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GENDER DIFFERENCE IN SITUATION AWARENESS WHEN RECEIVING

WAYFINDING DIRECTION BY LANDMARKS AND HEADINGS

by

Ziyi Dong

A Thesis Project Submitted to the College of Aviation,
School of Graduate Studies, in Partial Fulfillment
of the Requirements for the Degree of
Master of Science in Aeronautics

Embry-Riddle Aeronautical University
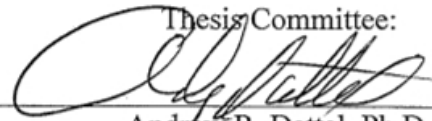Daytona Beach, Florida
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GENDER DIFFERENCE IN SITUATION AWARENESS WHEN RECEIVING
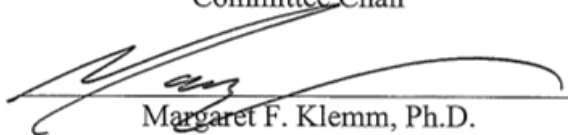WAYFINDING DIRECTION BY LANDMARKS AND HEADINGS

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This Thesis was prepared under the direction of the candidate's Thesis Committee Chair,
Dr. Andrew R. Dattel, Assistant Professor, Daytona Beach Campus, and Thesis
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School of Graduate Studies in partial fulfillment
of the requirements for the degree of
Master of Science in Aeronautics

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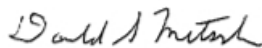Andrew R. Dattel, Ph.D.
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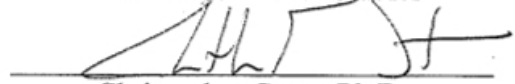
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Abstract

Researcher: Ziyi Dong

Title: GENDER DIFFERENCE IN SITUATION AWARENESS WHEN

RECEIVING WAYFINDING DIRECTION BY LANDMARKS AND HEADINGS

Institution: Embry-Riddle Aeronautical University

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In aviation, situation awareness (SA) is a fundamental requirement for effective flying

and air traffic control. This skill has greatly been associated with pilot and air traffic

controller performance. Previous studies in aviation and other fields have shown that

gender differences exist in SA performance. Four hypotheses were tested in this study:

women navigate better from landmark cues; men navigate better from headings cues;

women have better SA performance than men when receiving landmark directions; and

men have better SA when receiving cardinal directions. Thirty-eight participants drove a

driving simulator twice. While driving, participants were asked SA questions to assess

their SA performances. The results showed participants navigate better from landmark

cues regardless of gender. Men showed poorer SA in landmark conditions than in

headings conditions, but there was no significant difference in women. However, overall,

women performed worse in response time to answering SA questions. This study can be

beneficial for pilots' selection tests and providing special training for male and female

pilots.

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Chapter I

Introduction

In aviation, navigating is an important skill when conducting flights. Besides the physical mechanics of flight, navigating is the most critical step in the aviation emergency management process. Pilots should know where they are and know the terrain around and below. Even though aviation is a field highly dominated by men, more women are becoming involved in aviation. For instance, in recent year s, British Airways (BA) has been actively trying to recruit more women pilots. BA's chief pilot and head of training said in the press that BA is having some success as the number of female candidates for jobs went from 5% to 15% in the past couple of years ("Female pilots: A slow take-off", 2014). Gender differences in spatial abilities are considered among the largest gender differences in all cognitive abilities (Lawton & Morrin, 1999). Based on the type of directions given, are men better navigators than women? Does gender have an effect on SA when given driving instructions?

Significance of Study

Multiple factors have led to a sustained call for improvements in the content and goals for pilot and SA training systems. These factors include: a steady flow of women joining the aviation industry, inclusion of the new generation of pilots, advancement in academic research, and sophisticated SA training tools. Although the aviation industry and the military hold the significance of training and skill development in high esteem, few developments have been made in other industries. The findings of this research could remedy the lack of cross-disciplinary expertise for the development and implementation of training methods in non-aviation domains.

This study conducted an experiment to investigate how gender affects the wayfinding strategies and how gender difference and wayfinding skills affect SA. This could be used for training and selection purposes for multiple industries, including the aviation and driving industries.

Statement of the Problem

The aviation industry is always striving for new ways to improve safety and save lives. The aviation industry experiences the tragic loss of lives every year; therefore, having a healthy safety culture is critical for the industry. Most major airline accidents (i.e., 88%) involved problems with lack of SA (Endsley, 1995); therefore, SA improvements in aviation are vital.

SA is a skill that has long been associated with pilot and air traffic controller performance. Many previous studies have measured SA and spatial ability. These areas are identified as producing the largest and most consistent gender differences in the area of cognition. However, SA has infrequently been examined under two independent variables: gender difference and wayfinding strategies.

Purpose Statement

The purpose of this study is to see if gender differences affect SA performance. Additionally, to see which of female or male SA performances, if any, is better.

Hypothesis

The researcher tested the following null hypotheses:

H1: Women navigate better from Landmarks cues.

H2: Men navigate better from cardinal directions.

H3: Women have better SA performance than men when receiving landmarks directions.

H4: Men have better SA performance than women when receiving cardinal directions.

Delimitations

As pilots are more familiar with cardinal directions compared to non-pilots, the researcher did not specifically recruit pilots. Although the goal of the study is to assist in pilots' selection and training, this study did not recruit pilots as main participants and also used a driving simulator instead of a flight simulator. However, this design may affect the accuracy if applying the results into practical pilots' selection and training.

Limitations and Assumptions

First, all participants recruited were Embry-Riddle Aeronautical University (ERAU) students. Second, the driving experience of the participants highly varied from more experienced drivers to less experienced drivers. Third, the participants did not fill out self-evaluation forms for each driving task. Instead, participants filled only one form after completing the whole experiment. As a result, there was no comparison on self-evaluation scores. Finally, the experiment was a simulated environment, so the result may have slight discrepancies from the real environment.

Definitions of Terms

Sense of direction	The ability to know one's location and perform wayfinding. It is related to cognitive maps, spatial awareness, and spatial cognition.
Situation awareness	The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.

| Spatial Awareness | The ability to be aware of oneself in space. It is an organized knowledge of objects in relation to oneself in that given space. |

List of Acronyms

BA	British Airways
CERTS	Cognitive Engineering Research in Transportation Systems
ERAU	Embry-Riddle Aeronautical University
HTurn	The turn in the headings condition
LTurn	The turn in the landmarks condition
MRT	Vandenberg Mental Rotation Task
SA	Situation Awareness
SPA	Spatial Awareness
SPAM	Situation Present Assessment Method
SPSS	Statistical Products Services Solution

Chapter II

Review of the Relevant Literature

Situation Awareness

SA has been a well-known concept due to the repeated discussion of the characteristics of expert pilots in army and civil aviation. Although SA has its roots in aviation, SA has been cited as an important factor contributing to the performance of individual and teams in domains in which there is substantial amount of information to be processed, and conditions change rapidly. SA is usually applied to operational areas where SA is crucial to the success of job and goals. For example, good SA for firefighters can increase the efficiency of rescuing and keeping people safe from dangerous situations. The likelihood of untrained people detecting and escaping danger is lower for people with poor SA. SA is also an important construct to possess for static environments. For example, project managers who have good SA are able to predict unforeseen risks and execute better risk management.

Furthermore, SA facilitated the development of a system or an industry. For instance, audio and visual alarms should help to enhance operator SA, so that is the intention of developing the alerting systems.

The term SA comes from the field of military pilots and has been a subject of research for decades. However, it was not until a particular accident occurred that people started paying more attention to SA. Eastern Airlines 401 crashed in the Everglades outside of Miami years ago because all three cockpit crewmen were focused on a burnt-out landing gear indicator, and no one was flying the airplane (National Transportation Safety Board, 1973). This accident triggered further research on the SA field (Salas &

Dietz, 2017).

