Chapter X
Perceptions of Mobile Device Website Design:
Culture, Gender and Age Comparisons

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ABSTRACT

Anytime anywhere services offered through mobile commerce hold great potential to serve customers in wireless environments. However, there is limited understanding of how mobile Web site design is perceived by diverse users. This chapter explores how users who differ by culture, age, and gender perceive the design of a mobile device and their subsequent level of satisfaction with the device. Sixty subjects were tested in a controlled laboratory experiment on an Internet enabled phone. The results of a quantitative analysis were statistically inconclusive in terms of cultural and gender differences, but significant differences were found between older and younger users. However, an in-depth qualitative analysis of interview transcripts revealed some interesting differences among cultural, gender and age groups. Consistent with findings in the stationary Internet domain, design elements were found to impact satisfaction with mobile services.

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INTRODUCTION

Organisations will be well served to not be complacent with their wireless site design efforts… [But] *before wireless site designers can address the usability challenge, and before organisations can leverage the commercial benefits of m-commerce, a deeper understanding of what aspects of usability is important to users and how they may differ in a wireless context is required*. (Venkatesh et al., 2003, p.56)

Mobile commerce[1] (or m-commerce) has huge potential to serve customers in wireless environments. The adoption of m-commerce is dependent on consumer acceptance of new and well-designed technologies (Ancker & D'Incau, 2002; Coursaris et al., 2003: Kim et al., 2002; Kumar & Zahn 2003; Nysveen et al., 2005; Perry et al., 2001; Schrott & Gluckler, 2004; Yang, 2005). It is expected design characteristics may influence user perceptions towards a mobile device. Congruent with work done by Cyr (2008), Information Design (ID), Navigation Design (ND), and Visual Design (VD) may all contribute to user adoption of a technology, as well as to satisfaction with a mobile technology.

Concerning user attitudes of handheld devices, it is also expected that diverse categories of users based on culture, gender, or age may react differently to using the device. There is growing literature on cross-cultural website design, mostly evaluated within the context of the stationary Internet (Becker, 2002; Chau et al., 2000; Cyr, 2008; Cyr et al., 2006; Cyr & Trevor-Smith, 2004; Marcus & Gould, 2000; Sun, 2001). More recently, research has examined culture and mobile data services (Choi et al., 2006). Investigations have likewise examined gender and design in the context of mobile devices, but research results are mixed (Anckar & D'Incau, 2002: Kwon & Chidambaram, 2000; Teo et al., 1999). Finally, research that examines cohorts by age (younger versus older users) is practically nonexistent when design is considered, although some studies have focused on special needs and preferences of older users (Goodman et al., 2005), or features of a mobile device perceived by user groups as adding value (Anckar & D'Incau 2002).

To explore the role of user differences concerning the perception of the design of a mobile device, users who differ on cultural, gender and age dimensions were tested on an Internet enabled cellular phone. Related to culture, Canadian and Chinese cultures were chosen due to acknowledged diversity (Hofstede, 1980). Between-group comparisons were conducted with respect to screen design (including information design, navigation design, and visual design), and satisfaction with the mobile device. In an exploration of these topics, the paper provides a review of relevant literature leading to the hypotheses for testing, the methodology used, an elaboration of results, and discussion of the findings. Given the increased diversity of mobile users, developing an expanded understanding of user perceptions and preferences not only has theoretical importance, but also serves to enhance the reengineering of devices to best meet consumer requirements.

MOBILITY AND DESIGN

In the realm of the stationary Internet, effective website design engages and attracts online consumers (Agarwal & Venkatesh, 2002; Fogg & Tzeng, 1999; Hui & Triandis, 1985; Morgan & Hunt, 1994; Schultz, 2003). According to Gommans et al. (2001), 'A website has to be designed for a targeted customer segment…' Chau et al. (2000) argue the modes of information presented on the Internet, and the quality of graphics has a significant impact on user experience. Research in design suggests various guidelines for effective Web navigation (Childers et al., 2001; Farkas & Farkas, 2000), criteria for optimal Web design (Bernard, 2002; Egger 2001), and how aesthetics and usability might be linked (Tractinsky, 1997).

The sensory experience of the website can help to determine if a user stays and shops at a site (Rosen & Purinton, 2004; Yoon, 2002).

The quality of handheld displays that favor enhanced information design and visual design is steadily increasing and affects user perceived effectiveness of the presentation (Rau et al., 2006). While mobile screens are much smaller than those available on the stationary Internet (Schmidt & Frick, 2000), various studies demonstrate comprehension rates on smaller screens are generally equivalent to their larger counterparts (Dillon & McKnight, 1990; Duchnicky & Kolers, 1983; Resiel & Shneiderman, 1987). Other researchers consider the smaller screens of mobile devices a 'serious obstacle to usability of the mobile Internet' (Chae & Kim, 2004, p. 165). Sarker & Wells (2003) examined interface characteristics and network capabilities that affect the implementation and acceptance of wireless phones. They discovered while users were 'quite forgiving of physical limitations of the device due to technological constraints, they were bothered by flaws in the interface of the devices' (p. 37).

In recent years there has been increased attention to mobile usage and in 2004 the *International Journal of Human-Computer Studies* devoted a special issue to this topic. The issue addressed mobile use in a variety of contexts including human characteristics and interface systems, although design aspects of the mobile website were not specifically considered. Further, in 2005 *Behaviour & Information Technology* devoted a special issue to mobility from a human computer interaction (HCI) perspective. Topics included navigation support, user acceptance and trust, and user evaluation of usability of mobile devices. In research in which interface design and usability are examined for wireless devices in m-commerce, Tarasewich (2003) suggests many current principles of interface design can be transferred to mobile devices. He examines various issues such as content, user interaction with the device, issues of reading text on small screens, rapid serial visual presentation, and browser types.

Relevant to the current research, design categories for information design, navigation design, and visual design as suggested by Garrett (2003) were selected for systematic examination. A definition of each category follows.

a. **Information Design:** Elements of the site that convey accurate or inaccurate information to a user. For instance, the location of an icon on the screen would be the domain of information architecture, but whether or not that icon conveys the right information to a user is the domain of information design. Clear and logical presentation of information about services or products is also a component of information design.
b. **Navigation Design:** The navigational scheme used to help or hinder users as they access different sections of the site, such as the location and format of navigation aids.
c. **Visual Design:** Elements that deal with the balance, emotional appeal, aesthetics, and uniformity of the website overall graphical look. This includes colors, photographs, shapes, or font type.

