

Mobile Search Engines for Senior Citizens: Design Challenges and Opportunities

by

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Abstract

Although the Internet has the potential to enrich the lives of many individuals, senior citizens report having a difficult and frustrating time using the Internet to obtain information they need—particularly when trying to find information using mobile devices. While there are many reasons why this problem occurs, some studies indicate that websites are poorly designed for mobile access. In particular, the mobile versions of sites do not take into account issues that adults may face as they get older. Although there is ample information on how children and adults search the web using desktop devices, little research and insight has been provided for how older adults, or senior citizens, interact with and use mobile search engines, not just websites. To date, 76% of wired seniors have used a search engine to find information, compared to 80% of all Internet users; and, as mobile device technology continues to grow in popularity seniors report their willingness to use mobile devices (smartphones and tablets) in their daily lives. As a result, additional research is needed to see how this population interacts with and uses mobile devices, particularly mobile search engines, as they go about their daily routine. This thesis focuses on mobile search engine design for senior citizens, explores how seniors use mobile search in conjunction with other screens and across multiple devices, addresses cognitive issues that confronts disabled seniors as they age, and provides suggested design guidelines for user experience architects to utilize when designing mobile-friendly search engines that will be senior-friendly.

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Chapter 1: Today's Modern Senior

Introduction

As technology continues to advance, the digital divide grows narrower as more people from around the world are able connect to the World Wide Web and the Internet. Although the Internet has the potential to enrich the lives of many individuals, older adults (senior citizens) report having a difficult and frustrating time using the Internet to obtain information they need. While there are many reasons why this problem occurs, studies indicate that the issue revolves around websites that are poorly designed and do not take into account natural health issues older adults may get as they age. Usability expert Jakob Nielsen noted “most websites violate usability guidelines, making the sites difficult for seniors to use. Current websites are twice as hard to use for seniors than for non-seniors” (Nielsen, 2013). As a result, it is important for web designers and developers to collaborate so that seniors can have a positive online experience. In fact, “22% of Americans 65 and older use the Internet” and “62% of Americans age 50-58 years old ... have Internet access” (Fox, 2004). In this chapter, the goal is to understand who is considered a senior citizen, how this population accesses the web, and key cognitive barriers that might prevent seniors from quickly gathering needed information from desktop and mobile websites.

Defining “Senior Citizen”

Simply stated, it is hard to clearly define the term “senior citizen” as not all usability studies and research use the same age-range for this population. A variety of past studies include adults who are at least 50 years old while others use adults who are at

least 60 years old. Goldman Sachs has categorized those who are 60 to be an older adult “as retirement from full-time work, life expectancy, health, and economic expectations increase” (as cited in Arch, 2008). However, the American Association of Retired Persons (AARP) considers an older adult to be over 50 years old (as cited in Arch, 2008). Researchers Chadwick-Dias, McNulty, and Tullis (2002) only recruited participants who were at least age 55 for their research, while other research studies from Saygo & Blat (2007) recruited participants 65 – 74 years of age. Due to the complexity and confusing nature of clearly defining “senior citizen” computer psychologist Robert Bailey proposed a new classification system to help clarify age definitions. In summary, he proposed that young users are between 18-39 years, middle-aged users 40-59 years, older users 60-74 years and old-old users 75 years or older (Bailey, 2004). Perhaps the strictest researcher when it comes to defining “seniors”, Jakob Nielsen appears not to include individuals less than 65 years of age. He stated that “65 is too young to be truly considered “senior”” and cites retirement age of 69 years of age in Denmark and the increasing employee age of 70 in the United States as two factors to consider when thinking about the term in an international sense (Nielsen, 2013). While Bailey’s system does not seem to be widely used in usability studies and Nielsen’s suggestion of using participants 65 and over does not always get used by researchers, perhaps the best way to define “senior citizen” is an older adult who is of retirement age.

