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A Comparison Of The Effect Of Variations To U.S. Airport Terminal Signs On The Successful Wayfinding Of Chinese And American Cultural Groups

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A COMPARISON OF THE EFFECT OF VARIATIONS TO U.S. AIRPORT TERMINAL SIGNS ON THE SUCCESSFUL WAYFINDING OF CHINESE AND AMERICAN CULTURAL GROUPS

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For my parents, Sam and Rosalie Leib.

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Leib, Steven M. M.S., Purdue University, May 2010. A Comparison of the Effect of Variations to U.S. Airport Terminal Signs on the Successful Wayfinding of Chinese and American Cultural Groups. Major Professor: Brian G. Dillman.

Processing passengers quickly and efficiently is one of the top goals for airport administrators, and major international gateways have the added challenge of processing passengers representing a variety of cultures and nations. People having diverse cultural backgrounds may interpret signage layouts differently with respect to symbols and text. Consequently, dedicated research into signage perception may provide airport administrators with a more informed sense of how to convey appropriate movement and directional information within their terminals. There are many ways to answer the broad question of what signage encourages passengers to move most efficiently through an airport terminal. This study focused on the different ways in which Chinese and American airline passengers navigated through a terminal using either signs showing text only, symbols only, or both text and symbols. Quantitative in nature, the study used a unique computer simulation to generate paths having signage with English text, common symbols, or a combination of both. Participants clicked on arrows to follow the path to the specified goal for each different variation. Total completion time measurements and completion accuracy (in terms of correct versus incorrect clicks) were gathered. Analysis of the results suggested that there was a statistically significant difference related to cultural differences on a passenger's ability to wayfind based on the type of signage used. Additionally, within cultural groups

there was a statistically significant difference as to which arrangements encouraged better wayfinding and those which did not. Lastly, the results suggested a difference in which sign type produced the best wayfinding performance and which sign type people actually preferred.

CHAPTER 1. INTRODUCTION

Arriving at a major airport from a long-haul international flight can be a very stressful time for passengers. Changes in time zone, fatigue, and discomfort of travel are all factors that can contribute to an unpleasant arrival experience. Because many people are in a physically and mentally weakened condition, their goal is to be processed by Customs and Immigration and proceed to other airport locations as quickly and smoothly as possible, with added urgency to passengers connecting to domestic flights.

Additionally, airport administrators have a vested interest in processing passengers in a quick and efficient manner. Given the daily influx of international travelers, airport administrators cannot afford to delay the process of moving passengers and baggage through their airports. There are many ways in which airports can bolster their passengers' ability to move through their terminals, and as travel has become more economic and available to more people worldwide, there are a variety of factors to consider when making decisions on the subject of airport wayfinding, the process by which one navigates an airport terminal using visual cues.

While the use of text, symbols, and/or directional arrows may seem intuitive and obvious to passengers from within American culture, passengers from different cultures may interpret those same instructional cues differently. Furthermore, signage arrangements may cause alternate interpretations from non-Americans. For major airports, especially those that have significant numbers of international commercial flights from U.S. and foreign airlines, displaying signs that best help the

population of passengers move through the terminal is a goal that benefits everyone.

1.1. Statement of the Problem

As increasing numbers of international passengers pass through U.S. airports, and the portion of Chinese passengers as a subset, airports have apparently done little to their facilities to reflect the changes in cultural composition of their passengers. Aging facilities appear to have made few efforts to update signage, and airport administrators do not seem to consider the cultural background of their passengers when they do update signs. Because there is a fixed amount of walking room in terminals, passengers that cannot make effective use of signs can miss flights, cause unnecessary congestion, and waste their time as well as the time of the airport staff.

1.2. Significance of the Problem

China's economy is still in its infancy, and only in the past few years has the United States seen a rapidly growing number of Chinese passengers. According to the Air Transport Association, in the past few years, U.S. airlines have added or are planning to add nonstop flights from major American gateways to China. Delta Air Lines now flies from Atlanta to Shanghai nonstop; American Airlines flies to Shanghai from Chicago and plans to add Beijing; Continental Airlines flies from Newark to Beijing and Shanghai; United Airlines has a total of five daily nonstops from Washington D. C., Chicago, and San Francisco to Beijing and Shanghai; and by 2010, U.S. Airways expects to fly from Philadelphia to Beijing and United will add a flight from San Francisco to Guangzhou. Chinese airlines are adding flights to the United States as well. The three largest airlines in China, China Airlines, China Southern, and China Eastern, have all added flights to major American cities in the past decade. Hainan Airlines has just begun serving Seattle from Beijing and

Shanghai. With the increased number of Chinese visitors to the United States, it begs the question: How are airports handling this cultural influx? Chinese and American cultures are extremely different, and airports have naturally and historically catered to the latter in terms of signage and design. However, because there will be such an increased presence of Chinese passengers in certain U.S. airports, incorporating changes to help cater to another major culture can help increase terminal awareness, decrease confusion, and help passengers and airports work as efficiently as possible. If airport authorities ignore this culture change, the result could be increased confusion, missed flights, and wasted time - a cost burdened by passengers, airlines, and airports together.

1.3. Statement of Purpose

The purpose of this thesis is to develop an understanding of how two different cultures, Chinese and American, utilize the content of terminal signage differently when navigating to the Customs & Immigration area or other specified location of the airport upon landing at their United States gateway airport. This thesis narrows the many ways in which this issue can be addressed, and seeks to answer the following question: Is there a difference between the wayfinding abilities of Chinese and American airline passengers when they are presented with different signs using only English text, only symbols, or a combination of both?

This thesis compares the use of text and symbols combined with directional arrows to identify differences as to how Chinese and American passengers wayfind in U.S. airports. This study provides a quantitative comparative analysis with qualitative support of how the two groups navigate differently based on the addition or removal of text and symbols on airport signs.

1.4. Definitions

American passengers -- travelers whose native language is American English and

are residents or citizens of the United States, and were also born in the United States.

Chinese passengers – travelers whose native language is Mandarin Chinese or other Chinese dialect and are either residents or citizens of the People's Republic of China, including Taiwan, but excluding Hong Kong and Macau. They must also be born in the People's Republic of China or Taiwan.

Signage/sign – any placard or visual indication used to convey a message to viewers, usually but not always for the purpose of indicating where a destination is.

Symbols – icons or images used on signage to help explain a message, usually but not always coupled with a directional arrow.

Wayfinding – the process of using environmental cues, visual or otherwise, to help successfully navigate to a goal.

1.5. Assumptions

This research study makes three important assumptions for the purpose of feasibility and testability:

- All people understand directional arrows and commonly used symbols in airport environments.
- Reasonable measures have been taken to ensure that symbols that indicate various destinations (for example, the man and woman representing a restroom) have been chosen from reputable, well-accepted sources.
- All people have a most minimal and basic understanding of operating a computer (using a mouse to click on the screen).

1.6. Delimitations

There are several issues that this study does not address, for the purpose of reasonable scope and feasibility:

- The issue of using Chinese text on signs is not addressed; only sign arrangements displaying symbols and English text are used, because the scope of the study is limited to behavior in American airports.
- The study does not address Chinese and American subcultures. For example, the difference in sign perception between Chinese people from northern China and Taiwan is not be explored; both are considered acceptable representations of Chinese culture as a whole.
- Age differences within those cultures are not addressed.
- Gender differences within those cultures are not addressed.
- Only Chinese and American cultures are examined, and other Asian cultures and world cultures are not included in this study.

1.7. Limitations

There are a couple of limitations that may weaken the study:

- People participating in the study have been in the United States for some time, most are studying at a major American university, and all have at least have some understanding of the English language.
- Participants are also more likely to travel than many members of the larger population, because they have at least traveled to the United States once.

Based on these factors, the sample population is likely more educated, has traveled more, and has a better understanding of English than the population as a whole. However, as described in the methodology section, efforts have been taken to minimize these limitations.

CHAPTER 2. LITERATURE REVIEW

Fewings (2001) lays the groundwork for a problem that airports face every day: how to move passengers effectively through the terminal to get to various destinations. This can be described as "wayfinding," a term that defines the process of using environmental cues to successfully navigate to a particular destination. Fewings breaks wayfinding down into three different types, based on the reason for needing to reach a destination: recreation, resolute, and emergency wayfinding. Recreational wayfinding is considered the least urgent, where the navigator is wayfinding for their own enjoyment. For example, a simple "connect-the-dots" game or a stroll in a local park can be considered recreational wayfinding. Resolute wayfinding, however, has the goal of navigating as efficiently as possible. An example of this might be driving to a restaurant or walking to school, where the goal is to take the most efficient way possible. This is slightly different from emergency wayfinding, the third kind. This type of wayfinding has the goal of getting to a particular destination as fast as possible. This could be a fire escape, or running from an attacker, and according to Fewings (2001), "…people will instinctively seek to use these [routes] under traumatic conditions" (p. 179). Wayfinding, according to Fewings, is the product of many visual cues, including signs (placement, color, content), terminal design (in the case of an airport), and maps of the area. He concludes that based on his research that the different types of wayfinding command different types of information display. This naturally raises the issue of an airport, where wayfinding can be any of the three types depending on the circumstances, and implementation of effective airport signage to consider a variety of situations can be a major challenge for an airport authority.