These categories are represented in other work in design (Agarwal & Venkatesh, 2002; Yoon, 2002; Flavian et al., 2005; Palmer, 2002; Simon, 2001), and while not exhaustive are representative of key elements of website usability. The same categories were used by Cyr (2008) to study website design across cultures, and by Cyr and Bonanni (2005) regarding website design and gender. Further, in a study of mobile services Choi et al. (2006) consider three categories of user experience across cultures. These are content (similar to information design), information architecture (which includes navigation design), and graphical user interface (which is similar to visual design). In this research, information design, navigation design, and visual design are considered in the specific context of a mobile device.

Culture and Design

User preferences for website design features are known to vary across cultures (Barber and Badre, 2001; Cyr, 2008; Evers and Day, 1997; Nielsen and DelGaldo, 1996; Sun, 2001). Cyr and Trevor-Smith (2004) examined design elements for 30 municipal websites in each of Germany, Japan, and the United States. Significant differences were found across countries for use of symbols and graphics, color preferences, site features, language, and content. In a study in which user impressions were evaluated toward eight website design features, numerous differences were detected between collectivist Japanese and Chinese users with individualist British users (Hu et al., 2004). In the current investigation participants are tested who are either Canadian or Chinese. With respect to these cultures, Singh et al. (2003) compared domestic and Chinese versions of websites for 40 American-based companies and found differences in all the cultural categories examined.

Studies of m-commerce in different countries and considering different cultures are rare, although 'an understanding of the cultural dimensions of a market can aid marketers immensely in developing appropriate m-commerce services…' (Harris et al., 2005). In response, research in the area of culture and mobility is beginning to emerge. Cross-country differences were found for adoption of mobile applications in Hong Kong, Japan, and Korea (Kim et al., 2004), between the UK and Hong Kong (Harris et al., 2005), and between France and the USA (Carlson et al., 1999). Lee et al. (2002) compared Japan and South Korea in a study of m-commerce usage, and found significant cultural differences regarding value structures of the mobile Internet and their effect on users' satisfaction.

More specifically, and with respect to information design, research comparing user preferences in Canada, the U.S., Germany and Japan for perceived access and presentation of product information on a stationary computer uncovered few significant differences between the U.S., Canada, and Germany, but significant differences ($p<.01$) between these countries and a highly collectivist[2] culture like Japan (Cyr et al., 2005). Based on qualitative comments from the study, there appeared a desire on the part of Canadians, Americans, and Germans for utility - at least as far as obtaining site information is concerned. Choi et al. (2006) examined cultural characteristics and user experience attributes in mobile data services in Korea, Japan, and Finland. Based on qualitative findings, the authors found user experience attributes correlated to the user's culture and 'Finnish participants showed a cultural profile opposite to that of the Koreans' (p. 192). For example, in the area of information design Koreans and Japanese (both collectivists), preferred large amounts of information on a single screen while Finns (individualists) preferred direct, explicit communication and reacted negatively to large amounts of content. Related to the preceding studies, like the Finns, Canadians are individualists. Alternately, Chinese are collectivists in alignment with Koreans and Japanese.

H1a: *There will be differences between Chinese and Canadian users in the perception of information design of a mobile device. Canadian users will prefer utility in information design, while Chinese prefer more detail and depth of information presented in a mobile medium.*

Regardless of culture, users prefer easy to navigate websites. In an experiment using a stationary website, Simon (2001) found that North Americans prefer navigation that enhances movement and makes the interface simpler to use. In the study by Choi et al. (2006) in mobile data services as already mentioned, Koreans and Japanese liked clear and logical ordering of menu items, while Finns mentioned they most liked search facilities. Despite the paucity of prior research on navigation design across culture, and particularly in the con-

text of mobile devices the following exploratory hypothesis is offered.

H1b. *There will be no differences between Chinese and Canadian users in the perception of navigation design of a mobile device. Both Canadians and Chinese will prefer simple and logical navigation formats.*

User preferences vary by culture with respect to visual design of the interface. Color varies by culture. Red means happiness in China, but danger in the US (Barber and Badre 2001). When applied to Web design, color may impact user expectations of the interface as well as overall satisfaction (Barber & Badre, 2001). In a cross-cultural study on website design, a Japanese respondent indicated a preference for more pictures and an "emotional approach" (Cyr et al., 2005). In other work specifically focused on images used in website design, in qualitative analyses Canadians perceived images to have aesthetic, affective and functional qualities while Japanese respondents focused only on affective qualities (Cyr et al., 2006). Sun (2001) found that users from cultures such as China or Japan have a strong preference for visuals and aesthetic beauty of the interface. In a mobile context, Koreans and Japanese preferred colorful screen design and Finns preferred simple screen design with less emphasis on color (Choi et al., 2006).

H1c. *There will be differences between Chinese and Canadian users in the perception of visual design of a mobile device. Chinese will be more concerned than Canadians with aesthetic beauty in visual design.*

Gender and Design

Gender is frequently used as a basis for segmentation, and researchers have attempted to understand the fundamental similarities and differences between the men and women for decades (Deaux & Kite, 1987; Putrevu, 2001). Past empirical studies have shown significant gender differences across a variety of tasks and domains. For example, men often perform better than women on spatial orientation tasks, whereas females tend to score better on verbal or linguistic tasks (Simon, 2001; Deaux & Kite, 1987). Similarly, men and women differ in their reactions to visual images, affecting recall and recognition (Jones et al., 1998).

There are also gender differences in computer usage. Men and women diverge in Web acceptance, with perceived usefulness found to positively influence intention to use the Web more in men than women (Sanchez-Franco, 2006). Women use computers for collaboration and networking, while men view computers as a tool for obtaining and evaluating content (Gefen & Straub, 1997). Pearson et al. (2003) examined gender as a moderating variable to end-user computer efficacy, and found no differences between men and women although women were somewhat less confident to learn new computer applications. In other research, narrowing of differences between men and women has occurred concerning software use, anxiety, and enthusiasm (Rainer et al., 2003). Specific to mobile commerce, studies indicate that among Internet users men are predisposed to mobile adoption more than women (Yang, 2005; Brennan, 2000; Joines et al., 2003; Park & Jun, 2003; Rohm & Swaminathan, 2004). Contrary to these studies, gender differences were not detected in Spanish users related to shopping patterns and m-commerce adoption (Bigne et al., 2005).