As multiple studies have been conducted to understand SA and its role in performance, many definitions have emerged. Endsley (1988) explained that SA occurs at three levels: "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p.97). In 1995, Endsley further broke SA into three levels:

- Level 1 SA - Perception of the surrounding elements in the environment

- Level 2 SA - Comprehension of their meaning, and anticipation

- Level 3 SA - Projection of their status into the near future

Level 1 SA - Perception of the elements in the environment. Perception of information may come through visual, auditory, tactile, taste or multiple combinations. For example, a pedestrian is going to cross the intersection. He needs to keep an eye on traffic lights, watch out for moving vehicles and other pedestrians, and read a map, which can be quite confusing (e.g., some people are unable to correctly read maps). These cues may be very subtle, but it is possible to catch all of them. In aviation, a pilot should perceive necessary elements such as the nearest airport from current location, system and weather status, and warning lights. According to Jones and Endsley's conceptual framework, 13 incidents were classified as Level 1 errors (i.e., failure to perceive the situation correctly); eight out of 13 incidents were caused by failure to monitor or observe data. It is clear that without the accurate perception of the environment, it is impossible to achieve correct SA. Decision making based on this would not be accurate. Perception is the fundamental basis and crucial key factor involved in formation of SA.

Level 2 SA - Comprehension of the current situation. Level 2 involves the ability

to comprehend relevant information and builds upon Level 1 SA of accurate perception (Endsley, 2012). Thus, an individual who performs Level 2 SA is able to derive operationally relevant meaning and significance from Level 1 SA and comprehend the information (Endsley, 2012). In aviation, trained pilots or skilled maintenance personnel can tell something is wrong by just relying on the abnormal pitch of the engine. As another example, a trained cardiologist can hear minute differences in the rhythm of a heartbeat and can see significant patterns in a printout that the untrained observer would miss (Endsley, 2012).

Level 3 SA - Projection of future status. Level 3 SA builds upon the foundations of accurate perception from Level 1 SA and the efficient and effective comprehension of Level 2 SA (Endsley, 2012). Level 3 SA involves the ability to perform future prediction and projection of the given situation and surrounding environment (Endsley, 2012). For example, a pedestrian has to notice and understand correctly the traffic light and moving cars so he can cross the intersection safely.

Applying the definition from Endsley (1995) into this study, SA could be understood as the following:

- Level 1 - People have noticed something can assist them and are aware of the location where they are and which way they can arrive at a destination. For example, landmarks include colorful advertisements, favorable brand stores, and a rubbish bin. Descriptions of path include road signs, the wayside maps, etc.
- Level 2 - People understand the driving instruction correctly.
- Level 3 - People are able to point out the right or shortest way and prepare for the next step (e.g., making right, stop on the next intersection).

SA Errors Examples. Many fatal accidents have been attributed to poor operator SA. Karber and Endsley (2004) believed that many of the performance and safety problems that currently occur in the process control area are the result of difficulties with operators' SA. The analysis of offshore drilling accidents has revealed that more than 40% of such accidents are related to SA, and the majority of those SA errors (67%) occurred at the perceptual level, 20% concerned comprehension, and 13% arose during projection (Sneddon, Mearns, & Flin, 2013). Outside the offshore drilling industry, Level 1, Level 2, and Level 3 errors contributed to the following aviation accidents as listed:

- Level 1 - In 1972, the crew of Eastern Airlines flight 401 failed to monitor their altitude and crashed into the Everglades.

- Level 2 - In 1992, the pilots of China Northern Airlines flight 6901 could not understand the ground proximity warning system (GPWS) callout on final approach, resulting a catastrophic controlled flight into terrain (CFIT) accident.

- Level 3 - In 2009, the FedEx flight 80 crew reacted improperly during touch down which led to a fatal crash.

SA Misconceptions. A typical SA misconception is the three levels of SA in the model have been inaccurately characterized as a strictly serial model. Endsley (2015) pointed out that some researchers incorrectly interpreted and misunderstood the inter connection within the model. For example, Sorensen, et al. (2010) stated that without a sound development of Levels 1 and 2, the individual cannot achieve Level 3 SA (p. 453). Another example of misconception is Chiappe, Rorie, Moran, and Vu (2012). They characterized SA as a linear system. However, Endsley (2004) has clearly stated that this does not mean that perception, comprehension, and projection necessarily occur in linear

discrete stages (p. 319). A person who doesn't have Level 1 perception doesn't mean he will not have Level 2 or 3. For instance, "defaults" in the mental models that are used to fill in where Level 1 data are not known, based on current comprehensions or projections. In the same way, default values in the mental models can be used if exact Level 2 and 3 data values are not known. Overall, it is important to comprehend Endsley's theory correctly as SA is an important skill in aviation and even non-aviation dynamic environments.

Spatial Awareness and Situation Awareness

Spatial awareness (SPA) is the basic human ability to keep track of objects and directions, which is not SA but included within SA. Good SA requires good geographical SPA, but also SA requires more such as systematic SA, environmental SA, and tactical SA (Endsley, 1995). People have on occasion gotten lost when trying to find the way to a place they have never been to before. People may find it hard to tell the direction, even of familiar places, when asked by a stranger on the street. Those could be regarded as signs of poor spatial awareness. There are three definitions of SPA for a better understanding of what SPA is:

- SPA is a part of survey knowledge and can be defined as the ability to plan new routes, shortcuts, and detours (Klippel, Hirtle, & Davies, 2010);

- SPA refers to the ability to generate, represent, transform, and recall spatial information (Linn & Petersen, 1985); and

- SPA refers to the ability to point in the approximate direction of several objects while navigating in unknown terrain, and the ability to localize objects in the terrain has importance, especially for emergency operations (Bjorn, Charlotte,

Per-Anders, & Jonathan, 2013).

If SPA is understood as a three-dimensional awareness, then SA could be understood as a four-dimensional awareness. The differences between SA and SPA is SA is the integration of various awareness and the actions respond to the perception of integration of various awareness, but SPA emphasizes sense of direction and ability to navigate. More specifically, SA is problem solving in a three-dimensional spatial relationship complicated by the fourth dimension of time compression, where there are too few givens and too many variables (Lawton, 1992). SA encompasses the individual's experience and capabilities, which affect the ability to forecast, decide, and then execute. Spatial awareness represents the cumulative effects of everything an individual is and does as applied to mission accomplishment (Lawton, 1992).

Gender Differences and Wayfinding Strategies

Gender Differences Factors. Not only gender differences, but also a variety of internal mediators influenced SA such as previous experience and cognitive training. However, research conducted over multiple years show that when it comes to cognitive differences between genders, spatial cognition tends to be the only gender difference that might occur naturally. Gender differences in spatial abilities are considered among the largest gender differences in all cognitive abilities (Lawton & Morrin, 1999). Although several studies have been carried out, researchers have tried to explore the factors explaining their findings about the differences in gender cognition. Pioneers first began to work on factors such as hormones and genetic inheritance. Obersteiner (1879) studied attention by comparing men, women, the elderly, and individuals of low intelligence. Although females have a different brain structure than males (Goldmen, 2017), there is

no definite conclusion that physical structure has a significant effect on SA. More recently, researchers have highlighted the importance of the social factors on spatial task performance.

Wayfinding Strategies. In order to make and execute appropriate decisions about where to go, good wayfinding is a skill that helps people make the correct decisions about directions at the right time, relying on cognitive skills. "Spatial thinking" and "making the correct decisions" is related to the content explained earlier. In practical terms, it means creating a system of information that supports a user's ability to navigate his or her environment by viewing and quickly understanding signs, maps, and landmarks.

Evans and Pezdek (1980) came up with an environmental research theory, and Gärling, Lindberg, Carreiras and Böök (1986) further developed this theory. According to Evans's theory, first, the factors impacting cognitive mapping were organized into five empirical categories: age, familiarity, gender, class and culture, and physical components of settings. Second, environmental knowledge was distinguished between two types: route knowledge and configurational knowledge. Refer to the explanation from Lai, Penna and Stara (2006), they summarized the definition of two types of knowledge as below, which were similar to the types of driving instructions of this study:

Route knowledge includes important landmarks in the environment, the routes connecting them and the order of route turns (relational directions such as right, left, straight ahead) in wayfinding. *Configurational knowledge* refers to a more "global" representation of the environment according to a Euclidean reference system. Carinal directions and metric distances serve as coordinated to map spatial relationships among distinctive locations within a network of routes.

