2017

Exploring the Role of Culture in Online Searching Behavior from a Cognitive Perspective

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EXPLORING THE ROLE OF CULTURE IN ONLINE SEARCHING BEHAVIOR FROM A COGNITIVE PERSPECTIVE

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Philosophy in

Library and Information Science

College of Information and Communications

University of South Carolina

2017

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DEDICATION

To Mohammad and Mahmoud, for their friendship and love for our family.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my advisor, Dr. Sam Hasting, for giving me the opportunity to work with her and letting me to become a part of academic community under her leadership. Special thanks to the esteemed members of my dissertation committee, Drs. Jacek Gwizdka, Jingjing Liu, and Elise Lewis, for their guidance and support. Furthermore, I would like to thank the University of South Carolina (USC), USC's Office of the Vice President for Research, and the Institute of Museum and Library Services for supporting my doctoral research and graduate study.

I would not be able to pursue my dreams without the endless love and continuous support I received from my caring dad, Mohammad, and loving mom, Ashraf in the past 31 years of my life. Thanks to my brother, Alireza, and my sister, Samira, for the constant joy they bring to my life. Last but not least, I would like to thank my husband, Navid, for brightening my world everyday with the warmth of his love.

ABSTRACT

This research investigates differences in Web search behavior from a "cultural cognition" perspective, which was introduced by Nisbett and Norenzayan (2002). To explore the impact of culture and thinking styles on searching behavior is the objective. The overarching hypothesis is that there are cultural differences in cognitive styles and that these differences may lead into different searching behaviors. The findings help search engine designers provide an adaptive navigation support to users from different cultural backgrounds and cognitive styles. The fundamental research question underpinning this research becomes what are the relationships between users' cognitive styles and cultural background, and their Web search behavior? The results of this doctoral study help with understanding how cognitive processes are modulated by cultures so as to give rise to cultural specific thinking and Web navigation styles.

The assumption here is that differences in cognitive style will drive variations in Web search behavior based on national cultural orientation. To examine the research hypotheses, hundred and eleven research subjects are selected from three cultural groups: Americans, Iranians, and Chinese. The two independent factors that are studied in this experimental research are: cultural background and cognitive style. After answering a demographic questionnaire, the participants are given two types of task scenarios to perform on Google while two tracking applications (TechSmith Morae and MyGaze) record their mouse and eye movements. The users' search behavior is studied through

several measures of eye gaze, click behavior, and viewing pattern. By employing the Repeated Measures Analysis of Variance (RM ANOVA) test, the relationships between the independent variables and the search measurements are studied and analyzed using SAS statistical analysis application. This research was conducted in a controlled usability lab, and the participants were provided with a $10 incentive upon finishing the experiment.

Even though the results from the statistical analysis did not show significant evidence to support variation in cognitive styles between the participating cultural groups, country of origin appeared to be a strong predictor of differences in the measurements of search behavior. Considering the research hypotheses and the results, we found that the Americans' search behaviors tended to be more analytical and less explorative, whereas the Iranians and Chinese tended to engage in more exploratory behaviors.

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CHAPTER 1

INTRODUCTION

The Internet, one of the most popular modern technologies, has become an integral part of millions of people's lives across the globe. At present, some two and half billion people from all over the world are interacting with online information systems and seeking information. Those two and half billion online information seekers often have to use the same interface, drawing on their cognitive and evolutionarily shaped behaviors. The Internet is a universal medium, but the users, in fact, are very diverse in terms of their native language, cultural background, education, experiences, cognitive styles, and several other social and individual characteristics.

To gain an insight on users' search experience and effectiveness of search systems for the diverse population of online information seekers, studying Web search behavior has become an important topic for both information science researchers and information systems developers. Due to the diversity of online information seekers, it is essential to evaluate users' information behavior from different perspectives. The major part of the literature on search behavior investigates factors that impact users' Web searching experience, such as information needs, perceptions, prior Web search experience, task difficulty, and individual differences (see, e.g., Ellis, 1993; Ingwersen, 1996; Saracevic, 1997; Weber & Jaimes, 2011). However, search process is a cognitive activity and each individual has a unique cognitive style (Felder & Spurlin, 2005). Cognitive style is a

preferred and habitual approach to organizing and representing information, and it is shaped by everyday life experiences and socio-cultural factors. Hence, two of the important factors that influence Web searching are users' cognitive style and culture, which are currently under-researched in information behavior studies. The importance of those two factors is addressed below. Even though mainstream psychology tends to understand the mind to be similar to a digital computer or central processing unit (CPU), employing operations that are insulated from context, new perspectives in cognitive studies (such as externalism, embodied cognition and cultural neuroscience) suggest that mental processes are emergent properties of a self-organizing cognitive system that encompasses the interactions of brain, body, and the surrounding environment (Spivey, 2007). Recent cross-cultural psychological research revealed ample evidence that human cognition, especially cognitive style, is not independent of the context, content, or culture. The findings of eye-tracking studies showed that humans from different cultures are characterized by divergent thinking styles (Han, 2009; Chua et al, 2005). Specifically, people from Western cultures (e.g., Europeans and Americans) are characterized by an analytic cognitive style that is attuned to salient focal objects but less sensitive to contexts, whereas people engaged in East Asian cultures (e.g., Chinese, Japanese, Korean) tend to possess a holistic cognitive style that is attuned to background and contextual information. Also, brain-imaging research in the field of neuroscience showed that cultures not only shape multiple-level cognitive processes but also induce variation of neural correlates underlying cognitive processes such as perceptual/attentional processing (Na & Chan, 2015; Han, 2009). The emerging field of cultural neuroscience suggests that as both biological and sociocultural creatures, the human mental system is

evolving over time as a function of changes in biological material as well as changes in their sociocultural context, and their many interactions.

Similar to cognitive psychology, culture, ethnicity and socio-cultural factors have recently attracted researchers' attention in the field of information and search behavior. Current cross-cultural studies of information behavior (e.g. Komlodi & Carlin, 2004; Komlodi & Hercegfi, 2010; Kralisch & Berendt, 2004; and Marcos et al., 2013) have shown that users' cultural background plays an important role during Web searching. However, only a limited number of studies have shown the relationship between culture and Web search behavior. Additionally, most recent studies of search behavior from cultural perspectives are conducted based on Hall (1989) and Hofstede's (1980) framework of culture. The Hall and Hofstede cultural tradition is derived from the behaviorism perspective where they assume that culture manifests at the surface or at the behavioral level. Even though the proposed framework is useful and explanatory, they described culture as a product of combinations of simple and similar behavioral units that are the result of rather neutral and universal cognitive processes. However, from the cultural cognitive perspective, behavioral distinction is the product of cultural behaviors, which are embedded in cognitive processes (Faiola & Matei, 2005). Therefore, there exists a need to study the role of culture in searching behavior from cognitive perspective, rather than behaviorist perspective.

Searching for information on the Internet relies heavily on human cognition and perception (Card et al. 1983). Cognition and perception are processed at a series of levels during a search process (Belkin, 1980; Ingwersen, 1996). During an online search procedure, the user needs to pay attention to the information system, perceive, analyze,

categorize, recall information, and finally make a decision about his or her next move. Thus, to evaluate the users' search behavior, one needs to study it from a cognitive perspective and investigate cognitive characteristics of the users. User characteristics, particularly users' cognitive characteristics, are increasingly drawing attention in the field of information search behavior and human information interaction studies. As one of the cognitive characteristics, cognitive style was found to impact the search behavior when using information systems (Palmquist & Kim 2000; Park & Black 2007). Cognitive style (or information processing approach) is about the ways individuals gather and process information to make decisions and, as suggested by cultural neuroscience theories, can be influenced by culture. Information processing generally operates in an unconscious manner; this means that while an individual may be aware of the information searching process, he or she is often unaware of the mental processes that are used to acquire, analyze, categorize, store, and retrieve information in making decisions.

A comprehensive review of the information behavior literature shows that culture and cognitive style both have some impacts on the user's search behavior. However, studies that investigate influence of culture on information behavior have taken different pathways from the studies of information behavior from cognitive processing perspective. The former investigates the differences in information behavior from a behaviorist perspective and the latter studies cognitive style as an individualistic factor that affects information behavior. However, according to Nisbett's cultural cognition theory (2001), thinking style could be a socio-cultural factor rather than just a personal characteristic. Thus, having the theory of cultural cognition in mind, it can be concluded that there is a gap in cross-cultural studies of information behavior. To fill this gap,

researchers should investigate the role of culture in Web search behavior from a cognitive perspective. The findings help with understanding how cultural differences in thinking styles affect Web search behavior. It is also imperative to investigate which components of Web search behavior are influenced by users' cultural background as well as their information processing styles.

Understanding how users from different ethnicities and culture with different cognitive styles perform search tasks can help information system designers improve user interface efficiency. Furthermore, learning about the strategies and techniques a user employs to search information on online search engines can help the search engine designers to improve the effectiveness of their retrieval systems and provide special features to enhance experience of users during an information finding procedure. Knowing how a user with a particular cognitive style and ethnicity navigates the Web can help systems designers to provide an adaptive navigation interface that can facilitate efficient retrieval of relevant search results. Based on the search pattern of a user, search engines will be able to provide a personalized search interface and a customized Web design for major ethnic groupings for better information searching experience.

If user-interface design seeks to encompass human-experience design, then Web-based communication and interaction designers need to keep non-native English speakers, and particularly users of major ethnic groups in mind. Even though English is the first language of the Web (55.5% of the Internet content), only 28.6% of the Internet users are native-English speakers (Chu et al., 2015). With approximately 71.4% percent of the Internet users being from non-native English speaking countries with diverse cultural backgrounds (who often find it necessary to search in English), users' cultural

backgrounds need to be considered in applying concepts of user-interface and user-experience design. This is due to the fact that even though information seekers might be able to search in the language of the Web (i.e. English), they are still fundamentally diverse in terms of their culturally influenced thinking styles.

The theoretical frameworks of this study are taken from three fields of studies: information search behavior, cognitive psychology, and cultural cognition. The studies of information search behavior provide a framework for the Web search characteristics and the factors that need to be considered in studies of online search behavior. The studies of cognitive psychology set the methodological approaches in this research and provide a framework for the metrics of cognitive behaviors (such as eye-movements and mouse-movements) as well as a platform to identify the cognitive style of the participants. Eventually, the lessons from studies of cultural cognition inform the background theory of this research and ascertain the research hypothesis. Most of the recent studies on cultural cognition are influenced by Nisbett theory of cultural cognition, which was introduced in 2001. Nisbett raised the question about differences in thinking styles between different cultural groups and he addressed the question using eye-tracking technique in several visual scene perception experiments.

This research investigates differences in Web search behavior from a cultural cognition perspective. The goal is to explore the impact of culture and thinking styles on searching behavior. The overarching hypothesis is that there are cultural differences in cognitive styles and that these differences may lead into different searching behaviors. To examine this hypothesis, the research subjects are selected from three cultural groups: East Asian, Middle Eastern, and Western. To elicit their cognitive/thinking styles, the

participants are asked to take the extended version of Cognitive Style Analysis (CSA) test that was originally introduced by Riding in 1991 (Peterson et al., 2003a; 2003b). The computerized CSA test is designed to measure holistic and analytic cognitive styles by comparing how fast, on average, individuals respond on a verbal task compared to an imagery task, and how fast they respond, on average, on a holistic task compared to an analytic task. This test identifies the cognitive style of each participant and it is used in a regression analysis to identify the relationship between the two independent factors: cultural background and cognitive style. The participants are given two types of task scenarios to perform on Google while two tracking applications (TechSmith Morae and myGaze) record their mouse and eye-movements. The users' search behavior is coded based on several measurements of eye gaze and mouse behaviors that can help explaining analytic and exploratory behaviors. Finally, by employing the Repeated Measures Analysis Variance (RM ANOVA) test, the relationships between the independent variables and the dependent variable (search characteristics) are studied and analyzed using SAS statistical analysis tool. We will also create and compare visual viewing patterns between the participating groups with the use of MATLAB.

This study aims to explore the effects of users' cognitive styles and cultural backgrounds on their online search behavior. The findings help search engine designers to provide an adaptive navigation support to users from different cultural backgrounds and cognitive styles. The fundamental research question underpinning this research is the relationships between users' cognitive styles and cultural backgrounds, and their Web search behavior.

Although there exist several imperative factors that define one's cultural background, the only cultural determinant that is employed in this study is the country in which the participant was born and raised. Also, studies show that there are several individualistic cognitive characteristics that possibly affect Web search behavior (Riding & Cheema, 1991; Riding & Rayner, 2013), but among these characteristics, cognitive style is recognized as one of the most important user factors that affect Web searching strategies (Ford et al., 2001; Kim, 2008; Palmquist & Kim, 2000). Additionally, according to Nisbett's theory, cognitive style is one of the cognitive elements that is directly influenced by culture and the country of origin. Therefore, even though there are different individual and sociocultural factors that are found to influence search behavior, culture and cognitive style are the only two studied independent variables in this doctoral research.

CHAPTER 2

LITERATURE REVIEW

2.1 Related works

As depicted in the introductory chapter, the research that is presented examines the relationship between cognitive style, culture and Web search characteristics of users in two online searching tasks. Therefore, relevant work on Web search behavior, cultural impacts, cognitive style and the theory of cultural cognition style are discussed in this section. Also because the users' search behavior is recorded through mouse-tracking and eye-tracking applications, relevant literature on those techniques is discussed. Since this is a proposal for an information studies research, all the influential constituents of this experiment are discussed in the context of information searching behavior when possible.

2.2 Cognitive style and information seeking behavior (searching)

One of the most important factors that affect users' interactions with the information search system is that of their cognitive styles. This section discusses the concept of cognitive styles and its related measuring tools in information seeking behavior.

Information behavior has been the subject of several studies in the last 40 years. The literature on the topics of information needs and information seeking behavior demonstrates that information science is not the only field that is concerned with thistopic. There are several other disciplines that study how people seek and use

information, the techniques they employ to locate information, and the factors that encourage information use, such as psychology, anthropology and communication studies (Case, 2012). Even though "information seeking behavior" and "information behavior" are being used interchangeably in many studies, each of them refers to different related concepts. According to information scientist Thomas Wilson (1999), the person who coined the 'information behavior' term, information behavior is an umbrella term and it refers to human behavior in relation to sources and channels of information, including both active and passive information seeking, and information use. 'Information seeking behavior' or 'searching', on the other hand, is the purposeful action of seeking information that is emerged from an information need or a gap in the information seeker's knowledge.