It is anticipated the design of a website will impact user preferences, which in turn may produce different reactions between men and women (Chen & Dhillon, 2003). In one investigation in which gender and design are considered, Simon (2001) tests users' perceptions of a site, which refer to information richness, communication effectiveness, and communication interface. Women were found to have a less satisfied perception of the websites than men. Other work demonstrates differences between men and women for content

and navigation (Maltby et al., 2003) and preference for color or graphics (Rodgers & Harris, 2003). In a study of website design, Cyr and Bonanni (2005) found specific information design elements (such as site organization and presentation of product information) were perceived more favorably by men than women. Further, men found the sites easier to navigate, and liked certain visual design aspects such as degree of interaction and animations more than women.

The above findings on a stationary website suggest there will be differences between the preferences of men and women for interface design in a mobile context. This assumption will be explored in the following hypotheses.

H2a. *There will be differences between men and women in the perception of information design of a mobile device.*

H2b. *There will be differences between men and women in the perception of navigation design of a mobile device.*

H2c. *There will be differences between men and women in the perception of visual design of a mobile device.*

Age and Design

Age is another common dimension used to segment consumer and user groups. There has been a growing level of interest and research in issues relating human computer interaction and age groups (Goodman & Lundell, 2005). Some researchers have focused on the unique design characteristics posed by older adults. Hawthorn (2000) lists various physical, sensory and cognitive limitations that may alter with increased age and their implications for interface design. Physical limitations, such as reduced dexterity and precision, can make the use of small and delicate input devices (as found on various mobile devices) more difficult. Sensory limitations can create limitations for the design of computer output and cognitive limitations can affect the design of the interface itself. For example, cognitive spatial ability has predicted computer performance (Kelley and Charness 1995), and was demonstrated to decline with increasing age (Salthouse, 1992). In other research, age affected the retention of computer training (Brown, 2001), and confidence in learning new applications (Crosby et al., 2003). Older employees generally exhibited a less positive attitude towards computers (Brown, 2001), and were less satisfied users (Simmers & Anandarajan, 2001) than younger employees. It is expected that well designed visual cues such as text links and icons are able to support the needs of older users. The format for organizing Web contents and the amount of information appearing on a screen enable higher performance for older users as their visual search skills and selective attention diminish (Ellis & Kurniawan, 2000).

As with gender, studies that investigate mobile use or m-commerce with consideration of age or design are few. Stroetmann et al. (2002) found that 43% of elderly people surveyed had at least some difficulty with mobile devices and 21% had considerable difficulty because of some physical or cognitive impairment. In a study of Swedish teenagers, Weilenmann and Larsson (2000) reported that young people use a mobile phone in radically different ways from more mature adults. Younger users use a mobile device more for expression than for information, and for social purposes rather than for coordination or efficiency. In a study with Spanish users, younger people are more predisposed to m-commerce adoption than older Internet users (Bigne et al., 2005). In a report on mobile use in India (MACRO 2004), limited adoption of mobile devices among older users resulted from small buttons on the handset and tiny screens that impede user visibility. Goodman et al. (2005) found that text, speech, and photographs were all effective ways to present landmark information to older users using a mobile navigation aid.

In this investigation we are interested to examine design characteristics (such information design, navigation design, and visual design) as outlined by Garrett (2003) for a mobile device, in this case an Internet enabled phone. To our knowledge this is the first attempt to systematically examine these design features and how they may differ for older or younger mobile users. To develop some understanding in this area, the following exploratory hypotheses are offered.

H3a. *There will be differences between older and younger users in the perception of information design of a mobile device.*

H2b. *There will be differences between older and younger users in the perception of navigation design of a mobile device.*

H3c. *There will be differences between older and younger users in the perception of visual design of a mobile device.*

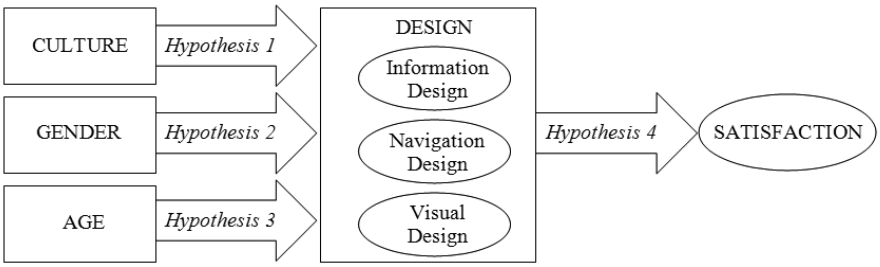
Design and Satisfaction

For many years customer satisfaction has been studied in physical environments (Balasubramanian et al., 2003; Parasuraman et al., 1988; Oliver, 1980 and 1999). More recently, research into consumer satisfaction has turned to the Web domain and examines 'stickiness' and 'the sum of all the website qualities that induce visitors to remain at the website rather than move to another site' (Holland & Baker, 2001). According to Anderson and Srinivasan (2002), e-satisfaction is defined as the contentment of the customer with respect to his or her prior purchasing experience with a given electronic firm. In the present research we adapt the definition for online satisfaction presented by Anderson and Srinivasan to suggest mobile satisfaction refers to contentment of the customer with the experience of using the mobile interface. However, there is no requirement for completion of a purchase in the current context. This definition is in alignment with Chae et al. (2002) who examined information quality related to user satisfaction for mobile Internet services.

Online satisfaction motivates online shoppers to stay at the site and return to the site in the future (Flavian et al., 2005; Bhattacherjee, 2001; Doll & Torkzadesh, 1988; McKinney et al., 2002) thus yielding a loyal customer outcome. In research into stationary websites, customer satisfaction is affected by content and context of the website (Flavian et al., 2005; Teo et al., 2003). More specific to information design, Szymanski and Hise (2000) discovered that product information and site design are critical to creating a satisfying customer experience. The experience of online shopping can be affected by the richness of product information presented (Palmer, 2002; McKinney et al., 2002), and is a dominant concern of the user (Kateranttanakul & Siau, 1999; Pitt et al., 1995; Zhang et al., 2000). A positive navigation experience and perception of a well-designed site may likewise result in online consumer satisfaction (Agarwal & Venketesh, 2002; Fogg & Tzeng, 1999; Palmer, 2002; Fogg et al., 2002; Hoffman & Novak, 1996; Koufaris, 2002; Nielsen, 2001), an enjoyable online shopping experience (Childers et al, 2001), and sales (Lohse & Spiller, 1999). Yoon (2002) found navigation functionality resulted in satisfaction, and induced Web visitors to remain at the site. Lohse and Spiller (1998) demonstrated that designing online stores with friendly user interfaces positively influences traffic and sales. Cyr (2008) found information design, navigation design, and visual design to all positively impact satisfaction for users from multiple countries.