(p.454)

In a process of defining a path or place, does the participant like to use route knowledge or configurational knowledge? And how is the SA performance when using these two types of environmental knowledge? Answering these two questions was the intention of this study.

According to Lawton (2001), overall, men tended to perform better when receiving cardinal directions than women, regardless of where they are from in the world. Another example of extended studies (Lawton & Kallai, 2002) examined gender and cultural differences in wayfinding strategies and anxiety about wayfinding; it also summarized three possible implications of gender differences in spatial ability. One possible implication of gender differences in spatial ability was that women and men may differ in their success at finding a destination in three-dimensional environments. The second implication was that women and men may differ in strategies for finding a destination. The third implication was that women and men appear to require a "sense of direction" when performing wayfinding tasks.

Measurements Used in Experimental Studies

Spatial orientation is a complex process that depends on numerous basic cognitive functions. For these reasons, studies investigating spatial orientation use a wide variety of measures. Most frequently used tasks to measure SPA or SA are summarized as follows: the Vandenberg Mental Rotation Task (MRT), pointing tasks, wayfinding, distance estimating, map drawing, self-report questionnaires for strategies, and self-evaluation questionnaires on orientation skills. MRT is a classic pen-and-paper test for measuring spatial cognition in humans, consisting of 12 target items. Each of the target items make

up one of the four rotated 2D graphic representations of 3D objects. The MRT requires

participants to identify two rotated images with the same target item out of four

alternatives. Multiple studies (e.g., Ira, Derek, Ronald, William, & Robert, 2005) have

tested participants in this way.

In regard to testing fields, there are three main fields that have been used: real

environment, simulated environment, and map. In all cases of studies that were in real

environment and simulated environment, the percentage males performed better than

females higher or slightly higher than percentage of the cases differences between and

females do not emerge.

Examples of previous studies using real environments include a spatial orientation

study conducted in a university campus (Kirasic, Allen, & Siegel, 1984; Montello &

Pick, 1993; Saucier et al, 2002), in a building (Sadalla & Montello, 1989; Lawton, 1996;

Lawton, Charleston, & Zieles, 1996), and in a maze (Schmitz, 1997).

Previous studies of spatial orientation in a simulated environment mainly include

3D computer simulations (Lawton & Morrin, 1999; Sandstrom, Kaufman, & Huettel,

1998; Waller, Knapp, & Hunt, 2001) and a 3D simulated maze (Moffat, et al, 1998).

However, the reason for male superiority to females with the 3D computer

simulations can be presumed that they spend more time playing videogames (Coluccia &

Louse, 2004). Therefore, investigating gender difference should combine several methods

other than a single method to get the most accurate and fair results.

Part of the research was represented by a map reading such as McGuinness &

Sparks (1983), Miller & Santoni (1986), and Brown, Lahar, & Mosley (1998). In these

studies, males performed better than females. Different from the result of simulated

environment and real environment, in 18.42% of the cases, females performed better than males. In additional, Miller & Santoni (1986), Schmitz (1997), and Brown et al. (1998) illustrated the different ways in which males and females reach a destination (Coluccia & Louse, 2004).

Meanwhile, Coluccia and Louse (2004) summarized the results of studies that used self-report questionnaires:

Self-report questionnaires for strategies were used by Lawton, 1994, 1996; O'Laughlin & Brubaker, 1998. Based on the given answers it emerges that males maintain a survey perspective when they imagine moving in the environment, preferentially relying on the visual-spatial properties of the environment and on configurational, orientation strategies. On the other hand, females maintain a route perspective; rely on landmarks and on procedural route strategies involving the route's knowledge. Finally, Lawton (1994, 1996), Lawton et al. (1996), Schmitz (1997), used the self-evaluation questionnaires to test participants' orientation skills. A homogeneous pattern emerges in the results: males estimate themselves to be more able in orientation and they show greater confidence in their own ability than females. On the contrary, females report a higher level of spatial anxiety than males, related to the fear of getting lost. (p.334)

Summary

In order to improve the safety and reduce the effect of poor SA, it is important to research the factors affecting SA. Previous researchers (e.g., McGuinness & Sparks, 1983) noticed that men outperform women in most cases, and women may navigate better when given landmarks other than cardinal directions. Also, men and women may

differ on SA performance under the influence of different wayfinding strategies.

Therefore, this study tested two factors: gender and different wayfinding strategies.

Chapter III

Methodology

Overview of the Study

This study explored how gender differences and wayfinding preferences can explain variances with SA in dynamic environments by investigating four hypotheses. H1 was that women navigate better from landmarks cues. H2 was men navigate better from cardinal directions (i.e., south and northeast). H3 was that women have better SA performance than men when given landmarks directions. H4 was men show better SA when given cardinal directions. This study was a two way within-subjects (the landmarks group and the headings group) and between-subjects (the female group and the male group) mixed design study.

Sample

Participants for the study were sampled from ERAU students in Daytona Beach, FL. Participants were recruited through a participant pool website and by recruitment in classrooms. The experimenter contacted them and scheduled a time slot. Participants received course credit if they completed the experiment. Thirty-eight participants participated in the study. There were 19 females and 19 males.

Materials

Demographic Questionnaire. A demographic questionnaire (shown in Appendix A) was given to participants at the beginning of the study asking questions like gender, when they received their driver's license, and approximately how many miles they drive each year.

Practice Scenario. Before participants drove the driving simulator, the

experimenter explained the different simulator operations such as the display of the simulator's car panel, the use of the pedals, the mirrors, and also gave some general guidance on the sensitivity of the steering wheel. Participants were required to follow the traffic regulations as they are in real life. A one-minute practice scenario was provided to help participants become more familiar with the driving simulator operations.

Experiment Scenarios. Participants drove the same scenarios in both experiments. The experiment scenarios consist of a small town, a mountain area, a city, a construction area, a mall with a parking lot, and residential blocks. In these scenarios, pedestrians cross the roads, pets walk on the street, cars appear suddenly, etc.

Instructions. Instructions were developed to indicate to the participant which way they should go and where to turn and stop. Two instructions were used in this study: landmarks instructions and headings instructions. The landmarks instructions supported the development of a mental representation using turning directions (i.e., right or left) and different landmarks (i.e., color, shape, façade area). Headings instructions supported the development of a mental representation using cardinal directions (i.e., south, north, east and west). Participants were instructed to follow the instructions as best they could. Landmarks and headings driving instructions are shown in Appendix B.

Landmarks Driving Instructions. Five turns were presented in the landmarks instruction. For better distinguishing and analyzing, these five turns were labeled as "LTurn1" to "LTurn5" as follows:

LTurn1-Turn right after you see J.M.R mart.

LTurn2-Turn left at the first traffic light and keep going.

LTurn3-Turn right after you see a Fedex truck parking on your right side.

LTurn4-Turn right when you see a building with blue roof in the intersection and keep going.

LTurn5-Turn left on the river street.

Headings Driving Instructions. Four turns were presented in the headings instruction and were labeled as "HTurn1" to "HTurn4" as follows:

HTurn1-Turn west at the first intersection and keep going into hilly area.

HTurn2-Turn north at the second traffic light in urban area.

HTurn3-Turn east at the first intersection in this zone.

HTurn4-Turn south at the second stop sign.

Software. The researcher pre-recorded SA questions by the Audacity software program. A STISIM M100 Driving Simulator was the software platform used to test the participants' preferred wayfinding strategies and their SA performances. Figure 1 is an example of driving scenarios of the STISIM M100 Driving Simulator. During the experiment, the Audacity software recorded participants' answers and response times.

Figure 1. An example of driving scenarios of STISIM M100.