The basis of cognitive perspective in information seeking behavior is that the human brain and cognition are the main driving forces behind information behavior. Dervin and Nilan (1986) were the first investigators who called for studies focusing on cognitive behavior and developing cognitive approaches to study information behavior and uses. By the end of the 1980s, several examples of information research focused on users as individual cognitive information processors. As an example, Belkin (1990) examined human information need from the cognitive perspective and he suggested that the states of knowledge of human beings (as information processors) influence what they perceive or produce. He further determined strong evidence to support the hypothesis that information need arises when an individual encounters Anomalous States of Knowledge (ASK). In his own words, an ASK is a situation where "the user realizes that there is an anomaly in [his or her] state of knowledge with respect to the problem faced." He

believes that the person approaches this gap in his/her knowledge by seeking information. According to him, the information seeking process begins with a problem and a need to solve the problem. The gap in states of knowledge refers to information need, which leads to information seeking.

Kuhlthau (1991) has also introduced a model that explains the stages of information search processes (ISP). According to Kuhlthau, people experience the information search process as interplay of thoughts, feelings and actions (Kuhlthau, 2005). Her theory is known as a multifaceted theory because it presents three types of activity in information seeking processes: physical, affective, and cognitive. Her studies cover a range of users, including college students, secondary school students, and public library users. In her model she introduces six stages in the information search process where she also describes the emotional states that accompany the stages. The first stage is initiation, where the information seeker acknowledges his or her need for information (which was inspired by Belkin's ASK model) and it is characterized by feelings of uncertainty and general thoughts about the problem area. The second stage is selection, where the user tries to find and to select the general topic area that she or he is interested in investigating. Then follows exploration, where the task is to search for information about the general topic she or he has found and further extend their understanding. The fourth stage is formulation, where the task is to focus on a more specific area within the topic. The next stage is collection, where the information seeker gathers relevant information about the specific topic. The last stage is presentation, where the search process is completed and the information seeker will be able to articulate the research question as well as the search findings.

Recently, with advances in technology and introduction of new measurements, techniques and tools in cognitive psychology, cognitive studies of information behavior have taken a new research path. The question of how users navigate online information systems and the impact of their individual cognitive characteristics, such as cognitive style, on the search behavior is a significant topic that has attracted some attention in the recent studies of information behavior. Messick has defined cognitive style as preferred consistent differences in the ways individuals organize, process and experience information (Messick, 1976). Similarly, McKay and colleagues defined cognitive style as an individual's typical or habitual mode of perceiving, remembering, thinking or problem solving that is "considered to be trait-like, relatively stable characteristics of individuals, ... (McKay et al., 2003)." Psychologists developed a wide variety of cognitive-style labels, theories, and models over the time, but they all agree that there are two types of cognitive styles. Cognitive style models such as field-dependent/independent (Witkin et al., 1977), holist-serialist (Pask, 1976), verbalizer-visualizer (Richardson, 1977), or wholist-analyst/ verbal-imagery (Riding & Cheema, 1991) are a few models amongst an impressive number of cognitive style theories that were introduced between the 1940s and 1980s. Field dependence versus field independence theory of cognitive style, which is derived from a series of studies of Witkin and Goodenough in 1981, is the most widely researched of cognitive style models (Messick, 1994; Ford & Chen, 2000). According to this model, field independent people tend to impose a structure on an unstructured field, while field dependent people perceive a complex field globally. As suggested by Rayner and Riding (2000), the wholist-analytic dimension in the cognitive styles model proposed by Riding and Cheema in 1991 corresponds directly to the field dependent/independent

model introduced by Witkin and colleagues in 1977, because they both discuss tendency for the individual to process information in parts or as a whole (Rayner & Riding, 2000).

Amongst the enormous number of cognitive style theories (Cassidy, 2004; Rayner & Riding; 1997), the wholist-analyst/verbal-imagery model that is proposed by Riding and Cheema in 1991 has recently drawn attention in the field of information behavior. Riding and Cheema's Cognitive Style Analysis (CSA) model is constructed upon previous theories of cognitive style using a factor analytic approach. The CSA model summarizes a number of different but correlated constructs into two principle independent dimensions: the wholist-analytic (WA) and the verbal-imagery (VI) (Riding & Cheema, 1991). The WA dimension of cognitive style describes the habitual way in which people think and learn. This affects the way they view and organize their information. The VA dimension of cognitive style describes an individual's preferred way of thinking and processing information. It refers to individual's tendency or preference to represent knowledge in either words (verbal) or mental pictures (images).

The reason that the CSA model is widely adapted in the recent studies of information behavior is due to several features of this model. The most important reason is that the two dimensions of the CSA, verbal/imager and wholist/analyst, can easily match to the structure of Web environments. Basically, any Webpage on the Internet has two levels: content and structure; the content of a Webpage is either visual or verbal (or auditory), and the structure of the environment can be altered by manipulation of the links arrangement. A Website can be designed to resemble an analytic and segmented structure, or a holistic and cohesive environment. Therefore, it is possible to personalize Websites based on the information seeker's preferences in organizing and learning

information using each dimension of the CSA model (Chen et al., 2005; Sadler-Smith & Riding, 1999).

Moreover, Riding introduced a computerized test in 1991 that assesses cognitive styles based on both ends of the CSA dimensions. The CSA test is designed to measure wholistic and analytic cognitive styles by comparing how fast, on average, individuals respond on a verbal task compared to an imagery task, and how fast they respond, on average, on a wholistic task compared to an analytic task. Despite the criticisms, the test has shown to have good reliability and validity by several studies of information behavior that adapted this measurement tool (examples include: Ford et al., 2009; Ford et al., 2001; Frias-Martinez et al., 2008). Also, the fact that the CSA test is a computerized test makes it more adaptable for both researchers and also more engaging for participants to use.

A number of studies have been conducted to explore cognitive styles among different information and Web users. Nigel Ford, Thomas Wilson, and Amanda Spink and their co-researchers conducted a series of joint studies to investigate the function of individual differences in Web-based searching (Ford et al., 2002; Spink et al., 2002a; Spink et al., 2002b). They assessed one hundred and eleven participants for Witkin's field dependence/independence using Riding's Cognitive Styles Analysis test and for Pask's holist/serialist biases. The results of their empirical research suggest that several individual differences particularly cognitive styles influence users interaction with information retrieval systems. In a few other studies, researchers showed that cognitive styles influence search time, online search experience, and search performance (Gwizdka, 2009; Palmquist & Kim, 2000; Kim, 2001; Kim & Allen, 2002).

Early studies on cognitive aspects of information behavior and interactive information retrieval investigated the influence of human cognition on searching behavior and resulted in development of a few integrated models for the interaction between users and information retrieval systems. Examples include Ingwersen's Cognitive Model of IR Interaction (1992, 1996), Belkin et al.,'s (1995) Episodic Interaction Model, Saracevic's Stratified Model of IR Interaction (1996a, 1997), Sutcliffe (Sutcliffe & Ennis, 1998; Sutcliffe et al., 2000), and Vakkari (2001). Recent studies of cognitive styles and Web searching behavior, however, focus on characterization of searching behavior and explore empirical evidence for interrelationships between Web searching and users' cognitive style.

Using Riding's CSA, Kinley and his colleagues in their recent study (2014) argued that users' cognitive styles influence their information searching strategies, query reformulation behavior, Web navigational styles, and information processing approaches. More importantly, they developed a user model that depicts the fundamental relationships between users' Web search behavior and their cognitive styles. This model provides the basis for the Web search characteristics of this present study. Similarly, in an eye-tracking experiment on the Web Tsianos et al (2009) investigated the relationship between the verbal/imager scale of the CSA model and learner behavior. The results suggested that the visual behavior of users in a Web environment depends on their cognitive style. Also, the findings of a study conducted on a sample of the general public using the CSA model (Ford et al., 2009) revealed that there are a number of interactions between individual differences, especially cognitive style differences, and the use of different Web search strategies.

Despite the high applicability of the CSA model in the field of Web search behavior, there are only a few researchers that have adopted this model. There exist a large number of various user search experience studies that can utilize the CSA model to learn more about information seeking behavior of the users on the Web. Web searching is the primary method of information acquisition for many people around the world; however, we are still far from fully understanding users' online search behavior from different cognitive perspectives. Hence, more user-centric analysis of Web searching needs to be done. In this study, the main goal is to explore the impact of culture and cognitive styles (based upon the CSA model and the cultural cognition theory) on Web search behaviors measured by eye movement and click behavior metrics.

2.3 Cognitive style and culture

There is a growing number of studies that suggest culture influences people's cognitive information processing styles (Rayner et al., 2007). This assumption is based on findings of several cross-cultural psychological and neurocognitive studies that are conducted on samples of different cultural groups. The results indicate that people from different cultures have differing thinking styles (Chua et al., 2005; Rayner et al., 2007). To elicit the cognitive processing differences among the different cultural groups, researchers have employed cognitive psychology and neuroscience techniques such as eye tracking and neuroimaging. This section presents a review of current cultural cognitive studies and the related research.

A review of the literature suggests that the most significant research that promotes the idea that culture fundamentally shapes thought were conducted by Lev Vygotsky (1978) and Alexander Luria (1971). They hold the idea that humans' cognitive processes

emerge from daily life activities that are culturally constrained and historically evolving (Nisbett et al., 2001; Nisbett & Norenzayan, 2002). Also, their research on designing a social model for learning suggests that culture is the primary predictor of human development. Accordingly, Ford et al (1994) argue that individuals from different cultural backgrounds differ in the cognitive strategies they employ when processing information.

Later, Sperber (1985; 1996) and his cognitive anthropologist colleagues proposed a general theory of the constraints that cognition may build on culture. This theory, "ecology of belief", or in other words, cultural features, is built on the distribution of ideas in a population as well as innate cognitive abilities of humans. Based on this concept, some ideas are easier to think and communicate than other ideas because of innate abilities of the human mind, on the one hand, and prior ecological condition on the other. Such ideas and beliefs are distributed and learned in all cultures with no instruction (Park & Huang, 2010; Pérez-Arce, 1999). Thus, culture is described as the socio-cognitive processes by which such ideas distribute and stabilize in the mind of people, families, ethnic groups, societies, and nations. Furthermore, Roy D'Andrade (1984) has introduced the idea of "cultural models" which describes how people interpret their experiences and make decisions in different circumstances.

The cultural model can explain how people interpret events differently across cultures, but the question is, does culture actually influence the thought process by which people perceive the world? Wilhelm Wundt, known as the "father of experimental psychology", was among the early psychologists that believed culture can influence human cognition. In his 1916 article, he stated that the mental sciences deal with

phenomena that are creations of the social community. Similarly, Greene asserts that the way humans act and behave is influenced by three factors: physiological, psychological, and sociocultural (Greene, 1995). He believes that in addition to biological components, the human psychological profile is formed with series of interpersonal and social factors that can significantly affect the shaping of cognition. These studies, eventually, led to the development of Boyd and Richerson's 1988 theory of "Culture–gene coevolutionary" which suggests that "cultural and genetic selection both affect how the mind and brain give rise to behavior (Chiao & Immordino-Yang, 2013, p.2)."

In 2002, Nisbett and Norenzayan introduced an influential cognitive view on culture and behavior, which is mainly inspired by the work of Russian psychologists, Vygotsky and Luria. Later, the results of influential research by Chua, Boland, and Nisbett in 2005 showed that the participating American students fixated more on the focal object in the scene, whereas Chinese students fixated more on the background. In this cross-cultural visual perception study, the participants' eye movements were recorded while they were viewing pictures of naturalistic scenes. The study by Chua et al. is part of a highly influential and frequently cited research series that are conducted by Nisbett and his colleagues in the field of cultural thinking (Similar studies include Masuda & Nisbett, 2001; Markus & Kitayama, 1991; Nisbett & Masuda, 2003; Nisbett et al., 2001). This study is particularly important because the analysis of eye movement data revealed convincing and direct evidence for cultural differences in the encoding of focal objects and contextual information in natural scenes.

Ever since Nisbett and Norenzayan introduced 'cultural cognition' theory in 2002, a number of studies investigated the notion of cultural specific thinking styles with the

use of different cognitive psychology and neurocognitive research techniques. According to cultural thinking theory, people from Western cultures (e.g., North Americans) tend to possess an analytic cognitive style, whereas people from East Asian cultures (e.g., Chinese, Japanese, Korean) tend to be characterized by a holistic cognitive style. The analytic cognitive style refers to being more sensitive to salient focal objects but less mindful of contexts; and the holistic cognitive style refers to being attuned to relationship, background and contextual information rather than the focal stimuli. The theory of cultural thinking is grounded on empirical evidence from a series of visual scene perception studies that employed eye-tracking research techniques on East Asian and Western participants.

Furthermore, Nisbett and Norenzayan conducted a historical study on ancient Chinese and Greek cultures based on the evidence that were gathered from the study of ancient Chinese and Greek philosophy, mathematics, and science to investigate the fundamental variation in their systems of thought that can affect cognition. They concluded that cultural difference in cognition appears because of the different historical developments of societies. Also, they suggested that different social practices and tools can lead to different thought processes that are, in fact, in harmony with the particular historical and social trajectory adaptations (Nisbett et al., 2001; Nisbett & Norenzayan, 2002).

Following the research that was conducted by Nisbett in 2002, there are a few other studies that were inspired by the idea that stable differences can be observed between East Asians and Westerners with respect to attention, contextual processing, categorization, and reasoning. This evidence illustrates that East Asians, as opposed to

Westerners, are more biased toward thinking about context, utilizing categories less, and relying on intuition and relationships. Nisbett suggests that East Asians are holistically minded and Westerners are analytically minded people. The study of Masuda and Nisbett in 2006 showed that Japanese participants were more likely to recall contextual details than Americans after viewing pictures of fish swimming in an underwater scene. Also, in a later study, they found that East Asians were more likely to detect contextual changes than Westerners were (Masuda & Nisbett, 2006). With respect to differences in formal reasoning, a study that utilized the Frame-Line test reported that Americans were more accurate in the absolute task, as opposed to East Asians that were more accurate in the relative tasks (Kitayama et al., 2003). The results of this study suggest that Americans tend to better recall the exact object, whereas East Asians tend to better recall contextual relationships.