While design research is limited within the mobile context, Tarasewich (2003) concluded: '[A]esthetics, along with usability, may also be part of designing an overall enjoyable user experience with mobile devices' (p. 12). Jiang and Benbasat (2003) found that mobile interface features can positively influence users' attitudes regarding product presentations. Graphical user interfaces, information architecture, and content

Figure 1. Research model for mobile services



all contributed to differences in perceived satisfaction with mobile data services (Choi et al., 2006). The preceding considerations lead to the final hypotheses:

H4a. *Perception of information design of a mobile device will impact user perceived satisfaction with the mobile device.*

H4b. *Perception of navigation design of a mobile device will impact user perceived satisfaction with the mobile device.*

H4c. *Perception of visual design of a mobile device will impact user perceived satisfaction with the mobile device.*

The above hypotheses as examined in this research are visually depicted in Figure 1.

RESEARCH METHODOLOGY

Participants

Sixty participants were recruited who were either Chinese or Canadian in origin (30 in each category). These countries were chosen to represent diverse cultural characteristics as per Hofstede (1980). Refer to Table 1.

Participants were also categorized by gender and age. Consistent with Aarnio et al. (2002), younger participants were 34 and younger and older participants were 35 or older. A relatively small sample size of 30 was chosen for each group due to the individualized and in-depth requirements of the data collection process. To participate, individuals must have used a cell phone for at least one year. In fact, all participants in the study were experienced users, and had owned a cell phone for approximately 4.5 years. Demographics of the sample appear in Table 2.

Table 1. Country comparisons (Source: based on Hofstede, 1980)

Country Dimension	Canada	China
Power Distance	Low (39)	High (80)
Uncertainty Avoidance	Low (48)	Medium (60)
Masculine	Medium (52)	Medium (50)
Individualism	High (80)	Very Low (20)
Long-Term Orientation	Very Low (23)	Very High (118)

Experimental Site and Device

Given the emphasis on aesthetics in usability, an attractive site was required, without interference from a slow or faulty live Internet connection. Most WAP sites in North America and Europe are primarily text based, however the Lonely Planet offered some visual treatment (www.lonelyplanet.com with access from a mobile phone at wap.lonelyplanet.com). Therefore the City Guide version of this site was chosen for the experiment and further enhanced. The site for this study featured a colored background and text cells, as

Table 2. Participant demographics

	Canadian (n=30)	Chinese (n=30)
Age	< 35 : 67% ≥ 35 : 33%	< 35 : 60% ≥ 35 : 40%
Gender	Male : 53% Female : 47%	Male : 43% Female : 57%
Highest level of education	High school : 40% Technical degree : 3% Undergraduate/College : 43% Masters/Doctorate : 13%	High school : 27% Technical degree : 3% Undergraduate/College : 53% Masters/Doctorate : 17%
Time spent online/week	22 hours	17.4 hours
Time owned a cell phone	4.8 years	4.4 years
Mobile Internet browsing experience	20%	17%
Use of the mobile Internet (if available)	Buy movie/concert tickets : 33% Download games/ring tones : 40% Check news : 50% Browse places to eat, shop, etc. : 47% Other: 33%	Buy movie/concert tickets : 30% Download games/ring tones : 60% Check news : 67% Browse places to eat, shop, etc. : 67% Other: 7%

well as photographs, maps and icons, among other features. Each version of the site was created in both English and Chinese. For the Chinese version, site contents were translated to Chinese, 'back-translated' from Chinese to English, and then this version was compared with the original English version to verify content equivalence. Screenshot pages appear in Appendix A. Testing occurred on a Nokia 6600 Internet enabled cell phone. This phone was considered very suitable to the aims of the investigation as it has one of the largest screens on the market and has a superior color display (65,536 TFT) capable of laptop quality images. The interface included a joystick option for easy navigation.

To prevent problems with download and browsing delays typical of a real website using WAP technology, website pages for the Lonely Planet were downloaded and saved locally on the cell phone. Based on feedback obtained from a pilot focus group (of 6), participants were not aware of this manipulation and perceived the connection to be '*real*'. Important to this study, saving the site locally allowed the content to be modified and the display speeds to be controlled.

Experimental Tasks

The pilot study with 6 participants was used to pre-test potential tasks and the experimental protocol including survey items and interview questions. Participants in the pilot study were initially asked to perform three information retrieval tasks: finding movie listings at a local theatre, choosing a restaurant in a different city, and booking a hotel in a different city. It was decided the restaurant task was most suitable because it was preferred by the pilot subjects and afforded excellent visual design opportunities. For the restaurant task, photos of the venue's interior as well as the map showing the location were included.

In the full study, each participant went through the experiment individually, under the supervision of a research investigator. For Chinese participants, all documents were translated and back translated, and a translator was available as required. The session began with a brief introduction and completion of a background data sheet, followed by familiarization with the Nokia 6600 device including a written summary of key functions. Once it was determined participants were

comfortable with the device they were read the following narrative:

Imagine that you have just arrived in San Francisco to meet up with an old friend. Your friend has suggested that you select a restaurant on your cell phone, and call her back with the address. Use the bookmarked CityGuide site to accomplish this task. Spend as much time as you need browsing through the featured listings for San Francisco. There is no need to actually write down any information or make any calls. Just let me know what your selection is when you're finished.

The device was then handed to the participant with the browser opened at the introductory page of the site. The site listing for San Francisco featured four restaurants. Participants first completed the task, and then responded to a survey and were interviewed regarding their experience. At the end of the experiment, participants were debriefed and received a $20 honorarium for their time.

Survey Instrument

Following the completion of the experimental task, subjects were asked to complete a paper-based survey. In this section, we provide an overview of the survey measurement items, focusing on its content and construct validity.

Content validity considers how representative and comprehensive the items are in creating the experimental constructs. Validity is assessed by examining the process by which the construct items were generated (Straub, 1989). Constructs should draw representative questions (items) from a universal pool (Cronbach, 1971; Kerlinger, 1964). In this research, survey items were adapted from previously validated work on Information design (Cyr et al., 2004 and 2005), Navigation design (Cyr et al., 2004 and 2005), Visual design (Cyr et al., 2004 and 2005; van der Heijden, 2003), and Satisfaction (Cyr et al., 2004 and 2005). All items were constructed as agree-disagree statements on a seven-point Likert scale. The complete survey appears in Appendix B.