2.1. China's Role in Aviation Development

Further challenges to airport wayfinding success come from the fact that airports are hosts to thousands of international passengers daily, and one of the fastest growing markets are passengers traveling between the United States and China. The differences in these two cultures (as well as all of the other cultures represented in airports daily) present additional challenges to ensuring successful terminal navigation. According to the Office of Travel and Tourism Industries (OTTI) 2008 passenger data, the United States received 493,000 Chinese visitors, which represents a 112% increase in visitors from just 2001. This is astonishing, especially given the fact that the Asian region as a whole had a 2% *decrease* in passengers over the same time interval. China also has the most impressive forecast for future growth in passenger exchange with the U.S. OTTI projections show that between 2008 and 2013, passengers from China will increase 61%, which is the highest of any country in the world (the second highest being a 45% passenger increase from Peru). This indicates a growing population of Chinese visitors in U.S. airports, which raises the question of cross-cultural wayfinding.

In addition, once in the United States, 50% of Chinese visitors report using the domestic aviation system, compared to only 25% of visitors from the Asian region as a whole (OTTI, 2008). In addition, 57.2% of Chinese visitors went to the state of California. This indicates a strong presence of Chinese passengers in domestic and international airports as a fraction of international visitors, especially in California airports. This is especially significant because Los Angeles International Airport, San Francisco International Airport, and San Diego International Airport are ranked 3, 13, and 27, respectively, on the list of busiest airports in the United States according to enplanements (FAA, 2008). It is perhaps this increasing presence of Chinese passengers that in 2007 the United States and China signed an agreement that will allow group travel to the U.S. from China much easier. The agreement cites China as being the seventeenth largest international market for visitors to the U.S. in 2006, which was a record for exchange between the two countries. It also cites an 81% increase in passengers between 2006 and 2011. This natural growth in

Chinese passengers, coupled with legislative encouragement from both governments, reinforces the need for airports to allow for multicultural wayfinding, especially with respect to Chinese culture given the sustained and predicted growth in the future.

2.2. Cultural Aspects

Garcia-Castro (2007) conducted an experiment that presented different arrangements of airport signs using Spanish translations to Spanish speaking passengers. After observing different combinations of signs, participants took a survey to determine how they felt about their content, arrangement, accuracy and usefulness. Comparing the results of the surveys, Garcia-Castro concluded three things:

1. There was a clear necessity of Spanish translations on signs in U.S. airports.
2. Certain Spanish phrases are preferred over others in situations where multiple terms are correct.
3. Spanish speaking people found that certain arrangements of graphics and translated text on airport signs were more conducive to wayfinding than others.

With a sample size was 38 and her research limited to Spanish speaking passengers, Garcia-Castro's generalized idea behind the study was that airports do need to acknowledge multicultural passengers who have different wants and needs for the purpose of successful terminal wayfinding.

Another interesting study was conducted with Chinese and American university students to determine which part of warning signs induced the highest perceived hazard. Conducted by Lesch, Rau, Zhao, and Liu (2009), it evaluated students' responses in both countries based on three factors: sign color, text used,

and symbol displayed. The researchers showed students different combinations of colors, words and symbols to convey the hazard, and students rated how high their perceived threat was. There were many results from the study, but one relevant result to understanding how Chinese people might perceive signage differently was that varying the symbols on signs that had the same color and word produced much greater fluctuations in perceived hazard for the Chinese students than the American students. "Therefore, in general, the language of the signal words did not have a large impact on perceived hazard-level." (Lesch, et al., 2009, p. 959). This result may be extremely relevant to airport signage because in this study the Chinese participants had a much deeper impact from the symbols used as opposed to the other factors (color and text) and could have strong implications as to how wayfinding can be improved in airports for Chinese passengers.

One of the biggest differences between Chinese and Western culture is the evolution of the writing system: ideographic versus phonetic. According to Dong Gu (2000), "The difference of the written sign has, since medieval times, been viewed as a conceptual divide that separates the Chinese and Western Languages" (p. 101). This has a major implication for airport signage, because both symbols and text are the primary components of signs at airports worldwide. Dong Gu describes how Chinese characters evolved from the idea of writing what something represents, whereas phonetic writing is based on assigning strings of familiar sounds to represent words. For example, the word "bird" in the phonetic writing system has nothing to do with the *idea* of a bird. It recycles four of the twenty-six letters of the English phonetic alphabet so that it can be understood and pronounced using sounds with which English speakers are familiar. In Chinese, however, a bird is represented by a symbol that is supposed to look like a bird. And it is not the only case – Dong Gu cites many examples where the Chinese characters look like what they represent. While his article does not explicitly mention airports or airport signage, it does allow one to understand one symbol in particular, the directional arrow. It is virtually understood by every culture in the world, and Dong Gu's article sheds some light on this fact – it is an indication of what it represents. The left arrow

is not just a meaningless symbol that means left, it actually *points* to the left. For this reason it is not difficult for Chinese to understand, and because it is such a common symbol in the phonetic alphabet as well, it is almost universally accepted.

Differences in cognition appear to be correlated to cultural differences. Chen, Oyserman, Reber and Sorensen (2009) explore the theory of individualism versus collectivism in Chinese and Western cultures. They make three claims about the nature of cognition and how it can be affected. First, they argue that cognition is a product of context, and it subsequently can be shaped and molded based on environment. Furthermore, the conscious awareness of the person is not relevant in how their cognition is shaped; one does not need to be aware of a psychologically meaningful situation in order for it to affect their cognition. Lastly, they describe how self-image has no bearing on cognitive development in a given context. This means that regardless of how a situation impacts one's self-image, there are distinct and separate effects to their cognitive ability.

These claims have a distinct impact on how a difference in culture has a bearing on cognition, and furthermore how cognition manifests itself in terms of language and behavior. They use this basis to show how two different cultures, Chinese and American, are collectivist and individualist cultures, respectively, but how situations can influence these mindsets to change cognition. They conducted eight experiments, each with cultures or sets of cultures, and found that although certain cultures are generally more individualistic or collectivistic, these cultural concepts are malleable, and can change based on context. For example, in one study Chinese students living in Canada were asked to describe their self-image in English and Chinese. The researchers found that when the students used Chinese to describe themselves, their answers were distinctly different from other students, but when they spoke English their answers related better to others. The conclusion that the researchers drew was that the change in cognition (the switching of language) influenced a cultural change in that situation. These results could have useful implications in the airport planning and the development of airport signage, specifically the use of different languages on signs and how it might actually be a

barrier on the group level, as it promotes cognitive difference in the situation of airport wayfinding.

The concept of human cognition in airport signs is especially important given that Boland, Chua, and Nisbett (2005) found distinct differences in the way people from Western and Chinese cultures perceived situations, and how their focus was dissimilar. Their study was both qualitative and quantitative in determining this result. In some situations, they asked Chinese and Americans to describe an image and found that Americans tended to focus on the primary objects of the picture, and Chinese more thoroughly described the background scene, a more holistic approach to taking in a picture. Even more specifically, the quantitative side of the experiment measured the eye movements of the participants: "If differences in culture influence how participants actually view and encode the scenes, there will be differences in the pattern of saccades and fixations in the eye movements of the members of the two cultures" (Chua, et al, 2005, p. 12630). To distinguish the effect of culture on the observations of scenes, the researchers showed participants images a first time, and then changed their backgrounds and presented the pictures to participants a second time. Measurements were then taken based on how much time the participant spent looking at the new background as opposed to the old foreground. Results indicated that "East Asians are less likely to correctly recognize old foregrounded objects when presented in new backgrounds…Thus, we have additional evidence for relatively holistic perception by East Asians: They appear to 'bind' object with background in perception" (Chua, et al, 2005, p. 12632). This study can have additional implications on the layout and presentation of airport signs, especially since it shows how backgrounds are not just arbitrary to certain cultures, and can influence cognition in terms of understanding foregrounds. This may be an important concept to the development of airport terminal signs.

2.3. Elements of Airport Signage

One symbol that exists on every airport sign and is imperative to successful airport wayfinding is the directional arrow. Fuller (2002) describes the prevalence of the directional arrow, and how it is on the forefront of aviation symbol standardization. On the subject of the arrow, Fuller states, "…arrows engage in a process of turning informational spaces into passages; the arrow transforms information into an order…its action is internal to its form" (p. 239). Figure 2.1 below shows two examples of airport signs utilizing directional arrows.

Figure 2.1. Signs displaying directional arrows: an exit sign in China and a sign at Dulles Airport in Washington D.C., respectively.

Also describing the future of airport sign standardization, Fuller discusses how signs create decisions, and strategic placement of signage in airports contributes to a healthy flow of passengers through terminals. For example, in the Sydney Airport in Sydney, Australia, passengers arriving at the airport from the street are confronted with only two options: departures or arrivals. After deciding to go to departures, *then* they are confronted with decisions about restrooms and restaurants. The clever breaking up of decisions, according to Fuller, can help alleviate traffic flow problems in terminals. The arrow facilitates this process, which is such a unique symbol in part because it indicates only a direction. "An arrow is a sign that has no referent; it assembles movement, it doesn't identify things" (Fuller, 2002, p. 233). For this reason, it is equally important to couple arrows with symbols

that are widely understood, which is a strong supporting point for the necessity of airport symbol standardization. One thing Fuller points out is that there are many organizations that have taken it upon themselves to try to become the authority on standardized symbols. For example, the Port Authority of New York and New Jersey (PANYNJ) created their own sign standard for their airports. The British Airports Authority (BAA), which is a private company that owns several airports in the United Kingdom, came up with its own standard for use in its airports. While this is not ideal, it is a beginning to creating a universal symbol standard for airport signage.

One organization that has tried to standardize symbols in major transportation hubs and events, such as the Olympics, is The Professional Association for Design. This nonprofit organization "stimulates thinking about design, demonstrates the value of design and empowers the success of designers." (The Professional Associate for Design, 2009). In the early 1970s this group began a joint program with the U.S. Department of Transportation to try to develop a standardized symbol set for U.S. airports. They hired a team of designers who did research on how to maximize understanding for different ages, cultures, and varying sign distances and in 1974 published a set of 34 symbols that they felt achieved this purpose. In 1979, they published an additional 16 more, bringing the total to 50. They claim to be usable worldwide, and are available without a copyright for anyone to use. However, it is very unclear as to how far their reach extends, and airports today still employ their own signage. Figure 2.2 contrasts a standard symbol as defined by the Professional Association for Design and two local variations.