Most recently, advances in cultural neuroscience methodologies and research technologies have begun to provide evidence of cultural variation in the neural correlates of mental processing and thinking styles. The central question in the study of cultural cognition is how cognitive functions are modulated by culture. Recent evidence from cultural neuroscience indicates that cultural values and even beliefs influence brain function across a variety of cognitive processes from vision to social cognition. Similarly, the findings of a brain imaging study in 2010 by Shihui Han showed that cultures induce variation of neural networks that underlie cognitive processes such as perceptual/attentional processing. The results of another influential study by Hedden et al. (2008) showed evidence that culture shapes basic perceptual processes across nonsocial and social domains. In this study, American and East Asian participants took a

modified version of the Frame-Line test while their brain responses were measured using functional magnetic resonance imaging (fMRI). The results showed strong evidence that one's cultural background directly affects the patterns of activity in a frontoparietal attentional network in basic perceptual judgment tasks. More importantly, the findings revealed that individual differences in how much a person subscribes to a particular culture (or is acculturated in it) influence the degree of the frontoparietal network engagement. In sum, there is ample evidence in cultural neuroscience research that reveals cultural differences in brain structure and function with the use of noninvasive methodologies such as functional neuroimaging (fMRI) or event-related potentials (ERPs) (Examples include Na & Chan, 2015; Chiao & Ambady, 2007; Han & Northoff, 2008; Kitayama & Uskul, 2011; Park & Gutchess, 2006; Chiao et al., 2013; Nisbett & Miyamoto, 2005; Nisbett et al., 2001; Goh et al., 2007; Goh & Park, 2009; Freeman, 2009; Rayner et al., 2007).

2.4 Culture and information behavior

Despite the popularity of online searching among various types of information seekers, we still do not have a clear picture of the user's characteristics and their role in Web searching experience. As online information searching is central in today's information society, it may be absurd to capitalize on its values without fully understanding how individual difference actually influences searching. The focal emphasis of most recent user search behavior studies is on task difficulties and the user's domain knowledge, while natural user's considerations such as cognitive processing style and cultural background remained understudied.

As explained in the first section, cognitive style is considered to have a key influence on search behavior and usability of the search system. Respectively, as discussed in the prior section, culture can have an important role in shaping one's cognitive style (Rayner et el., 2007). Hence, culture could also most likely have a strong relation to search behavior. Even though cross-cultural studies of information search behavior have recently drawn some attention in the field of information science, there is still a need for a systematic and rigorous study of Web search behavior from cultural perspective. This section presents a review of the current related studies in the field of information search behavior.

The theoretical grounding of much cross-cultural research on Web information behavior is derived from the behavior-driven perspective that reflects Hall (1966, 1976) and Hofstede's cultural model (1991). Early cultural studies of information seeking were mainly focused on identifying the cultural determinants. Komlodi and Carlin (2004) investigated the role of cultural dimensions of the frameworks described by Hall and Hofstede in information seeking. They considered those dimensions that are highly likely to influence information seeking. As a result, they identified four dimensions of Hofstede's five dimensional cultural model (including power distance, individualism vs. collectivism, femininity vs. masculinity, and uncertainty avoidance) and five dimensions of Hall's six dimensional cultural model (including speed of messages, high context vs. low context, time, action chain, and information flow) that impact information seeking behavior.

Kralisch and Berendt (2004) investigated the impact of various cultural determinants that are derived from Hall and Hofstede's cultural dimension models on

online search behavior. They categorized cultural differences into three groups: differences in amount of information needed, differences in time perception, and differences in space perception. The results showed evidence that the users' culturally determined thinking styles are reflected in their selection of the search options. Later, they explored the cultural influences that led to variations in users' navigation behavior, mainly information seeking behavior (Kralisch & Berendt, 2005). They employed Hofstede's long-term vs. short-term and uncertainty avoidance cultural dimensions as well as Hall's extension of Hofstede's concept of time (monochronic vs. polychronic) dimension to study differences in navigation patterns of the Web users. The findings of their study provided empirical evidence that confirms the impact of cultural dimensions on Web navigation behavior.

Further, a few other studies were conducted that explore differences in various culture groups' search and navigation behavior while studying differences in the use of a Website or a virtual learning environment. Iivonen and White (2001) studied the cultural differences in online search strategies among Finnish and American students. They attributed differences in searching style, cognitive style, language use and perceptions of search systems to varying levels of cultural differences among the participants.

A review of the literature showed that the central focus of recent cultural studies of search behavior is actually on visual search pattern differences between people from different cultures. In a controlled eye-tracking experiment on groups of participants with Middle Eastern and Western European cultural backgrounds, Marcos and colleagues (2013) evaluated the differences in interaction style and visual behavior on the first page of the search results in Google. The findings revealed significant differences in the

scanning patterns as well as search characteristics including success rate, number of scanned results, and total interaction time between the participating cultural groups. In a different comparative study, researchers investigated differences in users' perception of a Webpage with respect to cognitive style differences between East Asians and Americans. Visual analysis of the participants' eye movement patterns provided evidence for differences in Web scanning pattern between American and East Asians. Their findings also revealed a positive relationship between Web visual behavior and Nisbett's theory of cultural cognition (Dong & Lee, 2008). Although it is important to know about the visual pattern differences in search behavior for interface design purposes, it still does not fully explain how and which Web search characteristics are impacted by cultural differences.

Culture is important for understanding search behavior because it is one of the most relevant aspects of a user's personal context – a factor that has been shown to be significant but under-researched in current studies of information behavior (Rice et al., 2001). Reviewing the various threads of the subject of cross cultural information behavior reveals that what is lacking is a further development that merges the theoretical foci of cultural information behavior and cognitive Web search characteristics by exploring the cultural cognitive aspects of information search behavior. To better understand users' Web search experience, this study concentrates on the impact of individual differences in relation to two natural characteristics with respect to cultural cognitive theory: cognitive styles and culture. Both would most likely have a strong influence on search behavior and, if they did, in what ways would they be correlated to each other. The aim of this dissertation is thus to identify the impact of culturally influenced thinking styles on the Web search characteristics.

CHAPTER 3

METHODOLOGY

3.1 Study population

The target population of this study is graduate students (the University of South Carolina graduate students to be more specific). The postgraduate student population in the United States encompasses two types of status in general: American students and international students. Graduate students constitute a significant percentage of the Internet users considering their age and academic positions. Online information seeking is central to postgraduate students' personal and professional activities. Hence, it is imperative to study the influence of their natural characteristics (such as cognitive style and culture) on online search behavior. With that said, there are three major reasons in choosing this study's participants from this population.

The first reason for choosing graduate students is due to the English requirement of the experiment. Since two of the participating groups are selected from non-English speaking countries and the study is conducted in English, English proficiency of the participants is fundamental for both communication purposes and the actual experiment. It is particularly likely that international graduate students in an English-speaking country use English as their search language frequently both at home and at their academic institute for research and studying purposes. Additionally, all international graduate students who are enrolled at the University of South Carolina have met the English

language requirement at the time of admission. Also, the fact that they live in an English-speaking country as academic affiliates provides reliable reasons to assume that the participants feel comfortable performing Google searching tasks in English (the participants are screened based on their English proficiency and their confidence in searching in English).

Moreover, the influence of culture on Web searching behavior is one of the principal questions that will be investigated in this study; however, travelling to different countries is not feasible due to limitations in money and resources. Therefore, graduate students, as representatives of their home country's culture, are selected as the target population of this study. Participants' home country (nationality) determines their cultural background. Therefore, the international participants in this study are those students who were born and raised in their home country and have recently (Table 3.3) moved to the United States to pursue their educational goals. Since they have spent most of their time (at least 21 years) in their country of origin, it is likely that they still hold a strong tie to their cultural backgrounds and ethnicities. Similarly, the American participants are those graduate students who were born and raised in the United States. Hundred eleven graduate students from American, Chinese, and Iranian cultural groups were invited to participate in this study.

The last reason to choose graduate students is due to their experience in online searching. The graduate students (both international and American students) are among the populations that are likely to have several years of experiences in using different types of search engines for both academic and non-academic purposes. Although the

participants received a quick introduction to using Google prior to searching, having previous online search experience was a requirement in this study.

3.1.1 Participants

The study was conducted in a controlled eye-tracking lab at the School of Library and Information Science at the University of South Carolina (USC). Participants were invited through flyers and emails that were targeted to the International and American graduate students across different departments in USC's Columbia campus. From all students who signed up for the study, only those who possessed excellent English proficiency (TOEFL iBT =>90 out of 120) and were comfortable with searching on Google in English were invited to participate in the study. The sample population were well balanced based on the country of origin, gender, field of study, and year of study. The participants were between twenty-two to thirty-six years old. Also, a major number of the international participants have been living in the United States for more than three and less than six years.

Table 3.1 shows a summary of the participants' demographic information. Due to technical difficulties that occurred during the sessions, from one hundred and eleven study datasets gathered from students who came to the lab, only ninety-one of them were utilized for the analysis. Some of the technical difficulties encountered during the study included not being able to calibrate the eye-tracker with participants, sudden computer errors during the search, not being able to save the recording, accidental mistakes, etc. Table 3.2 and 3.3 provide more detail information about each participating group.

Table 3.1 Participants' demographic information (a)

	Category	Number of participants
Age	22-25	19
	26-29	30
	30-33	30
	33-36	12
Gender	F	44
	M	47
English proficiency	Excellent	60
	Native	31
Country of origin	USA	31
	China	30
	Iran	30
Current level of education	Graduate Student- Master	21
	Graduate Student- Doctoral	62
	Graduate Student- Postdoctoral	8
Field of study	Engineering	43
	non-Engineering	48
How comfortable searching in English	Comfortable enough	4
	Very comfortable	87
Years of search experience	5-6 years	26
	7 years or more	65
Frequency of searching on Google	Multiple times a day	89
	Once a day	2
Frequency of searching in English	Always	75
	frequently	16

Table 3.2. Participants' demographic information (b)

	Born and raised in home country	Language at home	First language of choice for searching
Americans	100%	100% English	100% English
Chinese	100%	100% Chinese	40% English
Iranians	100%	100% Persian	100% English

Table 3.3. Years of living outside of home country

	Years of living outside of home country				
	0-1 year	**1-2 years**	**3-4 years**	**5-6 years**	**7 or more years**
Americans	31	0	0	0	0
Chinese	0	3	14	10	3
Iranians	0	6	16	7	1

3.2 Data collection tools

In this study, the users' search behavior on Google is recorded through two tracking applications. The designated laptop (Dell Latitude) that the participants use in a usability laboratory at the University of South Carolina is equipped with TechSmith Morae [1] mouse tracking application and myGaze[2] eye movement tracker.

Recently, we have witnessed dramatic advances in both eye-tracking technology and the psychological theories that link eye-tracking data and cognitive processes (Gwizdka & Mostafa, 2017; Holmqvist et al., 2011, Granka et al., 2008; Goldberg et al., 2002). Introduction of affordable eye-trackers to the market has enabled researchers to employ this technology in their usability testing and Web information behavior studies. Researchers in the field of information science employ eye movement measurements to study information behavior form cognitive perspective (e.g. Miwa et al., 2009; Gwizdka, 2017; Gwizdka & Zhang, 2015; Gwizdka & Cole, 2013; Cole et al., 2013; Cutrell & Guan, 2007; Poole & Ball; 2006; Lorigo et al., 2006, Granka et al., 2004). According to the theories of cognitive psychology, eye movement indices reveal useful information about cognitive characteristics and attentional behavior. As Salvucci stated in 1999, eye movements provide a rich and informative window into a person's thoughts and intentions. Accordingly, with the use of eye trackers in studies of information behavior, we can learn about users' cognitive behavior when using an interface.

Use of eye tracking in Web search behavior studies provides insight into a user's cognitive strategies and thoughts, and allows us to identify patterns and behaviors that

[1] https://www.techsmith.com/morae.html
[2] http://www.mygaze.com/products/mygaze-eye-tracker

even the users do not consciously see and cannot express in words (Gwizdka & Mostafa, 2017; Lorigo et al., 2008; Goldberg et al., 2002). Ocular indices in the Web environment allow researchers to obtain understanding of what the information searcher is doing and reading without needing to interrupt the search process by asking the participant to think aloud. Comparing to traditional research methods in the field of information retrieval behavior, eye tracking measurements offer more reliable metrics to evaluate the actual behaviors that users employ when reading and making decisions about which link to select (Miwa et al., 2009; Poole & Ball, 2006). Online eye tracking research reviews identify several key variables as significant indicators of ocular behaviors, including fixation duration, saccades, pupil dilation, and scan paths (Rayner, 1998; Rayner et al., 2007). In this study, fixations and scan paths (which are described in this section) are selected as the eye gaze measurements for studying the users' search behavior.

3.2.1 Fixation

Fixation is defined as a period of time when the eye is relatively stable while taking in visual information (Holmqvist et al., 2011; Lorigo et al., 2006; Poole & Ball, 2006). Fixations are understood to be indicative of the viewer's attentional direction as well as the degree of cognitive processing. Thus, eye fixations are found to be the most informative metric for assessing information processing and cognitive behavior in visual perception tasks (Holmqvist et al., 2011; Goldberg et al., 2002).

Average fixation duration and number of fixations are the most commonly cited gaze measurements that are employed in the field of user information experience (Bojko, 2013). In cases where task duration is not equal for all participants, fixation rate is used instead of number of fixations. Fixation rate or fixation frequency is the number of

fixations divided by the duration of a task in seconds. In other words, fixation rate show the number of times an individual concentrated or focused during the trial. Thus, in this study, fixation rate is considered as the measure of analytic behavior during the course of search. According to Nakayama and colleagues (2002), fixation rate is negatively correlated to task difficulty. On the other hand, fixation duration indicates attention or processing time (Bojko, 2013; Cutrell & Guan, 2007). Longer fixations in reading, scene perception, and usability studies are often associated with more difficult activities that require more effortful cognitive processing. There is also an inverse relationship between fixation rate and fixation duration (Rayner, 1998; Holmqvist et al., 2011).