Construct validity assesses the extent to which a construct measures the variable of interest. In other words, there should be high correlations between items of the same construct (convergent validity), and low correlations between items of different constructs (discriminant validity) (Straub, 1989). Results of the principal components analysis with varimax rotation appear in Table 3. The loadings for navigation design, visual design, and satisfaction construct items exceed recommended thresholds (Hair et al., 1998). However information design had two items (ID3 and ID4) that had high cross-loadings with items in the visual design construct. As such, ID3 and ID4 were removed from our analysis in order to maintain discriminant validity.

Discriminant validity can also be assessed by the average variance extracted (AVE) for each construct. As shown in Table II, the AVEs were all above the recommended 0.50 level (Fornell & Larcker, 1981), which meant that more than one-half of the variances observed in the items were accounted for by their hypothesized factors.

Construct reliability (internal consistency) of the four factors was examined using Cronbach's α-value. As shown in Table II, α-values ranged from 0.61 (for information design) to 0.89 (for visual design). Rivard and Huff (1988) suggest that this measure for reliability should be higher than 0.5 and ideally higher than 0.7. Navigation design, visual design and satisfaction α-values are well past this recommended threshold, and the α-value for information design (with its two items dropped) is also in an acceptable range. Therefore, our survey instrument encompassed satisfactory content validity (as evidenced from drawing construct items from existing validated literature); satisfactory convergent validity (as evidenced from high item loadings and construct reliability); satisfactory discriminant validity (as evidenced from low cross-loadings of factor items and the AVE for each factor); and satis-

Table 3. Principle components analysis and reliability

	ID	ND	VD	SAT
Cronbach alpha	.61	.84	.89	.84
AVE	.57	.68	.60	.56
Items				
ID1	**.775**	.221	.094	.101
ID2	**.730**	.020	.311	.245
ID3	.598	.271	.559	.176
ID4	.546	.227	.537	.300
ND1	.250	**.700**	.302	.175
ND2	.004	**.891**	.072	.249
ND3	.222	**.862**	.131	.039
VD1	.110	.093	**.859**	.146
VD2	.336	.157	**.833**	.182
VD3	.101	.122	**.601**	.510
VD4	.214	.200	**.789**	.291
SAT1	-.159	.240	.247	**.661**
SAT2	.326	.060	.223	**.857**
SAT3	.313	.102	.137	**.810**
SAT4	.408	.279	.290	**.646**

Notes: ID=Information Design; ND=Navigation Design; VD=Visual Design; SAT=Satisfaction

factory construct reliability (as evidenced from Cronbach's α-values).

Interviews

Following the completion of the survey, subjects were asked open-ended questions in a tape-recorded interview. The interview questions were meant to solicit additional information about the participants' experiences with the experimental task and interface. The questions probed how participants liked the design of the site, what they would change, and whether or not they found the device useful.

Responses were content analyzed and coded using Atlas.ti. This software provides an effective means to analyze qualitative data such as interview transcripts. The qualitative analysis process consisted of the following steps: (1) data preparation (i.e. interview transcription and formatting); (2) in vivo coding (use of participants' words as code labels) and open coding (use of arbitrary labels for code labels); (3) category and concept building in which semantic relationships between codes are identified to build higher conceptual abstractions; and (4) theory building based on interpretation of the results.

RESULTS

The descriptive statistics and correlations for the perceptual constructs are shown in Table 4. Each of the design variables (ID, ND and VD) was correlated to each other, as well as to overall satisfaction. From the demographic variables, only age is positively correlated with visual design.

Table 4. Descriptive statistics and correlations

	Mean	Std. Dev.	ID	ND	VD	SAT	GEN	CUL	AGE
ID	5.43	1.04							
ND	5.73	0.90	.37***						
VD	5.28	1.09	.53****	.43***					
SAT	4.98	1.11	.49****	.43***	.59****				
GEN	----	----	.09	.01	.09	.08			
CUL	----	----	-.06	-.09	.02	.17	.10		
AGE	----	----	.04	.07	.26**	.18	-.10	.07	

Notes:
1 ID=Information Design; ND=Navigation Design; VD=Visual Design; SAT=Satisfaction
2. Descriptive statistics not provided for GEN, CUL and AGE, as these are dichotomous variables
3. * p<.10; ** p<.05; *** p<.01; **** p<.001

Overall, respondents have a rather favorable impression of the mobile interface, with mean scores of over 5 out of 7 for information design (ID), navigation design (ND), and visual design (VD). The mean score for satisfaction is 4.98, also indicating overall satisfaction with the site. To probe these results further, a word count was run on transcribed interviews using the atlas.ti software. The word 'easy' appeared 69 times, mostly in response to the question 'Try to describe the navigation experience on the site'. As such, the majority of users find the navigation of the device easy. One respondent elaborates, '*[U]sing the joystick was pretty straightforward, once I remembered to go left and right to go up the links. It was more intuitive to use the scroll button up or down…*'

Although information design receives a relatively high mean score (5.43), more than half the respondents thought there could have been more information about the restaurants on the site. This split into two category codes: one related to not enough information for each restaurant, which typically was lack of a menu (code *menu*) and two, not enough choice of restaurants (under the code *choice*). In terms of visual design of the site, the following quote captures some of the favorable sentiments as expressed by a number of users: '[E]*asy to use, attractively displayed, something that awes people, this display is very graphically appealing. I really want to play with this.'* Another user comments: *'The colors were good. The colors were actually fairly robust. Resolution seemed to be pretty good.'*

Tests of Culture, Gender, and Age as Moderators

T-tests of differences between culture, gender, and age group means for design and satisfaction are shown in Tables 5, 6, and 7 respectively.