Driving Simulator. The driving simulator was a desktop simulator (see Figure 2). Attached to the end of the desk was a small G27 Logitech (see Figure 3) steering wheel. Underneath the desk was a Logitech accelerator and pedal unit that is stabilized with stationary tape.
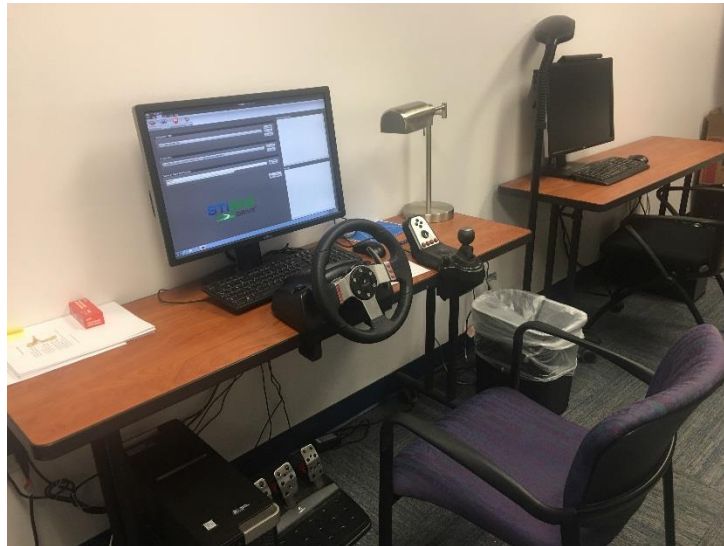
Figure 2. STISIM M100 desktop simulator.

Figure 3. G27 Logitech.

SA Questions. The researcher used the questions (shown in Appendix C) along with a modified version of situation present assessment method (SPAM) (Durso & Dattel, 2004) to assess the participants' SA performances. Two sets of SA questions were presented to participants when they were driving. The questions were counterbalanced across the scenarios.

Self-evaluation. The self-evaluation (shown in Appendix D) had three semantic differential scale questions which asked participants to rate the difficulty and workload of scenarios. On a scale of 1 to 5, participants selected one option from the 5 possible options.

Procedures

The experiment took place in the Cognitive Engineering Research in Transportation Systems (CERTS) Lab, room 131 in the College of Aviation, ERAU. In this mixed design experiment, participants were tested on performance and SA while driving the simulator. Participants first were required to read and sign an informed consent form (shown in Appendix E). Afterward, participants filled out a questionnaire asking their confidential basic information. The experimenter explained how to drive the simulator to participants. Participants then drove one minute as a practice. After practice, participants were tested on the driving simulator twice while the wayfinding instructions were presented in a random counterbalanced order. The experimenter explained the instructions including the starting point, route, and the destination. Participants were told to obey all traffic regulations (posted speed limit, stopping at red lights, etc.). After ensuring participants had no questions, participants put on a headset and waited to start. Each test lasted for 15 minutes. The experimenter started the Audacity software as soon

as the participant started driving. Six SA questions specific to the drive were played over

a headset in real time. The Audacity software recorded participants' answers and their

response times through speaking aloud into the microphone. In order to reduce the impact

of one response on another and to spread questions throughout the driving, only one

question was asked at a time, and the questions were separated in time by at least two

minutes. The first question was played somewhere between the two-minute and two-and-

half minute mark of the scenario. Questions then occurred roughly every two minutes.

After participants completed the first driving scenario, they could have a five-minute

break before continuing with the next test, if requested. The procedures followed on the

next driving task were the same for both scenarios. After completing the driving scenario,

participants were asked to fill out a self-evaluation survey and briefed about the intent of

the study.

Treatment of Data

There were two variables in this study: direction instructions and gender. All

collected data were analyzed to compare the difference in performance between men and

women and landmarks and headings. A t-test was conducted to examine the differences

on the demographic questionnaire. Despite this, several two-way mixed ANOVAs were

conducted to examine the differences on other measurements. The following

measurements were transferred from various responses to numerals and analyzed on the

Statistical Products Services Solution (SPSS) software.

Demographic Questionnaire. Demographic data were collected from the

answers that the participants wrote in the questionnaires. A t-test was conducted to

examine the difference between males and females on the mean number of years driving

and the mean number of annual miles driven.

SA Accuracy Rate. The participants answered six SA questions for each scenario. The researcher scored each correct answer as one point, for a maximum six points per driving task. Higher scores mean higher SA accuracy rate. SA accuracy rate was determined by a post-session replay of the scenario. For example, for the question "What is your current speed", the experimenter checked the speedometer at that point and the answer from the participant.

Turn Accuracy Rate. The number of turn accuracy means the number of turns participants correctly turned. Similar to SA accuracy rate, accuracy of turns was determined by a post-session replay of the scenario. The researcher scored each correct turn as one point, for a maximum five points in the landmarks driving task and four points in the headings driving task. Higher scores mean a higher turn accuracy rate.

Response Time. There were six response times for each driving task. The response time of questions participants answered wrong were not scored. For each correct answer, the researcher measured the time it took the participant to answer a question correctly and then calculated the average response time. Response time was measured from the end of the question until the participant responded. Using the Audacity software, the experimenter calculated the time interval by replaying the record. The response time unit used was milliseconds. For example, if the participant's response time was two milliseconds, then "0.2" was input into the spreadsheet.

Self-evaluation Scores. As shown in the self-evaluation (Appendix D), options were on a scale of 1 to 5. The researcher scored the number that participants chose.

Driving Performance Data. Driving performance data includes speed

exceedances, over limit % time, centerline crossings, road edge excursions, stop signs

missed, and out of lane % time. All the driving performance data were collected from the

software STISIM M100.

Chapter IV

Results

Descriptive Statistics

The following two sections describe the population sampled in this study, their answers of driving history, and their self-evaluation for the driving tasks.

Demographic Questionnaire. Table 1 describes the population sample in terms of the average number of miles driven per year and the average time the participants had a license. There were no significant differences on both of them.

Table 1

Demographic Questionnaire

	Participants	N	Mean	Std. Deviation	Std. Error Mean
Driving Years	Female	19	2.9853	2.43176	.55788
	Male	19	3.5616	2.28314	.52379
Driving Miles	Female	19	8036.84	7343.796	1684.782
	Male	19	12000.00	11368.817	2608.185