Researchers have shown that task difficulty, information complexity, domain knowledge, background experience, and individual characteristics such as cognitive processing style and cultural background will influence ocular behaviors (Gwizdka & Zhang, 2015; Gwizdka, 2014; Cutrell & Guan, 2007; Lorigo et al., 2006). Information retrieval in an online environment such as Google encompasses both a visual search activity and reading. It is expected that the average fixation duration of a search activity on Google will fall within the range of 225 milliseconds, which is the average for silent reading, and 300-400 milliseconds, which is the average for typing and scene perception (Rayner & Castelhano, 2007; Granka et al., 2004).

3.2.2 Scanpath

A scanpath of eye gaze movements include a sequence of fixations and saccades (Holmqvist et al., 2011) (saccades are understood as the extremely rapid and continuous movements of eye gazes between fixation points). Scanpath represents the pattern of eye gaze across the visual scene. Analysis of user scanpaths provides insight into users'

scanning behavior in a visual or online search activity. Current eye tracking research suggests that eye gaze pattern is mostly intentional and highly related to a viewer's cognitive thinking, expectations, and purpose. In Web usability studies, however, the length of scanpath is one of the most common metric that is utilized for analyses (Bojko, 2013).

3.2.3 Eye and mouse movement

Eye-tracking experiments are often conducted in formal controlled laboratories in which researchers can study the real-time projection of the user's eye gaze characteristics during the completion of tasks. Frequently, eye movement data are used for quantitative analysis using appropriate statistical techniques. Due to the complexity and multi-dimensionality of the eye gaze data and to fully understand effects of all random and fixed variables, three- and four-level linear mixed models are often used for data analysis; particularly, if the research objectives are to understand differences between conditions, task types, and other related metrics (Miwa et al., 2009; Poole & Ball, 2006; Cutrell & Guan, 2007; Chen et al., 2001). In this study, scanpath length (pixel), average fixation duration (ms), fixation rate (s^{-1}), and average fixation duration to first click (ms) are the metrics that are used for the analysis of search behavior as the indicators of the gaze behavior. Additionally, task time (s) and search time on Google (ratio) are the other two metrics that are employed for analysis.

Obtaining a low-cost estimate of how users act in online contexts is desirable, especially for understanding the process of online search. Research has shown that combining eye movement data with mouse data can be useful in better understanding of search behavior (Chen et al., 2001; Granka et al., 2008). Capturing eye movements

during search will enable us to learn about the user experience and the process they go through to eventually decide where to click and when to finish the process. On the other hand, click data shows actual scrolling and clicking behaviors of the information seeker's on the Web. Eye gaze data offers insight into information acquisition and information processing, while mouse data offers insight into information selection and browsing activities. Hence, relating eye movement behavior with click data can provide an even more comprehensive picture of the process through which online information acquisition and decision-making actually occur. In present study, users' click behavior and eye gaze behavior are simultaneously recorded while they are searching on Google. Number of clicks, number of links activated, and mouse movements (pixels) are the three click behavior variables used in search behavior analysis.

3.3 Cognitive style (the Extended CSA-WA) test

In today's society, online information searching is central to all everyday activities. However, it may be illogical to capitalize on the values of information searching on the Web without fully understanding of how individual differences actually influences searching behavior. As discussed in the literature review chapter, several studies emphasized the importance of considering cognitive variables as important predictors to information search process and outcome (Park & Black, 2007). Researchers suggest that cognitive styles play an important role especially in the development of hypermedia-based systems such as search engines because they refer to individuals' information processing habits, representing their typical modes of perceiving information, thinking, remembering, and problem solving (Messick, 1976).

To assess the cognitive style of the participants in the study, they are asked to take an extended version of a computerized cognitive style test that is originally introduced by Riding. The Cognitive Style Analysis test designed by Riding (1991) measures wholistic and analytic cognitive styles by comparing how fast, on average, individuals respond on a verbal task compared to an imagery task, and how fast they respond, on average, on a wholistic task compared to an analytic task. Despite numerous adoptions of the CSA test, the results of studies conducted by Peterson, Deary, and Austin (2003a; 2003b) showed that Riding's CSA test had poor re-test reliability. Thus, they proposed and tested an extended version of the CSA's wholistic-analytic dimension (Extended CSA-WA), which improved the test's reliability to a satisfactory level.

The Extended Cognitive Styles Analysis-Wholistic-Analytic test contains forty wholistic and forty analytic questions. In the wholistic tasks, the user is asked to judge whether two shapes that are made up of three basic geometric shapes (i.e. square, rectangle, and triangle) are identical or different (Fig. 3.1). The analytic questions ask the user to determine if a single shape is part of a complex figure (made up of three geometric shapes) (Fig. 3.2).

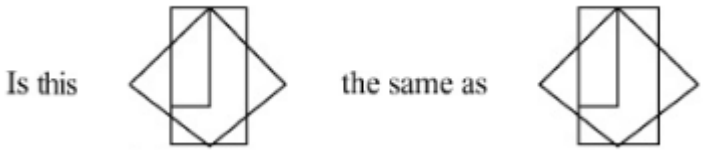

Figure 3.1 Example of a wholist task on the CSA-WA test

Figure 3.2 Example of an analytic task on the CSA-WA test

Participants were encouraged by the system and researcher to respond accurately but at a comfortable pace. They immediately received feedback on the accuracy of their choice for each question. A subject's cognitive style preference is measured by comparing the median reaction times on the wholistic questions with the median reaction times on the analytic questions. Participants' wholistic-analytic reaction time ratio identifies their relative position on a wholistic-analytic style continuum (Peterson & Deary, 2006). Overall, the Extended CSA-WA test assesses user preferences for wholistic versus analytic ways of organizing information.

3.4 Pilot Study

A pre-dissertation pilot study was conducted to test the feasibility of the proposed study, the recording technologies, and to find potential obstacles and limitations. The participants (aged 25-34) were invited and selected from three groups of graduate students at the USC: American, Chinese and Iranian (Table 3.4). Each participant was offered a $10 incentive that they received after the experiment. The experiments were conducted in English and in a usability laboratory at the USC. The subjects were asked to use Google as their search engine and Internet Explorer as their browser to perform four information-searching tasks without time limitation.

Table 3.4 Pilot study demographic

Ethnicity	Gender		Major		Age	TOEFL iBT Score	
	F	M	Engineering	Science		>95	<95
American	2	8	10	0	28<Age<34		Native
Chinese	3	7	7	3	28<Age<34	9	1
Iranian	4	6	9	1	28<Age<34	9	1

3.4.1 Findings

Tables 3.5 and 3.6 show summaries of the preliminary quantitative analysis of click and eye gaze data. Unfortunately, four of the ten datasets of American and two of the ten datasets of Iranian participants were not usable for data analysis due to some technical errors that occurred during the recordings. Basic comparisons of eye gaze (Table 3.5) and click (Table 3.6) data reveal clear variations in searching behavior of the participating groups. According to the differences that are observed from eye data characteristics (e.g. number of fixations, average fixation duration), it can be inferred that there are some differences in the thinking styles of the participants. Even though the Chinese and Iranian participants tend to show longer fixation durations on average, they showed smaller ratio of total fixation duration over the search time. This result suggests that the Americans tend to spend more of their time fixating than other search activities in comparison to their international counterparts. In other words, the Americans tend to be more focused than the Iranians and Chinese.

Table 3.5 Pilot study's eye movements data (average of all tasks)

	Americans	Iranians	Chinese
Number of Fixations (count)	5232	7945	10523
Average fixation duration (ms)	474	554	500
Total fixation time/ search time	54%	43%	37%
Participants	6	8	10

Considering the differences in click behavior between the participating groups, it can be understood that the Iranian and Chinese participants have been more active during the course of search than the Americans. Overall, non-American participants spent most of their search time on clicking rather than focusing on the content. The maximum time between clicks factor shows the Eastern participants' mouse movements were much faster than the Americans, which means that they were faster in decision-making and information selection when searching on Google. However, they were less attuned to the viewed information when compared to their American counterparts.

Table 3.6 Pilot study's mouse movements data (average of all tasks)

	Americans	**Iranians**	**Chinese**
Total time (s)	882	1290	1350
Mouse clicks	23	64	80
Mouse movements (pixel)	18300	69500	85000
Max time between clicks (s)	95	79	88
Webpage changes	25%	34%	40%
Datasets	6	8	10

These initial analyses of quantitative data support the theory of cultural cognition that was introduced by Nisbett. During the course of searching on Google, the Chinese participants acted more like holistically minded people, and showed more contextual and click activities rather than fixating and being focused. On the other hand, the American participants tended to act more like analytically minded people, and did less click activities and presented more concentration on the content. Moreover, as it was expected, the eye and click data values for the Iranians fell between the results that were observed for the Americans and Chinese (see Tables 3.5 and 3.6).

The lessons that were derived from the pilot study have led to further improvements in the main study. The main research design modifications that are applied

to the next phase include changes in task scenarios, task types, and search procedure. Furthermore, for triangulation purposes, the Extended CSA-WA test is employed to assess cognitive differences between groups. Also, more participants are recruited, and appropriate statistical tests are employed to investigate the relationships between culture, cognitive styles and online searching behavior.

3.5 Research Design

3.5.1 Variables

To achieve the aims of the study, an experimental user study is conducted. The study adopts a mixed-method approach that employs several data collection strategies and data analysis techniques. This experimental research is conducted in a controlled usability laboratory at the University of South Carolina. Using largely the quantitative research design, the main independent variables are cognitive style and culture. The dependent variables are a number of eye gaze, mouse behavior, and time measurements that are collected during two search activities on Google (see Table 3.7). The search behavior in this study is analyzed with respect to analytic behaviors (fixation rate); explorative behaviors (mouse movement, number of clicks, number of links activated and scanpath length); and cognitive workloads (average fixation duration, average fixation duration to first click and task time)

3.5.2 Procedure

Since human subjects are the main actors of this study, Institutional Review Board (IRB) approval is sought prior to commencement of research. Participants are canvassed through invitations at various USC International Student Association events,

postings around USC campus, and e-mails. At the end of each experiment, participants receive a $10 as a token of appreciation for their participation in this study.

Table 3.7 Description of dependent variables

	Variable	Description
Time Data	**Task time**	Amount of time spent on task (s)
	Search time (proportion)	Amount of time spent on SERPs divided by task time
Click Data	**No. of links**	Number of links clicked on SERPs (count)
	No. of clicks	Number of clicks on SERPs (count)
	Mouse movement	Length of mouse movement on SERPs (pixel)
Eye gaze data_SERPs	**Gaze duration**	Amount of time spent on SERPs (s)
	Scanpath length	Length of eye gaze movement on SERPs (pixel)
	Average fixation duration	Average of fixation durations on SERPs (ms)
	Fixation rate	Number of fixations divided by time spent on SERPs (s^{-1})
	Average fixation duration to first click	Average of fixation durations on SERPs until first click (ms)
Eye gaze data_task	**Average fixation duration_task**	Total average of fixation durations (ms)
	Fixation rate_task	Total number of fixations divided by task time (s-1)

Participants are selected from three cultural groups: Western (Americans, specifically), East Asian (Chinese, specifically), Middle Eastern (Iranians, specifically). All three groups of participants are graduate students (aged 22 -36) at University of South Carolina (USC) who have extensive experience of using the Internet to find the information they need at home, work, or at school (multiple times a day). The Chinese and Iranian participants are selected from those who were originally born and raised in their home country, and have moved to the United States in the past 7 years to attend a graduate program at the USC (78% of the Eastern participants have been living in the

states for 3 to 6 years). The non-American participants need to have an excellent level of proficiency in English and are asked to provide their TOEFL score in the pre-test questionnaire. The TOEFL, formally known as Test of English as a Foreign Language, is a test of an individual's ability to use and understand English in an academic setting, which has become an admission requirement for non-native English speakers at many English-speaking colleges and universities.

This study uses multiple data collection instruments, including the cognitive style analysis test, eye tracking, mouse tracking, two pre- questionnaires, and a post-search survey. The call for participation in the study was distributed through flyers around USC's Columbia campus and emails to all graduate students at USC. Interested participants were asked to fill out an online demographic and a search experience questionnaire. Invited participants were pre-screened based on their English proficiency and familiarity with searching on Google. The questionnaire contains several multiple choice demographic questions such as their age, gender, education, field of study, year of study, their level of experience with Web searching, the search engine they use, searching language, etc. (see appendix A).

The eye tracker is a portable recorder by myGaze (purchased in 2014) that runs on the latest version of its operating system and records eye movements at 30Hz sampling rate and 0.5°* gaze position accuracy. MyGaze requires to be calibrated with each of the participants to obtain higher precision. The Morae mouse behavior tracking application is purchased from TechSmith company and runs in the background while users are searching on Google. See Table 3.7 for detailed information about the types of data collected through the tracking systems.

Invited subjects were provided with full information about the research and the procedure at the beginning of the session and asked to sign a volunteering consent form (see appendix B). Furthermore, to ensure the participants pay full attention to the tasks, they were told that they must answer two questions about the given tasks at the end of their search. Next, the participants were given instructions about the Extended CSA-WA cognitive style test (E-CSA_WA) and were encouraged to focus on the accuracy of their responses rather than time. The E-CSA_WA test measures participants' wholist-analytic cognitive styles by means of a ratio. The ratios typically range from 0.4 through 4.0. In this study, however, the ratios ranged from 0.56 to 2.23 with the mean of 1.38 and standard deviation of 0.3. Figure 3.3 illustrates study procedure.

3.5.3 Tasks

The final and central step is to ask participants to search for information on the Web using the Google search engine. Before starting the searching tasks, the participants were asked to test their position in relation to the eye-tracker and laptop to ensure they are comfortable. After the calibration, the system automatically presented a task scenario to the participants. The participants were asked to carefully read the scenario in order to understand the question. All subjects were presented with two categories of search task scenarios (one task at a time): exploratory and analytical. Half of the participants received the exploratory task first while the other half received the analytical task. Exploratory tasks require the user to identify as many different aspects as possible for a given topic and explore different perspectives of an idea from various angles (Over, 1997). On the other hand, analytical search tasks are defined as tasks that need more goal-oriented and structured analytical strategies (Marchionini, 1995; Yuan et al., 2011).