Additionally, interview data was coded using two methods: (i) in vivo (using the participant's exact words as the basis for a code), and (ii) open coding (using arbitrary labels to code the data). Interview responses were systematically categorized in each design area (information, navigation and visual design). Altas.ti was used to create a concept map for the design areas, highlighting the actual number of responses in each code based on gender and culture. Refer to Appendix C. Although the numbers are relatively low, they signify response trends between the groups. In addition, representative quotations are included. Further, more theoretical themes were created from the emerging concepts, across the design areas. The main themes from our interview data were:

Table 5. T-test of differences between culture group means for design and satisfaction

	Group Means	t-value	p-value
ID	Can: 5.48 Ch: 5.37	0.433	.667
ND	Can: 5.81 Ch: 5.66	0.688	.507
VD	Can: 5.27 Ch: 5.32	-0.176	.861
SAT	Can: 4.80 Ch: 5.17	-1.279	.206

Notes: Can= Canadian; Ch=Chinese

Table 6. T-test of differences between gender group means for design and satisfaction

	Group Means	t-value	p-value
ID	M: 5.33 F: 5.52	-0.698	.488
ND	M: 5.72 F: 5.74	-0.076	.939
VD	M: 5.19 F: 5.39	-0.685	.497
SAT	M: 4.87 F: 5.06	-0.576	.567

Notes: M=Males; F=Females

Table 7. T-test of differences between age group means for design and satisfaction

	Group Means	t-value	p-value
ID	<35: 5.39 ≥35: 5.48	-0.277	.784
ND	<35: 5.68 ≥35: 5.82	-0.626	.534
VD	<35: 5.08 ≥35: 5.66	-2.274	.027**
SAT	<35: 4.83 ≥35: 5.25	-1.501	.139

*Notes: * $p < .1$; ** $p < .05$; *** $p < .01$*

- **Information Breadth:** The number of alternative (restaurant) choices. This is encapsulated by comment such as 'choices are limited' and unmet expectations for 'a lot of restaurants represented'.
- **Information Depth:** The amount of detail for each alternative (restaurant) choice. This is encapsulated by participants seeking 'detailed menus', 'prices', 'famous dishes', 'parking', 'exterior shots', 'reviews' and 'hours of operation'.
- **Visual Ease:** Utilitarian view on the interface design's capability to facilitate the task. This is captured through comments such as 'adequate resolution', 'easy to read' and 'easy to look at'.
- **Visual beauty:** Hedonic view on the beauty of the interface design. This is captured through comments such as 'cute' design, 'should be more charming', 'put some music', and 'animation would be good'.
- **Navigation layout:** The layout of the information within the site. Captured by comments such as 'laid out in a logical way', and too much 'scrolling'.
- **Navigation challenges:** Navigation/interaction challenges mostly stemming from inexperience with the new technology. Encapsulated by comments such as 'counterintuitive joystick' and not convenient to 'press the left side to select the options'.

Table 8 summarizes the analysis of the interview transcripts across the above emerging themes and individual differences (culture, gender, age).

Based on the survey data, it is surprising no statistically significant differences are evident for culture or gender. However based on the qualitative analysis of the interview data some differences in these categories are indicated.

These results support H1a that Canadians prefer utility of information design, while Chinese prefer more detail and depth of information. Canadians were much more disappointed with the number of restaurant choices (Information Breadth) than Chinese, who focused on the lack of restaurant details (Information Depth). This Chinese focus on Information Depth was particularly evident

Table 8. Summary of interview analysis across culture, gender and age groups

Design Area	Culture	Gender	Age
Information Design	Canadian: focused on Information Breadth Chinese: focused on Information Depth	Male: no noticeable patterns Female: focused on Information Depth (in particular, Chinese females)	Young: focused on Information Breadth Old: commented on both Information Breadth and Information Depth, with more focus on Depth
Navigation Design	Canadian: commented on both Navigation Layout and Challenges (in particular, Canadian women focused on Navigation Challenges) Chinese: very few comments on navigation	Male: some comments on Navigation Layout. Female: focused on Navigation Challenges (in particular, Canadian women).	Young: very few comments on navigation Old: some comments on Navigation Challenges
Visual Design	Canadian: focused on Visual Ease (in particular, Canadian men) Chinese: focused on Visual Beauty (mostly providing suggestions to augment beauty)	Male: No men commented on Visual Beauty; Canadian men commented on Visual Ease Female: focused on Visual Beauty (in particular, Chinese females)	Young: some comments on Visual Ease Old: commented on both Visual Ease and Visual Beauty (females only for Visual Beauty).

among Chinese women. H1b was also generally supported in that both Canadians and Chinese prefer simple and logical navigation formats. In the case of Canadians they thought navigation could in fact be simpler, and the Chinese made few specific comments. Finally, qualitative results also support H1c. It was predicted Chinese would be more concerned with aesthetic beauty of the mobile interface than Canadians. In fact, Chinese (women only) even commented on how to augment the beauty of the interface, and Canadians focused more on visual ease.

It is interesting to note that no male from either culture made comments on the visual beauty or hedonic elements of interface design. However there were some cases where women not only commented on their hedonic preferences, but also made distinctions of what they prefer versus what they think men prefer. Overall, while our quantitative analysis rejects hypothesis 2 concerning differences in gender, our in-depth qualitative analysis suggests there may be some interesting differences in these categories.

Some support is found for hypothesis 3. Using survey data, statistically significant differences exist between older users (35 or older) and younger users (under 35) for visual design, with older respondents indicating the design of the mobile interface more appealing. Generally speaking, older respondents seem more impressed with the novelty of the device and its design than the younger group. This is evidenced in the following comment from an older subject: '*The newness of it, it's captivating. Being efficient is fun sometime. Not having to wade through a whole bunch of stuff. Look at this, look at what it can do, you can do it really easily, and you can get the information before everybody else does.*'

Predicting Satisfaction

Regression analysis was performed to assess the determinants of satisfaction based on main effects and interaction effects of the variables in this research. Gender and culture categorization was straightforward, where dummy variables represented males/females and Canadian/Chinese participants. Age was also coded as a dichotomous variable for clarity in presentation (Morris et al., 2005). Participants who are 34 years of age or younger were categorized as 'younger', while those 35 or older were placed in the 'older' category (as per Aarnio et al., 2002). Morris et al. (2005) suggested that gender differences in

Table 9. Predicting satisfaction

	R^2	ΔR^2	β	Sig.
GENDER	.063	.013	.174	.551
AGE			.415	.171
CULTURE			.322	.270
ID	.422	.391	.220	.097*
ND			.230	.118
VD			.420	.002***
ID x GENDER	..031	-.021	-.120	.583
ND x GENDER			.192	.432
VD x GENDER			-.025	.924
ID x AGE	.175	.130	.061	.532
ND x AGE			-.111	.343
VD x AGE			.180	.122
ID x CULTURE	.071	.022	.306	.258
ND x CULTURE			-.105	.663
VD x CULTURE			-.104	.738
ID x GENDER x AGE	.018	-.035	-.005	.602
ND x GENER x AGE			.077	.654
VD x GENDER x AGE			.011	.948
ID x GENDER x CULTURE	.012	-.041	.086	.848
ND x GENDER x CULTURE			.181	.546
VD x GENDER x CULTURE			-.261	.573
ID x AGE x CULTURE	.131	.084	.361	.051*
ND x AGE x CULTURE			-.091	.636
VD x AGE x CULTURE			-.190	.448
ID x AGE x GENDER x CULTURE	.013	-.040	.166	.580
ND x AGE x GENDER x CULTURE			.116	.661
VD x AGE x GENDER x CULTURE			-.263	.452