Self-evaluation. Self-evaluation had three questions (see Appendix D). Figures 4, 5, and 6 show the mean of the female and the male group's answers to three questions. There was no significant difference on Evaluation question 1, $t(36) = -.17$, $p = .09$. There was no significant difference on Evaluation question 2, $t(36) = .7$, $p = .49$. A significant difference between female and male was found on Evaluation question 3 only, $t(36) = -2.03$, $p = .05$.
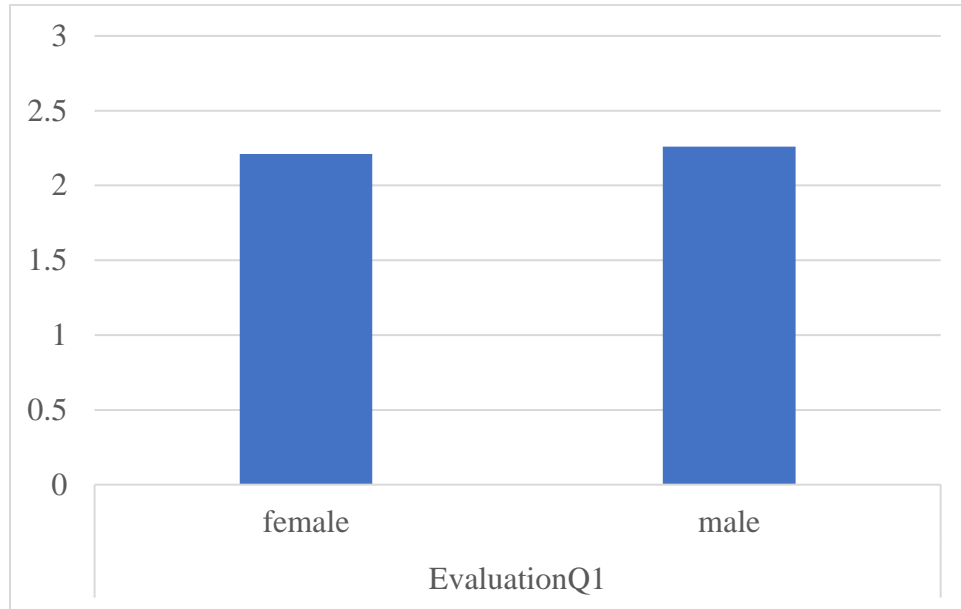
Figure 4. Comparison between the female group and the male group on EvaluationQ1.
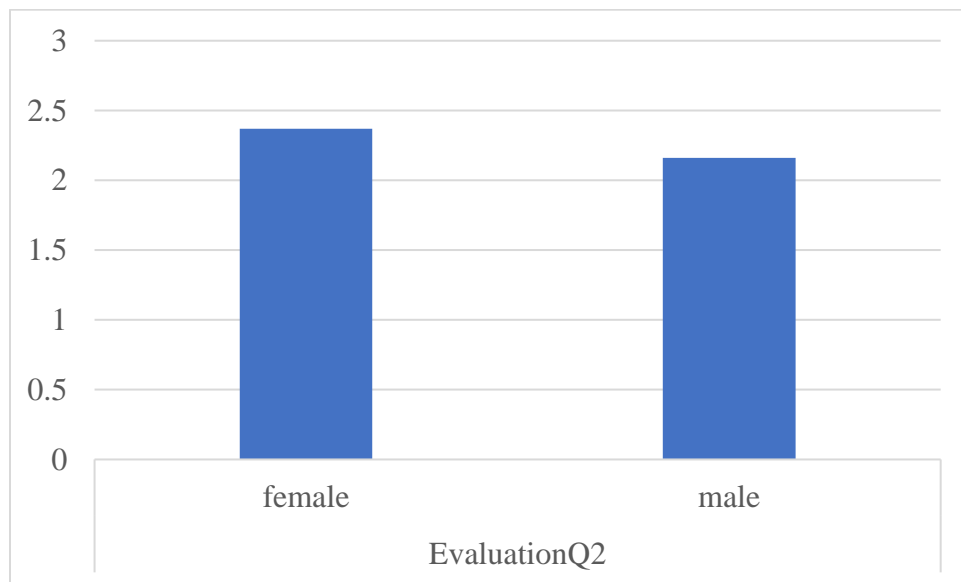
Figure 5. Comparison between the female group and the male group on EvaluationQ2.
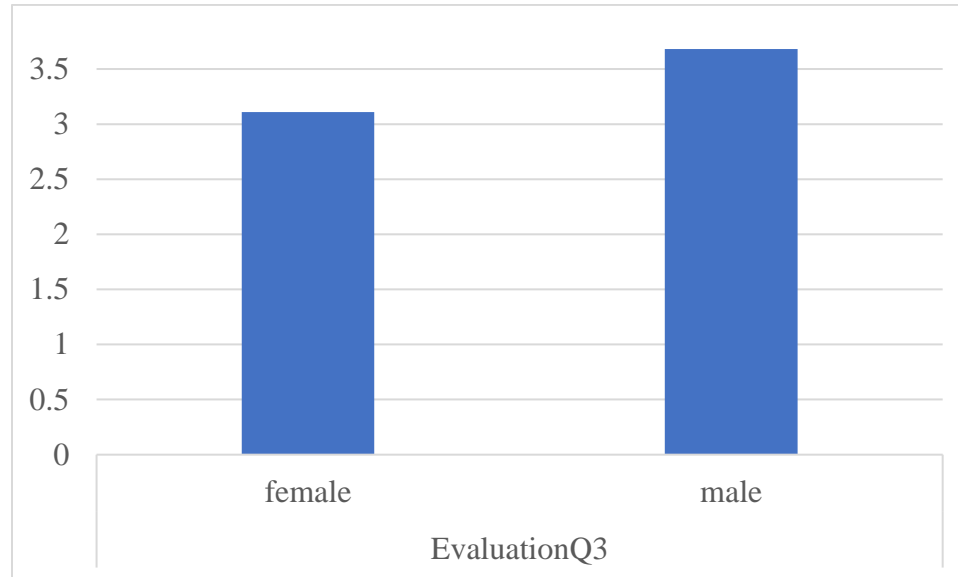
Figure 6. Comparison between the female group and the male group on EvaluationQ3.

Turns

Knowing where to go guided by the instructions was the first step for the participants. Whether participants turned wrong or right was the most direct indication of whether participants understood the instructions or not. HTurn 1 and LTurn1, HTurn3 and LTurn4, and HTurn4 and LTurn5 were the paired turns at the same intersection but different presentation on the headings instruction and the landmarks instruction. Several 2 x 2 ANOVAs were conducted to test the significant difference between the female group and the male group by the headings and landmarks driving task.

HTurn1 and LTurn1. There was no significant difference between the female group ($M = .84$, $SD = .38$) and male group ($M = .84$, $SD = .38$), $F(1,36) = .26$, $p = .62$, $\eta^2 = .01$. There was no significant difference between the headings group and the landmarks group, $F(1,36) = .49$, $p = .49$, $\eta^2 = .01$.

HTurn2. A one-way ANOVA was conducted, and the result was the gender

difference was not significant when doing the headings driving task, $F(1,36) = 1.13$, $p = .3$.

LTurn3. Both 15.8% female and male participants made a wrong turn at LTurn3. Three was no significant difference between female and male, $F(1,36) = .01$, $p = .94$.

HTurn3 and LTurn4. The type of instruction effect was significant, $F(1,36) = 8.65$, $p = .01$, $\eta^2 = .19$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = 3.31$, $p = .08$, $\eta^2 = .08$.

HTurn4 and LTurn5. The type of instruction effect was significant, $F(1,36) = 21.77$, $p < .001$, $\eta^2 = .38$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = .08$, $p = .39$, $\eta^2 = .21$. The interaction had significant difference, $F(1,36) = 4.74$, $p = .04$, $\eta^2 = .12$. The post hoc analyses showed that males were likely to make the correct turns in landmarks conditions than they were during headings conditions, $t(19) = -4.98$, p $< .001$, but females were no different between the two driving instruction conditions.

Turn Accuracy. The type of instruction effect was significant, $F(1,36) = 59.41$, $p = .00$, $\eta^2 = .62$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = .53$, $p = .78$, $\eta^2 = .002$. The detailed information is shown in Table 2 and 3.

Table 2

Landmarks Turn Accuracy

Participants			Frequency	Percent	Valid Percent	Cumulative Percent
Female	Valid	1	1	5.3	5.3	5.3
		3	1	5.3	5.3	1.5
		4	5	26.3	26.3	36.8
		5	12	63.2	63.2	10.0
		Total	19	10.0	10.0	
Male	Valid	3	3	15.8	15.8	15.8
		4	3	15.8	15.8	31.6
		5	13	68.4	68.4	10.0
		Total	19	10.0	10.0	

Table 3

Headings Turn Accuracy

Participants			Frequency	Percent	Valid Percent	Cumulative Percent
Female	Valid	0	1	5.3	5.3	5.3
		1	4	21.1	21.1	26.3
		2	1	5.3	5.3	31.6
		3	4	21.1	21.1	52.6
		4	9	47.4	47.4	10.0
		Total	19	10.0	10.0	
Male	Valid	0	1	5.3	5.3	5.3
		1	3	15.8	15.8	21.1
		2	4	21.1	21.1	42.1
		3	6	31.6	31.6	73.7
		4	5	26.3	26.3	10.0
		Total	19	10.0	10.0	

Driving Performance

Speed Exceedances. There was no significant difference between the landmarks group and the headings group, $F(1,36) = 1.43$, $p = .24$, $\eta^2 = .04$. There was no significant

difference between the male group and the female group as well, $F(1,36) = 2.40$, $p = .13$,

$\eta^2 = .06$.

