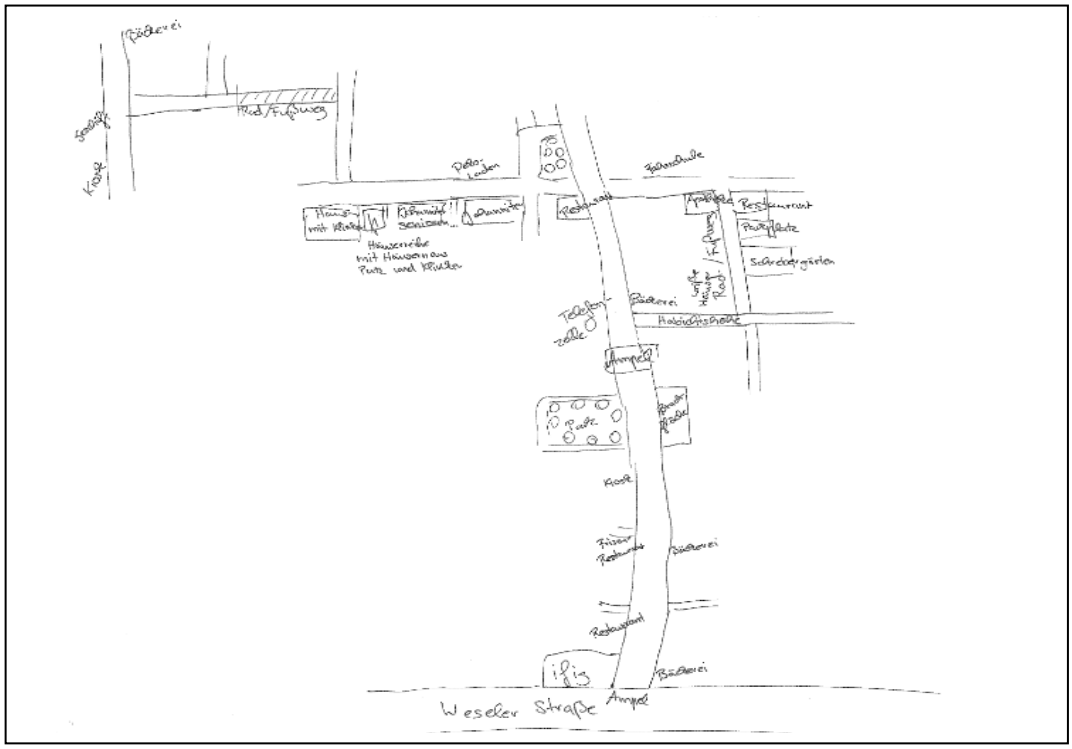


ROUTE A



ROUTE B

Sketch Map 3



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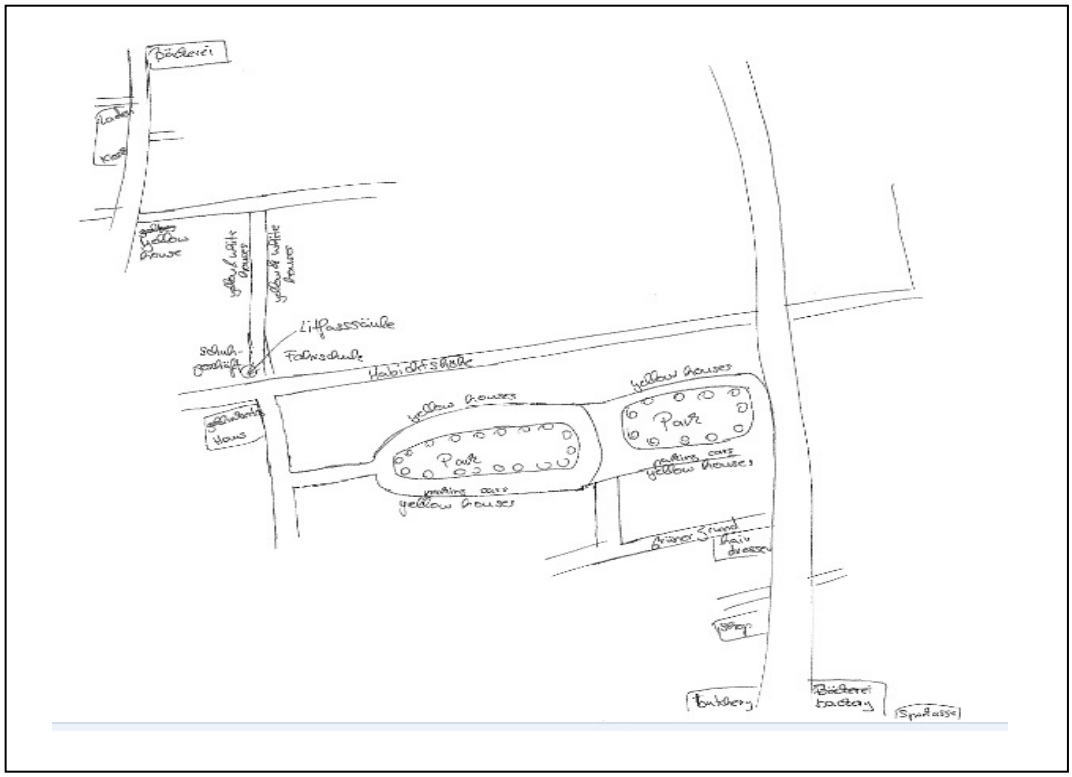
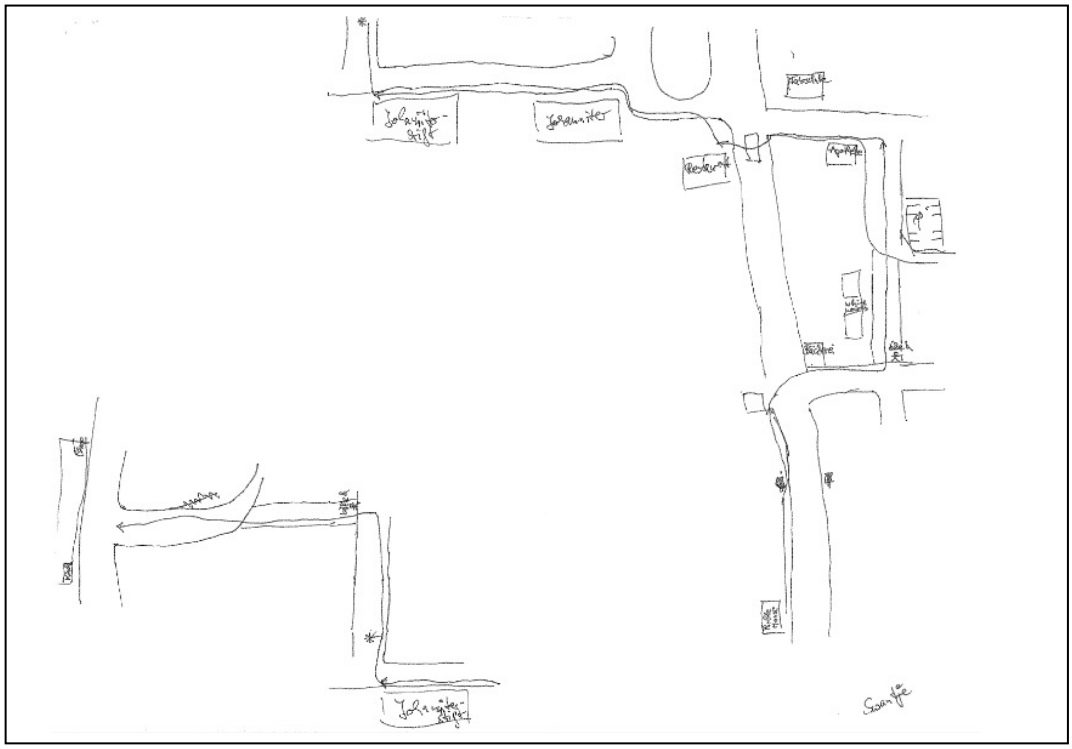


ROUTE B

Sketch Map 4



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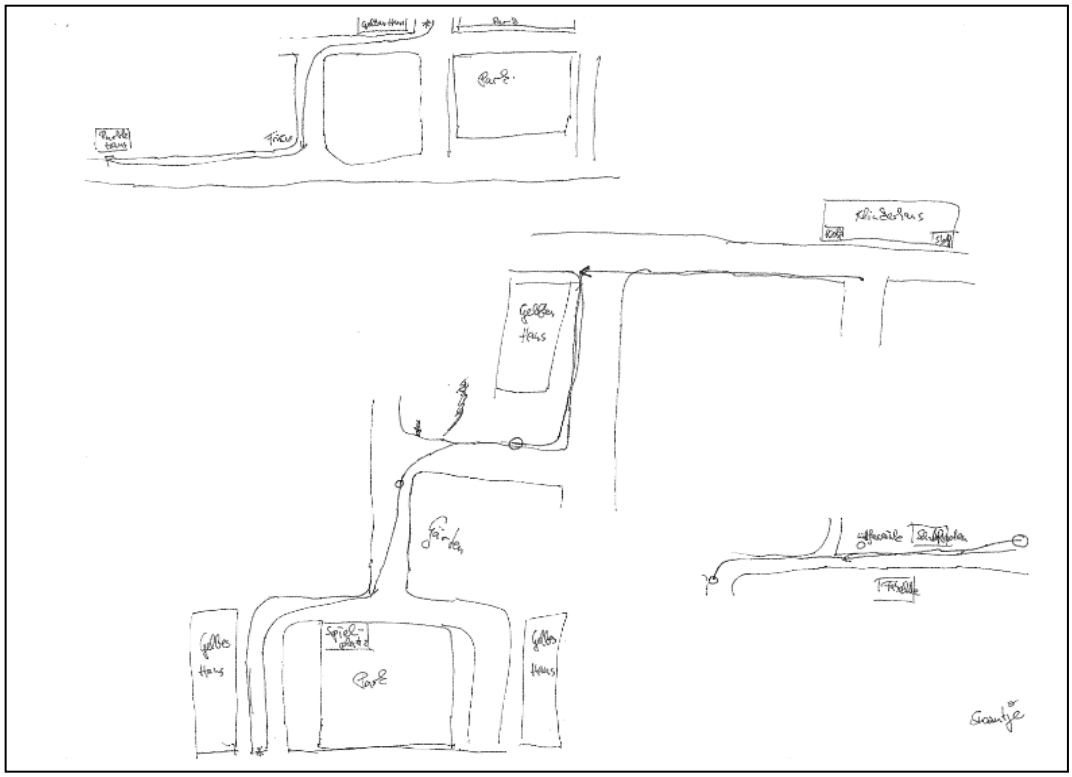

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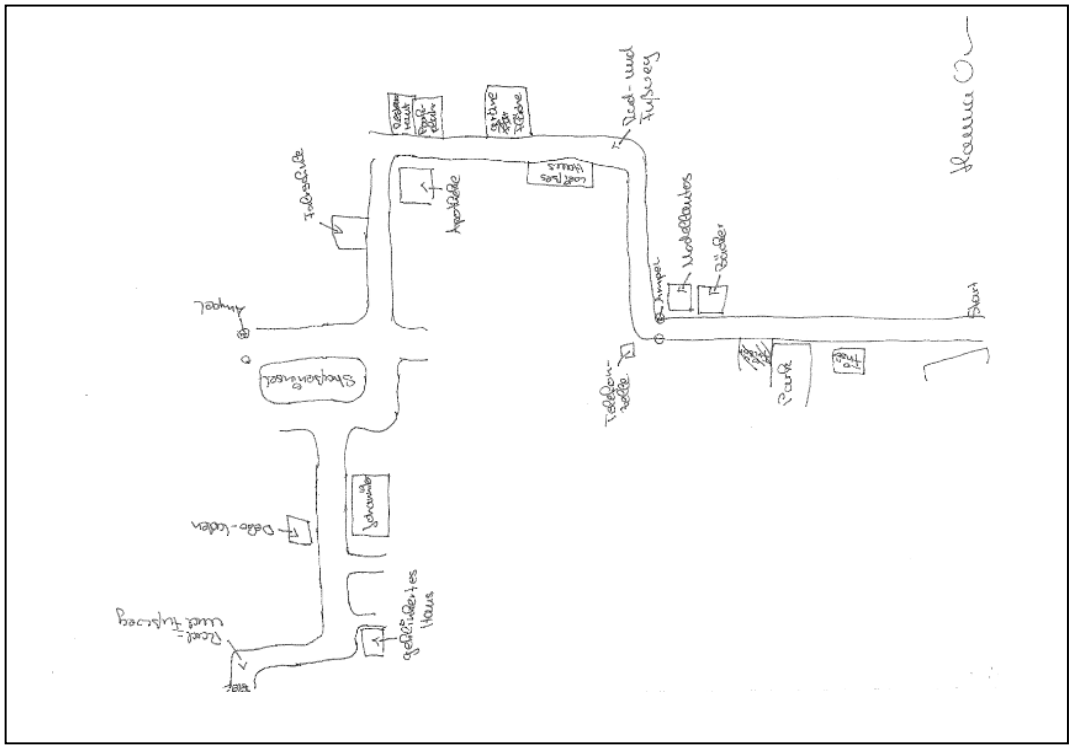
Sketch Map 5