As another example, the Phoenix Sky Harbor International Airport hired a consulting firm, Wilbur Smith Associates, to do an assessment of signage at the airport and create a unified set of guidelines for how the signage in the airport ought to appear. This internal manual, *Sign Standards & Guidelines* (2006) serves as the basis for how all signage in the airport should appear, and covers everything from road signs leading to the airport, to overhead directional signs for passengers, to parking garage signs.

Figure 2.2 Three different men. The image on the far left is the Professional Association for Design standard to indicate the men's restroom. The center image is Honolulu Airport's image to express the same idea, and the right image is London Heathrow Airport's man of choice.

In the *General Philosophy* section of this manual, it outlines five important elements of effective communication. These are consistency/uniformity, simplicity, continuity, repetition, and rehearsal. It defines each of these terms in depth, and based on the five principles, created signage that they felt fulfilled these requirements. Unfortunately, this manual offers no evidence as to how the five principles were determined to be important, and there is no data that shows whether the signs were effective in achieving those goals. As to whether or not there was any multicultural consideration in developing this type of signage, there is nothing presented in the manual that indicates this.

Although perhaps not with a multicultural intent, many airports have been moving toward a more standardized system of signs. Trottman (2007) describes how sign standardization in the United States is on the rise, and in support of Garcia-Castro's research with Spanish speaking travelers, describes how airports are running into multicultural barriers. For example, Delta Air Lines added flights to Spanish speaking Latin and South American countries and had a hard time deciding to put the Spanish word for "door" or "exit" on the gates in Atlanta. The language barrier is a significant issue, and is a big impediment to using text on signs that are

supposed to be universally understood, and is perhaps a large reason why the above sources claim that airports are shifting to standardized signs using symbols. This could be a contributing factor as to why "…wayfinding specialists are considering the next wave of sign technology: talking signs and video signs" (Trottman, 2007, pg B1).

CHAPTER 3. METHODOLOGY

This section outlines the type of research that was performed, how the study was conducted, and how sample groups were determined.

3.1. Research Type and Framework

This is a quantitative research study with a qualitative addition that tested how quickly participants could navigate through a simulated airport terminal based on the presentation of the airport signage. Participants used this information to guide themselves as if they have landed at a large American international airport from their arrival gate to the customs and immigration processing area. Upon completion of the experiment, they provided qualitative input as to why they feel they performed the way they did, providing insight as to what their individual perceptions concerning the signage were, regardless of their actual performance.

3.2. Samples

There are two distinct samples in this study. The "American" group is comprised of people who:

1. Are U.S. Citizens or U.S. Permanent residents.
2. Speak English as their primary language and have learned English from birth.
3. Have not studied any ideographic or Asian languages.
4. Were born in the United States.

This population will be considered Group 1, representing “American culture.” The second population, representing "Chinese culture," is comprised of people who meet the following qualifications:

1. Are citizens or permanent residents of the People’s Republic of China or Taiwan.
2. Speak Mandarin Chinese or another Chinese dialect as their primary language.
3. Were born in the People's Republic of China or Taiwan.

Each group is a sample population representing the two cultures. In this study there are 20 participants in each sample population, representing different ages, genders, and geographical areas within the limits of the aforementioned definitions of the cultural groups.

3.3. Data Collection

The following sections will discuss the advantages of computer simulation, which was used for this study, and a post simulation survey to qualitatively compare participants' perceptions of their performance to what was actually measured.

3.3.1. Computer Simulation

All participants first confirmed that they were eligible for the study based on the specified qualifications. They then used a computer simulation that presented nine rounds of sign paths each using one of three styles of signs:

1. A set of signs composed of symbols from the Professional Association for Design and directional arrows. (Figure 3.1).
2. A set of signs composed of English text and directional arrows. (Figure 3.2).

3. A set of signs composed of both symbols and English text with directional arrows. (Figure 3.3)

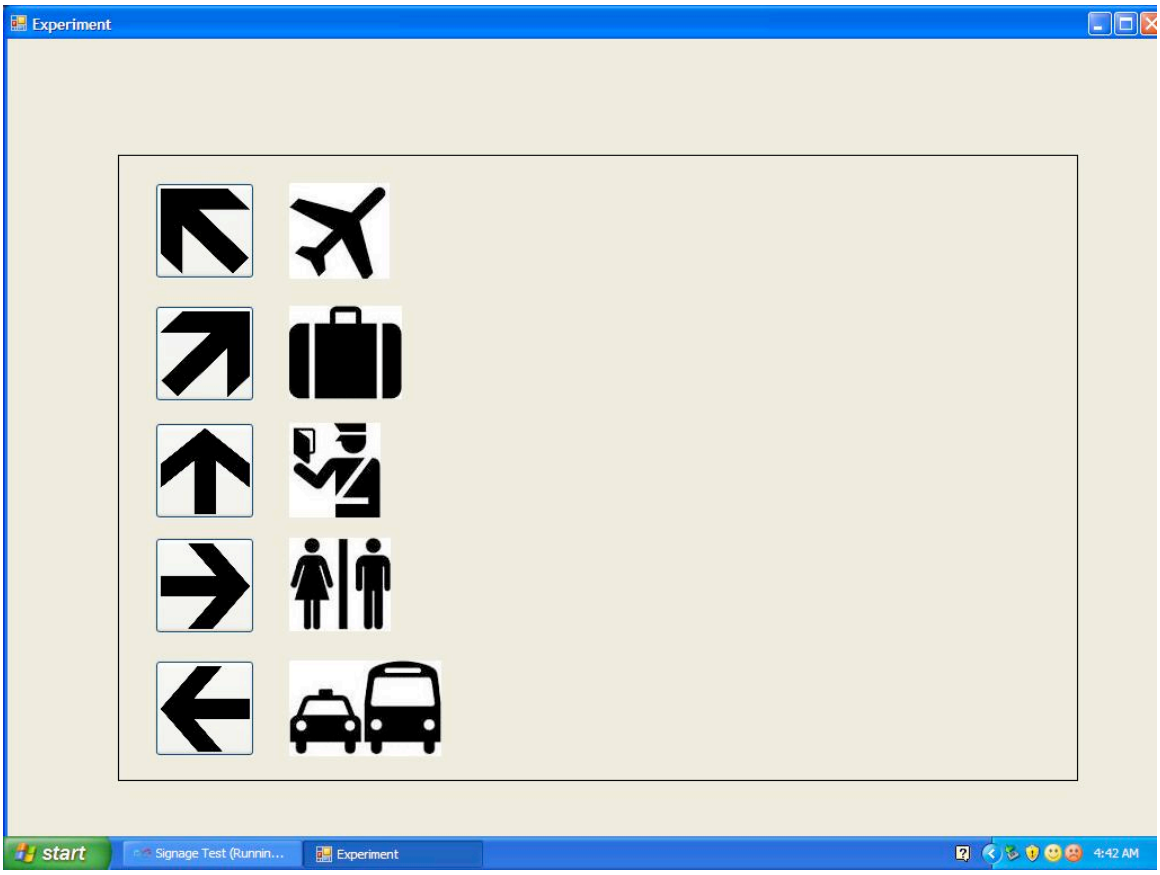

Figure 3.1 Screen shot from the computer simulation using the symbols-only set of signs for a particular round.

Participants were instructed that they had just arrived in the United States from an international flight and had to navigate to one of the five locations presented in all of the signs. Instructions were printed in both Chinese and English. Appendix A contains the full set of instructions that was given to each participant.

Every round had ten signs, and participants advanced to the next sign by clicking on the arrow corresponding to the correct location, which changed every round. Participants were timed from the start of the experiment until they

Figure 3.2 Screen shot from the computer simulation using the text-only set of signs for a particular round.

successfully advanced through all ten of the signs of the given round. If they chose to, participants were allowed to pause for a few seconds between rounds.

There were many advantages to using this particular type of measurement instrument to collect data. Primarily, controlling confounding variables was crucial; given that the variation in the time it took a participant to complete each round in some cases may have only been seconds. To ensure that these slight variations were the result of cognitive differences and to reduce the threat of outside factors playing a role in speed at which a participant navigated, all aspects of the experiment environment and simulation were strictly regulated. All 40 participants used the same computer, mouse, and mouse pad for the experiment. In addition, while the paths may have seemed random to each participant, they were

Figure 3.3 Screen shot from the computer simulation using the text-symbol set of signs for a particular round.

all predetermined, so every participant took the exact same test. To prevent faster navigation as a result of repetition, the simulation utilized a different sign type and goal for each round.

To prevent issues of language barrier playing a role, all instructions were printed in both Chinese and English. Rather than display each goal on the screen in English which might have favored the American group, the goals were printed on paper in both Chinese and English and all participants used the same sheet as reference for the goal each round. Appendix B is a copy of the goal list sheet.

Furthermore, every aspect of the simulation was the result of an attempt to control confounding variables. Arial type font was chosen for its popularity and clarity, all of the arrows were always displayed only on the left side of the sign to

minimize mouse movements, and all of the symbols including the directional arrows were taken from the Professional Association for Design, whose symbols are used worldwide. Pop-up windows were also employed to make the round changes obvious. This also allowed the participants to take a break if they desired.