Population Statistics and Internet Usage

Today there are more seniors than ever before accessing the Internet. Recent reports indicate that as of 2012 “19 million American seniors [are] on the Internet”

(Nielsen, 2013). Compared to November 2009 this is a significant increase when there were only 17.5 million active seniors using the Internet (Nielsen, 2009). That is more than a 55 percent increase from a February 2004 survey that indicated 8 million American seniors were online (Fox, 2004). The United Nations (UN) even estimates “that by 2050 one out of every five people will be over 60 years, and by 2150, one-third of the people in the world are expected to be 60 years of age or older” (as cited in Arch, 2004). Furthermore, it is estimated that “nearly 25.4% of minority adults will be a part of the older adult population by 2030” (as cited in Becker, 2004). Similarly, the oldest-old, those who are 85 years of age and older, are quickly becoming the fastest growing demographic within the senior category. According to The Bureau of Censes, it has been “estimated that the 85+ population would more than double to seven million by 2020 and eventually grow to 19-27 million by the middle of the 21st century” (as cited in Asla, Williamson & Mills, 2006). As a result, seniors comprise of the fastest growing demographic online.

According to Jakob Nielsen, one of the leading researchers on senior citizens using the web, there are two factors in the growth of senior citizens online. In his report “Seniors as Web Users”, Nielsen indicated that an “aging society” and “an increase of old people who go online” is the cause (Nielsen, 2013). Although more seniors are accessing information more than ever, it is also important to note “seniors continue to lag behind younger Americans when it comes to tech adoption. Many seniors remain largely unattached from online and mobile life—41% do not use the Internet at all, 53% do not have broadband access at home, and 23% do not use cell phones” (Smith, 2014). Barriers

to accessing information online may include learning new technology in an ever-changing world where updates and new devices come out on a monthly basis; physical challenges as a result of the natural aging process; and, general attitudes and beliefs about technology in general. Although there will always be individuals who personally will not access information online, the number of seniors who do not use the Internet at all is decreasing rapidly. In fact, as recruitment started for this research study, there were only two seniors, both aged 70, who indicated they did not access the Internet; instead, they mentioned their children would find information for them when necessary.

Aside from the users who do not access the web, these “wired seniors” (Fox, 2004) engage in many of the same activities as their younger counterparts. In 2003, 66% of seniors looked for health or medical information and completed product research online, whereas 47% of seniors bought products online and 20% of seniors engaged in online banking (Fox, 2004). Interestingly, in a recent study completed by The Pew Internet Project in 2014, “46% of online seniors (representing 27% of the total older adult population) use social networking sites such as Facebook and 6% use Twitter” (Smith, 2014). Seniors also go online to send and read e-mail, research family history/genealogy, locate financial and health information, as well as locate specific medicine dosage and health symptoms (Fox, 2004). The Nielsen Norman Group also revealed that “seniors were much more likely to turn to web-wide search engines like Google or Bing [first than traditional websites]. These sites are familiar and welcoming ground, and seniors used search engines 51% more than the younger users to complete tasks” (Nielsen, 2013). Given these statistics, it is imperative to design websites, search engines, and other

system as a service (SaaS) applications with seniors in mind. Although they are using the Internet more than ever, studies clearly indicate that seniors and older adults get frustrated when using the Internet. Based on these statistics alone, it is clear that companies and organizations need to keep the needs of this population in mind when designing digital experiences.

Mobile Usage Among Adults and Seniors

Smartphones and tablet devices are not just for teenagers and adults. On the contrary, older adults are quickly starting to use these devices on a regular basis. Across the board Gartner (2010) reported that “worldwide smartphone sales accounted for 19.3 percent of overall mobile phone sales in the third quarter of 2010, growing 96 percent from the third quarter of 2009” (as cited in Gomez-Barroso, Bacigalupo, Nikolov, Compano, & Feijoo, 2011, p.847). Current statistics show 77% of seniors own a cell phone while 61% of the oldest-old adults, those at least 85 years old, own a cell phone. Although smartphone adoption among seniors has grown slowly from 2011 from 11% to 18% in 2014 (Smith, 2014), there is an opportunity to not only help seniors overcome barriers of use but also design mobile websites and apps for ease of use and efficiency. For those older adults who do use smartphones, reading and sending e-mail was the number one activity reported, along with using the mobile phones built-in browser to search for information online (Smith, 2014). Furthermore, “search is the most visited website” on mobile devices constituting 77% of browser history (Google, 2011). More information regarding older adults usage of smartphones and tablets is needed, however

supplemental information about how adults aged 18 and over use mobile search can be found in Chapter Four: Mobile Search.