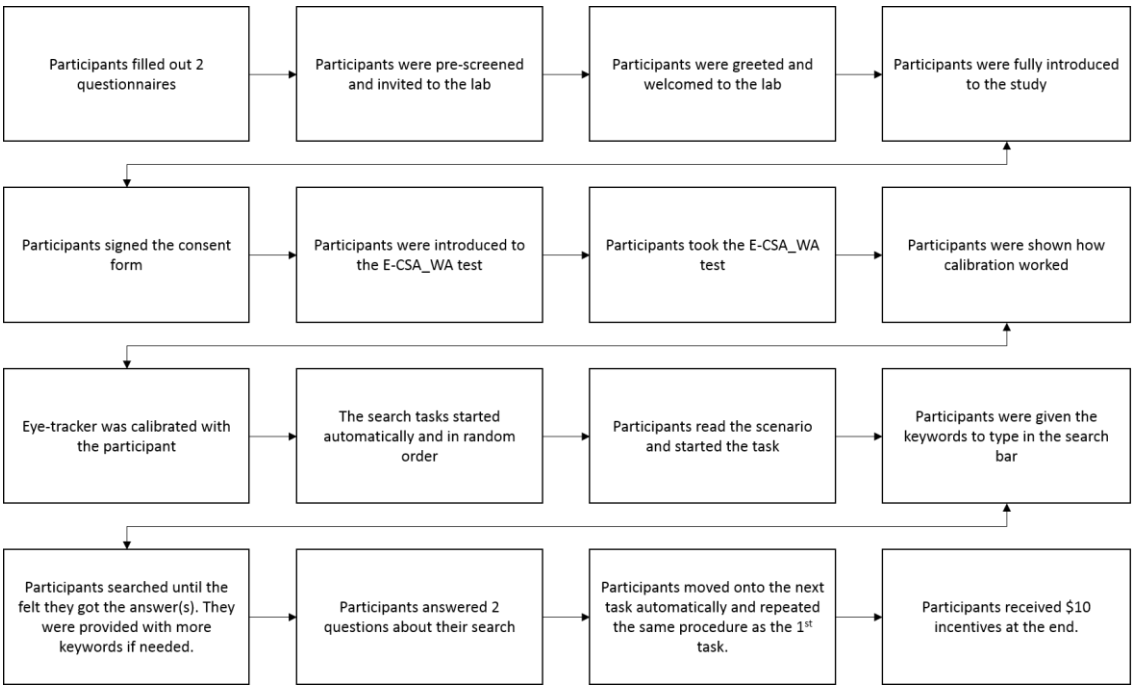

Figure 3.3 Study procedure

The following is the given analytical search task (coded as task one in the analysis):

"You have recently moved to London, England, and would like to know the relevant laws passed by the British government regarding child safety while travelling in vehicles. Identify three such rules."

The following is the given exploratory search task (coded as task two in the analysis):

"You, with your two friends, are planning a trek for one week in Solukhumbu in Nepal. The trekking will occur next month. You are told that tourists trekking here may get high-altitude illness. You decide that you should know more about the place, and the symptoms, seriousness and prevention of high-altitude sickness."

Participants could refer to the question at any time during search. The participants' gaze and mouse behaviors while they were reading the scenarios/questions were not included in the data analysis in this study. To maintain the consistency between the SERP pages visited by the participants, the researcher provided the keywords for the participants to use on Google search. Thus, the displayed search results were identical for everyone. The provided keywords were obtained from the most frequent keywords used by the participants in the previous pilot studies. While participants were performing the assigned search tasks on Google, their gaze and click behaviors were recorded with the use of two applications that were installed and run on the same laptop with which the user was working. The participants were also told to search as they would usually do and continue until they feel they have obtained satisfying information to answer the question. Once the participants started a task, they were asked to stay in the same browser until the end of the task and open a new browser for the second task. Also, a click on a search result would open the link in new tab. At the end of each task, the participants were presented with two questions about their search. The main purpose of this self-assessment was to ensure the participants were paying attention to the search tasks and that they tried to find some answers that is convincing to themselves (see appendix C). From the ninety-one participants in this study, eighty-five percent answered that they were hundred percent confident about their search and that they would be able to answer questions about the task.

3.5.4 Research questions and hypotheses

The study is focused on the impacts of two major characteristics relating to searching the Web, that is, cultural background and cognitive style. The fundamental

research question underpinning this research is the relationships between users' cognitive styles and cultural background, and their Web search behavior. While this research question remains the main focus, the following sub-questions corresponding to the four purposes of the study are sought:

1. In which ways, if any, do task differences influence searching behaviors?
2. Do country and cognitive style differences influence measures of searching behavior?
3. How do the two sets of independent variables (cognitive style and country) interact with each other to determine searching activities?
4. In which ways, if any, do cognitive style differences and country of origin influence searching behaviors?

Reviewing the relevant research about cognitive style and cross-cultural studies of information behavior led to formulation of the following hypotheses:

1. Cultural background differences influence Web searching activities with respect to eye gaze and mouse data.
2. Cognitive style differences influence Web searching activities with respect to eye gaze and mouse movement data.
3. There is a relationship between cognitive style and cultural background.
4. Cognitive style difference and cultural background interact with each other to determine Web searching activities.
    a. American participants act more like analytically minded people; meaning they are more focused and less explorative during the course of search.
    b. Chinese participants act more like holistically minded people, meaning they

are more explorative during the course of search.

c. Iranian participants' search behavior fall somewhere in between Chinese and Americans' searching patterns (but closer to the Chinese behavior).

In this study, 'focus' is measured by the fixation rate parameter. In addition, 'exploratory' behavior is measured by the click measurements defined previously such as the number of clicks, mouse movement, and number of links as well as the scanpath length that was recorded by the eye-tracker.

3.5.5 Analysis

Repeated measures analysis of variance (RM ANOVA) is used to assess the effect of cognitive styles and cultural background on Web-search behaviors. RM ANOVA is used to examine the mean of a quantitative variable (e.g. time spent) when subjects are measured under multiple conditions (e.g. two types of tasks), assessing within-subject variability. In addition to testing for within-subject variability, repeated measures ANOVA can assess the effects of a between-subjects factor (e.g. cognitive styles). The analysis is used to determine if there is:

1. A change in behavior over the two types of tasks (condition);
2. A difference in behavior between the cognitive styles and cultural groups (group);
3. An interaction between condition and group (e.g. if the change over the two tasks differs by cognitive style).

Moreover, the differences in visual Web search behaviors are assessed by analyzing the participants' viewing patterns. By plotting all eye gaze movements of each

participating group on one page in MATLAB we can compare the visual differences in their navigational approaches.

Lastly, to determine sample size estimates, a power analysis is conducted. G*Power[3] is a free online software package that can be used to conduct a power analysis. Figure 3.4 illustrates how to perform a power analysis for a RM ANOVA for which the goal is to assess the difference in behavior between the two cognitive styles.

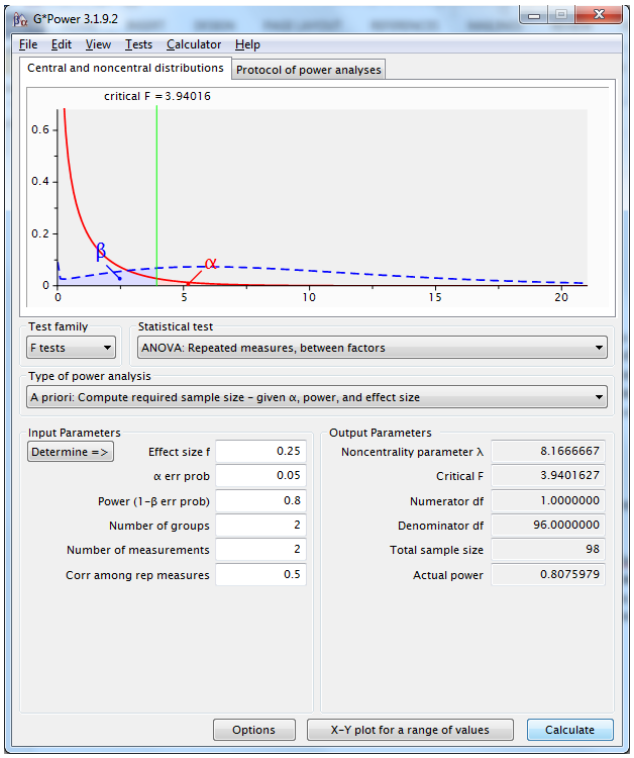

Figure 3.4 G*Power configuration

[3] http://www.gpower.hhu.de/en.html

CHAPTER 4

ANALYSIS

4.1 Introduction

This study examines differences in search behavior between three ethnic groups at two levels, behavioral and cognitive. Data concerning participants' search behavior at the behavioral level was collected via click logs through TechSmith Morae usability software. At this level, we analyze click behavior to examine if the participating groups act differently during the course of search. To study the behavior from cognitive perspective, we utilize eye gaze data that was collected through myGaze eye-tracker. We also examine differences in viewing patterns between the participating groups, which are typically studied via heat maps (e.g. Djamasbi et al., 2011). Varying colors show the number of fixations, with red indicating larger number of fixations, followed by yellow and green showing lesser number of fixations. Figure 4.1 illustrates the steps followed for analysis in this study.

4.2 Power analysis

A post-hoc power analysis is employed to estimate the probability of finding true significance of the results from 'Repeated Measures ANOVA, Between Factors' test. The effect size in this study is set to .34 using Cohen's (1988) criteria for total sample size of ninety-one. There are three participating groups and two measurements because participants were given two tasks to perform. The power analysis shows the findings of

this study are estimated to have the significance power of 82 percent. Table 4.1 provides further details about the power analysis with the use of G*Power.

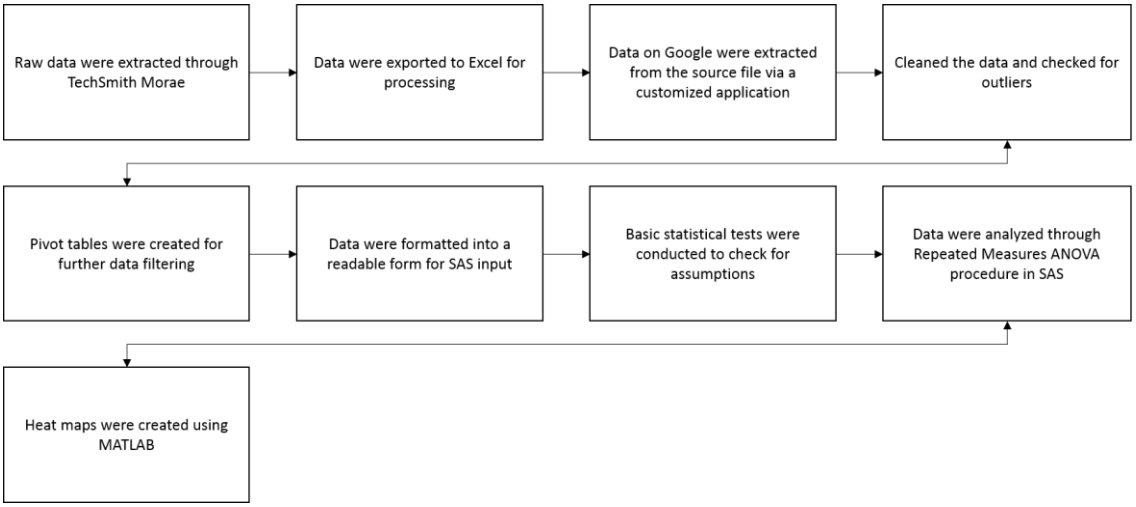

Figure 4.1 Analysis procedure

Table 4.1 Post hoc power analysis

F tests - ANOVA: Repeated measures, between factors		
Analysis	**Post hoc: Compute achieved power**	
Input	Effect size f(V) =	0.34
	α err prob =	0.05
	Total sample size =	91
	Number of groups =	3
	Number of measurements =	2
Output	Noncentrality parameter λ =	10.5
	Critical F =	3.101
	Numerator df =	2
	Denominator df =	88
	Power (1-β err prob) =	0.82

4.3 Variables

TechSmith Morae Manager was used to retrieve raw data that was recorded through myGaze eye tracker and Morae mouse tracker. Raw data was then exported to an Excel master file for further processing and cleaning. Since the focus of this dissertation is on

search behavior on Google, it was essential to extract eye gaze and click data on Google from the source file. Due to an extensive amount of data, the data extraction process needed to be done automatically. Thus, a customized data processing application was designed and used to obtain the intended data based on specific criteria. The application (developed in VB.NET) reads the file line by line from the beginning to the end. Each line, which is a comma-separated string, is divided into an array of strings. Then a user selectable item of the array, called keyword column, is searched for a given keyword. If the item of the array contains the keyword, that line and the following lines are written to the output file until a line with a non-blank keyword column, which does not contain the keyword, is reached. After that, the reading continues but those lines are not written to the output file until another occurrence of keyword is found or the end of file is reached.

The following table shows the description of the mouse and eye gaze measurements that were employed for analysis in this study. Because time limitation was not enforced, to make results comparable, number of fixations were normalized in the time domain (e.g. by dividing number of fixations by time spent on Google). In the field of eye tracking, the normalized number of fixations is called the fixation rate (Holmqvist et al., 2011). Also, since the focus of this study is on the search behavior on the search engine results pages (SERPs), we treated data on SERPs and entire tasks differently.

4.4 Procedure

The purpose of this study is to explore if the two independent variables, cultural background (country of origin) and cognitive style, have any meaningful impact on the dependent variables listed in Table 4.2. Cultural background is a data category that has three distinct groups in this study: American, Iranian and Chinese. Following discussions

with the designer of the computerized CSA-WA test (which was used to identify participants' cognitive style), it was decided to consider the cognitive style variable as a numerical continuous data set due to the lack of reliable evidence in identifying true cut-points. All dependent variables listed in Table 4.2 are numerical data and continuous.