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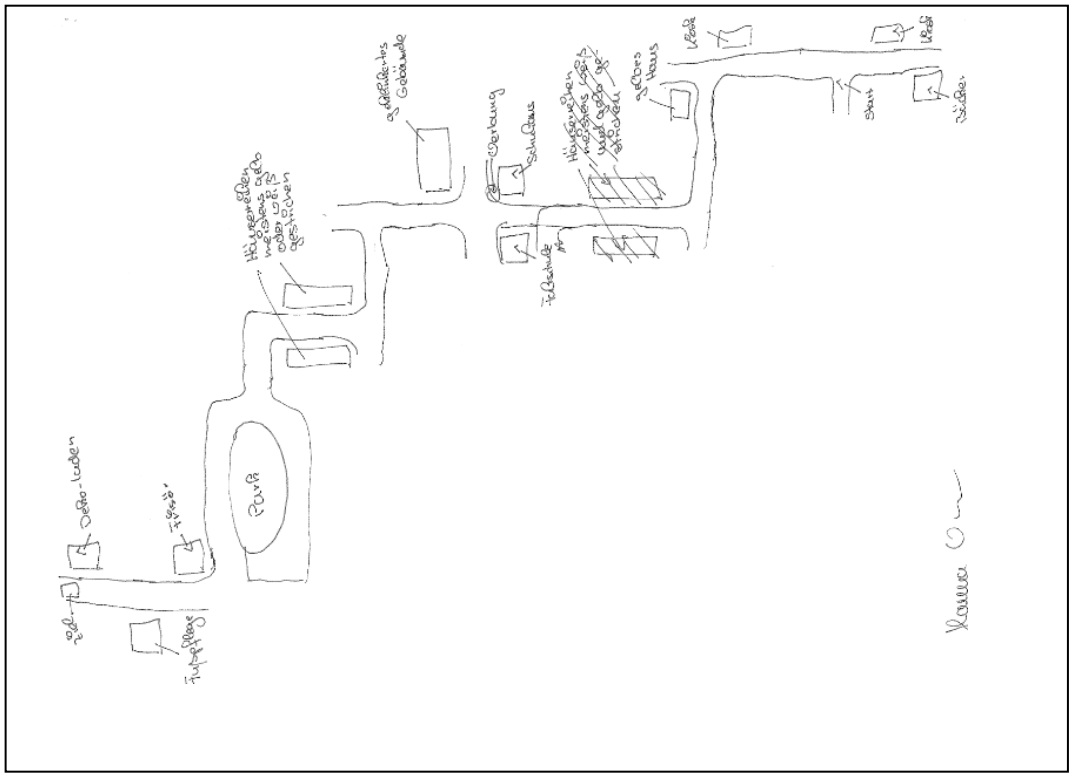
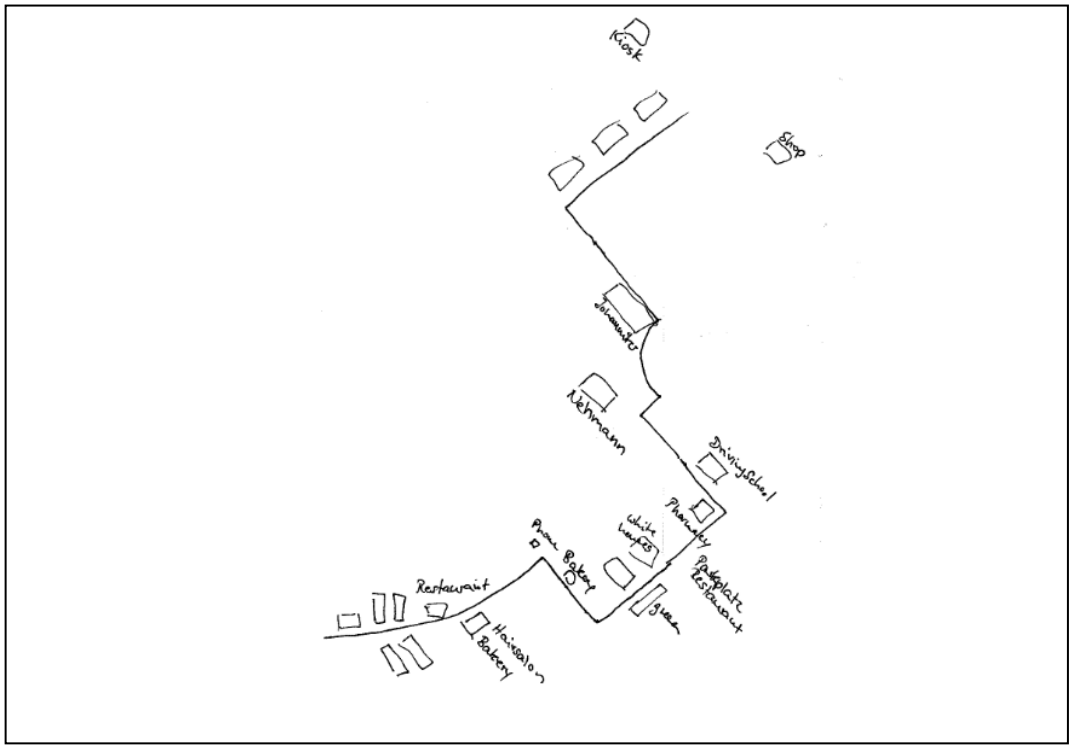


ROUTE B

Sketch Map 6



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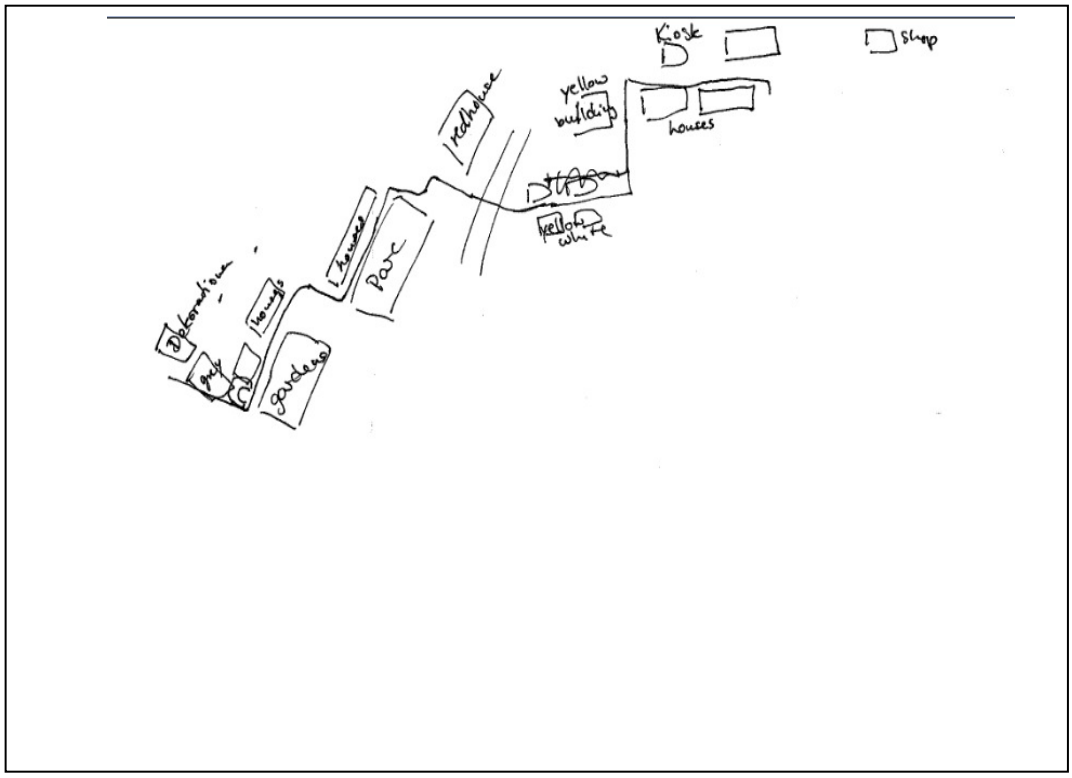
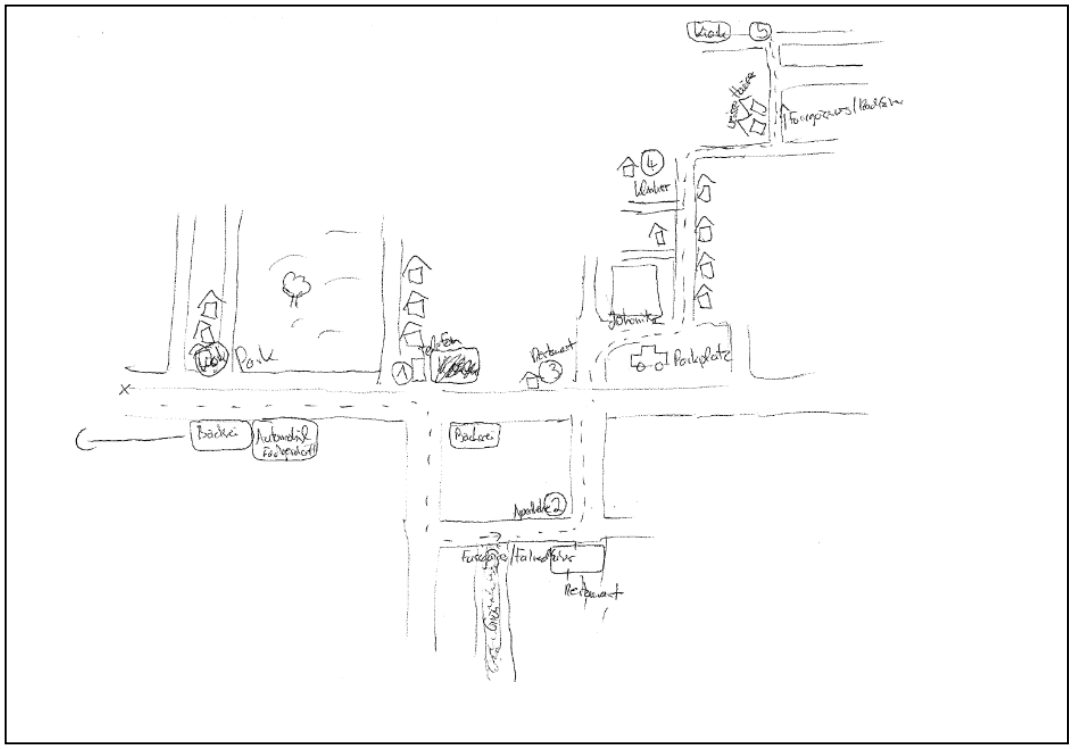


ROUTE B

Sketch Map 1 (WOMEN in A-R Group)



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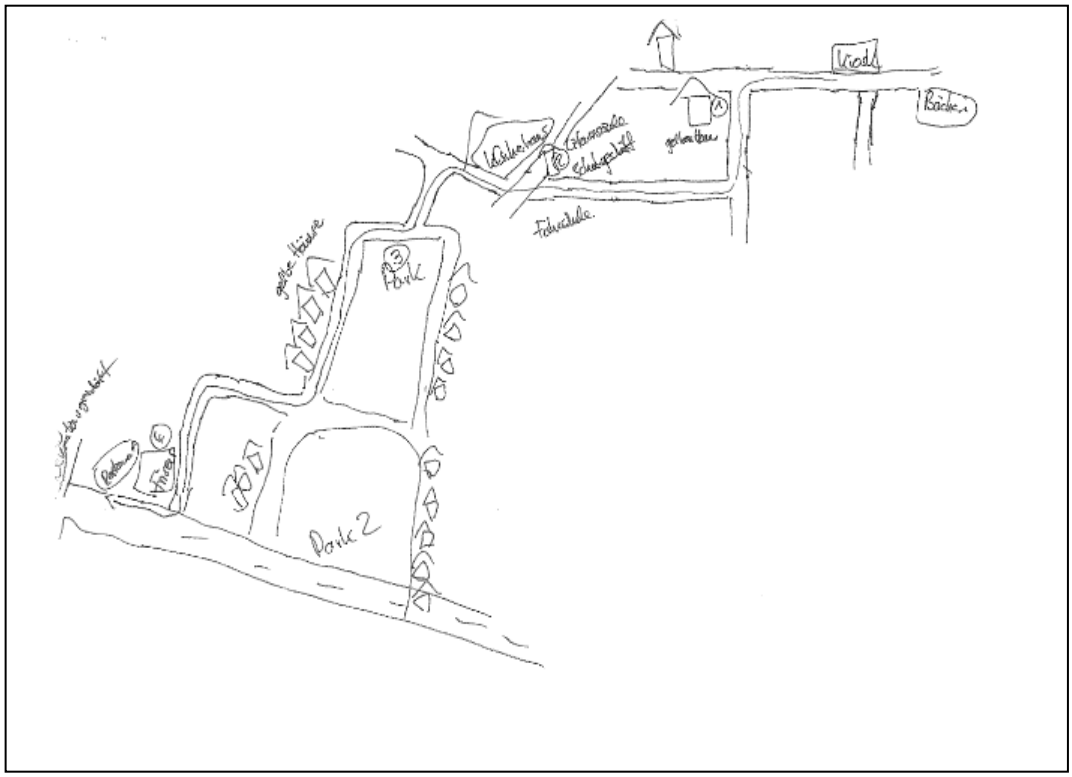
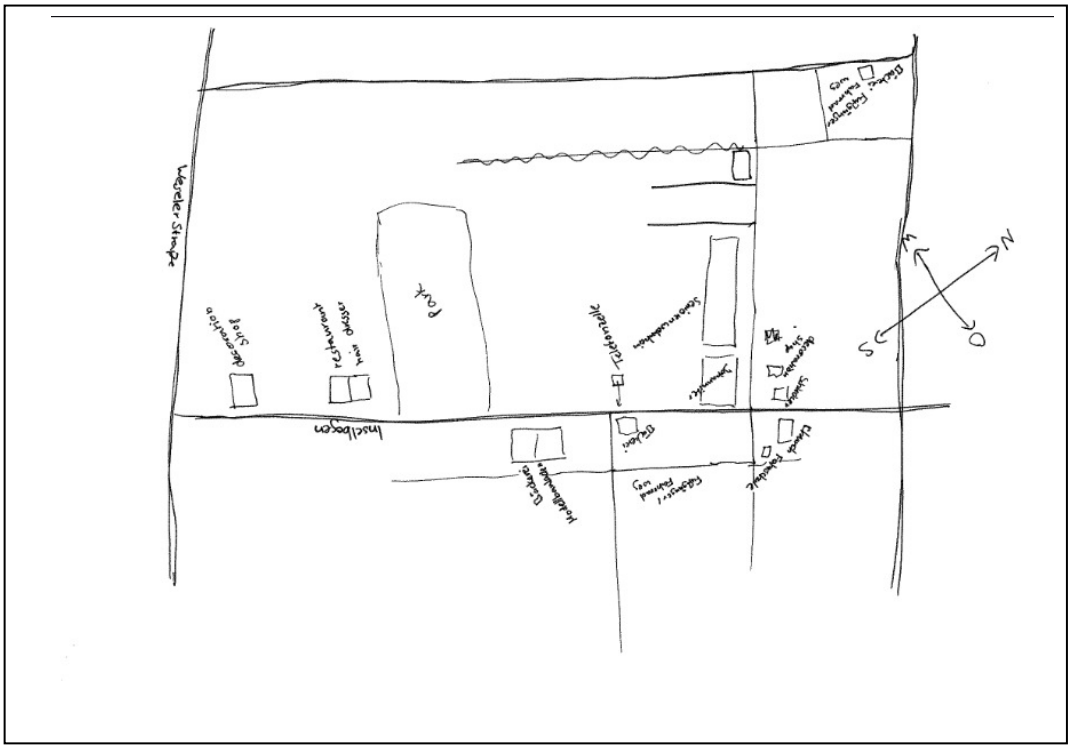