Notes: 1. ID=Information Design; ND=Navigation Design; VD=Visual Design
2. * p < .1; ** p < .05; *** p < .01

technology perceptions are more pronounced among older workers, and the interplay between key demographic variables should be examined in addition to investigating isolated demographic characteristics. This notion is supported by others in the information systems field (Butler, 2000; Venkatesh et al., 2000), as well as the field of psychology (Nosek et al., 2002; Kubeck et al., 1996). Therefore, in Table 9 the regression analysis examines various combinations of three-way and four-way interactions between demographic variables (e.g., visual design X gender X age).

In general, results of the regression analysis in Table 9 support hypothesis 4 that design elements do impact satisfaction with mobile services.

The effect size of independent variables on a dependent variable can be determined by comparing the R^2 of the dependent variable with and without the presence of each independent variable (Chin, 1998). The calculation for effect size (f^2) is as follows:

$$f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}}$$

The effect size of perceived information design, navigation design and visual design on satisfaction were $f^2=0.09$, $f^2=0.08$ and $f^2=0.23$, respectively. Cohen (1988) provides the following criteria for interpreting effect size: (i) for small effect size, $0.02<f^2\leq0.15$; (ii) for medium effect size, $0.15<f^2\leq0.35$; and (iii) for large effect size, $f^2>0.35$. Therefore, both information and navigation design were shown to have a small effect size on satisfaction, while visual design can be classified as having a medium effect size on satisfaction.

The only interaction effect shown to have a statistical impact on satisfaction is information design by age by culture. Not all groups were equally satisfied with information provided at the site. This is supported in our qualitative analysis. Canadians were primarily concerned about the limited number of restaurant options (Information Breadth), whereas Chinese sought more detailed information for each of the restaurant choices (Information Depth). As one Chinese participant noted, '*You need to know price of the restaurant, the surroundings, and what the location and street looks like, but maybe I would have to call them to get information and details*'. In contrast, a Canadian participant commented: '*I was expecting there would be a lot of restaurants represented. For San Francisco I would be disappointed, I wouldn't trust the source'*. This was particularly evident among the older participants.

DISCUSSION AND CONCLUSIONS

Egan (1998) makes the case for exploring individual differences in interface design, and claims 'differences among people usually account for much more variability in performance than differences in system designs or differences in training procedures' (p. 543). Individual differences may affect what users seek in a system's interface, and how they interpret such interfaces. Elements of a user interface appropriate for one group may not be appropriate for another.

For mobile devices, evidence of the impact of individual differences on design and satisfaction has been preliminary, scattered, and incomplete. In fact, the majority of previous research tends to examine the *adoption* of mobile devices by culture (Harris et al., 2005; Kim et al., 2004; Carlson et al., 1999), gender (Yang, 2005; Brennen, 2000; Joines et al., 2003; Park & Jun, 2003; Rohm & Swaminathan, 2004) or age (Wielenmann & Larsson, 2000) rather than based on design considerations.

In contrast, the current research explores user perceptions of mobile *design* by culture, gender and age. This has included a focus of information design, navigation design and visual design and how each impacts user satisfaction with an Internet enabled cellular phone. Our exploratory analysis

using both quantitative and qualitative data reveals some interesting differences for culture and age between user groups related to our three mobile design dimensions and satisfaction. Equally interesting is that there are no gender differences for the mobile device as tested.

In the realm of information design, overall Canadian and Chinese users felt there was adequate information presented on the mobile device, but each group was attentive to different types of information. Canadians focused on 'Information Breadth' (more choice of alternative restaurants) and the utility of information design, while Chinese focused on 'Information Depth' (more detail about the existing choices). This finding is in alignment with the qualitative results of Choi et al. (2006) who discovered that collectivist Koreans and Japanese preferred large amounts of detail on a single screen. With respect to gender and information design, no specific patterns emerged for men however women tended to focus more on 'Information Depth', especially Chinese women. This finding suggests women more than men desire detailed information content, perhaps related to different modes of information processing (Maltby et al., 2003). With respect to age, younger participants focused on 'Information Breadth' while older users desired both breadth and depth of information, with more emphasis on depth. Taken collectively, younger Canadian users were most concerned with 'Information Breadth' while older Chinese females were most focused on 'Information Depth'. These results have implications for mobile interface designers who aim to best connect with users.

On the stationary Internet, there is evidence that preferences for visual design vary by culture (Cyr, 2008; Cyr & Trevor-Smith, 2004). Users from collectivist cultures such as China desire visuals and aesthetic beauty of the interface, with emphasis on "affective" qualities (Cyr et al., 2006). On a mobile interface Choi et al. (2006) similarly found that collectivist Koreans and Japanese preferred colorful screen design, while Finns preferred simpler, less colorful screen design. Results from the current investigation parallel these earlier studies. In the area of visual design, Canadians focused on Visual Ease (utilitarian elements of design) while Chinese commented more on the 'beauty' of the design. Related to gender, men in both cultures and age groups were more concerned with 'Visual Ease' while women were more interested in 'Visual Beauty' and more aesthetic elements of the interface.

Almost all participants found the mobile interface relatively easy to use and navigate. The sites are not deep, are laid out in a logical way, and the joystick is easy to master. Chinese participants had little to say about navigation, while Canadians women and older users generally commented on challenges of navigation the interface. This finding is aligned to other work in which women found stationary websites more difficult to navigate (Cyr & Bonanni, 2005), or where physical limitations may have implications for interface design with older users (Hawthorn, 2000).

Consistent with findings for the stationary Internet, it is not surprising that in this investigation design elements impact satisfaction in a mobile service context. Further, the current work is consistent with Chae et al. (2002) who found that information quality of mobile services contributed to satisfaction. However, Chae et al. examined different elements of the mobile interface than in our investigation. Collectively, these findings support the assertion that regardless of technology or device, the interface is often considered the most important component of the entire system to the end-user (Sarker & Wells, 2003), and plays an important role in user attitudes (Bidgoli, 1990). As such, further research related to effective mobile design has commercial implications for m-commerce and is aligned to investigations of effective website design in e-commerce (Agarwal & Venkatesh, 2002; Fogg & Tzeng, 1999; Hui & Triandis, 1985; Morgan & Hunt, 1994; Schultz, 2003).