Table 4.2 Description of dependent variables

	Variable	Description
Time Data	**Task time**	Amount of time spent on task (s)
	Search time (proportion)	Amount of time spent on SERPs divided by task time
Click Data	**No. of links**	Number of links clicked on SERPs (count)
	No. of clicks	Number of clicks on SERPs (count)
	Mouse movement	Length of mouse movement on SERPs (pixel)
Eye gaze data_SERPs	**Gaze duration**	Amount of time spent on SERPs (s)
	Scanpath length	Length of eye gaze movement on SERPs (pixel)
	Average fixation duration	Average of fixation durations on SERPs (ms)
	Fixation rate	Number of fixations divided by time spent on SERPs (s-1)
	Average fixation duration to first click	Average of fixation durations on SERPs until first click (ms)
Eye gaze data_task	**Average fixation duration_task**	Total average of fixation durations (ms)
	Fixation rate_task	Total number of fixations divided by task time (s-1)

In statistics, when the measurements can be thought of as responses to levels of an experimental factor of interest, such as task or time, the correlation can be considered by performing repeated measures of analysis of variance procedure. Since all participants were asked to perform search for two different tasks, 'Repeated Measures ANOVA (RM ANOVA)' test is used to explore the relationships between groups and within tasks and

measurements of search behavior. Prior to running the analysis, sample populations were tested against ANOVA assumptions. Normality test on the dependent factors' residuals showed all variables are normally distributed and that the homoscedasticity assumption holds.

The RM ANOVA statistical test analyzes users' data at four different levels. The first level determines if there is any statistically significant evidence that shows a relationship between the independent variables (country and cognitive style score) and each of the dependent variables that are listed in Table 4.3 (i.e. time, mouse and eye gaze data). The second level tests whether there is any interaction between the two dependent factors. The third level examines if there was a significant difference in the means of independent variables, what the difference is and how. The fourth and final step explores the impact of task differences on the independent and dependent factors.

To apply RM ANOVA test to the dataset, we utilized 'General Linear Models (GLM)' procedure in SAS. The results of GLM procedure reveals if differences between cultural groups and cognitive style scores influence the means of the dependent search variables and test for differences in the means of the dependent variables broken down by the levels of the independent variables. GLM procedure in SAS handles models relating one or several continuous dependent variables to one or several independent variables. The independent variables can be either categorical variables, which divide the observations into discrete groups, or continuous variables. Table below shows the types of each variable used in this study. Additionally, by adding the 'Repeated measure' statement to the SAS code we can study if task differences influence the results.

Table 4.3 Type of variables

	Variable	Type
Independent variables	Country	categorical
	Cognitive styles (score)	continuous
Dependent variables	Task time	continuous
	Search time (proportion)	continuous
	No. of links	continuous
	No. of clicks	continuous
	Mouse movement	continuous
	Gaze duration	continuous
	Scanpath length	continuous
	Average fixation duration	continuous
	Fixation rate	continuous
	Average fixation duration to first click	continuous
	Average fixation duration_task	continuous
	Fixation rate_task	continuous

4.5 Analysis

4.5.1 Level 1

At this level, we test the effect of 'country' and 'cognitive style' differences on the means of the searching behavior metrics. Table below summarizes the findings from GLM procedure for task 1 and 2.

Per Table 4.4, the results from the analysis of variance showed there is strong evidence (P – value <= .05) that there are some differences between the means of search behavior variables, adjusting for student's country of origin except for the 'number of links', length of 'scanpath', and the 'gaze duration' on Google. On the contrary, regression analysis between the dependent factors and the cognitive style scores revealed that there is no evidence that the differences between the means of the search behavior variables changes with the student's 'cognitive style score' as measured by the CSA-WA test.

Table 4.4 Independent*dependent variables ANOVA

Independent variable	Method	Dependent variable	Significant evidence	P- value (<.05)	
				Task 1	Task 2
Country	**ANOVA**	Task time	Yes	0.006	0.010
		Search time (proportion)	Yes	<.0001	0.005
		No. of links	No	0.544	0.385
		No. of clicks	Yes	0.022	0.041
		Mouse movement	Yes	0.018	0.003
		Gaze duration	No	0.07	0.290
		Scanpath length	No	0.772	0.347
		Average fixation duration	Yes	<.0001	<.0001
		Fixation rate	Yes	0.027	0.020
		Average fixation duration to first click	Yes	<.0001	<.0001
		Average fixation duration_task	Yes	<.0001	<.0001
		Fixation rate_task	Yes	<.0001	<.0001
				Task 1	**Task 2**
Cognitive styles (score)	**Regression**	Task time	No	0.951	0.410
		Search time (proportion)	No	0.684	0.783
		No. of links	No	0.491	0.835
		No. of clicks	No	0.067	0.846
		Mouse movement	No	0.661	0.079
		Gaze duration	No	0.730	0.5279
		Scanpath length	No	0.357	0.204
		Average fixation duration	No	0.087	0.252
		Fixation rate	No	0.264	0.106
		Average fixation duration to first click	No	0.162	0.416
		Average fixation duration_task	No	0.163	0.302
		Fixation rate_task	No	0.439	0.040

4.5.2 Level 2

At this level, we test if the two sets of independent variables (cognitive style and country) interact with each other to determine searching activities. When several

measurements are taken on the same experimental unit (such as person in this study), the measurements tend to be correlated with each other. The tests of hypotheses for between subject effects show if the interaction between the two main effects is significant. Table 4.5 shows a summary of the results. The results clearly show no evidence of interaction between the two independent factors.

4.5.3 Level 3

At this level, we examine how participants' country of origin influences the means of search behavior variables. Since there was no evidence for the effect of the 'cognitive style' variable on the dependent factors, the rest of the analysis on this factor will not be reported. Additionally, there will be no further analysis on the 'number of links', length of 'scanpath', and 'gaze duration' dependent factors because there was no observation of effect based on findings from level one. Table 4.6 provides the least square means of those search behavior variables for which we observed statistically significant evidence of some variations between the participating cultural groups at level 1.

The Tukey-Kramer's Least Squares Means analysis in SAS reveals the variations in the means of the dependent variables between the participating groups. Overall, the American student participants appeared to have less mouse activities than the Iranians and Chinese participants during search. The Iranians and Chinese spent longer time on the tasks and had larger average fixation durations compared to their American counterparts. A notable observation is that the American participants possessed higher fixation rates than Iranians and Chinese in both search activities.

Table 4.5 Country * cognitive style ANOVA

Analysis	**Analysis of Variance**			
	Dependent variable	**Significant evidence**	**P- value (<.05)**	
			Task 1	**Task 2**
Country*cognitive style	Task time	No	0.909	0.946
	Search time (proportion)	No	0.879	0.486
	No. of links	No	0.173	0.150
	No. of clicks	No	0.750	0.998
	Mouse movement	No	0.631	0.003
	Gaze duration	No	0.878	0.486
	Scanpath length	No	0.772	0.141
	Average fixation duration	No	0.375	0.532
	Fixation rate	No	0.203	0.268
	Average fixation duration to first click	No	0.167	0.824
	Average fixation duration_task	No	0.330	0.922
	Fixation rate_task	No	0.891	0.996

Table 4.6 Tukey-Kramer least squares means

	Least Squares Means					
	Adjustment for Multiple Comparisons: Tukey-Kramer					
Dependent variable	**Task 1**			**Task 2**		
	Americans	Iranians	Chinese	Americans	Iranians	Chinese
Task time	259.88	434.55	354.34	583.02	752.63	686.74
Search time (proportion)	0.38	0.24	0.30	0.35	0.23	0.29
No. of clicks	7.52	8.58	9.95	19.44	25.13	26.19
Mouse movement	25368.59	39947.40	36447.83	50074.22	95136.32	83134.72
Average fixation duration	354.04	439.10	416.60	358.39	442.70	427.78
Fixation rate	6.53	5.33	5.01	9.98	7.10	6.24
Average fixation duration to first click	343.39	436.60	416.32	343.74	450.21	421.00
Average fixation duration_task	348.70	447.97	421.94	350.72	448.34	430.95
Fixation rate_task	2.91	2.37	2.14	3.07	2.50	2.19

4.5.4 Level 4

At this level, we study if task differences influence searching behaviors using the 'Repeated measures' statement in the GLM procedure. The results are summarized in Table 4.7.

Per the table below, the test of hypotheses for within subject effects showed no evidence that the means of the search variables change with changes in the tasks, except for only one variable (number of clicks). In other words, task differences did not show any influence on the task time, search time, mouse movement and eye gaze measurements.

Table 4.7 Univariate tests of hypotheses for within subject effects – RM ANOVA

	Univariate Tests of Hypotheses for Within Subject Effects			
	Repeated Measures Analysis of Variance			
Variable	**Pr> F**			
	Task	**Task*country**	**Task*cognitive style**	**Task*cognitive style *country**
Task time	0.085	0.968	0.252	0.987
Search time (proportion)	0.330	0.197	0.416	0.203
No. of clicks	0.019	0.896	0.687	0.985
Mouse movement	0.767	0.269	0.021	0.168
Average fixation duration	0.359	0.877	0.395	0.907
Fixation rate	0.207	0.036	0.073	0.011
Average fixation duration to first click	0.471	0.857	0.528	0.915
Average fixation duration_task	0.321	0.100	0.371	0.077
Fixation rate_task	0.066	0.819	0.141	0.873

4.6 Viewing patterns

We studied viewing pattern with the use of heat maps that were generated in MATLAB (Figures 4.2-4.7). Varying colors show the number of fixations, with red

indicating larger number of fixations, followed by yellow and green showing lesser number of fixations. Participants did not fixate on the areas that show no heat map coloration. Researchers (e.g. Poole & Ball, 2006) argue that general importance or noticeability of an object increase the number of fixations in the area. Hence, the red areas on the heat maps represents the semantic importance of the content.

The heat maps for all three participating groups clearly illustrates an 'F' shaped pattern, which is the typical reading pattern on the search result pages (Nielsen, 2003). As it was observed from statistical analysis on fixation rates in the previous section, the heat maps on the number of fixations also showed that the American students had fixated more often than their Iranians and Chinese counterparts during search.

4.7 Conclusion

In this chapter, the results from four different levels of the linear regression model were reported. Mainly, the findings showed that the country of origin of the participants is a strong indicator of the search variables and that the participating groups acted differently from one another. In addition, there was no evidence that indicates a relationship between the participant's nationality and their cognitive style scores. Lastly, findings revealed that task differences in this study do not impact measurements of search behavior. The next chapter will discuss the observed results in relation to the research hypothesis and the theoretical framework.

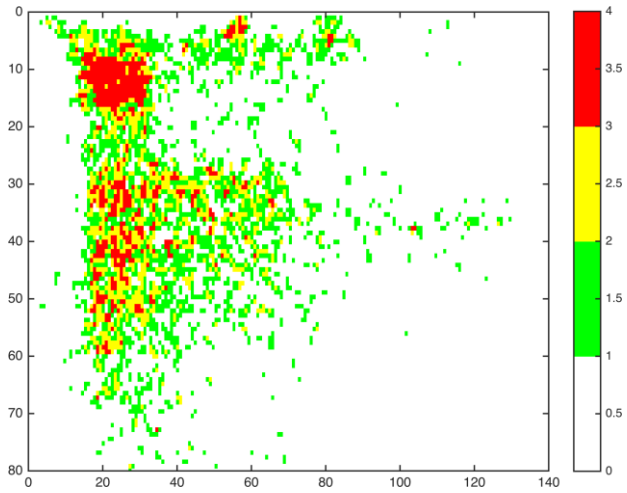

Figure 4.2 Americans' viewing pattern and frequency of fixations (Task 1)

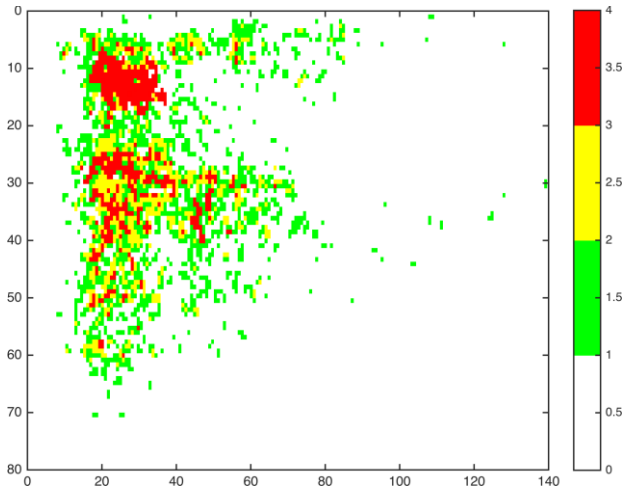

Figure 4.3 Iranians' viewing pattern and frequency of fixations (Task 1)

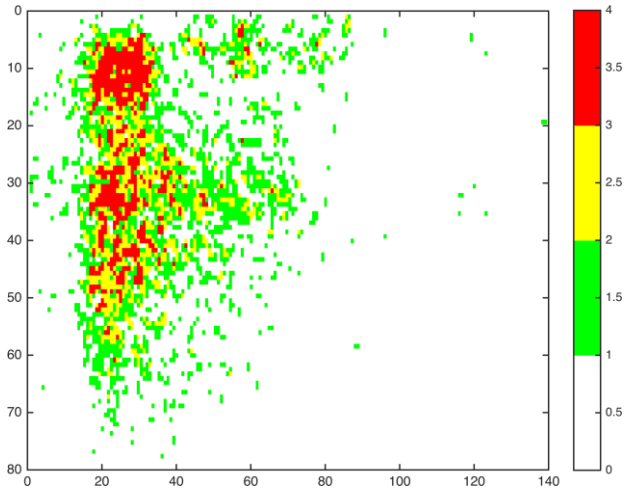

Figure 4.4 Chinese' viewing pattern and frequency of fixations. (Task 1)

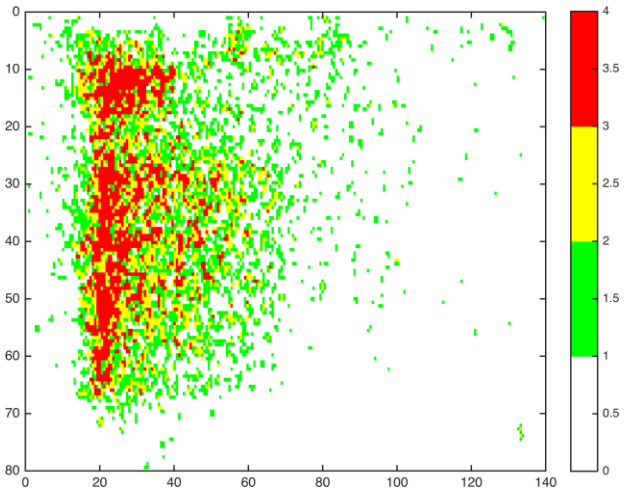

Figure 4.5 Americans' viewing pattern and frequency of fixations (Task 2)