The time each participant took to navigate each round was recorded and collected. To do this, the simulation created a new file for each participant and recorded the start time and stop time for each round, to the nearest second. If the participant clicked an arrow that indicated a destination other than the one specified for that round, the computer would produce an error message and require them to try again. During this time there was no interruption to the computer measuring the time the participant took to complete that round. In addition, the computer would make a note in the participant's file stating the round, sign, and which incorrect choice was made. A copy of a sample output from the computer program can be seen in Appendix D.

3.3.2 Post-Simulation Survey

Upon completing the ninth round, the participant was prompted to complete a short survey about what they experienced. The simulation then asked the participant five questions:

1. Which of the three sets of signs did they find to help them navigate the quickest?
2. (An optional opportunity to explain their choice by typing English text).
3. How many times per year do they travel between a foreign country and the United States (This question was multiple choice with options of 0-1, 2-3, or 4+)?
4. Which symbols did the participant find confusing? (The program displayed all of the symbols chosen for the experiment and allowed the participant to check any number of them, including zero).

5. (An opportunity to explain their choice[s] by typing English text).

All of this data was immediately transferred to that participant's file after each question. If they chose to type English text to explain their choices, their answers were recorded exactly as entered. The questions were displayed on the screen in English only but an accompanying document had both English and Chinese and could be used for reference. The list of the survey questions that was given to participants in paper form can be seen in Appendix C.

CHAPTER 4. DATA AND FINDINGS

This chapter describes the data, both quantitative and qualitative, that was acquired from participants of the Chinese and American groups, of which there were 20 in each sample.

4.1. Quantitative Analysis

The following is a quantitative analysis of how the Chinese and American groups performed from both within their own sample populations and when compared to each other's performance.

4.1.1 Results Within the Chinese Group

Table 4.1 shows the raw data for each of the Chinese participants. Times are expressed in minutes and seconds, and numbers in parenthesis indicate the number of errors the participant made during that round. (Times not followed by numbers in parenthesis indicate that the participant made no errors during that round). The first column, labeled "participant," is simply a number to differentiate data entries. A graphical representation of this data is shown in Figure 4.1. The enclosed box part of the graph shows the interquartile range (the lower end of the box representing the 25th percentile and the upper end of the box representing the 75th). Values beyond this range are considered outliers. The lines extending vertically show the upper and lower quarter of values, while the line through the center of the box shows the median.

Table 4.1 *Raw data taken from each Chinese participant from each round.*

Participant	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9	Total Errors
10	1:00	0:22	0:14	0:26	0:18	0:12	0:21	0:14	0:11	0
16	1:44	0:18	0:16	0:20	0:19	0:13	0:13	0:23	0:09	0
18	0:50 (1)	0:17	0:16	0:17	0:26	0:14	0:14	0:13	0:10	1
20	2:22	0:16	0:26	0:17	0:27	0:16	0:18	0:19	0:14	0
22	2:28	0:26	0:22	0:20	0:17	0:16	0:18	0:18	0:11	0
24	1:21	0:13	0:14	0:16	0:12	0:15	0:15	0:11	0:12	0
26	4:08	0:52	0:17	0:16	0:18	0:18	0:17	0:15	0:10	0
28	0:43	0:16	0:24	0:17	0:22	0:16	0:15	0:13	0:12	0
32	0:33	0:15	0:16	0:16	0:15	0:13	0:55 (5)	0:13	0:11	5
34	1:30 (2)	0:18	0:15	0:18	0:17	0:20	0:17	0:16	0:13	2
36	1:42 (1)	0:12 (1)	0:26	0:24	0:25	0:16	0:21	0:21 (2)	0:21 (3)	7
38	1:09	0:38	0:29 (1)	0:21	0:24	0:28	0:24	0:21	0:12	1
51	1:15	0:29	0:29	0:33	0:34	1:08 (1)	0:37	0:31	0:44	1
66	2:08	0:19	0:14	0:14	0:17	0:10	0:16	0:12	0:09	0
68	3:21	0:13	0:12	0:15	0:17	0:13	0:14	0:14	0:20	0
90	1:10	0:22	0:21	0:17	0:18	0:16	0:17	0:15	0:13	0
92	1:27 (1)	0:16	0:17 (1)	0:19	0:20 (1)	0:12	0:18	0:15	0:10	3
94	1:06	0:15	0:11	0:16	0:16	0:14	0:14	0:12	0:09	0
96	2:06	0:13	0:14	0:19	0:14	0:11	0:15	0:12	0:10	0
98	1:13 (1)	0:11	0:13	0:17	0:16	0:14	0:18	0:12	0:11	1

Based on this data, the aggregate totals for each round were determined. Table 4.2 shows the aggregate totals of the Chinese participants for each round.

Table 4.2 *Aggregate Totals of the Chinese participants by round.*

Round	Sign Type	Group Time (seconds)
1	Text	1996
2	Combination	401
3	Symbols	366
4	Text	378
5	Combination	392
6	Symbols	355
7	Text	397
8	Combination	320
9	Symbols	272

Next, since each participant was exposed to the same type of path three times (in terms of sign type) it was possible to isolate the round that had the fastest aggregate wayfinding time for each sign type. It is important to note that these were the rounds that had the shortest total wayfinding time for the group as a whole; the fastest rounds for each individual may have varied. For the Chinese participants, the aggregate wayfinding time was the shortest in round four for the text-only signs, round eight for the combination text-symbols signs, and round nine for the symbols-only signs, with aggregate totals of 378 seconds, 320 seconds, and 272 seconds, respectively.

Figure 4.2 shows a visual representation of only those three data sets. Notice that the magnitude of the variations is decreased when compared with Figure 4.1 because it is a compilation of only the best performance rounds.

For the signs with symbols, the mean wayfinding time was 13.6 seconds, with a standard deviation of 7.85. For the signs with the combination of text and symbols, the mean wayfinding time was 16 seconds with a standard deviation of 4.94, and for the signs with just text the mean wayfinding time was 18.9 with a standard deviation of 4.44. These were the results of the aggregate best performance rounds with N=20 for each data set.

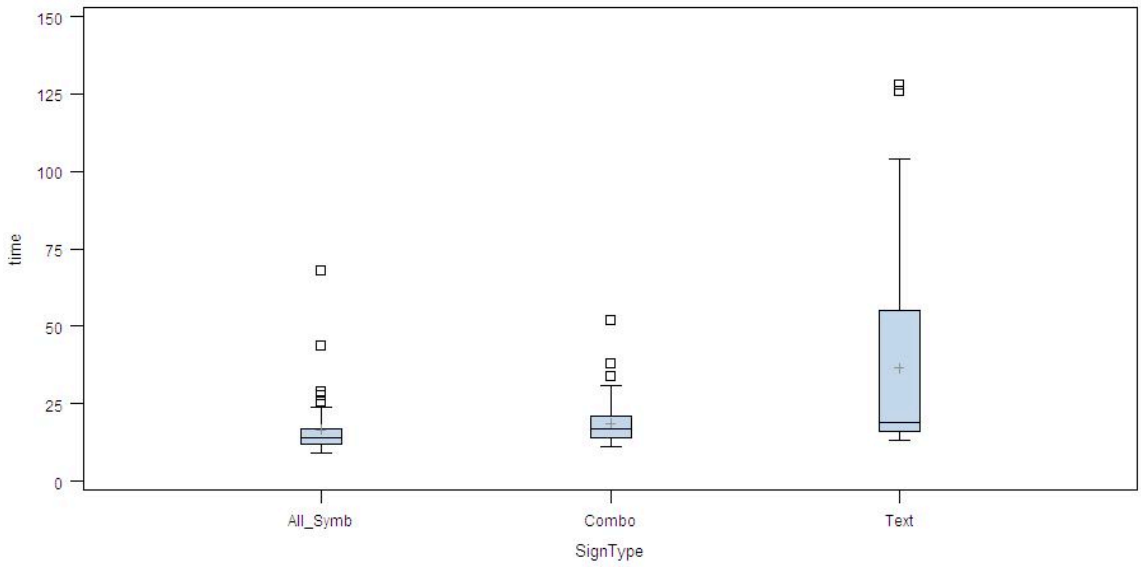

Figure 4.1 Aggregate data for all nine rounds for the Chinese group divided by sign type.

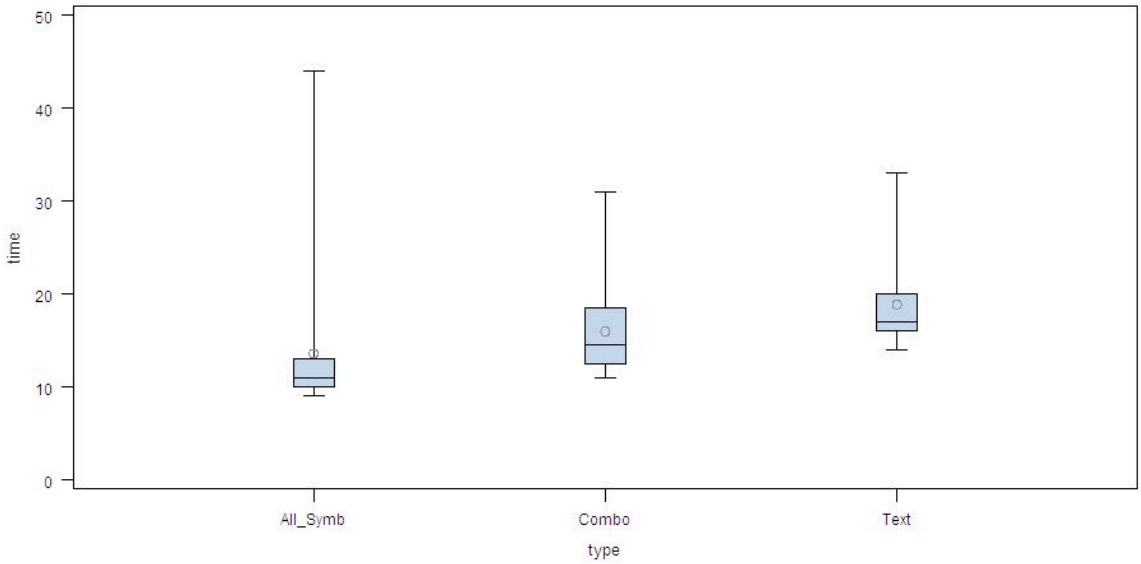

Figure 4.2 Aggregate data for the Chinese group for the best performance rounds of each sign type.