Health and Aging Factors

It has been said that personal health is our best asset, but over time health naturally declines. As McNeil (1997) and Vanderheiden (2001) explained, by the time individuals reach age 65 it is likely they will have some kind of disability, and indicated poor eyesight to be the most common issue among older adults (as cited in Hanson, 2002). As individuals age their vision, metacognition, cognition, hearing and physical abilities can become impaired. Whether minor or severe, these impairments have consequences on an older adult's ability to access the Internet and find information in an efficient and effective manner.

One type of impairment visible in older adults is vision decline. Vision impairments come in many forms, the most common being the need for glasses with strong prescription lenses. Causes of sight problems in older people as reported by the Royal Institute for the Blind (RNIB) come from a variety of sources including but not limited to age-related Macular Degeneration (AMD), glaucoma, and diabetic eye disease (as cited in Arch, 2008). In fact, visual impairments usually start around the age of 40. Seniors over the age of 55 in particular could notice a “decreased ability to focus on near tasks, have color perception and sensitivity issues, and notice a reduction in the visual field” (Arch, 2008) so “stimuli must be stronger and objects of attention need to be at the center of vision” (Farhan, 2012). Though only about 10% of Americans over 80 are considered legally blind, an even smaller amount of the oldest-old retain perfect vision

(Farhan, 2012). Therefore, it is important that graphic designers, with the assistance of user experience architects, design interfaces that seniors will be able to understand and see clearly.

A decline in metacognition, the awareness and understanding of one's own thought processes, is a second age related issue that affects many older adults and seniors. As a result, seniors often have the most trouble with learning new technologies. Though there are several schools of thought as to why this occurs results from conditional associative learning studies (learning new patterns from trial and error), have indicated “the hippocampus is critical for retention whereas the frontal lobes [of the brain] are necessary for the conditional aspects of the task” (Moscovitch & Winocur, 1992). In studies with older adults, there is typically some type of dysfunction between these areas of the brain. Essentially this means that young adults have a much easier time learning new tasks, and as a result are usually able to learn new technology faster.

Alzheimer’s Disease, a type of metacognition impairment, is the most prevalent impairment among older adults 60 years and older and it affects how effective the Internet can be for this population. Meta-memory is the “knowledge of one’s memory abilities and functioning.” Meta-memory problems can be seen on a larger scale among older adults compared to young adults due to “selective decline in frontal lobe functioning related in executive functioning” (as cited in Dinet & Vivian, 2009). For instance, 1 in 8 older Americans have Alzheimer's while 43% of people aged 85 and older have the disease (“2011 Alzheimer’s Facts and Figures”, 2011). Furthermore, “time delays can lead to short term memory loss” which means that user interfaces and systems

need to be streamlined and support memory recognition for older adults especially in the design of complicated systems because this population often “fail to combine or carry out” little tasks that may lead to the larger goal at hand (Farhan, 2012). Interestingly, it has been pointed out that as memory declines so does intelligence. Botwinick (1978), Salthouse (1982) and Storandt (1977) observed that when older adults take timed standardized tests, declines in intelligence arose particularly those with average to above average IQ scores, and even when the timed component of the test was removed, there is still a decline in overall performance (Moscovitch & Winocur, 1992). As a result of these observations in regard to cognition and metamemory, it is not surprising that older adult performance on working memory measures and overall time-on-task decline with age (Arch, 2008).

According to Dinet and Vivian (2009), meta-memory is essential, especially within the process of online search as the user must know when to stop. Search is a cyclic process with three stages: preparation, exploration, and consolidation (as cited in Dinet & Vivian, 2009). Within this cyclic process and model, which has been researched and examined by various researchers such as Dinet & Rouet (2008), and Lazonder & Rouet (2008), the end-user must first prepare for the task by deciding which menu or link to choose – from a search standpoint, this could be the decision of which search engine to use, and ultimately how to navigate to the search engine. Next, the end-user explores the set of information provided. From a search perspective, this means analyzing the search engine results page (SERP) and processing the information provided. Finally, the end-user consolidates the information and determines if the results, or search results, match