ROUTE B

Sketch Map 2



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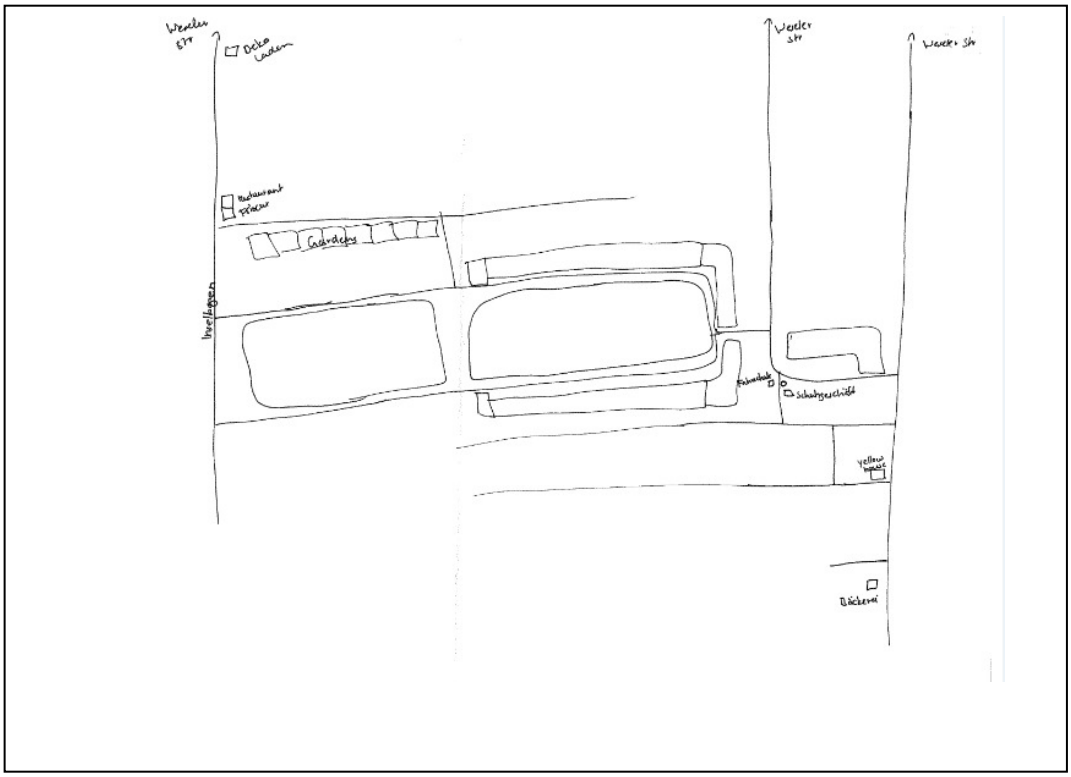
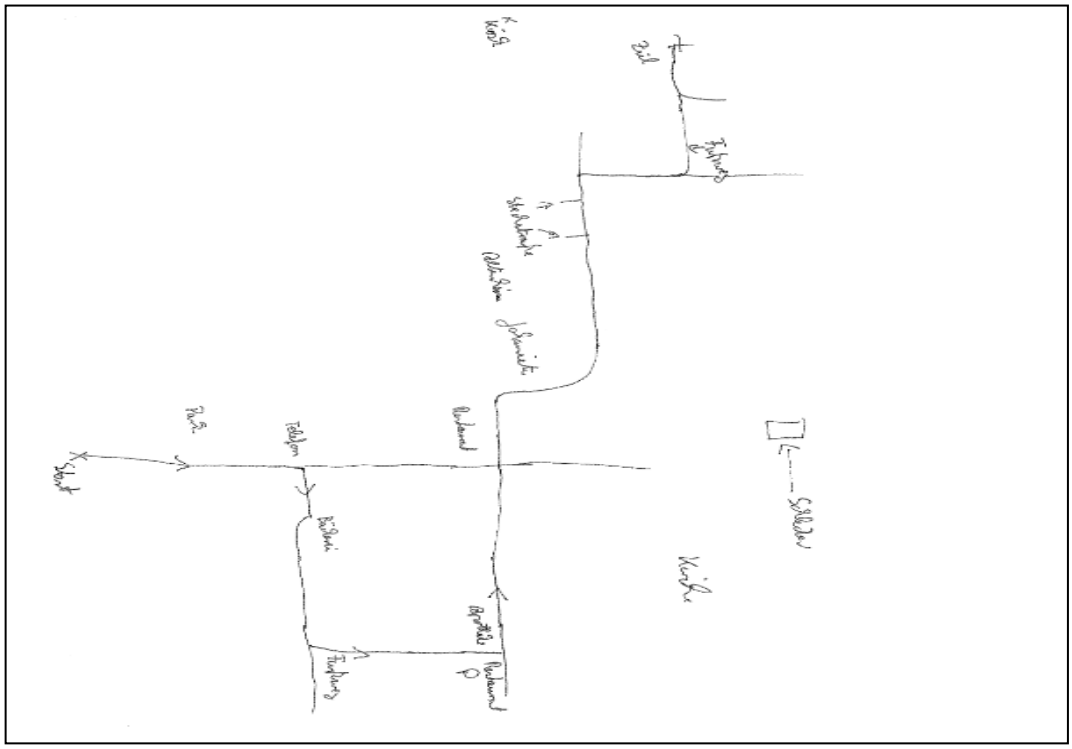


ROUTE B

Sketch Map 3



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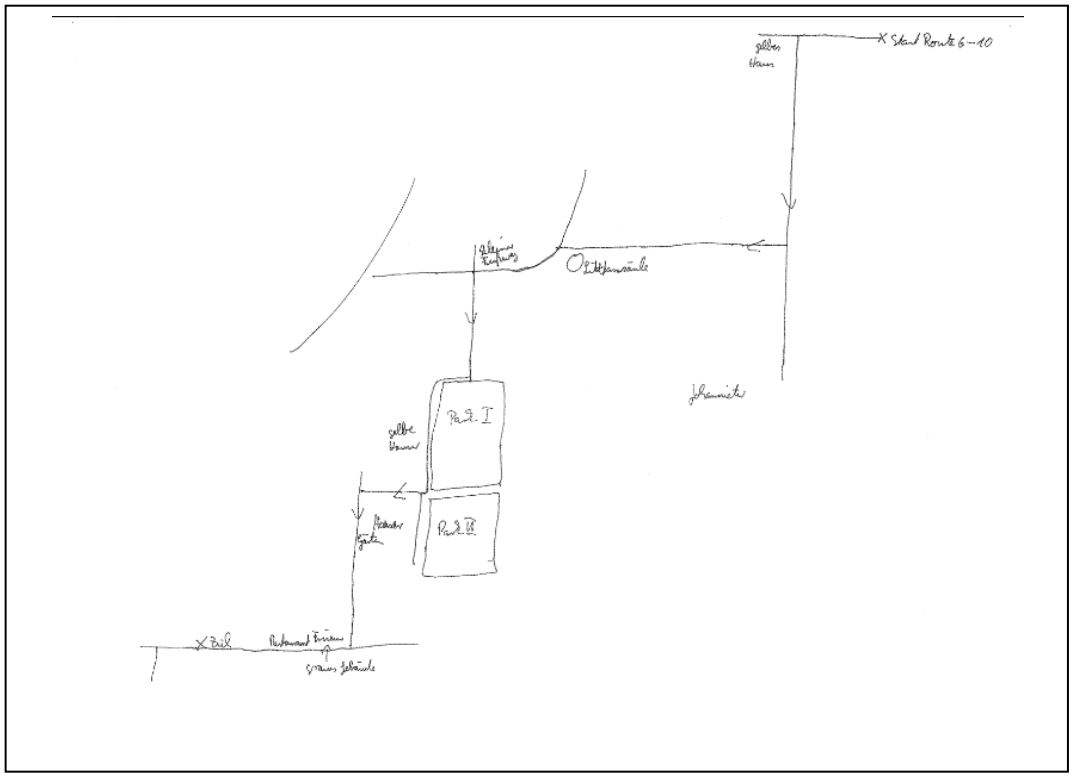
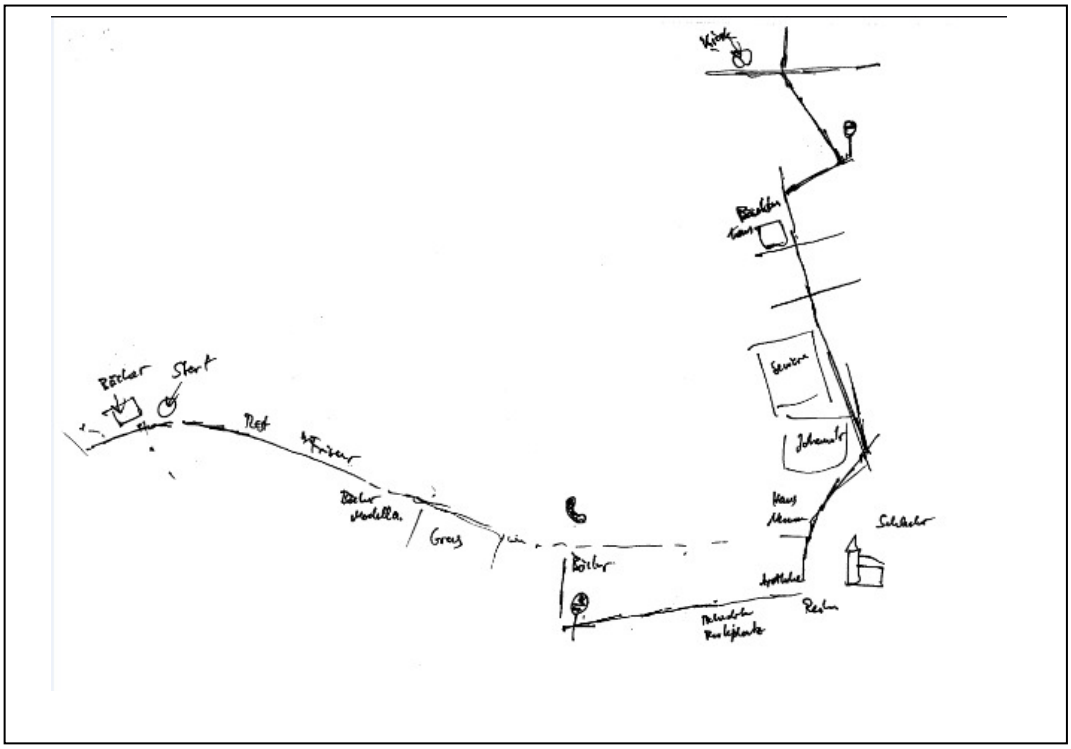


ROUTE B

Sketch Map 4



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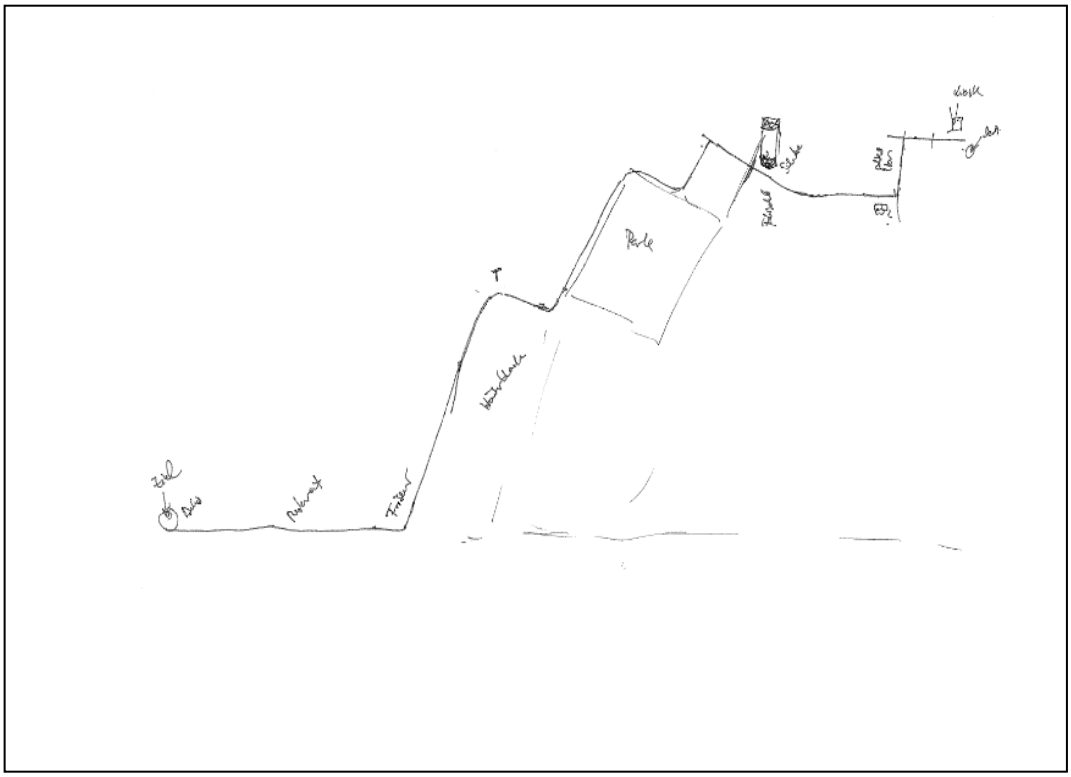
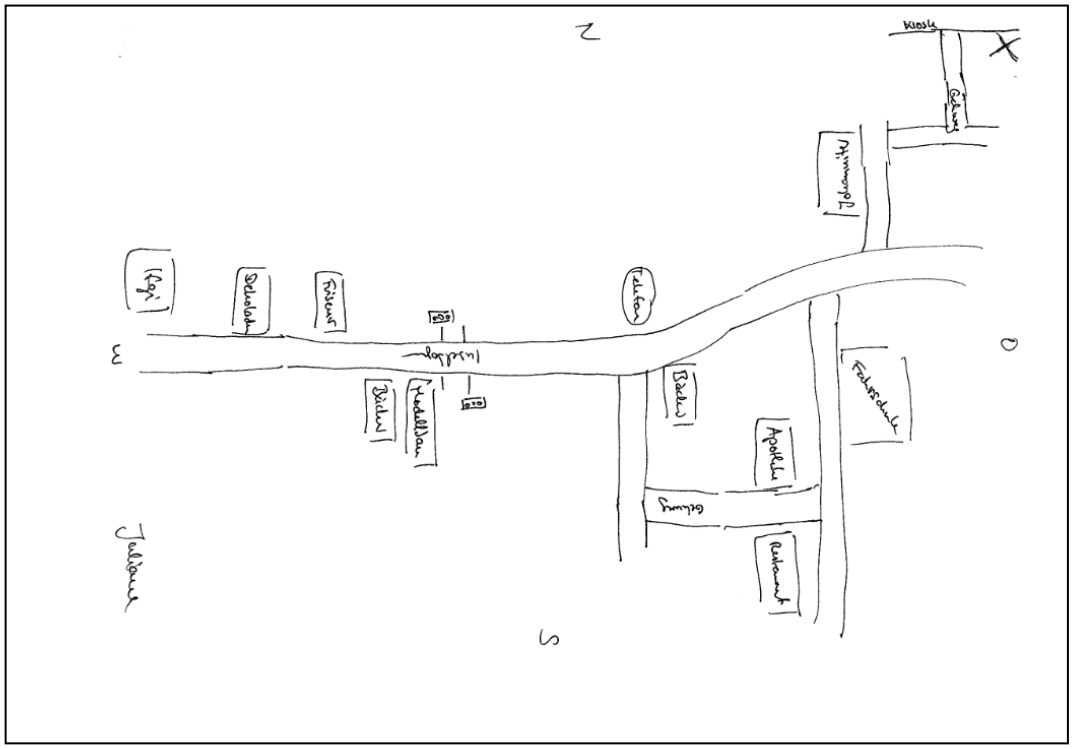