After identifying rounds four, eight, and nine as the rounds with the highest performance on the aggregate level, the next step was performing a statistical

analysis of variance (ANOVA) to determine the likelihood that the variation of the data was not due to just random chance. ANOVA was acceptable for this set of data because the largest standard deviation of the three sets, 7.85, was smaller than twice the smallest standard deviation of the sets, 4.44. This, in turn, is based on the assumption of normality of the data sets, which is reasonably assumed for N>15 (N=20 in all three cases).

First, it was necessary to hypothesize that the true means (as opposed to this data which shows sample means) of the each of the wayfinding times are the same for all for all the sign types. This null hypothesis, H_0, was used by the ANOVA to determine the likelihood that this particular set of data supported it.

The ANOVA produced a critical value (F) of 4.00, which, for two degrees of freedom, corresponded to a p-value of 0.0237. Furthermore, it produced a coefficient of determination (R^2) of 0.1230, which means that 12.30% of the variation of wayfinding times was directly due to the change in sign type.

Looking at the errors the participants made, shown in the last column of Table 4.1, there were a total of 21 errors made. This indicates a point during the specified round where a participant clicked on a destination other than the assigned goal. Of the 21 errors, 52.38% of them (11) were made during the text-only sign rounds. Additionally, 19.04% of the errors (four) were made during the combination sign rounds, and 28.57% (six) were made during the symbols-only sign rounds.

4.1.2. Results Within the American Group

Table 4.3 shows the raw data taken from the American group. The data for Table 4.3 is formatted in the same way that Table 4.1 is.

Table 4.3 *Raw data taken from each American participant from each round.*

Participant	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6	Round 7	Round 8	Round 9	Total Errors
3	0:54 (2)	0:16	0:16	0:15	0:19 (1)	0:11	0:14	0:16 (1)	0:09	4
5	0:47 (1)	0:15	0:13	0:17	0:13	0:15	0:12	0:14	0:12	1
7	1:27	0:12	0:20	0:14	0:17	0:14	0:13	0:14	0:20	0
9	1:09	0:16	0:15	0:15	0:14	0:14	0:14	0:14	0:12	0
11	1:03	0:21	0:13	0:18	0:20	0:13	0:18	0:15	0:09	0
13	0:25	0:11	0:20	0:16	0:32	0:13	0:12	0:14	0:14	0
15	1:48	0:18	0:18	0:23	0:12	0:18	0:17	0:13	0:13	0
21	0:30	0:18	0:17	0:18	0:16	0:14	0:15	0:12	0:11	0
23	0:40	0:12	0:12	0:12	0:13	0:10	0:11	0:12	0:12	0
25	0:45	0:17	0:13	0:16	0:13	0:12	0:14	0:12	0:09	0
27	0:53	0:14	0:22	0:14	0:21	0:12	0:12	0:12	0:09	0
29	2:08	0:16	0:17	0:17	0:16	0:14	0:12	0:15	0:13	0
33	0:45	0:23	0:18	0:26	0:13	0:11	0:12	0:11	0:09	0
69	0:37	0:17	0:16	0:15	0:15	0:16	0:14	0:11	0:11	0
77	2:17 (1)	0:12	0:21 (2)	0:14	0:14	0:12	0:12	0:15	0:11 (1)	4
79	0:59	0:19	0:23	0:15	0:15	0:18	0:14	0:19	0:14	0
81	0:51	0:10	0:12	0:13	0:11	0:17	0:12	0:11	0:12	0
85	1:37	0:17	0:16	0:16	0:15	0:16	0:13	0:13	0:11	0
86	0:43	0:14	0:13	0:15	0:12	0:12	0:13	0:17	0:11	0
99	0:26 (2)	0:13	0:12	0:12	0:11	0:19 (1)	0:11	0:11	0:11 (1)	4

Again, the data in Table 4.3 above produced the aggregate wayfinding times for each round. This data is presented below in Table 4.4

Table 4.4 *Aggregate totals of American participants by round.*

Round	Sign Type	Group Time (seconds)
1	Text	1244
2	Combination	311
3	Symbols	327
4	Text	321
5	Combination	312
6	Symbols	281
7	Text	265
8	Combination	271
9	Symbols	233

Continuing, the same process as was done with the data from the Chinese participants; the rounds in which the American group performed the best were identified. Rounds seven at 265 seconds, eight at 271 seconds, and nine at 233 seconds, were the rounds in which the American group navigated the fastest for signs with text only, signs with the text-symbols combination, and signs with symbols only, respectively. Again, these are the rounds where the group performed best as a whole, and were not necessarily each individual participant's best round for that sign type. A visual display of the spread of wayfinding times for all rounds is shown in Figure 4.3, and a visual display of the spread of wayfinding times for the best performance rounds is in Figure 4.4. Again, the variation is much narrower in the data in Figure 4.4 because only the best performance rounds are shown there. This set of data shows that for the best performance rounds, the American group had a mean wayfinding time of 11.65 seconds with a standard deviation of 2.54 for the symbols-only sign type, a mean wayfinding time of 13.55 seconds with a standard deviation of 2.19 for the combination text-symbols sign set, and a mean wayfinding time of 13.25 seconds with a standard deviation of 1.83 for the symbols-only sign type. These sets of data are assumed normal because N>15 in all cases (N=20).

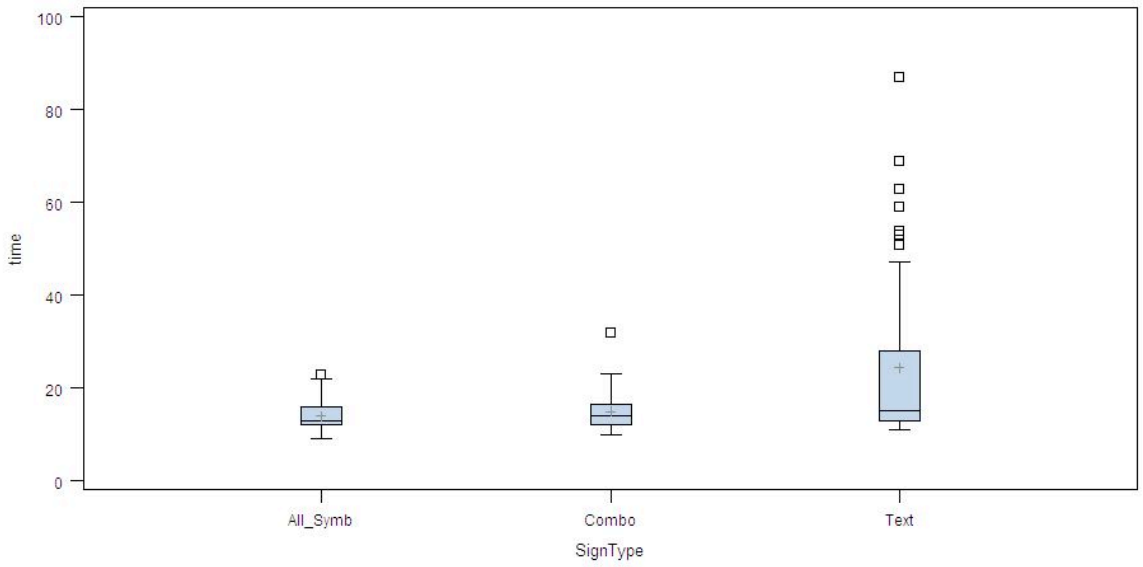

Figure 4.3 Aggregate data for all nine rounds for the American group divided by sign type.

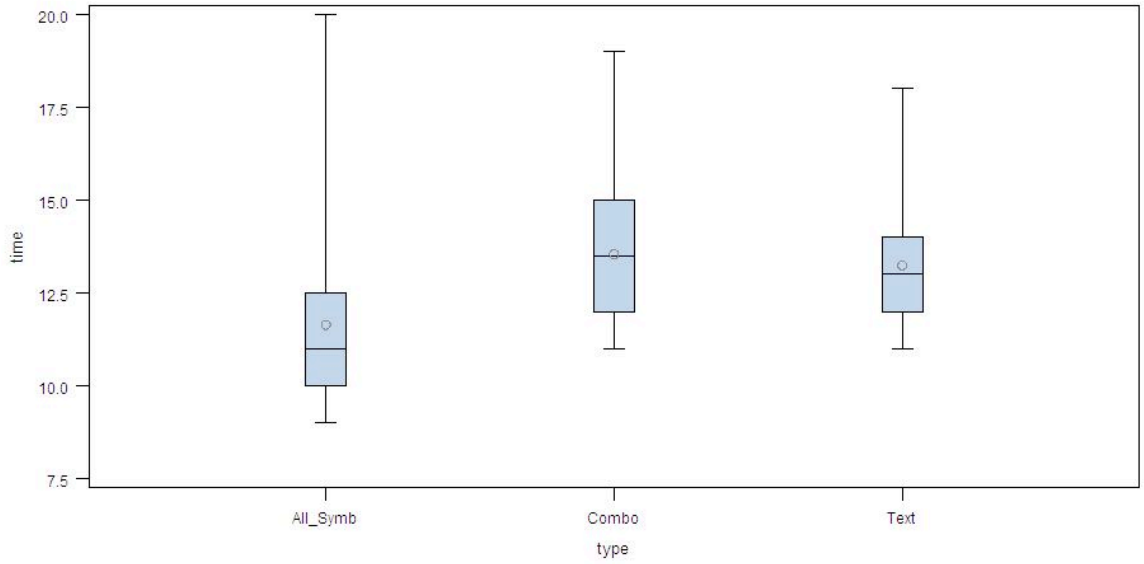

Figure 4.4 Aggregate data for the American group for the best performance rounds of each sign type.