This is an initial exploratory study with a limited sample size, representing only two cultures. Although participants are representative of the desired cultural groups, they may not fully represent the socio-economic group within their country. It is recommended that follow-up studies draw samples from larger populations, and from additional culture groups. Also, usability evaluations themselves may be culturally bound. As Yeo (2001) points out, participants from various cultures are prone to provide false statements during usability evaluations to allow the designer to 'save face'. Research is needed to develop usability and research methodologies that accurately reflect personal opinions and preferences across cultures. Further, designers tend to ignore the role culture may play in the design of the interface (Sheridan, 2001), in particular within the Web context (Jagne et al., 2005). While many studies have been inconclusive, cultural factors deserve further investigation (Kwon & Chidambaram, 2000). At the very least, researchers and designers will ideally seek to better understand design elements that promote cultural attractiveness.

It is noteworthy that only one mobile application (a restaurant selection) and only one WAP site (lonelyplanet.com) are used in this experiment. The site offered some visual treatment, but has a narrow structure and simple layout. A more complex site with a deeper hierarchy may reveal more pronounced differences across diverse groups. Future research should consider multiple designs across multiple mobile applications. A positive feature of this investigation is the application of design elements as outlined by the design community (Garrett's 2003 categorizations for information design, visual design, and navigation design) to a mobile treatment. Further, in a nascent area of study as represented here, a strong point of the investigation is the use of both quantitative and qualitative methodologies. In addition to surveys, interview data was evaluated using atlas.ti software to provide a systematic evaluation of words or phrases into categories relevant to this investigation. The use of atlas.ti afforded deeper insights into the user experience than survey data alone can provide.

This research is an important first step in understanding the impact of individual differences on the design and satisfaction of mobile services. This relatively unexplored area is worthy of future attention. The quest for further knowledge as to how culture, gender and age impact technology use and satisfaction implies appreciation that these relationships are dynamic, and subject to continuous transformation (Simon, 2001). Enhanced understanding of subtle dimensions related to specific user groups will eventually enable fulfillment of expectations for optimal anytime and anywhere services.

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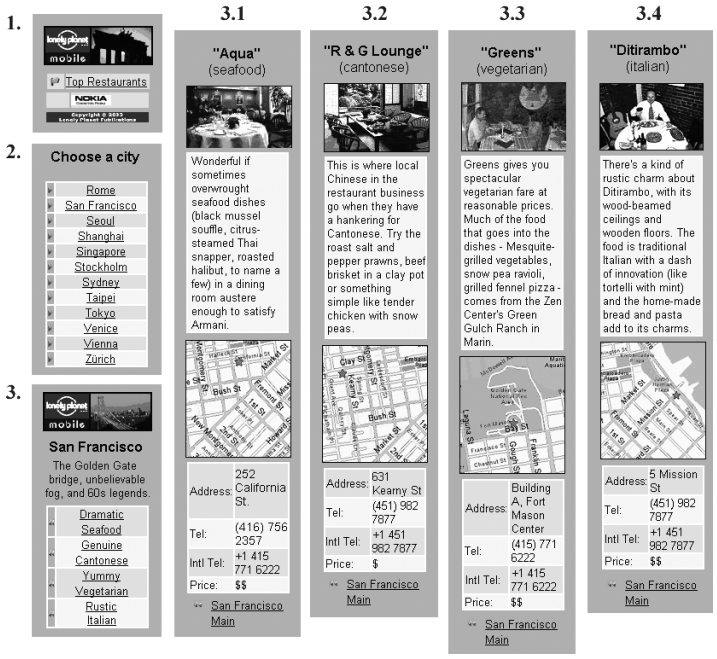
ENDNOTES

1 Throughout this paper the terms ‘portable’, ‘handheld’, ‘mobile’ and ‘small-screen’ refer to essentially the same type of device, typically called a ‘smart phone’. Also, the term ‘mobile Internet’ refers to accessing the Web directly on a small-screen, handheld, or mobile device that may be connected to the Internet.

2 The work by Geert Hofstede (1980) outlines 5 cultural dimensions: (1) Power distance - extent to which a society accepts unequal distributions of power in organizations and institutions. (2) Uncertainty avoidance - how societies accommodate high levels of uncertainty and ambiguity in the environment. (3) Masculinity-Femininity - in feminine societies there is an emphasis on quality of life and relationships; cultures that focus on material success and assertiveness are considered more masculine in orientation. (4) Individualism-Collectivism - in an individualist society individuals are expected to consider personal interests over interests of the group and individual decision-making is valued; in a collectivist culture the good of the group is more likely to be considered. (5) Time Orientation - whether the focus in on short-term vs. long-term considerations. For a further elaboration of Hofstede’s cultural dimensions, refer to Hofstede (1980) or Simon (2001).

APPENDIX A. SCREEN SHOTS



English Version: Numbers indicate different pages, or decks

Chinese version: Numbers indicate different pages, or decks

APPENDIX B. DESIGN SURVEY

Following are the statement used in the survey**.** Each was answered on a 7-point Likert scale from strongly disagree to strongly agree.

Information Design **[Sources: Cyr et al. 2005; 2004]**
ID-1: I find the information logically presented.
ID-2: All service options, service attributes and restaurant information are well presented.
ID-3: I find the information to be well organized.
ID-4: The presentation of information is effective.

Navigation Design **[Sources: Cyr et al. 2005; 2004]**
ND-1: This browser provides good navigation facilities to information content.
ND-2: I can easily navigate the CityGuide site.
ND-3: I find the CityGuide site easy to use.

Visual Design **[Sources: Cyr et al. 2005; 2004; van der Heijden 2003]**
VD-1: The screen design (i.e. colors, boxes, menus, etc) is attractive.
VD-2: This site looks professionally designed.
VD-3: The graphics are meaningful.
VD-4: The overall look and feel of the site is visually appealing.

Satisfaction **[Sources: Cyr et al. 2005; 2004]**
S-1: This site appeals to me emotionally.
S-2: This service completely fulfills my expectations.
S-3: This service satisfies my needs well.
S-4: Using this service is satisfactory overall.

APPENDIX C: ATLAS.TI CONCEPT MAP

Note: C_M = Canadian male, C_F = Canadian female, CH_M = Chinese male, CH_F = Chinese female.