ROUTE B

Sketch Map 5



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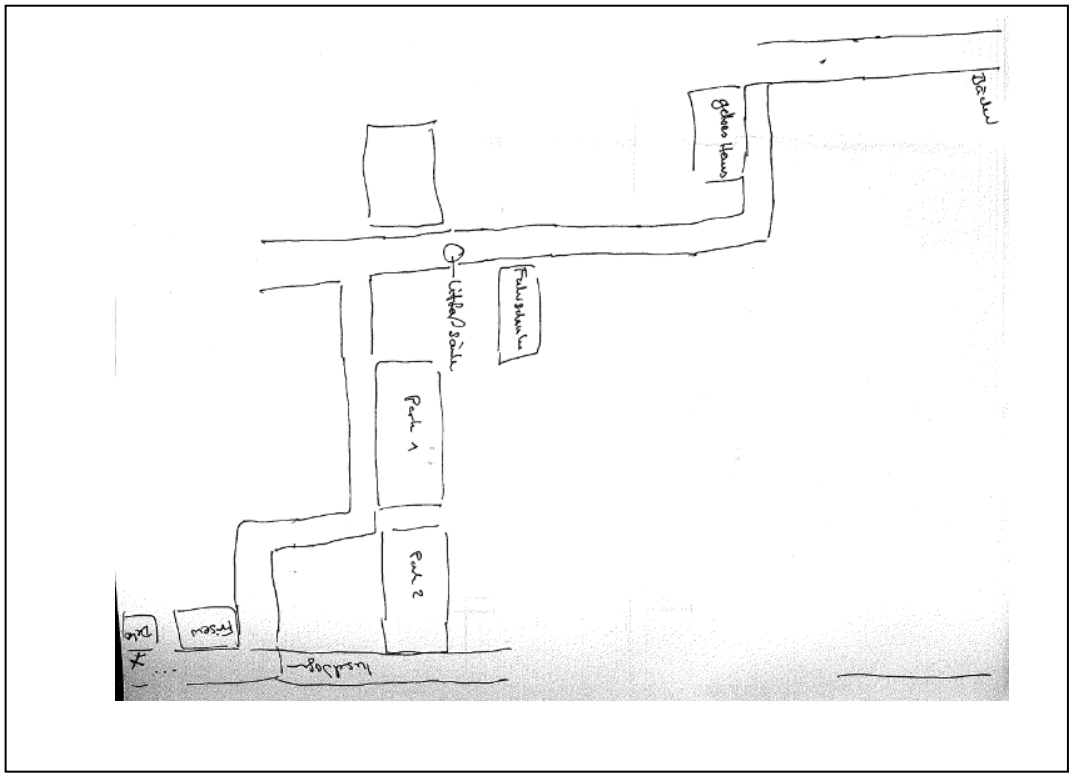
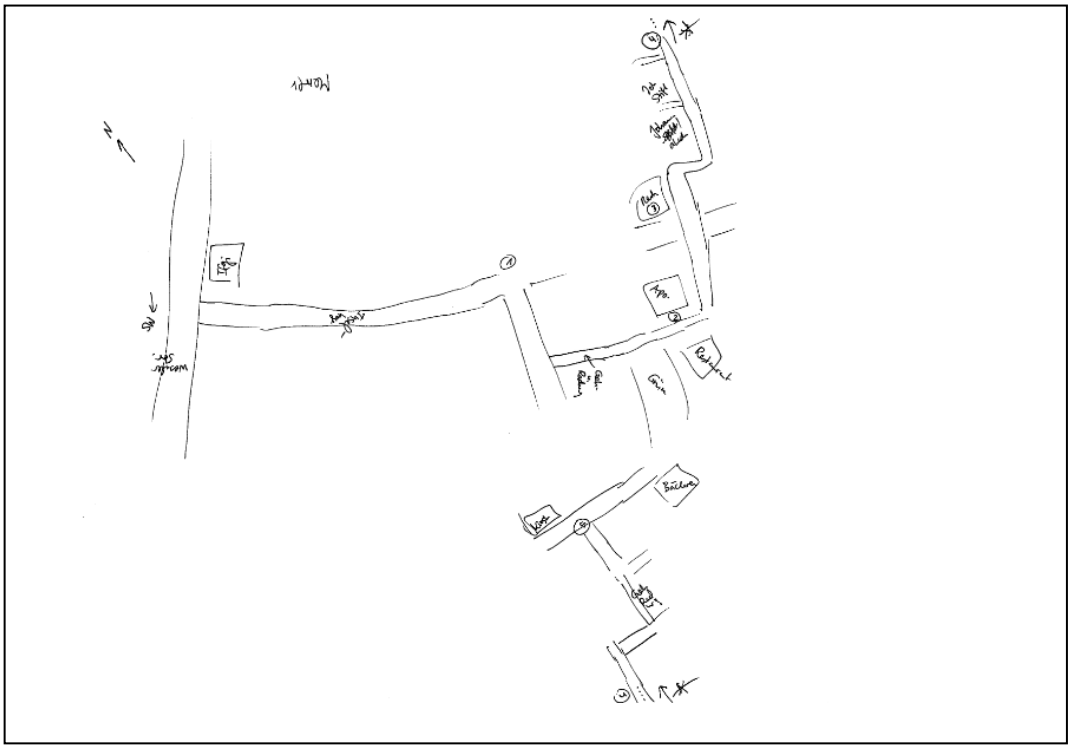


ROUTE B

Sketch Map 6



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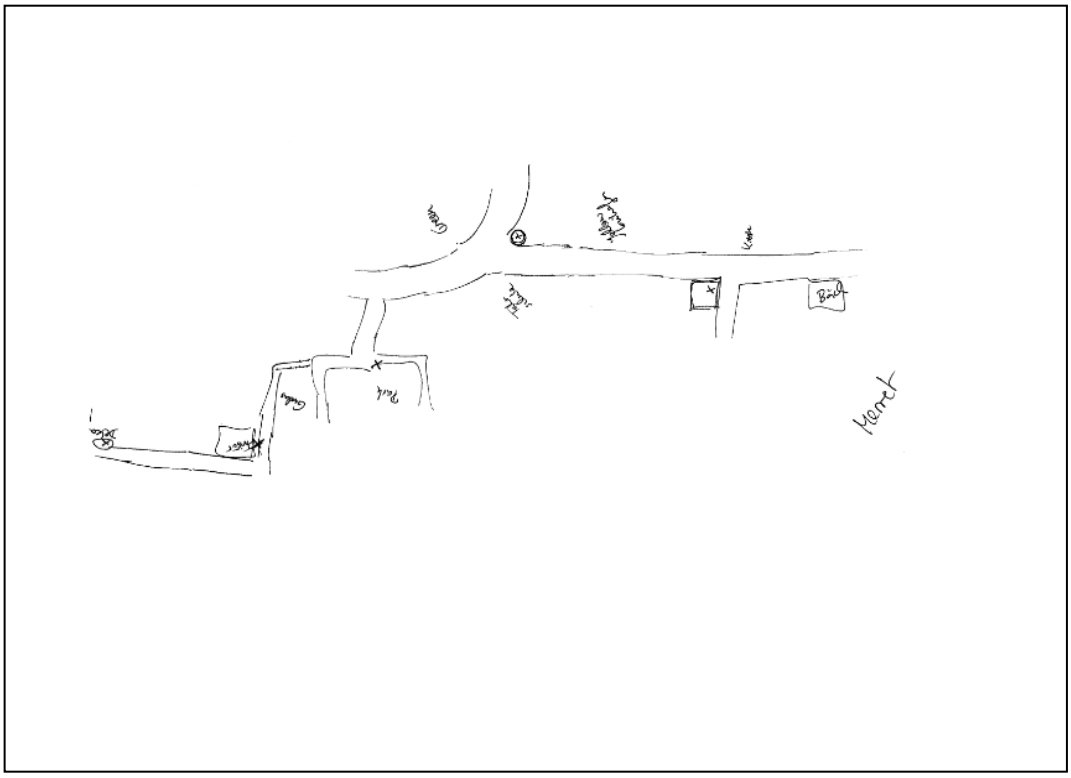
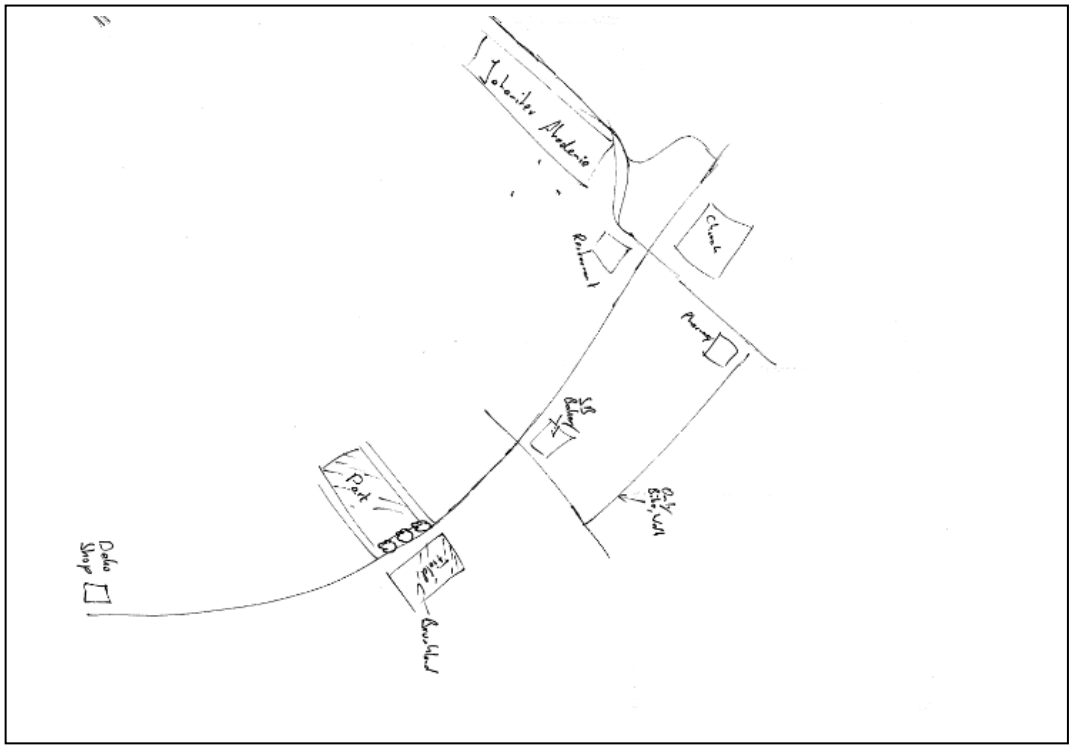
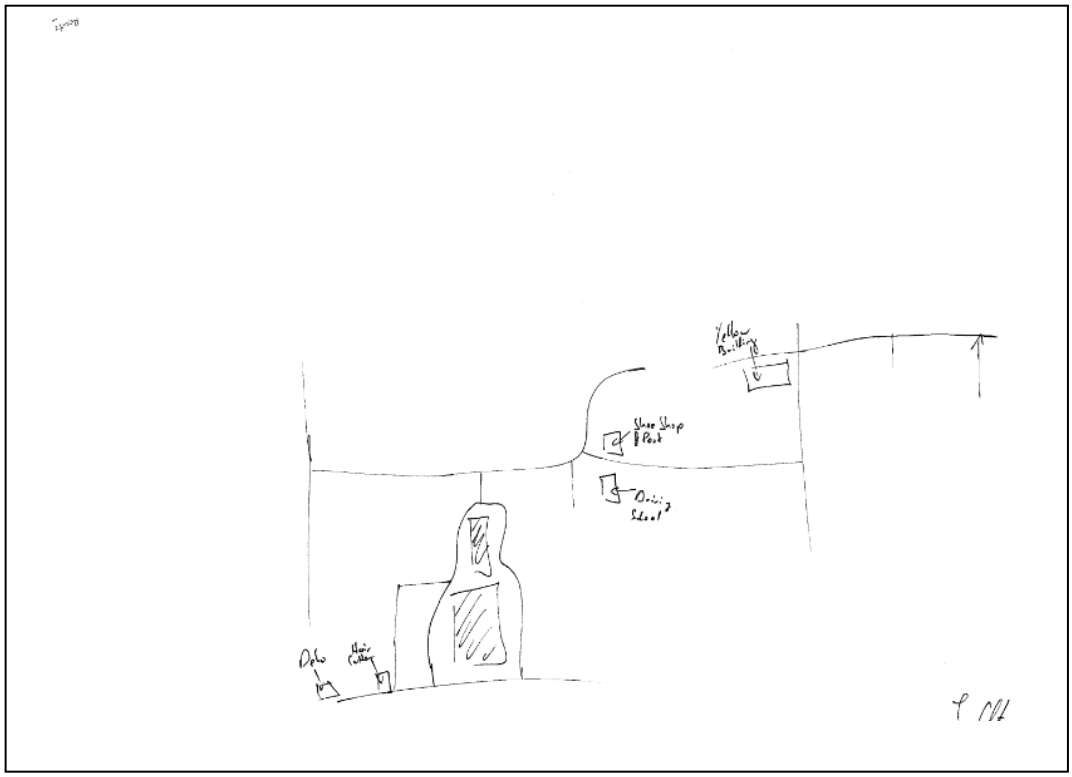


ROUTE B

Sketch Map 1 (MEN in R-A Group)