H_0 for the ANOVA of the American data was again the presumption that all of the true means are equal. The ANOVA was used to determine the likelihood that the sample means were a result of random chance as opposed to a rejection of H_0.

The ANOVA produced a critical value (F) of 4.29, which, for two degrees of freedom, corresponded to a p-value of 0.0184. The coefficient of determination (R^2) from the ANOVA of the American data was 0.1308; meaning 13.08% of the variation of wayfinding times was directly due to the change in sign type.

Considering errors, the American group made a total of 13 mistakes in various rounds. Specifically, there were six errors (46.15%) made during text-only rounds, although all of them were made in just the first round. Five errors, (38.46%) were made in symbols-only rounds, and two errors (15.38%) were made during the text-symbols combination rounds.

4.1.3. Cross-Cultural Comparison

On the aggregate level, the American group navigated faster than the Chinese group in every single round, and therefore for every signage type as a whole. But to determine whether the differences in wayfinding times were statistically significant, a two-sample t significance test was used to compare the data. Below, Figures 4.5, 4.6, and 4.7 show a graphical comparison of the two groups' wayfinding times broken down by each sign type.

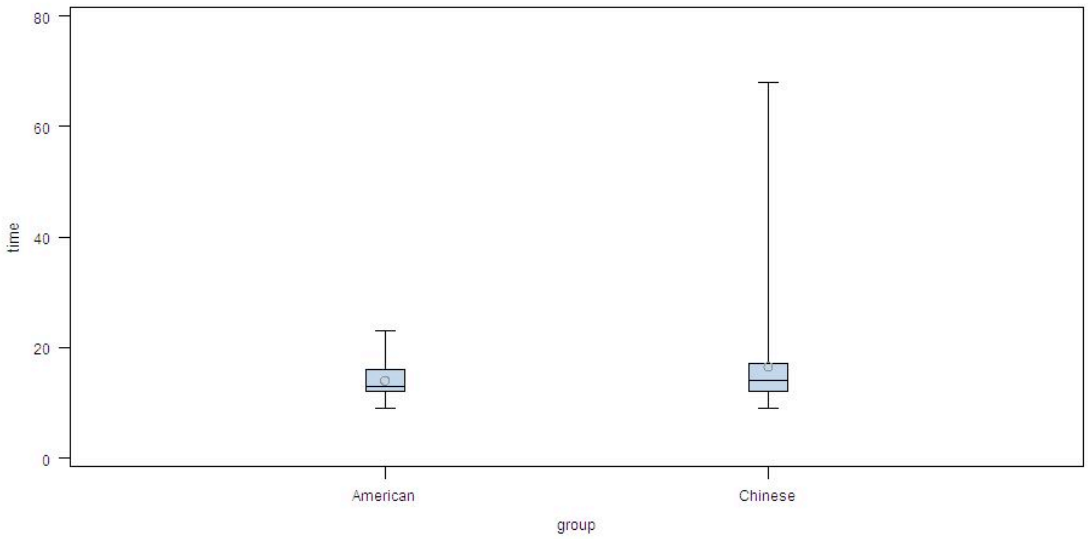

Figure 4.5 Aggregate wayfinding times of the Chinese and American groups for the symbols-only sign type.

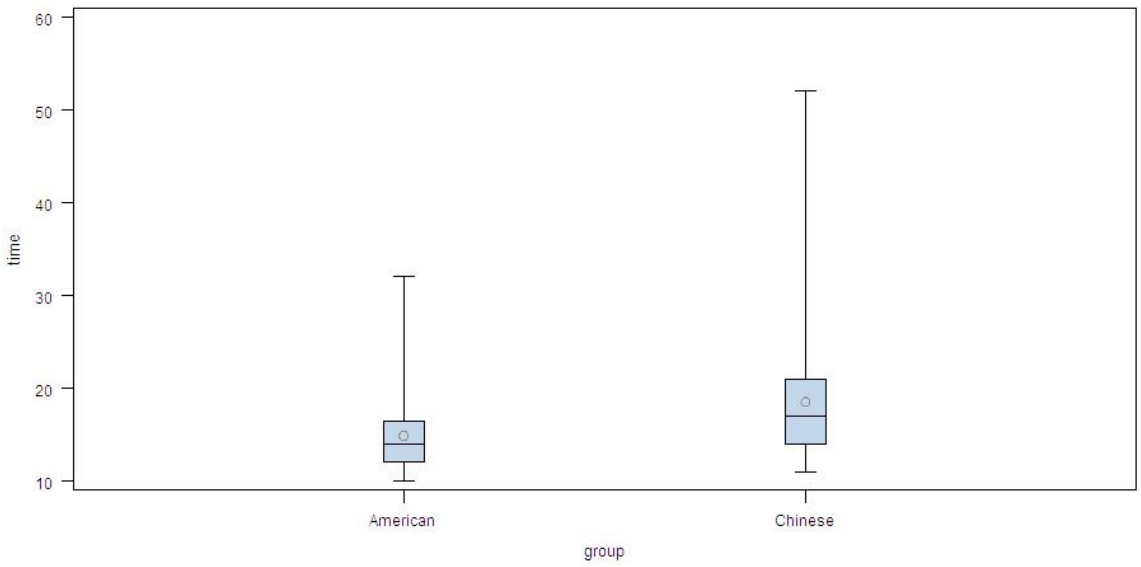

Figure 4.6 Aggregate wayfinding times of the Chinese and American groups for the combination text-symbols sign type.

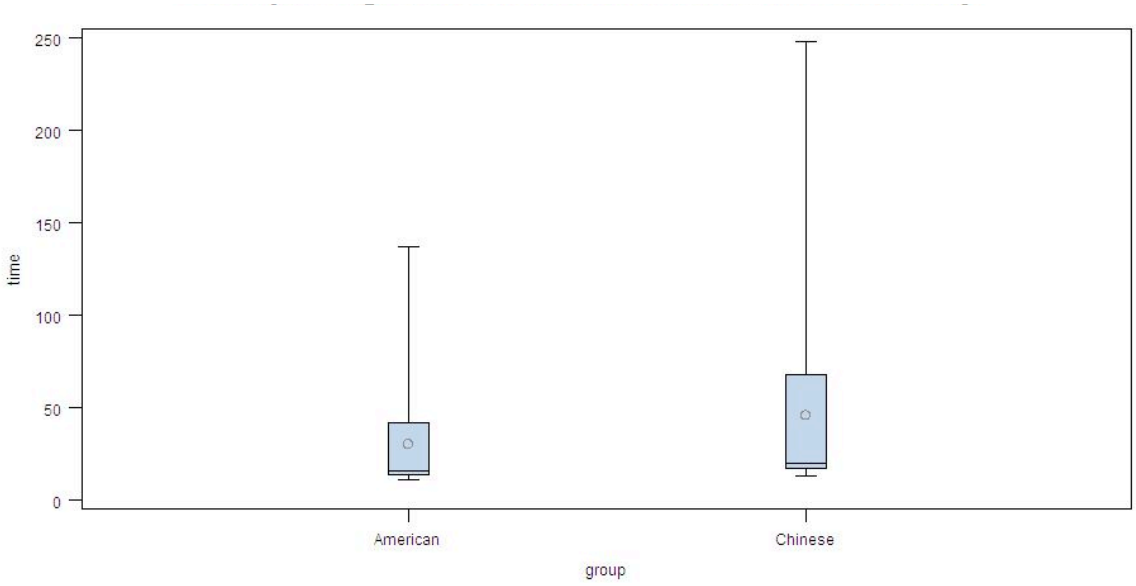

Figure 4.7 Aggregate wayfinding times of the Chinese and American groups for the text-only sign type.

The results of the first two-sample t significance test showed that in the case of the text-only sign type, the average means for the American and Chinese groups were 30.5 seconds and 46.18 seconds, respectively. The p value for this data set was .0366.

The analysis of the data from the wayfinding times of the combination text-symbols sign set yielded means of 14.9 seconds and 18.55 seconds for the American and Chinese groups, respectively. The p value in this case was .0008.

The last data set, the symbols-only sign set had means of 14.01 and 16.55 for the American and Chinese groups, respectively. Considering the closeness of the means and spread of the individual results, the associated p value for this set was .0496.

With respect to errors, the American group made fewer mistakes than the Chinese group. In fact, the 13 errors made by the American group compared to the 21 errors made by the Chinese group mean that the Chinese group made 61.56% more errors than the American group.

A summary of the errors is shown below, in Table 4.5. This shows the total number of errors made by each group divided by round. As a note, in some cases one participant may have committed all of the errors where in others each error might have been from a different participant.

Table 4.5 *Errors from each cultural group divided by round and sign type.*

Round	Type	American Group Errors	Chinese Group Errors
1	Text	6	6
2	Combo	0	1
3	Symbols	2	2
4	Text	0	0
5	Combo	1	1
6	Symbols	1	1
7	Text	0	5
8	Combo	1	2
9	Symbols	2	3

After combining the total number from each group, it was possible to compare the aggregate number of errors of the American group to that of the Chinese group, both visually and statistically. Figure 4.8, shown below, is a graphical comparison of the total number of errors made by each group and their spread of values.