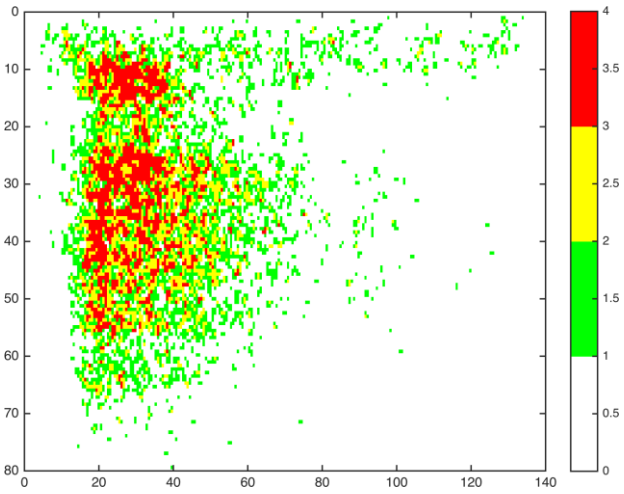

Figure 4.6 Iranians' viewing pattern and frequency of fixations (Task 2)

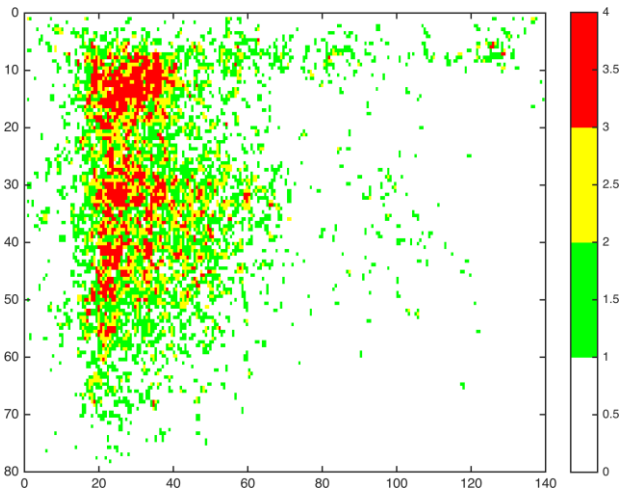

Figure 4.7 Chinese' viewing pattern and frequency of fixations (Task 2).

CHAPTER 5

DISCUSSION AND CONCLUSION

As discussed in the previous chapters, current literature in cultural cognitive psychology suggest that people of different cultural backgrounds tend to act cognitively different. According to the series of eye-tracking studies conducted by Nisbett and his colleagues, Westerners have a tendency to be more analytical than East Asians (Nisbett & Miyamoto, 2005) do. In addition, recent studies in the field of Web search behavior provide some evidence that suggest there are some differences in Web search behavior with respect to cultural differences between the users (e.g. Iivonen & White, 2001; Kralisch & Berendt, 2004; Marcos et al., 2013). In this study, however, we study the relationships between culture, cognitive style and Web search behavior as measured by eye and mouse tracking tools.

The sample population was selected from graduate students who are originally from China, Iran, and United States. The overarching hypothesis is that people from different countries would show different search behaviors while searching on Google. The secondary hypothesis is derived from Nisbett's theory of cultural cognition, which suggests Westerners seem to act more like analytically minded people and East Asians tend to be more like holistically minded people. Since holistic cognitive style indicates more exploration, it is expected to observe more search activities from the Chinese participants, especially at the behavioral level. Furthermore, as analytical cognitive style

suggests more attention to the content, it is expected to observe fewer activities from the American participants. Additionally, we anticipated that the Iranian participants would act more like their Chinese counterpart in the search activities. Because, considering Hofstede's dimension of culture scales, Iranians and Chinese share more similar cultural values with each other than with their American counterpart (Hofstede et al., 2010). Besides, the Iranian and Chinese participants were required to perform the given search tasks in English, which is their second language

Because we are interested in the search behavior on SERPs, we mainly focused on the part of data that corresponds to the time when the participants were on the search result pages. Additionally, we analyzed the fixation rates and average fixation durations for the entire time spent on task to obtain an overall understanding of the participants' behaviors. More, we did not consider the data for the time before the SERPs was loaded on the browser.

To make the discussions more comprehensible, the dependent variables in this study were categorized into three groups: the variables that associate with cognitive workload (e.g. task time and fixation duration), variables that relate to analytic behavior (e.g. fixation rate), and the variables that explain exploring behavior or search activities (e.g. number of clicks and mouse movement). Additionally, since the participants performed two different tasks, (however not the main goal of this study) we also discussed whether task differences influence any of the search behavior factors. The rest of this chapter will be focused on discussing the study questions based on the results from the analysis chapter.

5.1 Discussions

5.1.1 RQ1: In which ways, if any, do task differences influence searching behaviors?

To achieve a realistic search behavior, search tasks were formulated according to the Simulated Work Task Situation model proposed by Borlund and Schneider (2010). Each participant completed two tasks (one analytic and one explorative) in random order. Participants were required to type in each set of phrases in the search box and then look for the answer to the question on the search results page. The results from the Repeated Measure ANOVA (Table 4.7) show there was no within subject effect between task differences and the two independent variables (country of origin and cognitive style). Also, there is no evidence of relationship between tasks and the measurements of search behaviors, except for the number of clicks. In order for participants to finish task 2, they needed to explore more search results comparing to task 1; which explains the meaningful influence of task differences on number of clicks. For the rest of the search measurements, however, the observed differences in search behavior (as discussed below) between the cultural groups are independent of the task type.

Even though several studies argue that task types influence search behaviors (e.g. Liu et al., 2010; Lorigo et al., 2006; Cutrell & Guan, 2007), there was no significant evidence of task effect on eye gaze measurements and mouse movement in this study. The difference in findings can be due to the differences in the analysis and variable definitions. Tasks in this study are considered as different conditions/treatments of the independent variables rather than the independent variable. In other words, we studied the changes in the means of search behavior measurements for different cultural groups under different conditions, which were the two tasks in this study. In RM ANOVA, the

magnitude of the difference between means can appear to be large and there still not be a significant difference (as seen in Tables 4.6 and 4.7 for 'task time' and 'mouse movement'). This observation could be because the variation within and between responses (ratio variable and interaction term) is included in the effect analysis in RM ANOVA. For instance, for 'mouse movement' there is significant interaction effect of task and cognitive style.

5.1.2 RQ2: Do country and cognitive style differences influence measures of searching behavior?

Here we discuss the influence of country of origin and the participants' cognitive style scores on search performances separately. Current literature provides some evidence that suggests there is a relationship between search behaviors and cognitive styles. While some researchers argue there is a direct relationship between cognitive style and search activities (e.g. Kao et al., 2008; Ford et al., 2002), some others believe that cognitive style influences search behaviors in conjunction with other factors such as prior search experience. Palmquist and Kim (2000) argued that while cognitive style had a significant influence on the search performance of novice searchers, the influence was greatly reduced in those searchers who were comfortable with online searching. Hence, previous search experiences influence effects of cognitive style on the search performance (Palmquist and Kim, 2000; Kim, 2000). In a similar study, researchers found a correlation between cognitive style and the searching experience and that this interaction affected the search behavior (Park & Black, 2007).

In this study, however, there was no correlation found between the cognitive style scores as measured by the E-CSA-WA test and any of the search measurements. This

result could be because the participants were selected from a homogenous population with regards to their previous search experience. Unlike previous studies, the sample population was selected from those students who had extensive searching experience (at least 5 years) on Google. Hence, even though the finding agrees with some previous studies, there was no evidence that indicates there is a relationship between cognitive style and the predictors of search behaviors.

Even though we did not observe a correlation between cognitive styles and search performances, the results from the analysis of variance test between the country of origin and the search variables reveal significant evidence that the means of the dependent search variables change with the participants' nationality. The findings are in line with similar studies that examine search behavior through the lens of culture with the use of eye tracking method. Komboldi and Hercegfi (2010) investigated the differences between American and Hungarian students via psychophysiological tools and found there are varying levels of cultural differences in information seeking on the Web. Similarly, in a cross cultural study of Web search behavior with the use of eye gaze measurements, Marcos and colleagues (2013) suggested that the Middle Eastern and Western European students differ in reading patterns, time on SERPs, number of scanned results, and success rate. Another study between Finnish and American participants found that there are cultural differences in choice of initial search strategy (Iivonen & White, 2001).

To examine search behavior in this study, several eye gaze and click variables were utilized to discover any correlation between nationality and the participants' analytical behavior (fixation rate), exploratory behavior (click data and scanpath length) and their cognitive load (fixation duration and time data) during the course of search. The

P-value for most of the dependent factors is significantly smaller than .5, which means there is strong evidence that nationality is associated with the measures of search behavior. The study findings suggest the country of origin affected the search measurements as listed in Table 5.1.

Table 5.1 Country*dependent variables ANOVA

Independent variable	**Method**	**Dependent variable**	**Significant evidence**	**P- value (<.05)**	
				Task 1	**Task 2**
Country	**ANOVA**	Task time	Yes	0.006	0.010
		Search time (proportion)	Yes	<.0001	0.005
		No. of links	No	0.544	0.385
		No. of clicks	Yes	0.022	0.041
		Mouse movement	Yes	0.018	0.003
		Gaze duration	No	0.07	0.290
		Scanpath length	No	0.772	0.347
		Average fixation duration	Yes	<.0001	<.0001
		Fixation rate	Yes	0.027	0.020
		Average fixation duration to first click	Yes	<.0001	<.0001
		Average fixation duration_task	Yes	<.0001	<.0001
		Fixation rate_task	Yes	<.0001	<.0001

From the dependent factors, the number of links activated, length of scan path, and the gaze duration on SERPs were not found to be influenced by the differences in the participants' country of origin. However, even though there were no variations in the average time the participants spent on Google, the proportion of the time spent on Google over the task time was significantly affected by the nationality of participants. As it will be discussed in the last question, the search time proportion was larger for the American participants comparing to the Iranian and Chinese participants. This difference in search

behavior could be because the Americans may tend to trust Google and the information provided by Google Search more than the Iranians and Chinese participants; thus, they tended to spend more time on SERPs because they expect to find their answers from the result page itself rather than exploring the contents of the links provided.

5.1.3 RQ3: How do the two sets of independent variables (cognitive style and country) interact with each other to determine searching activities?

Based on the theory of cultural cognition (Nisbett & Norenzayan, 2002), the assumption was that there is an interaction between the cognitive style and country variables. To identify the participants' cognitive style, they were required to take the computerized cognitive style analysis test (E-CSA-WA) that was designed by Peterson and her colleagues in 2003. The 'Median Wolistic Analytic Ratio' (Med W/A RT) score was used in the analysis of variance between the participating cultural groups. The Med W/A RT scores of the participants followed right skewed distribution and ranged between minimum of .56 and maximum of 2.23 with the mean score of 1.3 and standard deviation of .32. Yet, the results of ANOVA test did not provide any significant evidence that supports the interaction between cognitive style score and the country of origin in relation to the measurements of search behaviors. Also, the results of between factor analysis of variance on cultural groups and the cognitive style score did not suggest that the means of cognitive scores are different between the participating cultural group (P- value= .99).

Even though existing literature suggests that people's cognitive styles vary across nations and cultures (Nisbett & Miyamoto, 2005; Frankish & Evans, 2009; Choi et al., 1999; Ji et al., 2004), there was no observed variations between the participating nationalities. One reason that can attribute to the similarity between the participating

groups is that the sample population was merely selected from a pool of the graduate students (mainly doctorates) whom may share similar thinking styles. The finding may suggest that there might be a correlation between cognitive style and the level of education, which needs to be examined in future studies.

5.1.4 RQ4: In which ways, if any, do cognitive style differences and country of origin influence searching behaviors?

In the discussion section for the second research question, we found that there are number of search behavior measures that are affected by the differences in the participant's home country. In this section, we will discuss the differences in search behavior between the three different nationalities with regards to the theoretical framework of this research. First, we will discuss the results for search activities to examine how and in which ways the participating groups' explorative behavior differ from one another. Second, we discuss the fixation rate differences between the groups. Last, we examine the time factors and the variations between nationalities. The data used for comparison in this section is based on the results from the Tukey-Kramer's least squares means analysis as shown in Table 5.2. As shown below, the numbers are relatively larger in task two than task one. This difference is because the participants were required to search for more aspects in order to find enough information to answer the second task. Whereas, task one was an analytical question and simpler in comparison to task two.

Table 5.2 Tukey-Kramer least squares means

	Least Squares Means					
	Adjustment for Multiple Comparisons: Tukey-Kramer					
Dependent variable	**Task 1**			**Task 2**		
	Americans	Iranians	Chinese	Americans	Iranians	Chinese
Task time	259.88	434.55	354.34	583.02	752.63	686.74
Search time (proportion)	0.38	0.24	0.30	0.35	0.23	0.29
No. of clicks	7.52	8.58	9.95	19.44	25.13	26.19
Mouse movement	25368.59	39947.40	36447.83	50074.22	95136.32	83134.72
Average fixation duration	354.04	439.10	416.60	358.39	442.70	427.78
Fixation rate	6.53	5.33	5.01	9.98	7.10	6.24
Average fixation duration to first click	343.39	436.60	416.32	343.74	450.21	421.00
Average fixation duration_task	348.70	447.97	421.94	350.72	448.34	430.95
Fixation rate_task	2.91	2.37	2.14	3.07	2.50	2.19

To examine differences in the explorative behavior while searching on Google, the number of clicks, length of mouse movement, and the number of links activated were analyzed with respect to the country of origin variable. The results suggest that even though the participants' behavior did not differ in the number of links they opened during the search, they showed notable differences in their click behavior on Google. The Chinese participants had higher number of clicks on Google followed by the Iranians and Americans. In terms of mouse movements on SERPS, the Iranians had the largest movement (measured by number of pixels) followed by the Chinese and then Americans. Hence, the American group showed fewer mouse activities (clicks and movement) as compared to their Chinese and Iranian counterparts. The results appear to agree with the study's assumption that hypothesized that the American participants tend to be less explorative than the other two groups as it was suggested by Nisbett's theory.