their initial goal. It is important to note that these three stages usually occur at the same time as it relates to search engine related tasks because an end-user is almost always deciding which search result to click (exploration) and deciding whether or not the result might assist with the goal in mind (exploration) as they scan through the SERP. As Dinet & Vivian explained in “Elderly People as Web Seekers: Needs, Strategies and Difficulties”, “because the user must remember her/his search topic during her/his information searching process and because she/he must decide to begin or to stop one of the three stages ... meta-memory is essential” (p.397). As a result, meta-memory has a direct impact on the users’ ability to complete a search, and therefore increases the overall time-on-task for senior citizens (2009). Their study results indicated “the average time spent to perform the information search tasks for participants with high meta-memory skills is always inferior to the average time to perform the same activity for participants with low meta-memory skills” (Dinet & Vivian, p.400, 2009).

Overall hearing also declines with age. While hearing loss is not as significant a problem for web designers compared to the aforementioned age-related issues, it can affect web use especially as streaming video and audio files become prevalent in today’s “Web 2.0” environment. Those with hearing loss indicate an “inability to hear high-pitched sounds ... while 18.8% of the UK population aged 61 to 80 years old experience moderate to profound deafness” (Arch and Abou-Zahra, 2008). Farhan (2012) indicated that “older adults miss attention getting sounds with peaks over 2500 Hz ... and due to selective loss of high frequency [in the English language] may mean that parts of speech are not heard and [the] impaired listener needs to guess [at] meaning” (p.3). For the

design of speech related software systems like Apple's Siri, which is available on the iPhone and iPad, these applications need to be able to cope with slower than usual speech or weaker voices. It also means that for websites with streaming video and audio, the addition of transcripts will help older users get the most out of the intended application.

Lastly, decline physical abilities prove to be a challenge for seniors. Some issues related to motor disabilities include tremors and postural instability associated with Parkinson's Disease and arthritis (Arch 2008). Motor disabilities also may include reduced muscular control "such as involuntary movements including tremors and lack of coordination [as well as] missing limbs" (Abou-Zahra, 2012). As Hawthorne (2000) indicated, decreased motor coordination "makes it difficult to move and click a mouse, scroll down [a] Web page or click on standard sized links" (as cited in Becker, 2004). Additionally, Chadwick-Dias, et.al., (2003) reported that it could take longer to complete movement [related tasks] compared to younger adults and children (as cited in Becker, 2004, p. 391). Consequently for search tasks this means that overall time-on-task increases significantly when older adults need to use a computer mouse compared to the task of typing a query into a search engine (Dinet & Vivian, 2009). Although there are a number of pointing devices designed for individuals with disabilities like arthritis, designers should take into account that these may not always be available to the end-user.

Chapter 2: Website and Search Engine Design for Seniors

Introduction

The development of new technologies such as mobile devices like smartphones and tablets, touch-based devices, and wearable technology like the FitBit and other exercise-related devices, mean that there is an ever-increasing need to include older adults and seniors in usability testing sessions. Doing so will ensure that these devices are accessible to all types of users, particularly seniors who exhibit a higher level of disabilities compared to young adults and children. Even the most basic technology systems like websites need to be looked at from the perspective of seniors since website technology continues to grow and expand with the use of mobile devices.

Related Work

Many usability studies have been conducted to show that the majority of senior targeted websites such as SeniorNet.com, Medicare.gov, AARP.org, Seniors.gov and general public targeted websites such as WebMD.com, WellsFargo.com, and BarnesandNoble.com do not comply with basic design standards and guidelines set forth by the World Wide Web Consortium (W3C). Additionally, usability studies continuously demonstrate older users' frustrations with completing specific tasks. Researcher Epstein completed one of the first information seeking studies for seniors over age 65. The study, which involved only in-person interviews with 900 people from England, concluded that older adults worried most about health and financial literacy and planning (Dinet & Vivian, 2009). In research studies directly related to web use, Chadwick-Dias, McNulty, and Tullis (2002), found participants over the age of 55 had significantly longer task