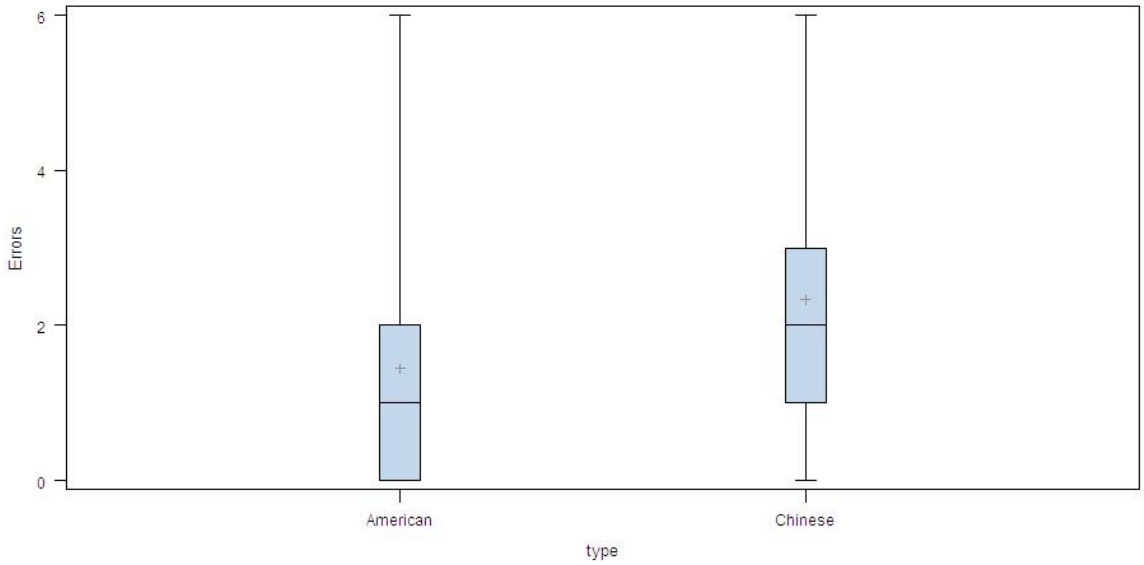

Figure 4.8 Aggregate error comparison between the American and Chinese groups.

Although there were only nine observations for each group, the standard deviations for the American and Chinese groups were 1.88 and 2.0, respectively. This, combined with the fact that the data is approximately normal despite N<15, makes an ANOVA permissible.

The results of this test were a test statistic of .94 corresponding to a p-value of .3456. The R^2 for this data set was .05575, suggesting 5.58% of the variation in making errors was due to the cultural variation.

4.2. Qualitative Analysis

A qualitative post-experiment survey provided the participants' opinions regarding which signs they found easiest to navigate as well as if they found symbols confusing, with an opportunity to explain why. They also reported the frequency of their international travel (to and from the United States).

Thirteen of the 20 Chinese participants felt that the text-symbols combination signs were the easiest to use to navigate. Within this group, many of the explanation responses indicated that they preferred the multiple information media so that one can help clarify the other if it was not clear on its own. One participant who chose the combination signs wrote, "Because the signs with pictures is easier for people to recognize and text can let me make sure I am not misunderstanding what the signs mean." Most of the other participants that chose this option did so not because they had trouble understanding the text or symbols, but because they enjoyed the further clarification.

Of the five that preferred the symbols-only sign type, the general response was that they understood the signs, and therefore regarded the text as unnecessary information. In this group, there was only one response second question about which symbols they found confusing - this group appeared to have a solid understanding of what each symbol meant.

The two people that preferred the English text did so because they did not feel the symbols were intuitive and added confusion to the wayfinding process. Both agreed that the symbols were hard to associate with their idea of the goal, and one even commented that many people would not know the symbols especially if it was their first time traveling.

Regarding recognition of the symbols themselves, the two aforementioned participants seemed to be on the extreme end of recognizing and understanding the symbols. Generally, participants indicated that they found some symbols confusing and others not, and there were two obvious trends indicated by the data. First, the immigration symbol was the most confused, with eight of the 20 participants in agreement. Their feelings were that it did not really embody the concept of

immigration. Two participants actually felt that the symbol indicated police, or a police station. Many of the other participants simply could not discern its meaning without the aid of the text. One of them wrote, "if it is the first time to meet,you [*sic*] have no idea what they mean".

The other trend was a fair amount of confusion toward the "connecting flights" symbol. Participants that found this confusing, of which there were six, felt that there was a problem with the absence of another plane. Many of them wrote that there ought to be two planes to indicate a transfer, and some felt that that particular symbol would be better to indicate departures or arrivals.

The American group had very similar results as the Chinese group, but was stronger in that they had more convincing numbers to emphasize their choices and opinions.

An overwhelming majority, 14 of the 20 participants (70%), chose the combination text-symbols sign type as their preferred sign type. This group almost unanimously agreed that it was better to have more information on the sign so that they could look at either the text or the symbols, and if necessary have one help explain the other. One American participant wrote, "You can read the words or recognize the picture. There are two ways to recognize the right answer." Many other participants agreed and wrote very similar responses.

Five participants chose the text-only sign type, and generally agreed that they preferred not having the added distraction of trying to figure out the meaning of a symbol when the word was all that was necessary. One even felt that in order to understand the symbol they had to convert the symbol back into words anyway. Participants also indicated that they felt many of the symbols were confusing, and overall were more distracting rather than helpful in helping them wayfind.

In American group, only one participant indicated that their preferred method for wayfinding was the symbols-only sign type. One participant simply wrote, "Reading takes longer".

Regarding the symbols themselves, the American group was also very similar to the Chinese group in their opinions about which signs were confusing. More than

half (11/20) of the participants agreed that the symbol for "immigration" was confusing. They cited the same reasons as the Chinese group, explaining that the man in the symbol was ambiguous, the symbol could indicate a lot of things other than "immigration" and that nothing about that particular symbol made them think about immigration.

Additionally, the second most confusing symbol according to the American group was the symbol for "connecting flights," just like the Chinese group. Again, the reasoning is very similar. Participants commented that there was just one airplane in the image, or that it could mean a variety of different things. Five participants of the 20 felt this way.

Comparing the two groups as a whole, both the Chinese and American groups had very similar responses to the survey questions. And regarding frequency of travel, all participants except for a handful in the Chinese group indicated that they travel internationally to or from the United States once or less per year.

One response, or lack thereof, that stands out strongly was the complete absence of the "restrooms" symbol. Not one participant in either group found that symbol confusing. While every other symbol was considered confusing by at least one participant of the 40 total, it appeared that everyone understood the indication for the restrooms.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

This section describes the outcomes and results of the study. For the purposes of determining statistical significance, an alpha level of $\alpha = .05$ was used as the significance threshold. This is a commonly accepted number in the field of statistics to describe data as statistically significant (Craig, et al., 2009). The implication of this alpha level (.05) is that statistically significant data (p-values less than or equal to the alpha level) are 95% likely to reflect the variation of the true means of the data sets being compared, and only in 5% of tests or less will data potentially produce results that appear statistically significant but are not.

5.1 Conclusions

It is possible to draw a number of reasonable conclusions from this study. Considering first the data from within the groups, the Chinese group navigated each signage path with an analysis of variance p-value of .0237 - different enough wayfinding times to show statistical significance. This means that there was indeed a clear difference in wayfinding speeds for the Chinese group among the three different sign types, and the data from this sample likely reflects the greater population as a whole.

This set of results is somewhat similar to the preferences expressed in the post-experiment survey. The Chinese overwhelmingly preferred the combination text-symbols sign type, followed by the symbols-only sign type, and lastly the text-only sign type. While it is certainly no surprise that the text-only sign type was both

the slowest to navigate and the least preferred, it is interesting to note that while the Chinese performed best for the symbols-only sign type, they preferred the combination text-symbols sign type to navigate. This may indicate a higher value in wayfinding accuracy rather than time as a more important goal for passengers in airport terminals, as they also made more errors in the symbols-only sign type.

The results from within the American group are similar. The p-value for the ANOVA of the wayfinding times was .0184, far less than the commonly accepted .05 significance level. This means that the difference in wayfinding speeds reflected in this study are also very likely to mirror those of the American population as a whole.

The survey responses from the American group were a bit surprising. Like the Chinese, Americans preferred the combination text-symbols sign type overwhelmingly, but unlike the Chinese, the Americans performed (with statistical significance) the absolute worst for this sign type. The fact that Americans prefer the sign type that leads to their slowest wayfinding, combined with the preference of the Chinese participants, corroborates the idea that airport terminal passengers value the accuracy of their wayfinding over the time. This is likely because despite it being their worst performance in terms of time, it turned out to be their best performance in terms of accuracy. Only 2 errors were made on the aggregate level for the combination text-symbols sign type, as opposed to the 5 errors made on the aggregate level for the symbols-only sign type (for which they navigated the fastest).

Unfortunately, with a p-value of .3456, the difference in errors measured by each group was not statistically significant. Although this potential is more likely than not (65.5% more likely) there was not strong enough likelihood to reject H_0, which was that the true means of error rates between the two groups were equal to each other. It is therefore inconclusive as to, on the aggregate level, whether Americans wayfind with more accuracy than Chinese.