Over Limit % Time. Over limit time was the percentage of the total time of

speeding over the total driving time. See fraction below:

$$Over\ limit\ \%\ time = \frac{the\ total\ time\ of\ speeding}{the\ total\ time\ of\ driving}$$

Even though speed exceedances were analyzed, each participant had different

total driving time; over limit % time was analyzed too. In the headings driving task, the

mean of the male group ($M = 11.68$, $SD = 1.39$) was nearly twice as many as the female

group ($M = 6.56$, $SD = 6.24$). Similarly, in the landmarks driving task, the mean of the

male group ($M = 13.82$, $SD = 8.60$) was nearly twice as many as the female group

($M = 7.84$, $SD = 5.71$). There was no significant difference between the landmarks group

and the headings group, $F(1,36) = 2.78$, $p = .10$, $\eta^2 = .72$. However, there was a

significant difference between the male group and the female group, $F(1,36) = 5.47$,

$p = .03$, $\eta^2 = .13$.

Centerline Crossings. As Table 4 shows, the number of times the male group

crossed centerlines was more than the female group no matter what the landmarks or the

headings driving tasks. The type of instruction effect was not significant, $F(1,36) = 1.99$,

$p = .17$, $\eta^2 = .52$. When the impact of instruction was a main effect, the gender effect was

also not significant, $F(1,36) = 2.09$, $p = .16$, $\eta^2 = .52$.

Table 4

Centerline Crossings

	Gender	Mean	Std. Deviation	N
Hcenterline crossings	female	8.16	5.113	19
	male	9.42	6.874	19
	Total	8.79	6.010	38
Lcenterline crossings	female	8.89	3.414	19
	male	11.47	4.402	19
	Total	1.18	4.099	38

Road Edge Excursions. Table 5 shows the descriptive results of road edge excursions. The type of instruction effect was not significant, $F(1,36) = .26$, $p = .61$, $\eta^2 = .07$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = 3.57$, $p = .07$, $\eta^2 = .09$.

Table 5

Road Edge Excursions

	Gender	Mean	Std. Deviation	N
Headings Road Edge Excursions	female	8.32	9.214	19
	male	4.89	3.125	19
	Total	6.61	7.004	38
Landmarks Road Edge Excursions	female	8.11	4.545	19
	male	6.32	3.267	19
	Total	7.21	4.008	38

Stop Sign Missed. The type of instruction effect was not significant, $F(1,36) = 1.56$, $p = .22$, $\eta^2 = .04$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = .01$, $p = .94$, $\eta^2 = 0$.

Out of Lane % Time. Similar to out of limit % time, out of lane % time was the percentage of the total time of being out of lane over the total driving time. See fraction below:

$$Out\ of\ lane\ \%\ time = \frac{the\ total\ time\ of\ being\ out\ of\ lane}{the\ total\ time\ of\ driving}$$

In the headings driving task, the total out of lane time of the female group ($M = 1.64$, $SD = 5.93$) was more than the male group ($M = 9.80$, $SD = 6.94$). Conversely, in the landmarks driving task, the time of the male group ($M = 11.78$, $SD = 3.46$) was higher than the female group ($M = 11.13$, $SD = 3.58$). The type of instruction effect was not significant, $F(1,36) = 1.91$, $p = .18$, $\eta^2 = .05.$, when the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = .04$, $p = .95$, $\eta^2 = .0$.

SA Performance

SA Accuracy. The mean differences of SA accuracy is shown in Figure 7. In the headings conditions, the mean and standard deviation (SD) of the female group was $M = 4.87$, $SD = 0.83$; the mean and standard deviation (SD) of the male group was $M = 5.35$, $SD = 1.11$. In the landmarks conditions, the mean accuracy of the female group ($M = 4.46$, $SD = 0.64$) was higher than the male group ($M = 3.82$, $SD = 0.81$). A 2 x 2 ANOVA was conducted to test the two variables. The type of instruction effect was significant, $F(1,36) = 9.838$, $p = .00$, $\eta^2 = .24$. When the impact of instruction was a main effect, the gender effect was not significant, $F(1,36) = .04$, $p = .8$, $\eta^2 = .02$. However, the interaction effect was significant, $F(1,36) = 3.99$, $p = .03$, $\eta^2 = .21$. The post hoc analyses showed that males correctly answered fewer questions in landmarks conditions than they did during headings conditions, $t(18) = -3.98$, $p < .001$, but female SA accuracy was no different between the two driving instruction conditions.
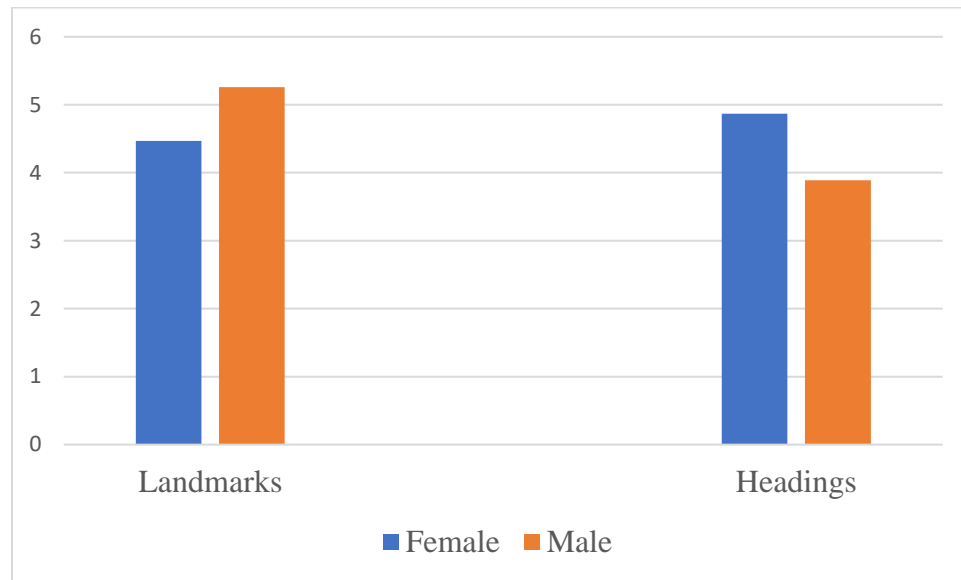
Figure 7. The mean differences of SA accuracy.

Response Time. The response time of the female group ($M = 2.65$, $SD = 1.85$) was much longer than the male group ($M = 1.67$. $SD = 0.94$), no matter what the landmarks or headings driving tasks (see Figure 8.) The type of instruction effect was not significant, $F(1,36) = 1.14$, $p = .29$, $\eta^2 = .04$. When the impact of instruction was a main effect, the gender effect was significant, $F(1,36) = 5.11$, $p = .03$, $\eta^2 = .14$.
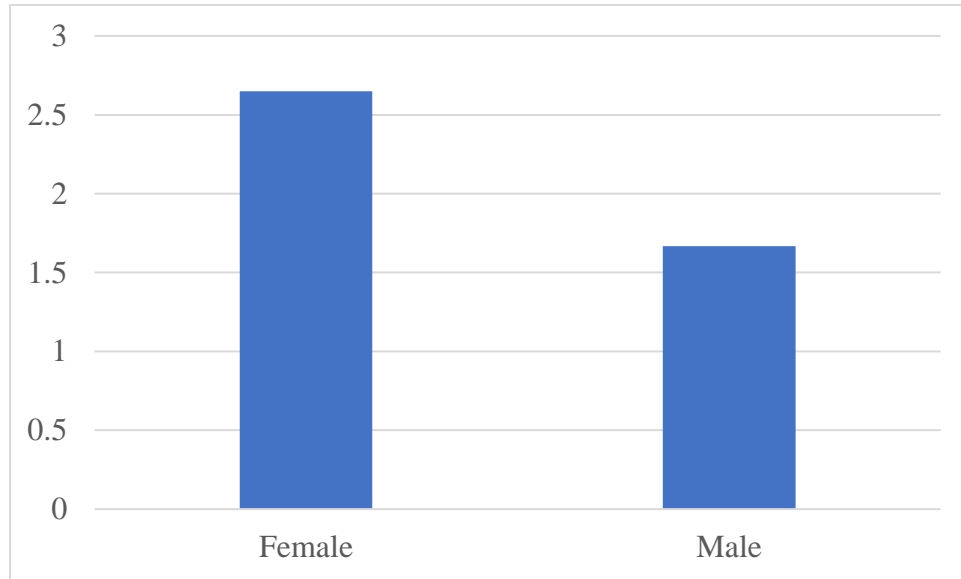
Figure 8. The mean differences of response time between females and males.