duration times than those under the age of 55 (p. 32). For example, it took on average 148.3 seconds for older adult participants to complete a task compared to 109.5 seconds by those under the age of 55. Additionally, of the tasks the participants were asked to complete, only 44.8% of older adult participants were successful. Therefore, “Task success was correlated with actual age. The older people were, the fewer tasks they completed successfully” (Chadwick-Dias, McNulty, and Tullis, 2002). Finally, their study showed older adults tended to be more cautious when interacting with a website such as clicking on a link and instead spent more time reading information before interacting with the website further. The study also demonstrated that “older users were often confused as to where they were within the context of the Web site. Several times they clicked on a link in the [main] navigation when they were already on that page” (Chadwick-Dias, McNulty, and Tullis, 2002). Another usability study completed by Becker (2004) demonstrated issues with state (.gov), commercial (.com), nonprofit (.org), and news (.com) websites. Becker found that of 125 websites observed, approximately 38% of state websites had pull-down menus; pull-down menus or “roll-over menus” proved to be problematic because “precise movement of the mouse may be physically challenging” especially for those who have motor skill problems (Becker, 2004, p.393). 72% of newspaper websites contain three or more pages of content which “requires memory recall of Web content” and can affect seniors with cognitive decline (Becker, 2004, p.393). Finally, 96% of nonprofit websites wrote content in a font size less than or equal to 12 point which can make seniors frustrated because they cannot read the text even if they have on their glasses (Becker, 2004, p.393). Further usability studies show

similar findings where older adults have difficulty completing a task successfully and/or take a longer time to complete compared to younger users due to usability issues with navigation, treatment of links, label choices, and content placement.

In addition to usability studies on website effectiveness for seniors, there has also been a myriad of research studies completed in prior years as it relates to information seeking on search engines. One of the first few studies involving mobile search came in 1999 and 2002 and showed that for search tasks on Personal Digital Assistants (PDA) where the search UI was the same as desktop search engines, browsing and searching proved to have a negative influence on task performance (Sweeney & Crestani, 2005). Yet, Stronge, Rogers & Fisk (2006) believed that inefficient search strategies and overall lack of Internet experience and knowledge are the cause of failed tasks and overall more difficulty using search engines compared to younger adults (as cited in Dinet & Vivian, 2009). These researchers identify a real problem, but they are mistaken to focus exclusively on the inexperience of older users. In order to improve the search experience of older users, it is necessary to address health factors that come with age, and contribute to an older user's difficulty in successfully using search engines. Additional research indicates that if seniors cannot find information quickly, they are more likely to quit the task at hand and get help from another person (Sayago & Blat, 2007). In a specific study completed by Sayago & Blat (2007) using participants age 65 to 74, it was found that out of the three predominant strategies to search for information online, basic search, advanced search, and online directories, older adults were 3 times faster in finding information using basic search engines like Google compared to using directories such as

the Yahoo! Directory. The study indicated “difficulties using the mouse have a stronger effect on the total search time than difficulties in typing queries” and “the directory was the slowest mainly because of information overload” (p.4). As search engines have become more sophisticated in how queries are processed, advanced search features on commercial search engines like Google and MSN Bing, and directories like the Yahoo! Directory, have quickly become obsolete. Nevertheless, it is interesting to see how these search strategies impacted seniors when they were available.

Other researchers have examined electronic information seeking with older adults using different types of online search engines other than traditional World Wide Web (WWW) search engines. Researchers Czaja and Sharit (1999) looked at information search and retrieval in health insurance databases. Asking young and older users to search for health insurance coverage information on a specialized health insurance database, Czaja and Sharit found that older adults up to age 75 used fewer phrases and fewer overall queries compared to younger users. Since the study controlled for speed, their results showed that cognitive abilities and prior experience with the database influenced how well a participant would effectively search and find the correct answer to the task. According to Czaja and Sharit, providing basic computer training to older adults is just as important as accounting for working memory and age differences in evaluating results (as cited in Czaja and Chin Lee, "The Internet and older adults; Design challenges and opportunities", 2001). Similar information retrieval research completed by researchers Mead, Sit, Jamieson, Rousseau, and Rogers (1996) used an online library database. Their research indicated that overall, younger adults had better search strategies compared to

older adults, who made many more errors formulating search queries (as cited in Czaja and Chin Lee, 2001). Although examples of search query errors were not reported in the article, it might be assumed that these errors were related to how the query was entered into the database, as early databases and search engines relied on the user entering Boolean operators into their search query.