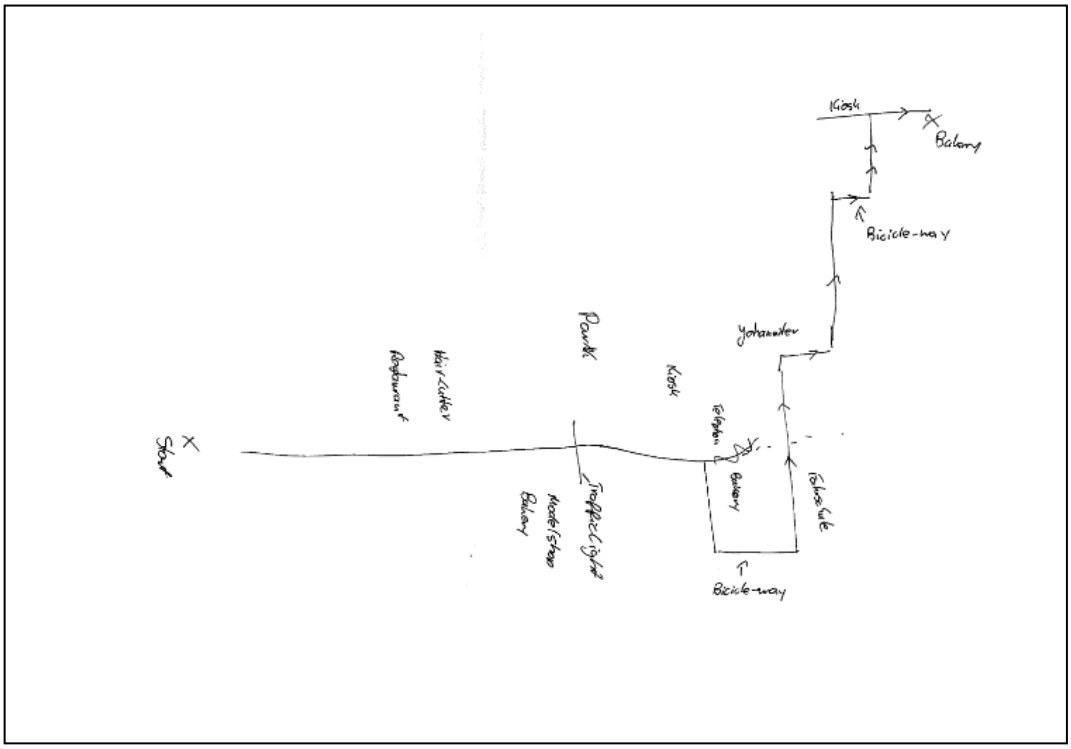


ROUTE A



ROUTE B

Sketch Map 2



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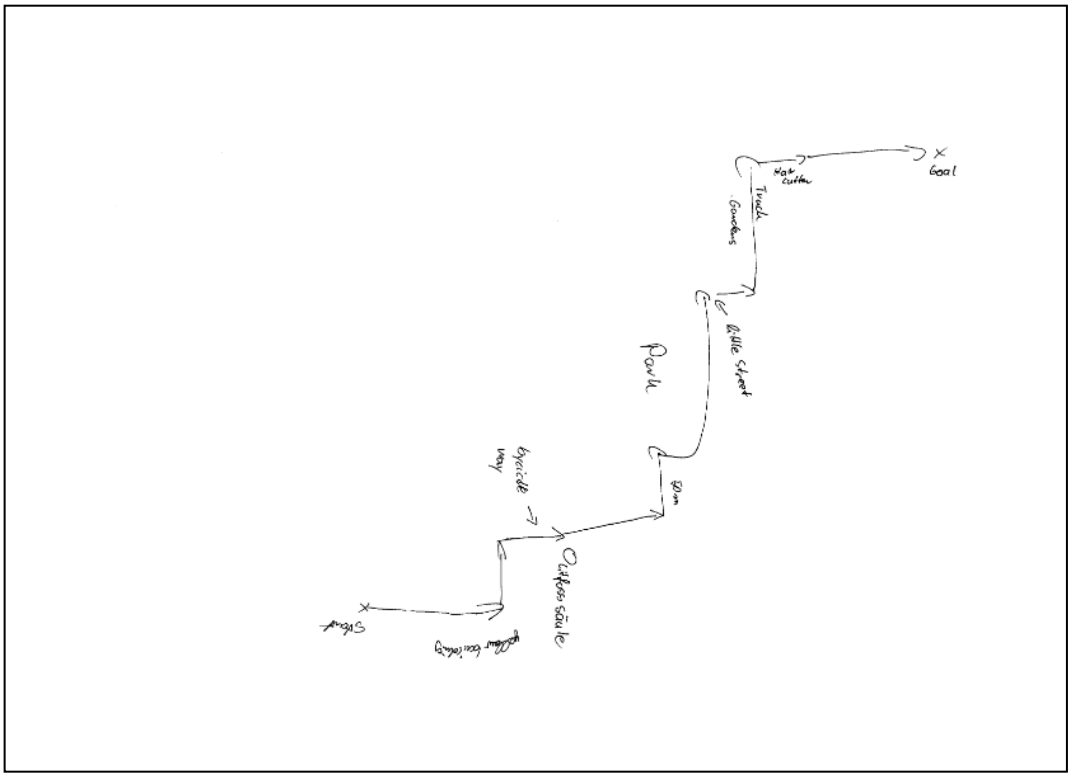
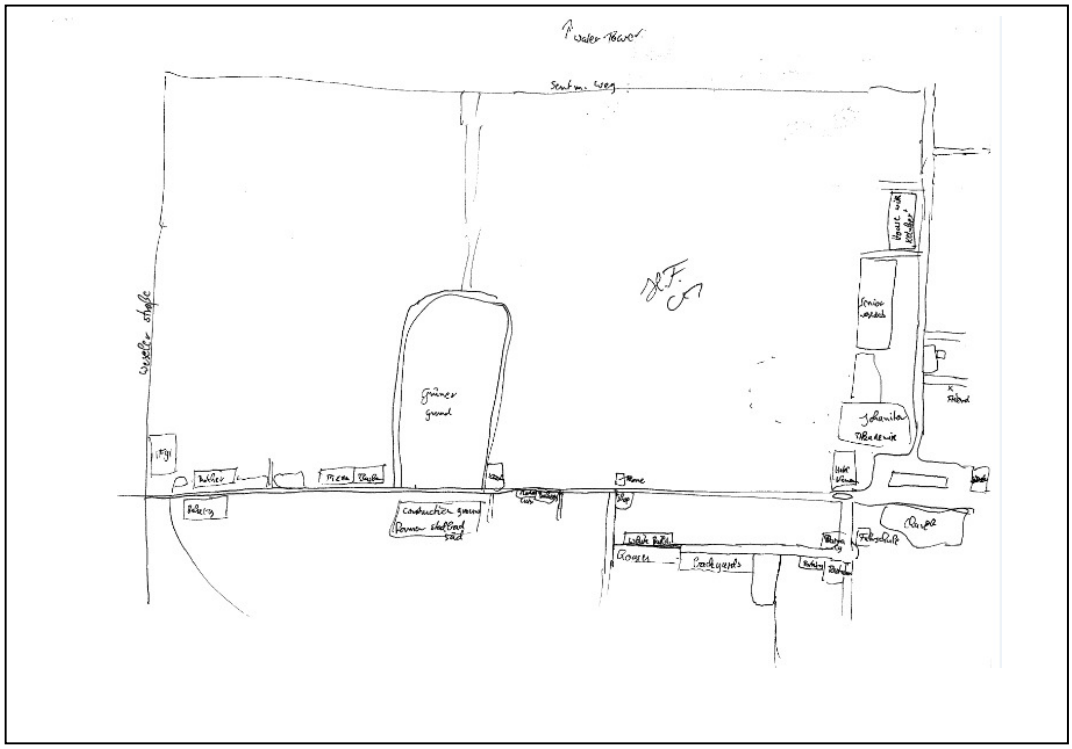


ROUTE B

Sketch Map 3



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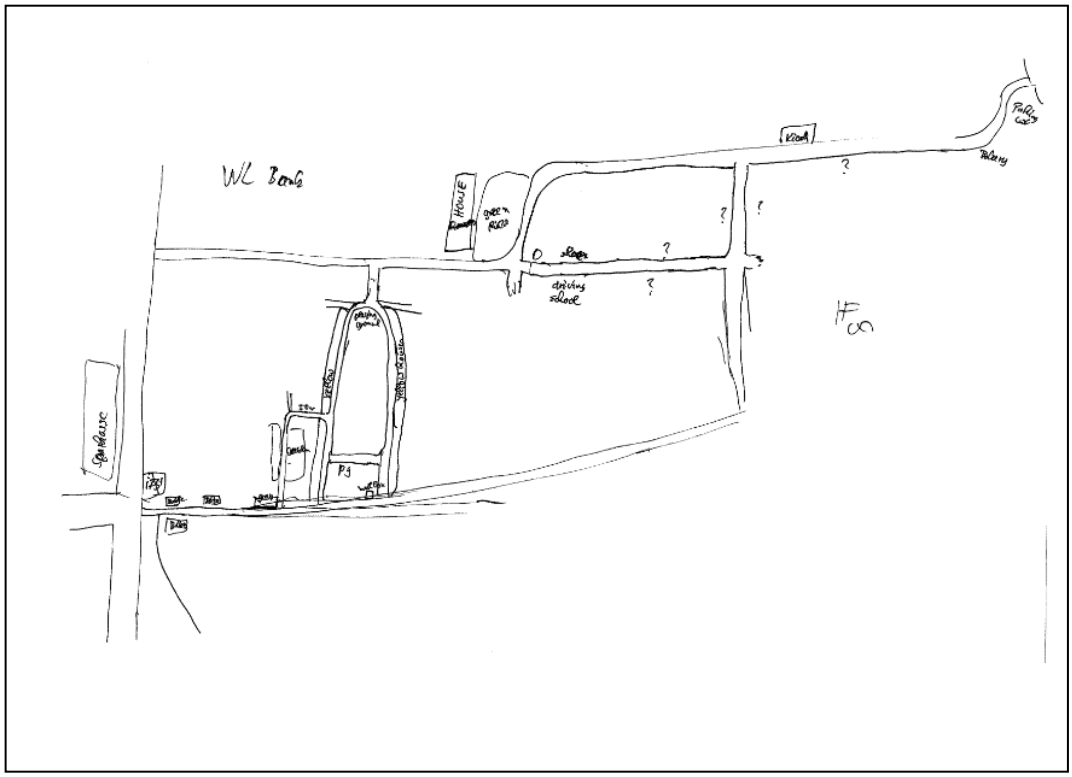
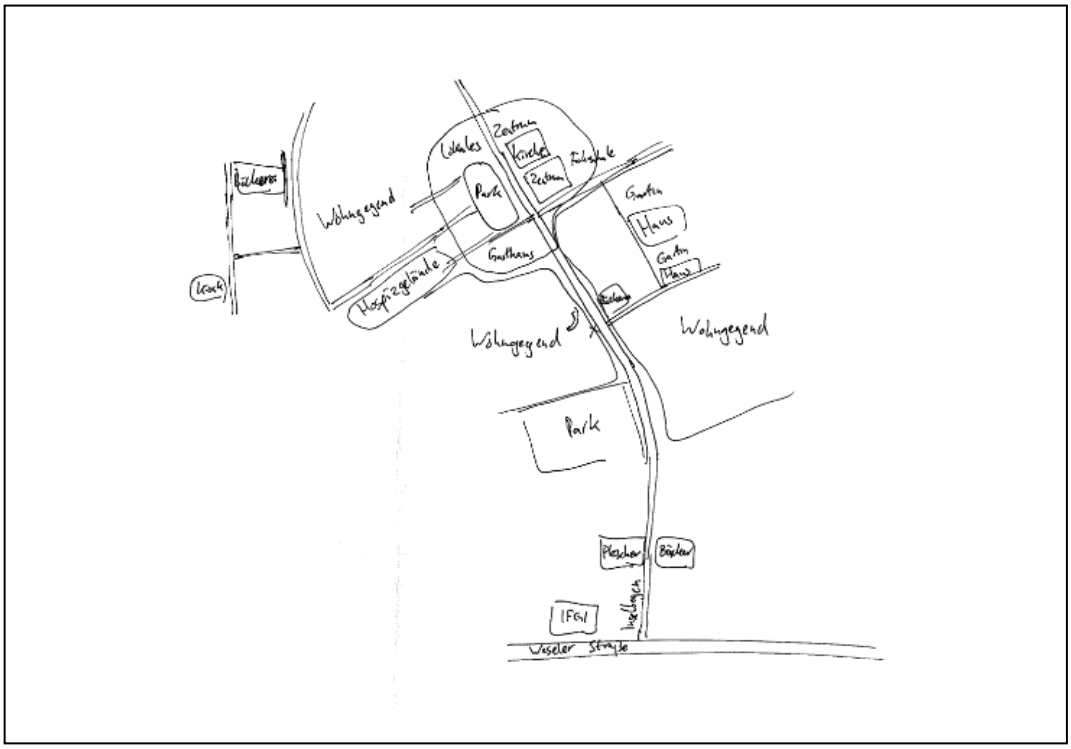


ROUTE B

Sketch Map 4



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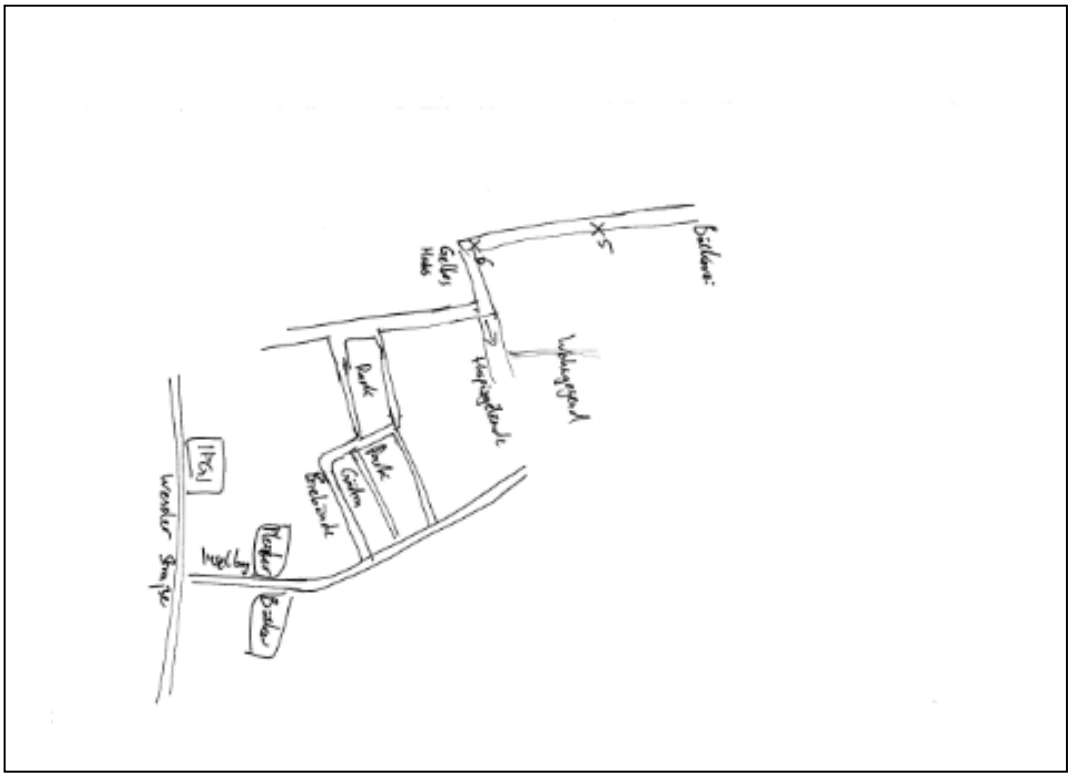