Chapter V

Discussion, Conclusions, and Recommendations

Discussion

SA Accuracy. The effect of the type of instructions was significant, and the interaction was also significant. Participants performing under landmarks condition had lower SA accuracy than those performing under headings conditions.

The post hoc analyses showed that, in the landmarks conditions, males answered fewer questions correctly than they did in the headings conditions, but there was no significant difference in female SA accuracy for either of the two driving instruction conditions. This result suggested that men performed much worse with landmarks directions compared to headings directions.

Response Time. Adam et al. (1999) stated that the present study examines the possibility that men and women might employ different information processing strategies in a task that requires a verbal response to a spatial location stimulus. Adam et al.'s (1999) result was consistent with previous studies (Simon, 1967; Lahtela et al., 1985). That is, men showed shorter reaction time than females. Males may have "binary, split-half" (or dichotomizing) strategy, while females may have a "serial, left to right" strategy. Welford (1980) pointed out that dichotomizing strategy is the most efficient procedure of processing information. According to these studies, men have more efficient processing strategies than women, which could be considered as the reason why women have longer response time than men in this study.

Self-evaluation. Of the three evaluation questions, only Question 3 showed a significant difference between the female group and the male group. The mean of the

male group (M = 3.68, SD = 0.82) was higher than the mean of the female group (M = 3.11, SD = 0.94). Males expressed higher confidence in answering the questions asked during the driving scenario than females did. However, males got fewer questions correct in performing under the landmarks conditions than they did in the headings conditions, while female SA accuracy scores were not significantly different in either condition. This suggested that males did not have accurate assessment on their SA performance.

Turn Accuracy. Regardless of gender, participants performed better when they followed the landmarks instruction than when they followed the headings instruction. The first reason could be that participants could tell cardinal directions at the beginning of the driving task. After a few turns, the mental maps of the participants started to be unclear or participants started to be confused and disoriented. Cardinal directions may have demanded greater working memory, thereby affecting performance. Second, it was hard for participants to confirm the correct direction and make a correct turn at the next intersection if they previously had made a wrong turn. Third, the unclear mental map in their mind could fluster the driver and result in missing some key words in the instruction. For example, in the headings instruction, there were sentences "Pass the zone under construction and enter the zone with lots of cars parking there. Turn east at the first intersection in this zone." Few participants turned east before entering the car parking zone.

This study intended to test the theory that males do better with cardinal directions and females do better with landmarks directions, but it is interesting to find out that regardless of gender, people are more likely to handle directions by using left or right than using north, east, south, and west.

Conclusions

This preliminary evaluation has produced three findings as following:

Finding 1. Women took longer than men to answer SA questions in all conditions.

Finding 2. Participants performing under landmarks conditions had lower SA accuracy than those performing under headings conditions.

Finding 3. The post hoc analyses of SA accuracy showed that, in the landmarks conditions, males answered fewer questions correctly than they did in the headings conditions, but there was no significant difference in female SA accuracy in either conditions.

In this study, there are two measurements of SA: SA accuracy and response time. Based on the result of these two measurements, there were some inconsistencies in the conclusion: women took longer than men to answer SA questions in all conditions, meanwhile, men answered fewer questions in landmarks than they did in the headings condition, but women had no difference in either conditions. This may or may not be the true reflection of women SA, but definitely it is most likely a true reflection that men have poor SA in landmarks conditions. Anecdotally, the researcher noticed that women were too shy or unconfident to speak out the right answers even when they know they were right. It is consistent with the finding that men were more confident than women when answering the SA questions.

Recommendations

While this study alone does not supply enough evidence, data, and information to initiate widespread changes into the training system, it opens the door to many potential follow-up studies and for some small changes to be made. The researcher recommends

future studies to sample pilots instead of drivers from varying regions and ages to maximize the accuracy of experiment results. Also, due to the experimental task may demand greater working memory, thereby affecting performance, the researcher recommends to explore the performance differences under the effect of working memory.

One of the conclusions of this study is that males had poor SA in landmarks conditions than in headings conditions. In 2016, the Federal Aviation Administration's Aeronautical Center stated that 93.29% of active pilots were males. In the male-dominated aviation industry, runway incursions are a continuing problem (Croft, 2017). Also, runway and taxiway incursions might be based more on landmarks than headings. There is maybe a connection between runway incursions, and men don't do well with landmarks.

When collisions occur outside of the runway, the aircraft and/or vehicles involved are usually travelling relatively slowly; in contrast, when a collision occurs on the runway, at least one of the aircraft involved will often be travelling at a considerable speed. As mentioned in Chapter IV, there was a significant difference between the male group and the female group on "over limit % time". In both of the landmarks and headings driving tasks, the percentage of speeding time for the male group was near twice as much as the female group. The majority of current pilots are men. Considering these facts, when training male pilots, it is very important to address the dangers of speeding. The researcher recommends starting the first day of training, male pilots learn that speeding increases the risk of significant aircraft damage and the severity of the consequences therefrom, including serious or fatal injury when taxiing.

The results showed that men don't do well with landmarks, and runway and taxiway incursions might be based more on landmarks than headings. There are a couple of typical scenarios of runway incursions. One of them is a flight crew-induced situation, which is related to this study. The occurrences of flight crew-induced runway incursions happen when an aircraft lands at an unfamiliar airport and the flight crew becomes disorientated and unconfident of their position as they exit the runway. These two reasons match the finding of this study, which is men have poorer SA in landmarks conditions. To avoid this problem, current flying simulation software could develop new "taxi to gate" scenarios and integrate new scenarios into current flying scenarios.

Furthermore, the researcher also recommends that specific simulated software or games are needed to develop to train male pilots SA and the ability to be guided by landmarks. Most of the ground schools have a simulator class but no specific SA class. In addition to that, the flight schools bring in cockpit-based surface moving maps, which present pilots with a dynamic image of the airport, showing their own aircraft's position within it. Using these maps while taxi training, pilots could become more and more familiar with how to confirm their own position in real airports, which would improve their SA. Good SA is an ability, and this ability will be very beneficial when pilots taxi in unfamiliar airports. They can apply the skills they learned during training to confirm their own aircraft's position while landing at airports they never been before.

Finally, this study found that participants navigated better using landmark cues, regardless of gender. This is an important reference for some navigation tools such as Google maps and Garmin. Current navigation tools could consider the needs and preference of people or even develop a function to let people set their preferences.

Lesson Learned. Throughout the process of developing the study, the researcher encountered several issues and obstacles. For example, due to the technical difficulties, the driving simulator didn't save all the data of all the participants recruited. Thus, some of the early data collected were unusable.

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Appendix A

Demographic Questionnaire

Questionnaire

Gender_____   No_____

When did you receive your driver's license?

How many miles do you driver each year approximately?

Appendix B

Driving Instructions

Landmarks Driving Instructions

Turn right after you see J.M.R mart. Go through the mountain area and enter a city. Turn

left at the first traffic light and keep going. Turn right after you see a Fedex truck parking

on your right side. Enter the construction zone and drive slowly. Pass the construction

zone and a plaza. Turn right when you see a building with blue roof in the intersection

and keep going. Enter the residential area. Turn left on the river street.