Although search engines and databases that emerged in the early 1990's have significantly changed in the past 20 years, much can still be learned from this early work about the search behaviors of older. These studies indicate that it is important to take age and aging factors into consideration when designing online content for seniors. Running usability tests as Becker, Czaja and Chin Lee, and Sayago & Blat did with seniors validated concerns of product inefficiencies and justified future major design changes.

Suggested Design Guidelines

Based on prior research studies with older adults using search engines, databases, and websites for information retrieval, scholars have come up with suggested design guidelines based on best practices. Newell and Gregor (2000) "proposed that standard user centered design techniques ... be replaced with User Sensitive Inclusive Design, which seeks out diversity, in order to ensure systems are truly usable by older people" (as cited in Zajicek, 2004). In their paper "User Sensitive Inclusive Design – in search of a new paradigm", Newell and Gregor state that the concept "design for all" is often an impossible task and should be revised by the better term "accessible by most" (Newell and Gregor, 2004, p.42). Furthermore, Ben Shneiderman, a pioneer in the field of universal usability, defines universal usability in a more formal way as "having

more than 90% of all households as successful users of information and communication services at least once a week” (

Although products may not be able to be used successfully by all peoples, a product should at least be accessible by the majority of people, and thus serve to a more general and diverse group of potential end-users. The basic User Centered Design Guidelines written with the help of researchers and the W3C, Web Accessibility Initiative, help put best practices into context.

The suggested design guidelines below provide best practices for designing websites and search for older adults. Note that this is not an exhaustive list of best practices but rather provides a starting place for designers and developers to build upon. The guidelines listed below are taken from researchers from Chadwick-Dias, McNulty, and Tullis. As a direct result from the exploratory study with seniors using mobile search engines, additional suggested guidelines can be read in Chapter 5. Design guidelines 1 through 8 are direct from Chadwick-Dias, McNulty, and Tullis (2002), and guidelines 9 through 12 are direct from John Ferrara (2008) from Boxes and Arrows.

1. Use action word links
2. Make link treatments consistent and obvious
3. Make icons and bullets links
4. Use scalable fonts and options to increase font size
5. Use consistent instructions
6. Keep terminology simple

7. Use simple navigation and provide redundant navigational cues
8. Minimize the use of secondary windows
9. Minimize the search results set by allowing users to filter and sort
10. Ensure search results can be easily scanned and are comprehensible
11. Highlight the terms that match the query words originally submitted
12. Consider tools that assist in formulating a query, such as suggestion functions

Guidelines are helpful to create solutions but they should not replace usability testing the solution with actual end-users. Although these best practices may help alleviate some of the most common usability issues older adults may face, they do not take into consideration the types of health issues or different personas that may be using the system.

Chapter 3: Search Behavior

Introduction

Although the mental model of search may appear simplistic on the surface, in reality the search process can be much more complex. As the cyclic process of search described in Chapter One, section Health and Aging suggests, the end-user must know when to stop searching when it is felt the information provided is a solution to the search query. Since thought-processes can be complex and human behavior unpredictable, end-users have demonstrated varying behavior patterns when using online search. This chapter discusses general search behavior patterns and the direct impact on end-user success.

Search Behaviors and Patterns

There are three types of search queries: navigational queries, informational queries, and transactional queries. Andrei Broder, who defined these three types of search queries in his article “A Taxonomy of Web Search”, suggests that based on the search task, the user will tailor their search query to ensure they get the proper information without having to dig (as cited in Liu, Rau, and Gao, p.365). Navigational queries help the user find a particular website or pinpoint a specific source of information whereas informational queries help the user find a specific piece of information on one or two websites. Keywords used with informational queries tend to be more vague however, as users will want to make sure they have enough context and understanding of the answer, and to ensure that the information is trusted and credible. Finally, transactional queries

help the user conduct a “web-mediated activity” such as completing an online form or watching a video (as cited in Liu, Rau, and Gao, p.365).