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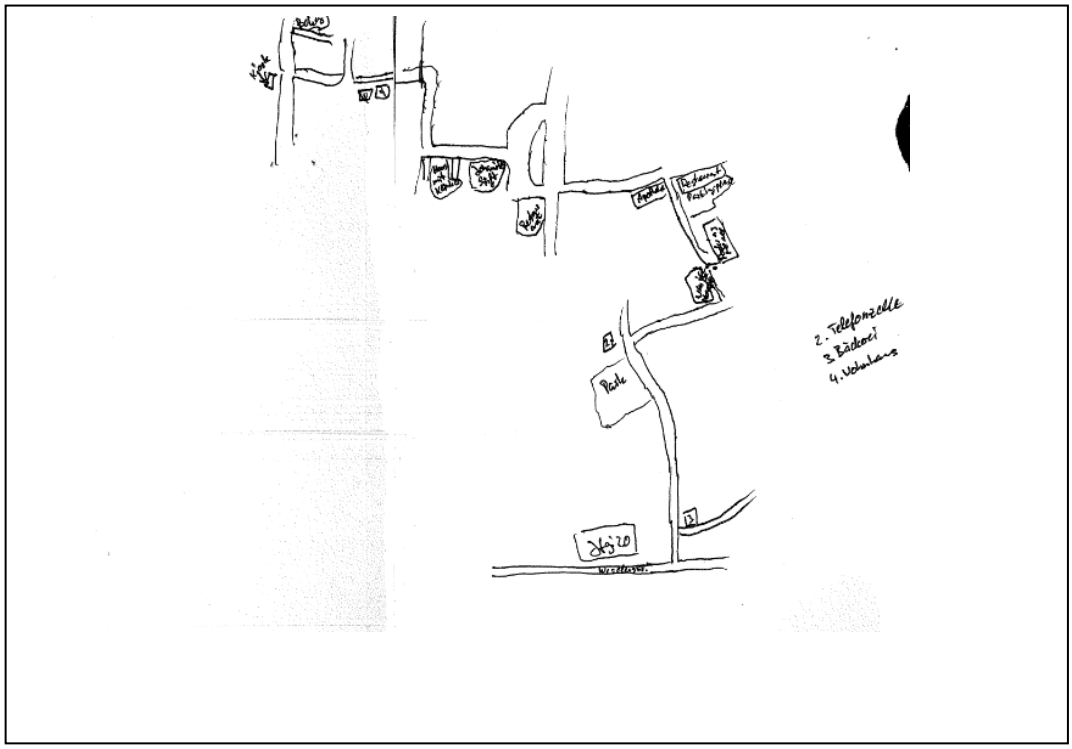
Sketch Map 5



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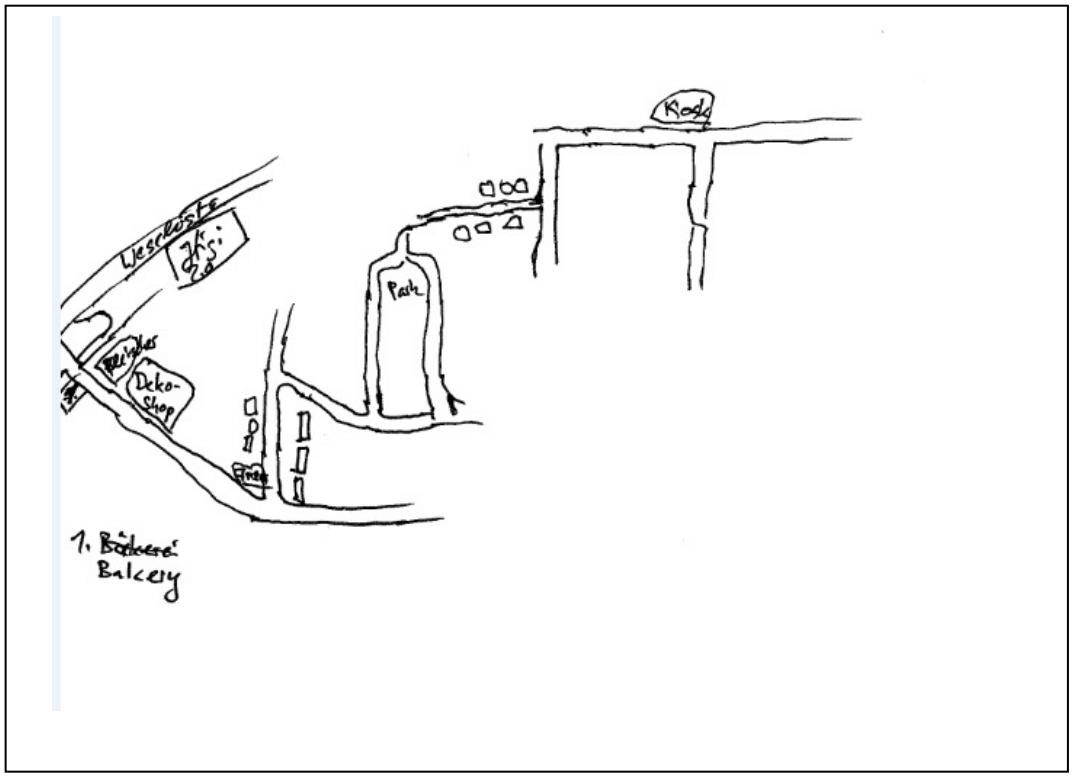
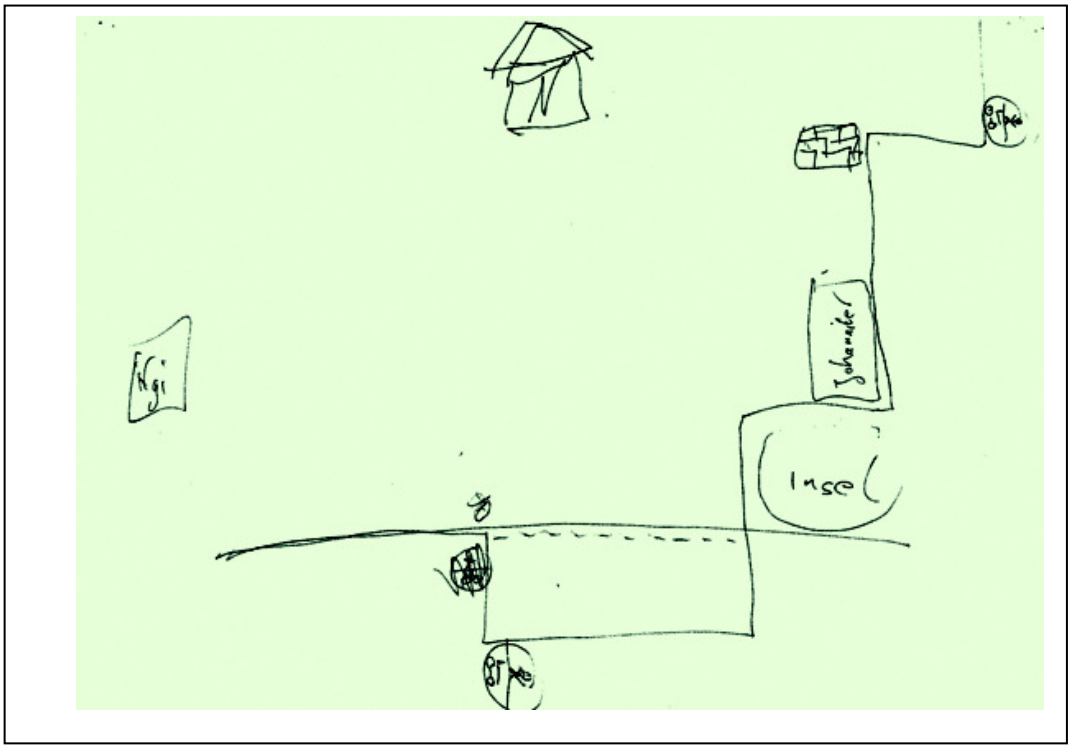


ROUTE B

Sketch Map 6



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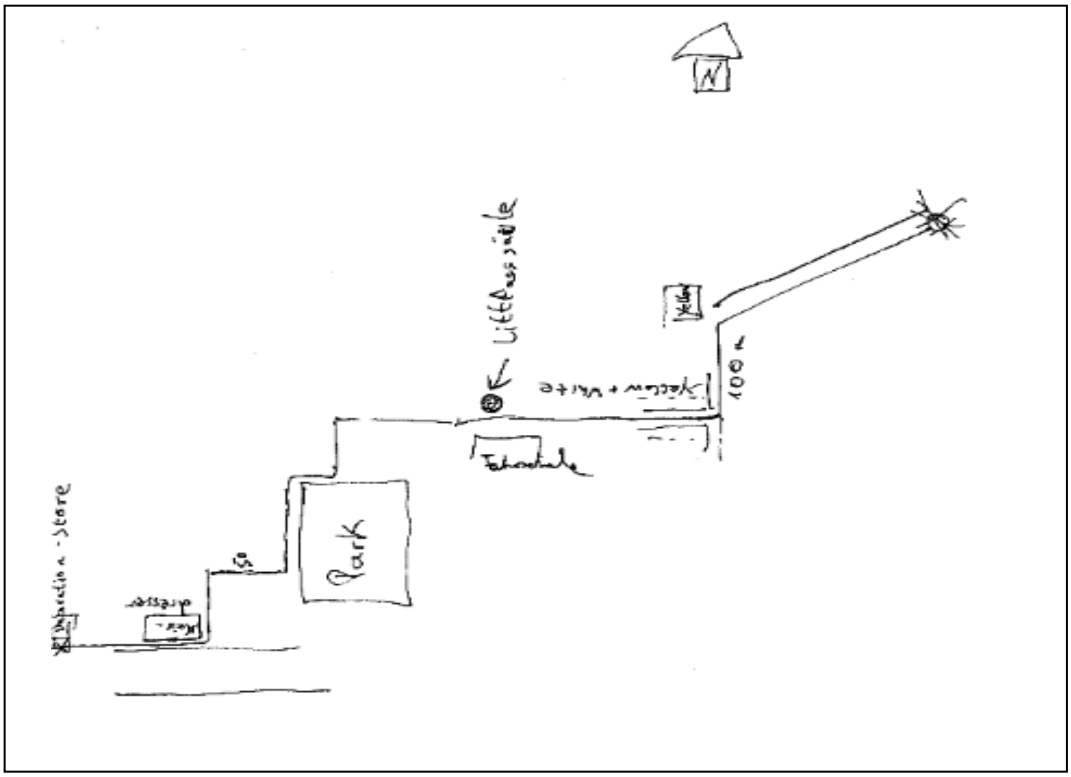
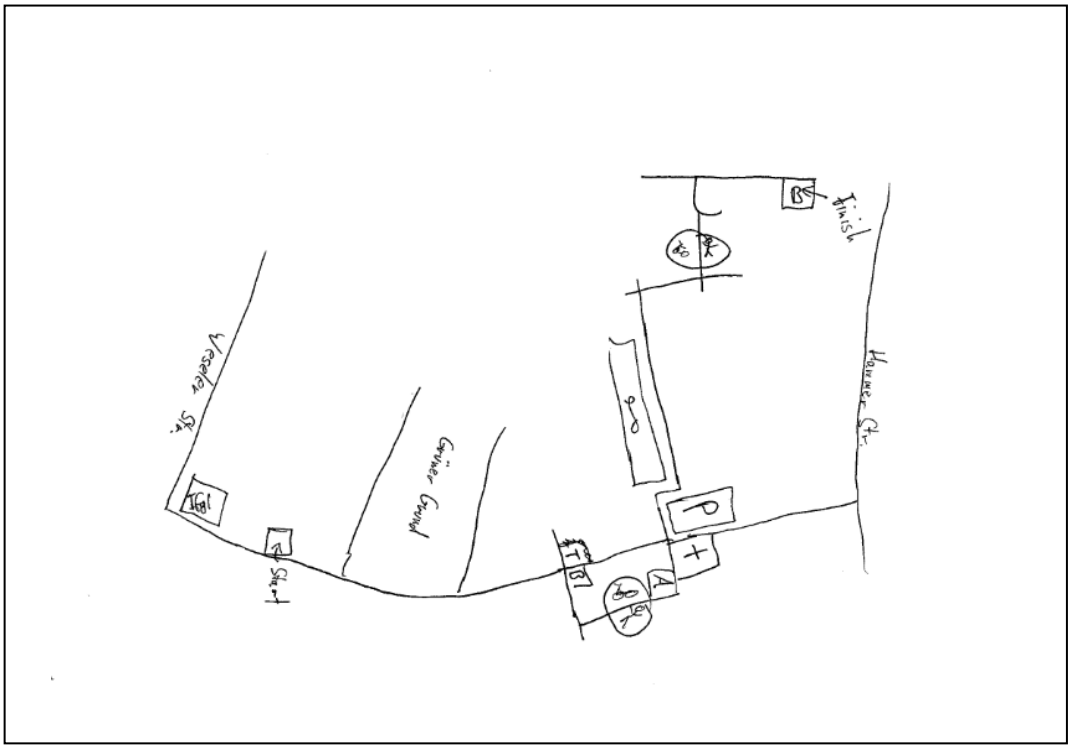


ROUTE B

Sketch Map 1 (MEN in A-R Group)