An analysis of how the groups compared to each other for each sign type showed that, in all three sign types presented in this study, the American group navigated faster than the Chinese group. For the text-only sign type, Americans navigated faster than Chinese with a p-value of .0366. For the combination text-

symbols sign type, Americans navigated faster, with a p-value of .0008. Lastly, for the symbols-only sign type, the American navigated faster with a p-value of .0496. All of these p-values are less than the $\alpha = .05$ level, and are therefore statistically significant. The most interesting of these values is perhaps the p-value for the combination text-symbols sign type comparison. This value, .0008 is so small that it is basically a guarantee that as a whole, for signs that have both English text and symbols, Americans wayfind faster than Chinese. Interestingly enough, this is even more significant than the p-value for the comparison of the English text-only wayfinding times. This implies that the addition of symbols to an airport terminal sign makes the Chinese group wayfind faster, and the American group navigate slower (both with statistical significance as described above), but at the same time solidifies the extreme likelihood that in that situation, the Americans will still navigate faster, in an American airport. However, because all three of the p-values for the cross-cultural comparisons are less than $\alpha = .05$, it is a reasonable conclusion that no matter what the usage of English text and/or symbols, Americans will be able to navigate faster in an American airport terminal.

5.2. Recommendations

Part of the conclusion of this study is that there is a distinct difference between what sign type people prefer and with what sign type people perform the best. This puts airport administrators who make decision of what type of signs to put in their terminals in a unique position. They can either value what will move people through their terminals the quickest or value what people prefer, regardless of their performance. Airport administrators are therefore recommended to determine their hierarchy of values for their airports. Ranking values such as wayfinding time, passenger preference, and wayfinding accuracy will help guide an airport administrator as to which sign type will be the best fit for their airport.

In addition, airports should also begin to consider the future and current cross-section of passengers their airports encounter daily. This study focused on the cultural influence of Chinese and Americans, but as will be described in section 5.3, comparing performance and preferences of other cultural groups may yield different results. For example, this study specifically may be more applicable to airports on the west coast of the United States, but airports in the American south and east ought to consider their own cultural cross-section based on their flight frequency to Latin America and Europe. From this perspective, perhaps a national sign type standard is not the direction toward which airport administrators should aim. Instead, it may be more beneficial to airports to have sign types that meet their own passengers' needs best, which may differ geographically. This, however, only applies to sign layouts, and is not a recommendation for choosing symbols to indicate various destinations on the signs themselves. The post-experiment survey in this study showed that both cultural groups felt very similarly about which symbols were confusing and which were clear, and having varying symbols to explain the same locations at different airports is not a recommendation encouraged by these results.

5.3. For Further Research

Further research is needed to learn more about how people wayfind in airports and what factors influence the speed and accuracy of wayfinding. This study focused only on the differences between two large cultural groups, but there may be more or different variation between other cultural groups, or even sub cultural groups. In addition, there may be additional variation based on age, gender, travel frequency, educational level, or many other reasons.

There may also be differences in wayfinding based on the arrangement and presentation of the signs themselves. This study focused only on the differences between text, symbols, and a combination of the two to see that impact on

wayfinding. There are many other ways to vary signs to see their impact on wayfinding. For example, one could compare signs with English text and foreign text, signs with symbols on the other side of the text, signs with arrows in different locations, signs with different numbers of locations on them, or many others. Even something as seemingly small as font style on an airport sign could have an impact on wayfinding.

Furthermore, additional research is needed to determine which symbols are best to encourage successful wayfinding. The symbols used in this study come from the Professional Association for Design, which partnered with the U.S. Department of Transportation to develop what they consider "standard" symbols for signs. However, the fact that the majority of both the Chinese and American groups of this study found that at least one of those symbols, "immigration," was confusing indicates the need for more research to determine which symbols are truly best for successful wayfinding.

There are many opportunities for additional research. This study employed only one variance to airport terminal signage and examined how it affected the wayfinding speed of two cultural groups. Learning more about how other airport sign factors influence these and other groups of people can lead toward the development of signs that have maximum affectivity for airport terminal wayfinding.

5.4. Summary

This study examined how wayfinding differed between two cultural groups, American and Chinese, based on varying the type of airport terminal sign they followed. Three variances were presented, one set of signs with only symbols, a set with only English text, and a set that combined the two. The results can be summarized in four major points:

- There is a statistically significant difference among wayfinding speeds for each of the three sign types for both the American and Chinese groups.
- The American group navigated significantly faster than the Chinese group, on the aggregate level, for every sign type.
- There was a clear difference for both groups between what sign type was best for wayfinding and what sign type was preferred by most of the group.

The results indicated that there is indeed a influence of culture on how people wayfind, and there is certainly further study that can be done to explore the extent of this influence and how other factors play a role in successful wayfinding.

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APPENDICES

Appendix A: Experiment Instructions

A Comparison of the Effect of Variations to U.S. Airport Terminal Signs on the Successful Wayfinding of Chinese and American Cultural Groups Participant Instruction Sheet

文化差异与机场客运大楼寻路标志功能:中国和美国的比较

研究参与者引导表

A. Introduction

Thank you for participating in this study!

多谢您参与这项研究！

- The purpose of this experiment is to determine how quickly people from different cultures can navigate an airport terminal using different types of signs.
- 本实验的目的是发现来自不同文化背景的人,如何正确并且迅速地使用机场客运大楼路径指示标志。
- Upon completing the experiment, there will be a brief survey asking you about what you experienced.
- 本实验将有一个简短的调查,询问您使用机场客运大楼的经验。
- Your participation will take approximately 15-20 minutes.
- 本实验大约需要15-20分钟
- No personal information will be collected in this experiment and all participation is completely anonymous.
- 在这个实验中,任何收集到的个人资料,将完全是匿名并接受机密处理。
- Your participation is voluntary and you may choose to end the experiment any time.
- 您的参与是自愿的，您可以选择任何时候终止参与本实验.

B. Instructions

In this experiment, a computer will simulate signs you might see in an airport terminal. You will be presented with screens that show a typical airport sign with a list of potential destinations and corresponding arrows.

在这个实验中,电脑将模拟您可能看到的机场标志。你将会看到电脑屏幕上,显示一个机场标志以及可能的目的地清单和相对应的方向指示箭头。

- Your goal is to act as if you have just arrived in the United States from a long international flight and are navigating in the airport terminal to the **Goal** area **as quickly as possible**.
- 设想您经过长途飞航刚刚抵达美国的国际机场,并在机场内快速向外部前进
- Clicking on the arrows will advance you to the next sign.
- 点击电脑上的路径指引箭头, 您将会连接到下一个指引箭头.
- If you click an arrow that indicates a destination other than the specified **goal**, the computer will ask you to try again.
- 如果您点击箭头后, 出现不对的目标指示或信息,电脑将会要求您再次尝试.
- The experiment consists of nine rounds of different "paths" of signs, and at the completion of each round the sign path will reset.
- 本实验共有九次不同的"方向标志" 测试,每测试完一次, 系统将重新开始.
- Some paths will include signs that have English text, some paths will have commonly used airport symbols, and some paths have a combination of both.
- 实验路径标志将包括英文与常见的机场导引符号
- If you like, you may take a short break between rounds.
- 测试之间如果您疲倦了, 请休息一会

Remember to click the arrows that lead you to toward the **goal** area and try to proceed **as quickly as possible.** If you have any questions at this time, please ask.

请尝试用直觉尽快地点击箭头,带您去想去的目的地。

After this experiment, if you have any questions you may contact the principal investigator,
完成实验后,如果您有任何疑问, 请联络的首席研究员或任何研究员

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You may also contact the Institutional Review Board for questions regarding privacy and information protection:
您也可以联系机构审查委员会 (IRB),有关个人隐私和信息保密的问题. 地址是:

Institutional Review Board (IRB)
Human Research Protection Program
Young Hall 1032
Purdue University
West Lafayette, IN 47907
Phone: 49-41527; Fax: 49-49911
irb@purdue.edu

Appendix B: List of Goals

List of **Goals** for each round:
目标名单, 分**别**为一

1. Immigration 入境事务处

2. Restrooms 厕所

3. Ground Transportation 汽车运输

4. Baggage Claim 行李领取

5. Immigration 入境事务处

6. Connecting Flights 转机

7. Restrooms 厕所

8. Ground Transportation 汽车运输

9. Connecting Flights 转机

Appendix C: Qualitative Post-Experiment Survey

Survey Questions: 调查问题

1. Which signs were easiest to understand? 哪些迹象最容易理解的?

2. Please explain why. 请解释原因.（可选）

3. How many times each year do you travel between a foreign country and the United States? 每年多久 你与外国和美国旅行?

4. Which symbols were confusing to you? 哪个图片困惑吗?

5. Please explain why. 请解释原因.（可选）

Appendix D: Sample Output

Below is the output for participant 98, a member of the Chinese group. The notation after the error entry indicates which of the ten signs the error was made on, what the participant chose, and what the correct choice was.

Hello! This is for participant 98.
Round 1 began at 8:17:09 PM
An incorrect entry was recorded. (2,1,2)
Round 1 ended at 8:18:12 PM.
Round 2 began at 8:18:13 PM.
Round 2 ended at 8:18:24 PM.
Round 3 began at 8:18:27 PM.
Round 3 ended at 8:18:40 PM.
Round 4 began at 8:18:41 PM.
Round 4 ended at 8:18:58 PM.
Round 5 began at 8:19:00 PM.
Round 5 ended at 8:19:16 PM.
Round 6 began at 8:19:16 PM.
Round 6 ended at 8:19:30 PM.
Round 7 began at 8:19:30 PM.
Round 7 ended at 8:19:48 PM.
Round 8 began at 8:19:49 PM.
Round 8 ended at 8:20:01 PM.
Round 9 began at 8:20:01 PM.
Round 9 ended at 8:20:12 PM.
Survey began at 8:20:15 PM.
Participant said text/symbol combination signs were easiest to navigate.
it has both word and picture
Participant travels internationally 0-1 times per year.
Participant finds the immigration symbol confusing.
Participant finds the baggage claim symbol confusing.
if it is the first time to meet,you have no idea about what do they mean.