As mentioned earlier, the international participants performed the search activities in English, as their second language. Therefore, it is plausible that it took longer for the Iranian and Chinese participants to finish the tasks. Furthermore, the results showed that the international participants had longer average of fixation durations than the Americans did. Longer fixation durations in eye gaze studies indicate higher cognitive workload (Holmqvist et al., 2011). The higher the mental workload is, the more difficult the task is. Therefore, the observed longer average fixation time for the non-native English speakers indicate that they needed more time to understand the content. However, despite showing shorter task time and fixation duration, the results showed that the Americans had higher fixation rate than the other two nationalities. Higher fixation rates mean the Americans had more numbers of fixations in comparison to the Iranians and Chinese for their time on Google. Higher number of fixations indicates higher frequency of fixations or focus.

The findings suggest that the Americans tended to be more analytic during the search activities in comparison to their Asian counterparts, despite the fact they had lower average fixation duration and task time. As illustrated in the figures 2-7 in chapter 4, the Americans had higher number of fixations followed by the Iranians and then Chinese participants, while maintaining similar F-shaped viewing patterns. The results are in line with the research assumption that hypothesized the Americans act more analytical and are more focused than the other two nationalities. The analytical behavior of the American not only was observed while searching on Google, but also when they were examining the contents of pages other than SERPs. On the other side, the Chinese and Iranians engaged more in exploratory activities (more clicks and movements) and were more active and less analytical while performing the searching tasks. Additionally, the higher

fixation rate for the Americans could also be attributed to the language of search, which was English. Comparing to the Iranians and Chinese, it is possible that the American participants tended to be more attuned to the information provided on SERPS because they were more familiar with the language. Therefore, they were able to grasp more information during search time compared to their international counterparts, thus higher fixation rate.

Even though we observed variations in the fixation rates and average fixation durations between the groups, the means of gaze duration on Google seems to be equal for all nationalities. Yet, the search time ratio was higher for the Americans than the other two groups. This finding indicates that the proportion of the time spent on searching on Google over the time spent on reading the contents of the links was higher for the Americans followed by the Chinese and Iranians, which could be due to the trust factor as discussed earlier. It is likely that the American participants tended to spend more time on search pages because of their possible trust in the information that was provided to them by Google and their expectations to find answers on SERPs rather than websites.

As mentioned above, the Chinese and Iranian participants showed lower fixation rates and higher fixation durations than the Americans while searching on Google. Similar analyses on those indicators at the task levels also revealed the same behaviors for the participating groups. While the smaller fixation durations showed that overall it was easier for the Americans to perform the tasks, the higher fixation rates showed that they tended to be more focused than the other groups. Moreover, like the fixation durations on Google, the average fixation durations for taking the first action seem to be

affected by the country of origin. The Iranians had longer fixations followed by the Chinese and Americans.

5.2 Conclusion

Considering the research hypotheses and the results, we found that the Americans' search behaviors tended to be more analytical and less explorative, whereas the Iranians and Chinese tended to engage in more exploratory behaviors. Also, even though it took longer for the non-American participants to finish the task, they spent less time on Google comparing the American participants. Overall, considering the higher fixation durations or cognitive workload for the Eastern participants (despite similar length of scanpath), it can be concluded that the language factor plays a critical load in the users' search performance. Yet, given the higher fixation rates and lower click activities for the Americans, the findings agree with the theories about holistic cognition of Eastern cultures versus the analytic style in Western cultures. It needs to be noted that despite the observed variations in the search behaviors (both at the behavioral and cognitive levels) between the participants from Eastern and Western cultures, no evidence was found that indicated a relationship between nationality and cognitive style as measured by the E-CSA_WA test.

From the eye-tracking's standpoint, the average fixations and fixation rates are normally in an inverse relationship (Holmqvist et al., 2011), which is the pattern we also observed in this study. As shown in Table 5.2 while international groups possessed larger average fixation durations, they showed lower fixation rates. On the contrary, the Americans had smaller average fixation durations, but higher fixation rates. In addition, congruent to the observations in this study, the time on task and the average fixation

durations are often in a direct relationship (Holmqvist et al., 2011). The direct relationship suggests that the longer the time users spend on task, the more difficult the task is. In this study, the results showed higher mental workloads for the international students than for the Americans. Overall, even though the tasks appeared to be less difficult for the Americans, they tended to be more focused (analytic) than their Eastern counterparts. In contrast, the Iranians and Chinese acted more holistically and engaged more in exploratory activities.

5.3 Limitations

As with any experimental study, the generalizability of the results in this study is limited to the setting and the tasks used. The sample population for this study was selected from a unique population with certain characteristics. The sample consisted entirely of graduate students and due to time and money limitations, the study was limited to one hundred and eleven participants. Also, the non-American participants were selected from those who have migrated to South Carolina for their higher education (with excellent level of English proficiency) so may not fully reflect the dominant culture of their nationality. Moreover, the study was conducted in a controlled eye-tracking lab, which does not necessarily reflect a real life environment. Additionally, the employed models of the eye-tracker and mouse tracker can arguably affect the precision of the data collection. Due to the budget limitations in acquiring the user experience facilities, we were required to limit our options to certain devices with lower price tags. Hence, for validation purposes, there is a need for more cross-cultural studies of searching behavior with higher precision neurophysiological tools.

The cognitive style analysis (E-CSA_WA) test, used in this study, is just one of the tools to assess cognitive styles. Cognitive styles also include other dimensions beyond 'wholist-analytic', which was the only dimension employed in the E-CSA_WA score analysis. Therefore, there is a need to consider other cognitive styles assessment tools in future studies.

In this study, the participants were asked to perform pre-designed search tasks on Google. Therefore, their information need was limited to what was required to perform the assigned search tasks. In the future, there is a need to expand the study by giving a choice to participants to search for their own identified information problems.

Despite the limitations and with respect to the broad variety of variables observed, we observed several statistically significant correlations. Therefore, we believe that the results show a certain connection between culture or the nationality of users and their search behaviors. The post-hoc power analysis suggests 85 percentage of precision in the results; yet, the findings cannot be extended to the entire population of Americans, Chinese and Iranians because of the limitations related to the quantity and quality of the sample and data gathering, which calls for more elaborate study designs in the future.

5.4 Future studies

Due to the imperative role of language in search behavior, it is required to replicate this study in the participant's mother language. Even though there are a few studies that suggest cultural factors' influence is more dominant than language (e.g. Ji et al., 2004; Setlock & Fussell, 2011), we are still far from fully understanding information behavior with respect to the interaction between language and culture. The cultural

studies of search behavior are still young and need more scientific and rigorous investigations with the use of cognitive research methods.

Despite the broad variety of independent variables in search behavior, the discussions in this study were around the country of origin and their cognitive style. Yet, there exists several other variables such as level of education, gender, field of study, search experience, first language of choice for searching, etc. that can be considered as the predictors of search behavior. The findings of this study can be employed in a search behavior model building procedure to better understand what factors are involved in a particular behavior and/or cognitive process, and how these factors interact to produce the outcomes they do. In an upcoming publication, we will discuss the differences in the gaze and click behaviors with respect to the Chinese participants' first language of search. Moreover, by utilizing eye gaze data to supplement the mouse data in this study we found that the users' log data might not provide a comprehensive understanding of the users' experience with the system. Hence, it is required to include some forms of neurophysiological tools in the studies of user behavior to obtain a complete perspective about their behaviors.

5.5 Implications and Suggestions

This study, which focused on Eastern and Western graduate students at the University of South Carolina, contributes to the existing literature on cross-cultural studies of search behaviors. Results provide substantial evidence that there is a connection between country of origin and the measures of search behaviors when searching in English. For search engine designers, the results provide insight for increasing search performance by adapting the SERPs information architecture toward

users' nationalities and their behavior. For software engineers, the results suggest users from different countries have different approaches in perceiving information, therefore when designing for a large audience of international users, regardless of the language of the content, it is imperative to consider cognitive differences between different nationalities for higher usability. For the user-experience research community, the results suggest utilizing cognitive research methods provides a comprehensive perspective on actual users' behaviors, some of which may not be identifiable through users' log data. For those educators who also interface with international students, the findings suggest that they may need to employ a culturally sensitive adaptive approach in providing information to their students. Considering cultural differences in searching for information might help with providing more effective and efficient learning environment for students.

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APPENDIX A

STUDY DEMOGRAPHIC SCREENERS

2. **Gender** *
Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Prefer not to say

3. **Current education status** *
Mark only one oval.

- ◯ Undergraduate
- ◯ Graduate Student- Master
- ◯ Graduate Student- Doctoral
- ◯ Graduate Student- Post Doctoral

4. **Field of study** *
Mark only one oval.

- ◯ Engineering (ex: computer, electrical, civil)
- ◯ Science (ex: physics, chemistry)
- ◯ Social Science
- ◯ Medical

5. **What year are you in?** *
Mark only one oval.

- ◯ 1st
- ◯ 2nd
- ◯ 3rd
- ◯ 4th
- ◯ 5th
- ◯ 6th

6. **What Language(s) do you speak?** *
Tick all that apply.

- ☐ Chinese
- ☐ English
- ☐ Persian (Farsi)
- ☐ Spanish
- ☐ Other

7. **Are you an international student?** *
Mark only one oval.

- ◯ Yes *Skip to question 8.*
- ◯ No *Skip to question 11.*

International students

8. **Where is your home country?** *
Mark only one oval.

- ◯ Bangladesh
- ◯ China
- ◯ India
- ◯ Iran
- ◯ United states
- ◯ Other

9. **How many years have you been leaving outside of your home country?** *
Mark only one oval.

- ◯ less than a year
- ◯ 1-2 years
- ◯ 3-4 years
- ◯ 5-6 years
- ◯ 7 or more years

10. **What is your TOEFL iBT score range?** *
Mark only one oval.

- ◯ 70-80
- ◯ 81-90
- ◯ 91-100
- ◯ 101-110
- ◯ 111-120

Last page

11. **How many years of experience do you have searching for information on the Web in English?** *
Mark only one oval.

- ◯ less than a year
- ◯ 1- 2
- ◯ 3-4
- ◯ 5-6
- ◯ 7 or more

12. **Are you able to participate in 1 hour in-person lab study at Davis College? Located at 1501 Greene St.** *

Mark only one oval.

- ◯ Yes
- ◯ No

13. **What's the best E-Mail address to contact you?** *

_____

14. **Whats the best phone number to contact you?**

_____

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Search Experience

*Required

1. **How often do you use Google for searching?** *
   Mark only one oval.
   - multiple times a day
   - once a day
   - once a week
   - once in a while

2. **How often do you search in English?** *
   Mark only one oval.
   - always
   - frequently
   - sometime
   - never

3. **How comfortable you are searching in English?** *
   Mark only one oval.
   - very comfortable
   - comfortable enough
   - not comfortable

4. **What is your first language choice for searching?** *
   Mark only one oval.
   - English
   - Chinese
   - Persian
   - Spanish
   - Other

5. **What language do you speak at home?** *
   Mark only one oval.
   - English
   - Chinese
   - Persian
   - Other

6. **Were you born and raised in your country of birth?** *
Mark only one oval.

- ◯ Yes
- ◯ No

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APPENDIX B

CONSENT FORM

My name is Sara Chizari. I am a doctoral candidate in the School of Library and Information Science at the University of South Carolina. I am conducting a research study in the field of online information behavior, and I would like to invite you to participate in my study. This study is funded by the University of South Carolina Office of the Vice President for Research. The purpose of the study is to explore the impact of culture on humans' online browsing behavior. This form explains what you will be asked to do if you decide to participate in this study. Please read it carefully and feel free to ask any questions you like before you make a decision about participating.

The aim of this study is to investigate the role of culture and cognitive style in humans' online information searching behavior. In particular, you will be asked to look for information on the internet in your own tradition. You will be given a survey that asks for your demographic information and then you will be asked to perform 2 tasks (using English). Also, you will be asked to take a test called CSA-WA, which determines your cognitive style. While you are looking for information on the web, your activities will be recorded through eye-tracking, mouse tracking, and screen recording technologies.

There are no known risks associated with participating in this research except a slight risk of breach of confidentiality, which remains despite steps that will be taken to protect your

privacy. Study information will be kept in a secure location at the University of South Carolina. The results of the study may be published or presented at professional meetings, but your identity will not be revealed.

Although you probably won't benefit directly from participating in this study, I hope that others in the web design community in general will benefit by the result of this study. In this study I aim at investigating whether users' national culture has any impacts on the way they browse for information on the web.

At the end of this experiment you will receive $10 as a token of appreciation for your participation in this study.

Participation is anonymous, which means that no one (not even the research team) will know what your answers are. So, please do not write your name or other identifying information on any of the study materials. The only document with your name on it will be this consent form, and it will be stored separately from your study information. Your responses will only be identified by a participant number, which will not be linked to your identity.

Participation is confidential. The results of the study may be published or presented at professional meetings, but your identity will not be revealed. A number will be assigned to each participant at the beginning of the project. This number will be used on project records rather than your name, and no one other than the principle investigator will be able to link your information with your name. Study records will be stored in locked filing cabinets and protected computer files at the University of South Carolina.

I will be happy to answer any questions you have about the study. You may contact me at chizari@email.sc.edu or my faculty advisor, Professor Sam Hastings, hastings@sc.edu if you have study related questions or problems. If you have any questions about your rights as a research participant, you may contact the Office of Research Compliance at the University of South Carolina at 803-777-7095.

Taking part in the study is your decision. You do not have to be in this study if you do not want to. You may also quit being in the study at any time or decide not to answer any question you are not comfortable answering. Participation is not related to your regular course work and participation or withdrawal will have no impact on grades.

I have read the contents of this consent form and have been encouraged to ask questions. I have received answers to my questions. I give my consent to participate in this study, although I have been told that I may withdraw at any time without negative consequences. I have received (or will receive) a copy of this form for my records and future reference.

□ Yes – I want to participate in the study.

-OR-

□ No – I do not want to participate in the study.

_____ _____

Participant's Signature Date

APPENDIX C

POST – TASK QUESTIONS

Will you be able to answer the question(s) you were asked in this task? In other words, will you be able to tell us what you have found regarding the question(s)?

Yes	Almost	Somehow	Maybe	A bit	No

How confident you are about your findings? Have you found the answer(s) you were looking for?

100%- Yes	80%- Almost	60%- Somehow	40%- Maybe	20%- A bit	0%- No