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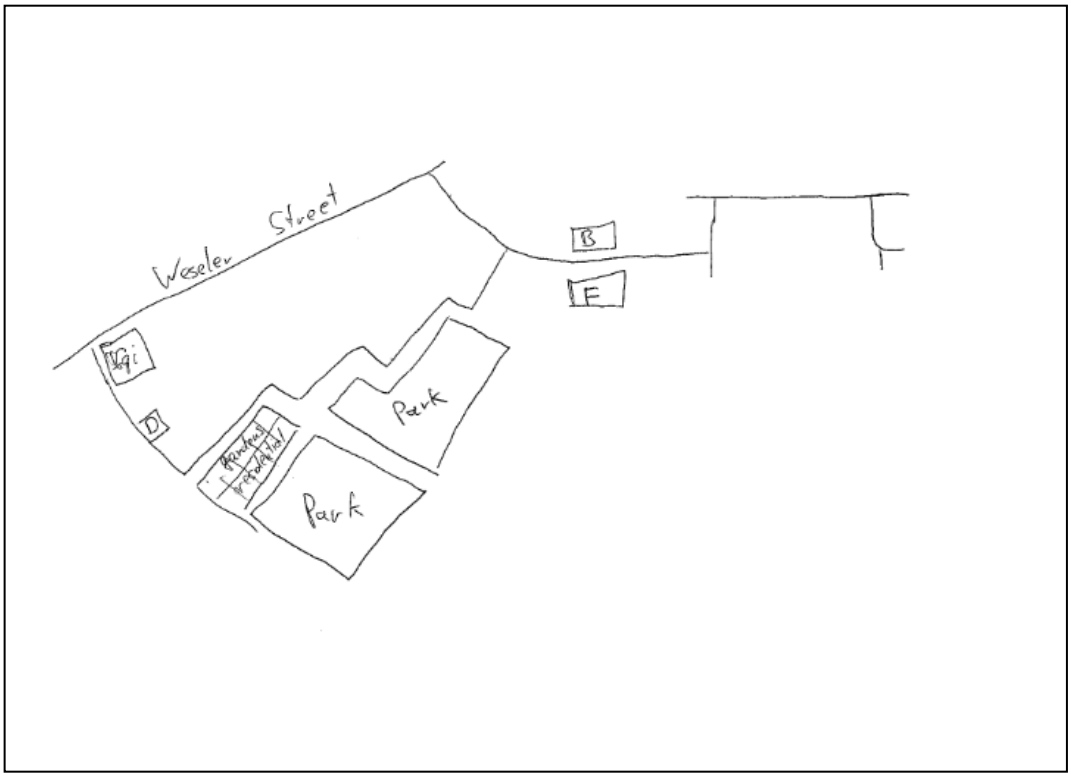
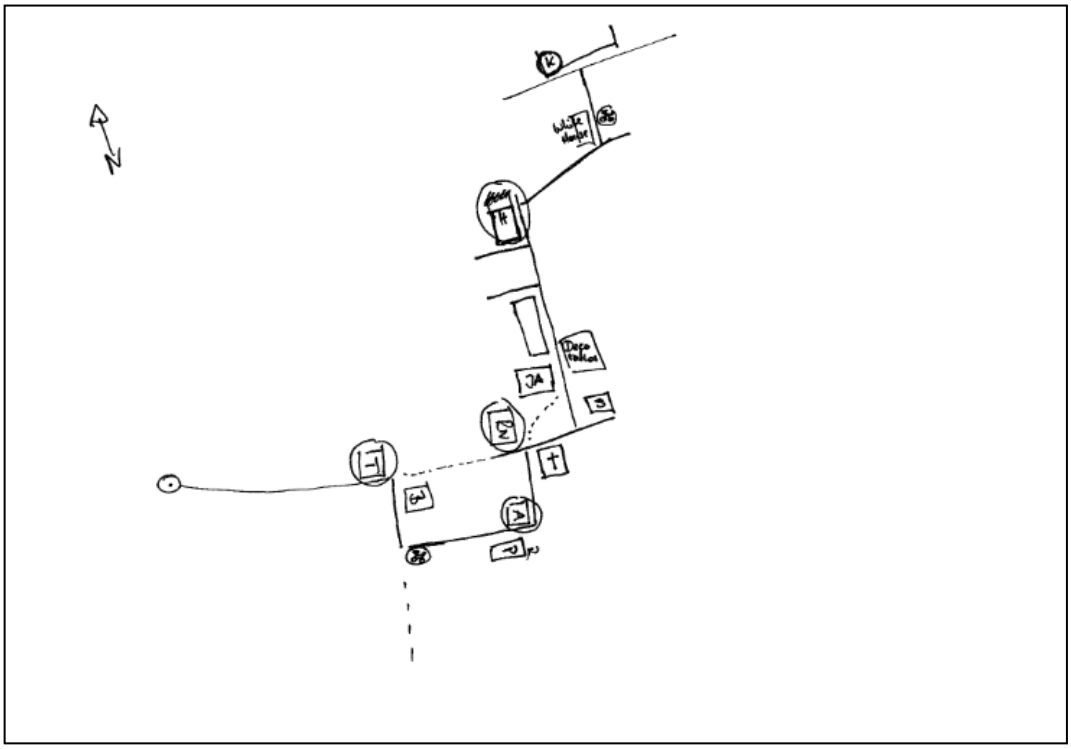


ROUTE B

Sketch Map 2



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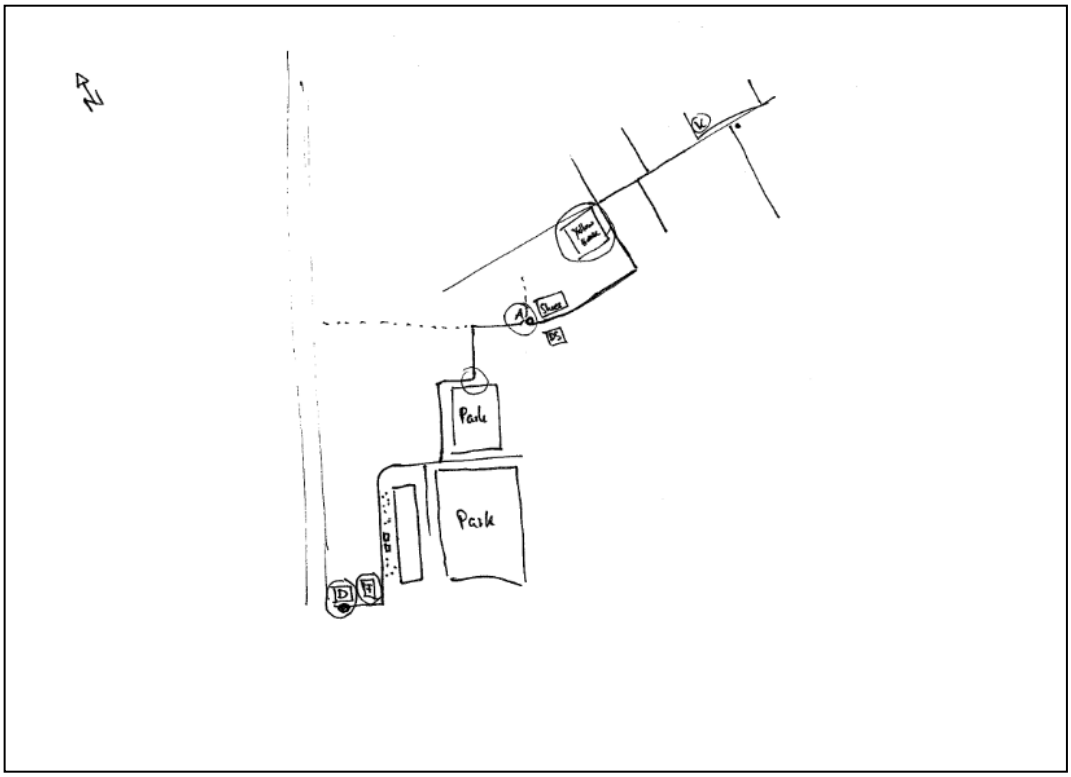
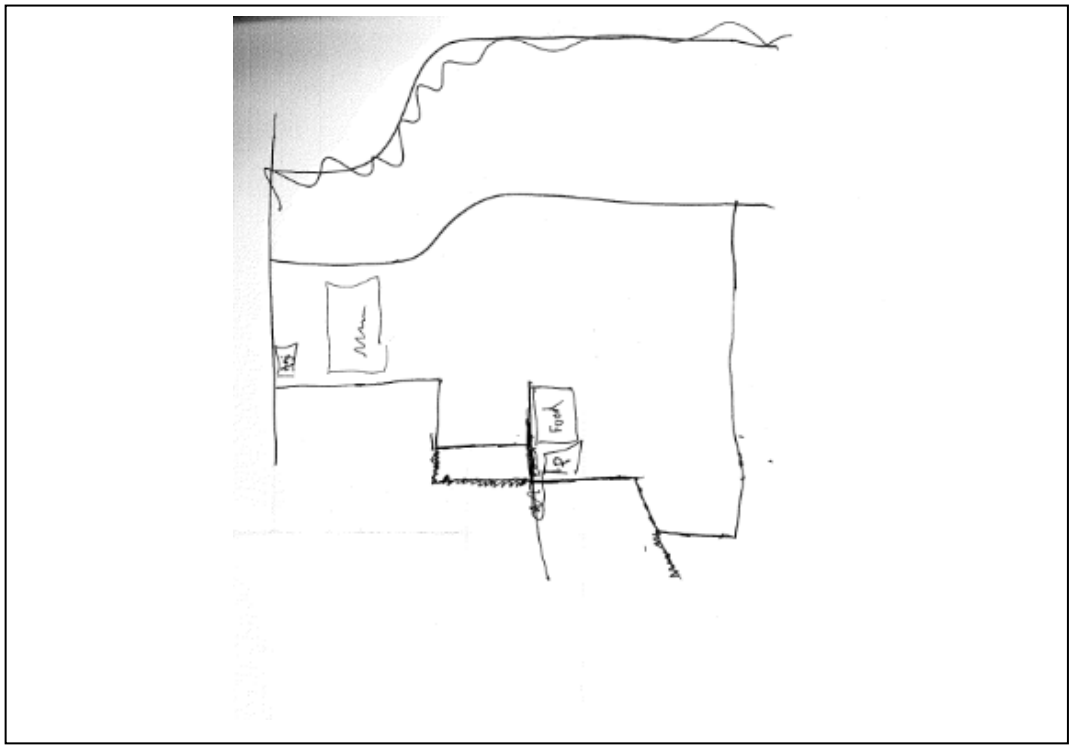


ROUTE B

Sketch Map 3



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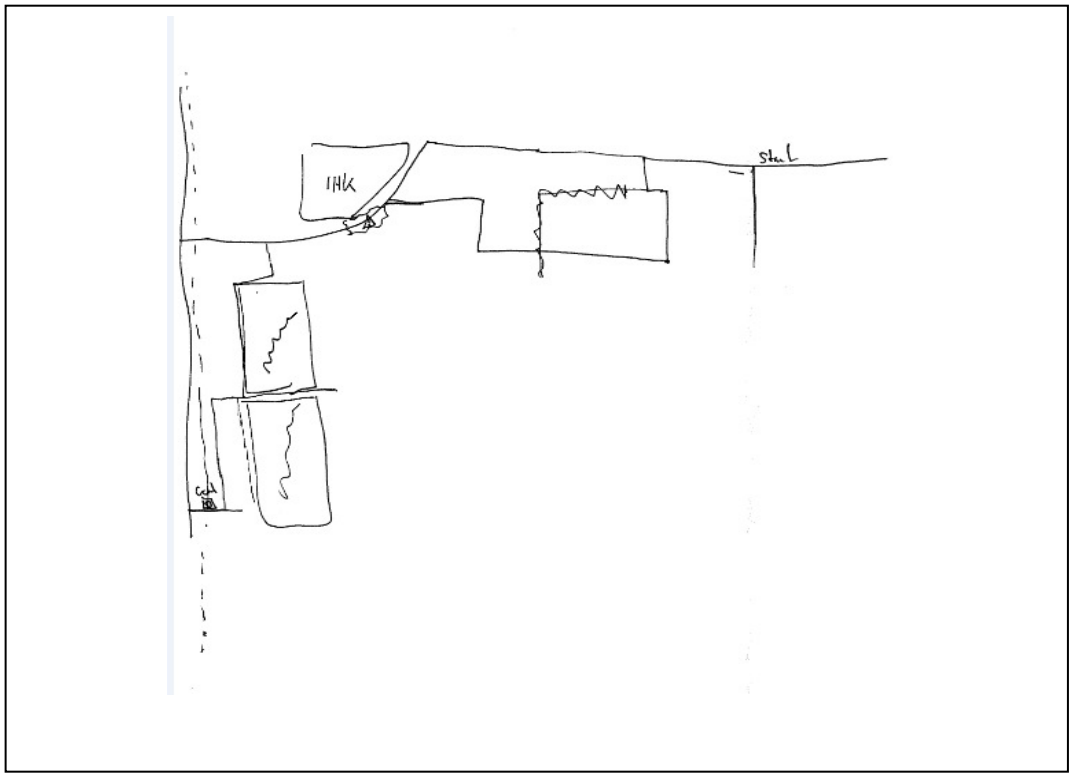
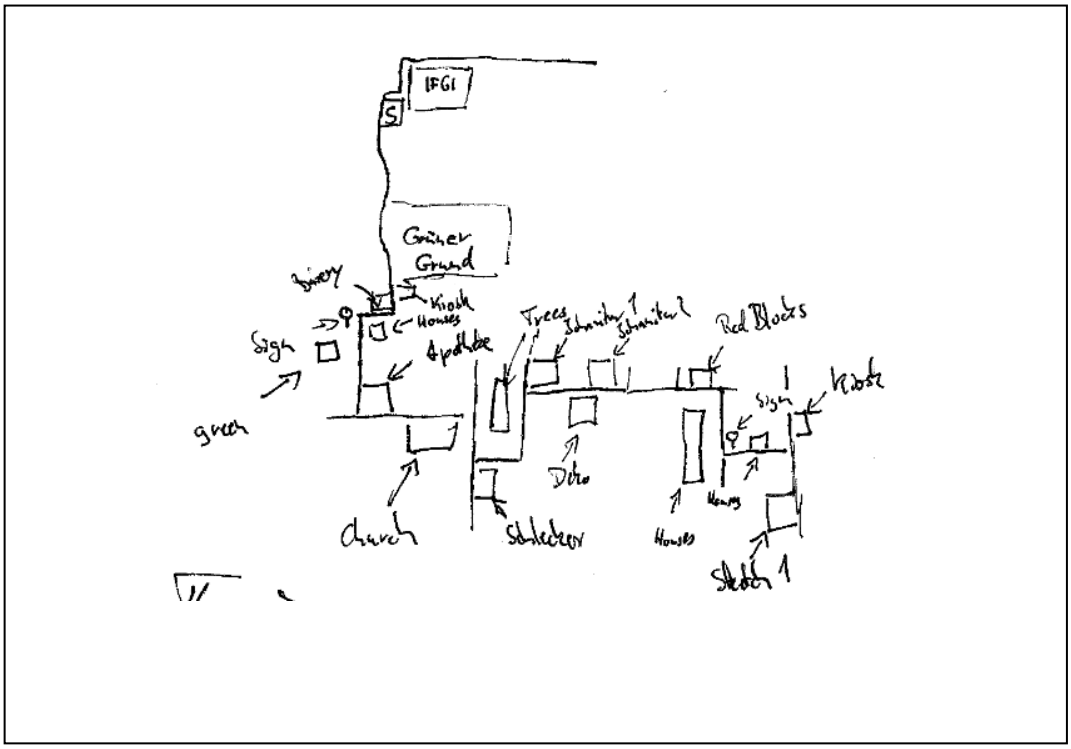