Headings Driving Instructions

During this 15-minute driving scenario, you will go through at least four different zones

with different views. In the beginning, you start out headings north and enter a block.

Turn west at the first intersection and keep going into hilly area. Pass the hilly area then

reach the urban area. Turn north at the second traffic light in urban area. Keep going

straight and you will enter a constructional zone. Pass the zone under construction and

enter the next zone with lots of cars there. Turn east at the first intersection in this zone.

Follow the road and you will enter the populated area. Turn south at the second stop sign.

Appendix C

SA Questions

SA Questions

Landmarks Scenario SA questions:

1.   What's your current speed?

2.   Is there a car behind you?

3.   At your next turn, will you turn left or right?

4.   What's the posted speed limit on this road?

5.   Is it safe to accelerate right now?

6.   Did you see a dog when you driving?

Headings Scenario SA questions:

1.   What's the speed limit on this road?

2.   At the current moment, is there any visible indication that a pedestrian could step in front of your car?

3.   Did you exceed the speed limit at any time during this scenario?

4.   Which way did you turn (left or right) at your last turn?

5.   What's your current speed?

6.   At anytime during this drive, did you brake to avoid hitting a pedestrian?

Appendix D

Self-Evaluation Form

Self-Evaluation

No._____

1.   How difficult was it to understand the instructions presented?

1_____2_____3_____4_____5

Very easy   Very difficult

2.   How difficult did you find the driving task?

1_____2_____3_____4_____5

Very easy   Very difficult

3.   How confident did you feel in answering the questions asked during the driving

scenario?

1_____2_____3_____4_____5

Not confident   Very confident

Appendix E

Consent Form

AGREEMENT TO PARTICIPATE IN

Difference in Situation Awareness When Receiving Wayfinding Direction By Landmarks And Headings

STUDY LEADERSHIP.   You are invited to participate in a research study that is being conducted by Ziyi Dong, MSA student, Embry-Riddle Aeronautical University (ERAU), Daytona Beach.

PURPOSE. The purpose of this study is to examine the cause-and-effect relationships of two independent variables (i.e., gender and wayfinding direction) and the SA performance.

ELIGIBILITY. To be in this study, you must be 1) 18 years or older and have a driver's license. 2) Enrolled or work at ERAU.

PARTICIPATION. During the study, you will operate a driving simulator. In addition, you will be asked questions specific to the task. Your involvement in this study will be approximately less than one hour.

RISKS OF PARTICIPATION. The risks of participating in this study are minimal. As the Drive sim being used are desktop simulators, there is a small possibility that you may experience slight dizziness associated with the use of the simulator, resulting from interacting with a video game interface. The motion sickness symptoms include fatigue, uneasiness, headache, dizziness, and vomiting. If you feel any negative side effects from stress and motion sickness, or if feel psychologically or physically uncomfortable during any phase of the experiment, you can request to terminate the session or withdraw from the study at any time with no penalty. You will be encouraged to visit the ERAU Health clinic if it is necessary. The ERAU Health clinic can be reached at (386) 226-7917 and dbhealth@erau.edu.

If you have used a desktop simulator or gaming device previously, and have not experienced motion sickness, it is unlikely that you will experience any motion sickness or dizziness in this study. Otherwise, you experience in this study should not exceed normal levels of stress during similar everyday situations.

BENEFITS OF PARTICIPATION. Your participation will help us better understand wayfinding skills and SA in a driving environment.

VOLUNTARY PARTICIPATION. Your participation in this study is voluntary. No compensation, other than possible class credit as determined by your instructor or professor, will be given for participating in this study. You may stop or withdraw from the study at any time or refuse to answer any question that participants are uncomfortable

answering without penalty. If you stop or withdraw from the study but still want to get class credit, your instructors (or professors) could assign you to do another assignment that equivalents to the difficulty and time of this experiment. For example, reading one-hour related articles. The possible class credit will be determined by your instructor or professor. If you decide to withdrawal from the study, any data collected will be disposed of and not analyzed. Your decision whether or not to participate will have no effect on your current or future connection with anyone at ERAU.

RESPONDENT PRIVACY. Your responses in this study will be confidential. Only myself directly involved in this study will have access to the data. In order to protect the confidentiality of your responses, I will provide each participant with a random ID for the study. Any collected data or personal information will be entered and stored in a password protected file on a password-protected computer or in a locked file cabinet. The data will be stored for 3 years after any publication, if any, and then will be shredded. No compensation, other than possible class credit as determined by your instructor, will be given for participating in this study.

FURTHER INFORMATION. If you have any questions or would like additional information about this study, please contact Ziyi Dong at (386) 679-7472 or ZIYID@my.erau.edu or you can contact my thesis advisor, Andy Dattel, Ph.D. at (386) 226-7795 or andy.dattel@erau.edu.

The ERAU Institutional Review Board (IRB) has approved this project. You may contact the ERAU IRB with any questions or issues at (386) 226-7179 or teri.gabriel@erau.edu. ERAU's IRB is registered with the Department of Health & Human Services – Number – IORG0004370.

CONSENT. Your signature below means that you understand the information on this form, that any and all questions you may have about this study have been answered, and you voluntarily agree to participate in it. A copy of this form can also be requested from Ziyi Dong.

Signature of Participant   _____   Date _____
Print Name of Participant _____

Signature of Researcher _____
Print Name of Researcher_____   Date_____

Appendix F

Permission to Conduct Research

Embry-Riddle Aeronautical University
Application for IRB Approval
Expedited Determination

Principle Investigator: Ziyi Dong

Other Investigators: Andrew R. Dattel

Role: Student **Campus:** Daytona Beach **College:** Aviation/Aeronautics

Project Title: Difference in Situation Awareness When Receiving Wayfinding Direction By Landmarks And Headings

Submission Date: 10/31/2017

Review Board Use Only

Initial Reviewer: Teri Gabriel **Date:** 12/07/2017 **Approval #:** 18-058
Exempt: No

IRB Member
Reviewer #1 Signature: Haydee M. Cuevas   Digitally signed by Haydee M. Cuevas Date: 2017.12.11 12:52:17 -05'00'   **Date:** 12/11/2017

IRB Member
Reviewer #2 Signature: Dr. Timothy B. Holt   Digitally signed by Dr. Timothy B. Holt DN: cn=Dr. Timothy B. Holt, o=Dean, College of Aviation, ou=ERAU, Prescott campus, email=holt@erau.edu, c=US Date: 2017.12.12 08:17:17 -07'00'   **Date:** 12/12/2017

Dr. Michael Wiggins Michael E. Wiggins, Ed.D.   Digitally signed by Michael E. Wiggins, Ed.D. DN: cn=Michael E. Wiggins, Ed.D, o=Embry-Riddle Aeronautical University, ou=Aeronautical Science Department, email=wigginsm@erau.edu, c=US Date: 2017.12.13 10:43:33 -05'00'
IRB Chair Signature: **Date:** 12/13/2017

Expires: 12/12/18

Brief Description:

Using a driving simulator, this study will investigate preferred strategies on wayfinding based on gender with the use of environmental knowledge. The Audacity software will record participants' answers and response times.

This research falls under the expedited category as per 45 CFR 46.110 (b) because one or both of the following apply:

(1) ☑ some or all of the research appearing on the list below are found by the reviewer(s) to involve no more than minimal risk,

(2) ☐ minor changes in previously approved research during the period (of one year or less) for which approval is authorized.

Research activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the following categories. The activities listed should not be deemed to be of minimal risk simply because they are included on this list. Inclusion on this list merely means that the activity is eligible for review through the expedited review procedure when the specific circumstances of the proposed research involve no more than minimal risk to human subjects. (Bankert & Amdur 2006)

1. ☐ Prospective collection of biological specimens for research purposes by noninvasive means.

2. ☑ Collection of data from voice, video, digital, or image recordings made for research purposes.

3. ☐ Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. (NOTE: Some research in this category may be exempt from the HHS regulations for the protection of human subjects 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.) [This means research that presents *more than minimal risk to human subjects.*]