ROUTE B

Sketch Map 4



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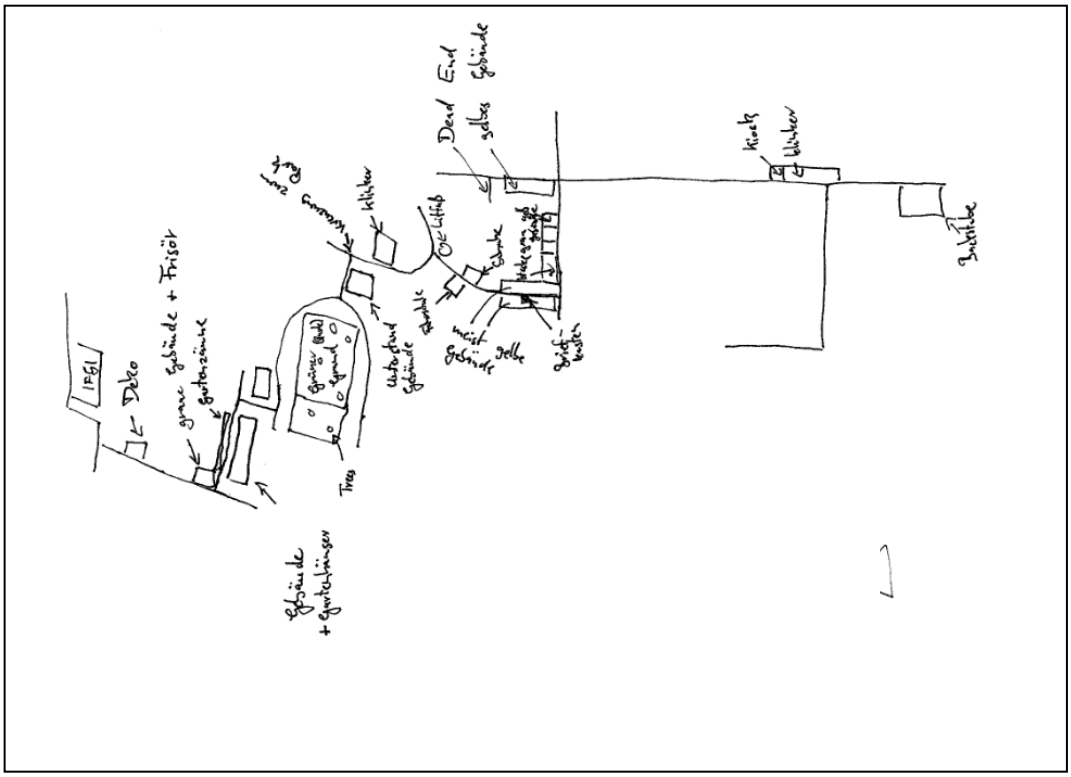

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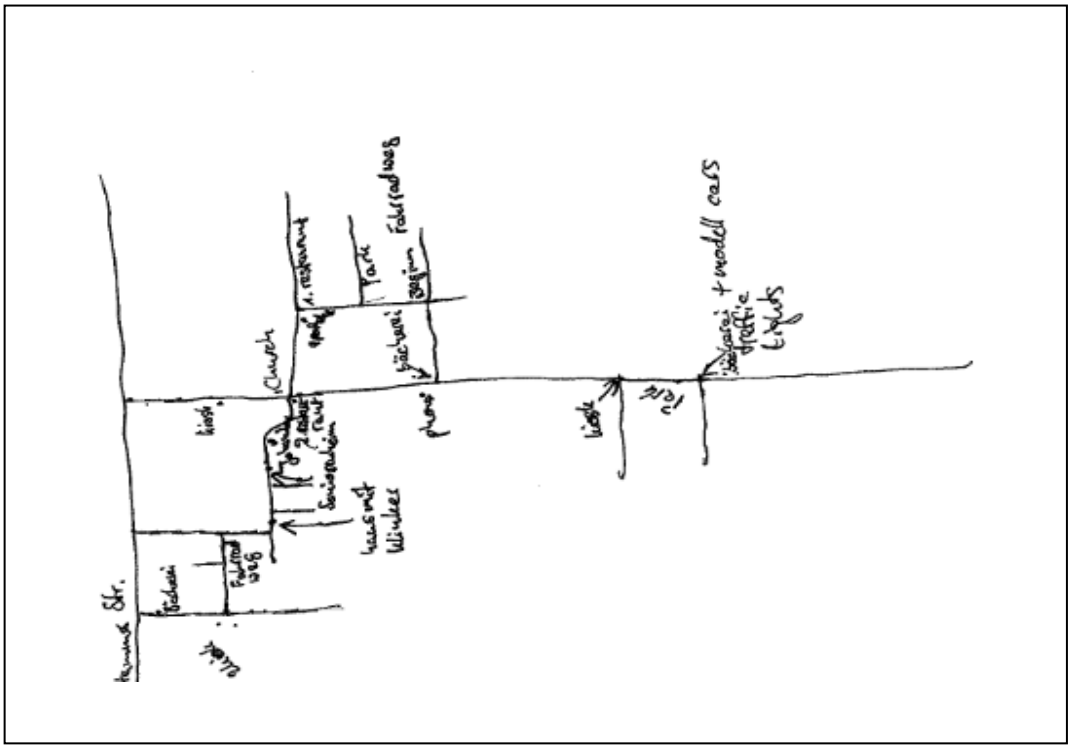
Sketch Map 5



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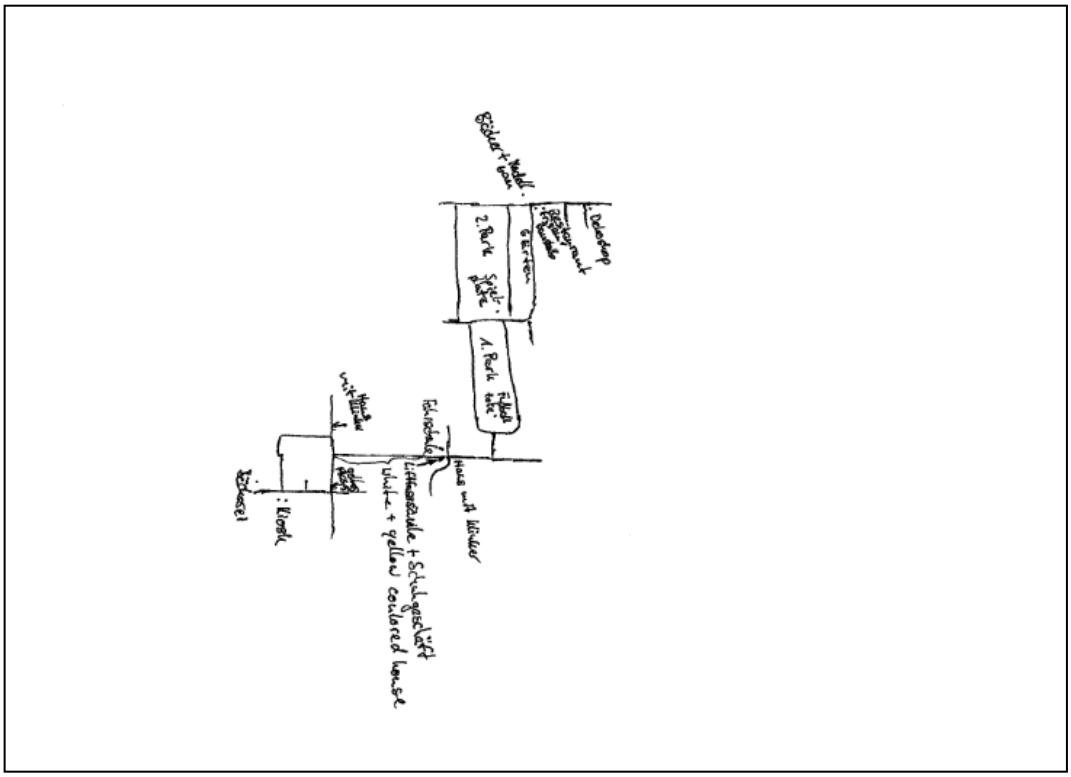
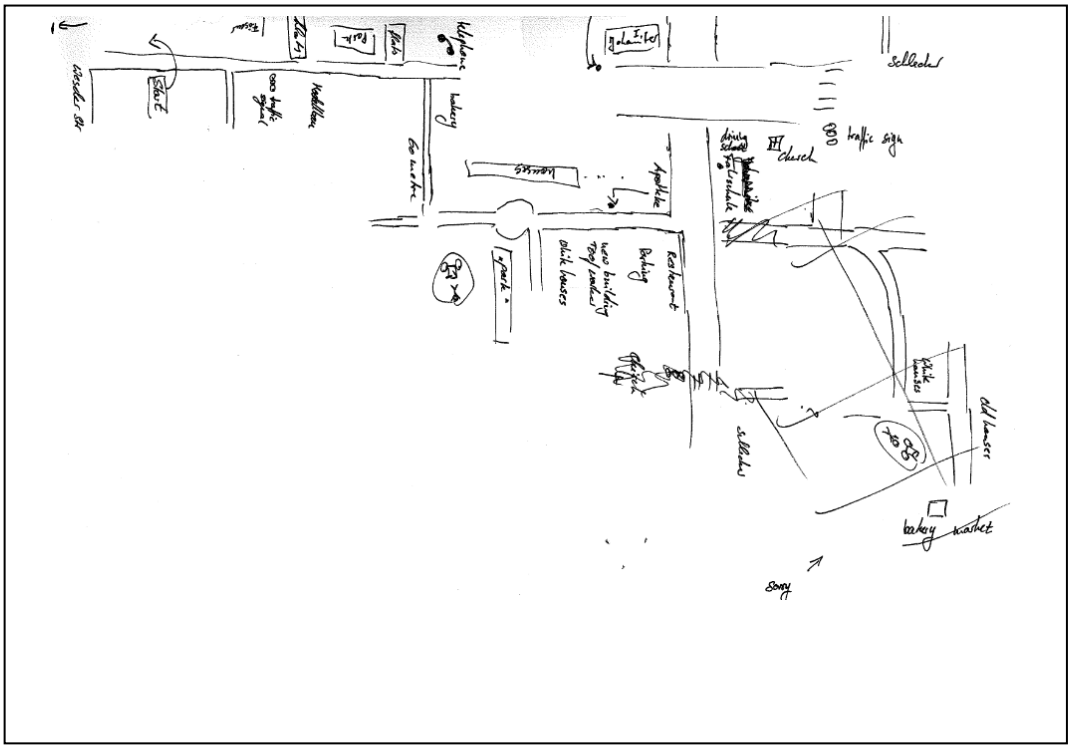


ROUTE B

Sketch Map 6



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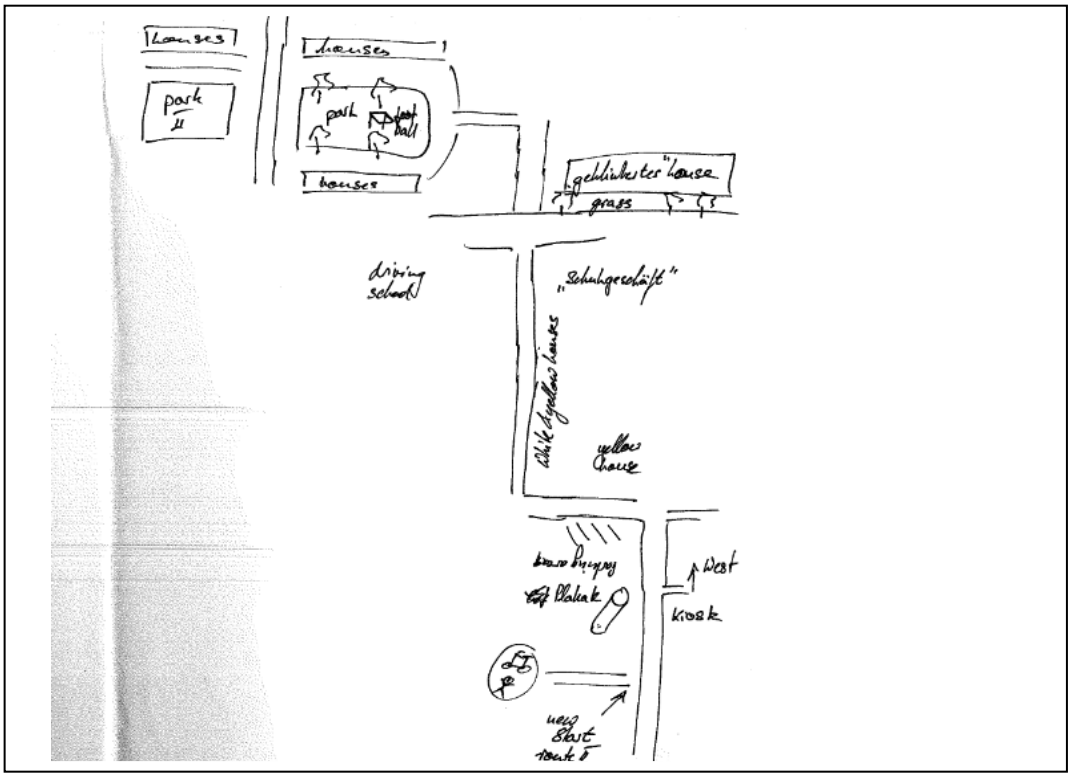
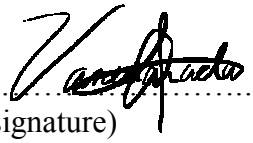


ROUTE B

Student Declaration

I hereby declare that the submitted work has been completed by me the undersigned and that I have not used any other than permitted reference sources or materials nor engaged in any plagiarism. All references and other sources used by me have been appropriately acknowledged in the work. I further declare that the work has not been submitted for the purpose of academic examination, either in its original or similar form, anywhere else.

Declared in Münster ……02 March 2010……..
(date)


……(Matrikelnummer 361151)
(signature)