While content can easily be transformed for desktop and mobile devices, unfortunately designers do not have control over factors that affect user search behavior. According to researcher John Ferrara from BoxesandArrows.com, domain expertise, search expertise, cognitive schemas, and search goals are factors that affect user search behavior. These factors, especially when combined, can either assist a user in successfully completing a search and obtaining the information needed, or can cause frustrations. Ferrara explained that overall, search success is based on the “overall familiarity [and expertise] on the subject on which he or she is searching” (Ferrara, 2008). If the user has a level of familiarity within the subject matter, search queries tend to be more specific and generally, users know the verbiage to use. By contrast, those without domain knowledge can be less certain about where to start their search and what keywords to use so it may take them longer to find the intended information, and perhaps more importantly, will be unsure of how to evaluate such results. Search experience is a second factor that can affect search user behavior. Essentially, the better understanding a user has over the selected search engine, the better off they are in performing a search and analyzing the search results. A third factor that affects search user behavior is cognitive behavior, which according to researcher Nigel Ford “can range from global to analytical thinking” (as cited in Ferrara, 2008). Ford illustrates that “global thinkers first try to build a broad level of understanding across related topics” whereas “analytical thinkers dive right into a single topic and research it thoroughly to resolve a specific

problem” (as cited in Ferrara, 2008). Another factor is the goal of the search; each search query seeks to answer a specific question. As a result, the user can vary the search query types as outlined by Andrei Broder. Lastly, a user’s surrounding environment can affect search behavior. Broder points out that if a user is rushed to complete a search due to “external pressures” such as deadlines or the user’s overall mood, environment can have a major impact on how well a search is completed, synthesized and evaluated (Ferrara, 2008).

In addition to the described search factors that affect search results, Peter Morville and Jeffery Callender illustrate succinctly the various types of search patterns users typically deploy when conducting an online search. In general, there are four types of search patterns; alternate between search and browse; pogosticking; minimize results sets; and, judge results quickly (Ferrara, 2008; Morville and Callender, 2010). Within the pattern of alternating between search and browsing, users will follow search result links on the search engine results page (SERP) to a given website/webpage, and then follow links provided on the website. If a user is not satisfied with the information provided on the website, they will return back to the SERP and continue the process all over again. In essence, this is similar to pogosticking. Pogosticking, which was first coined by Peter Morville, describes how users quickly jump to and from the SERP and provided search result. Interestingly, in 2010 Google started experimenting with a “Get More” link listed under the search description to allow users to see additional results on the same SERP. Google stated that the “Get More” link is “a way to help people get back more results that are similar to the one they initially selected and which perhaps will better match their

query” (Schwartz, 2010). The link periodically appears at the bottom of forum website links, and media related sites with photos and videos, but researchers are unsure about whether it actually helps with this particular user pattern. A third type of search pattern is minimizing the search result set if the user feels the query has provided too many results, as typically seen in the “Showing Results X of X” statement or “About X Results” statement above the list of results. Users may also judge the list of search results too quickly through scanning the SERP. By doing so, the user will often either go past the first search results page “and proceed several pages deep into the results set [only to] go back to the initial results to look more carefully” or the user will “look only at the first few results before deciding whether the query was successful or not” (Ferrara, 2008).. Actively monitoring users to gain insights and making small design changes can make a significant impact in helping users get what they need in a timely matter. As such, some of the design recommendations listed in Chapter Two and Chapter Five may help the overall search engine user experience.

Distinctive Qualities of Mobile Search

Research indicates that mobile search differs greatly than desktop search. Aside from how the search engine interacts with the user on mobile compared to desktop due to limited interaction features and a smaller screen to accommodate long result lists, searchers are utilizing mobile search much differently compared to traditional desktop web search. In many ways, mobile search is quite distinctive to desktop search as mobile gives the ability to search locally relevant information based on GPS (Gomez-Barroso et.al, 2011). As mobile gains popularity for its “on the move” ease of use, the context of

mobile search usage changes. Consequently, various researchers have found several themes key to mobile usage. Context dependency is a vital theme that every mobile user experiences many times over. For instance, Lumsden and Brewster “noted a common conflict between mobility and mobile HCI: interacting with a mobile device induces competition for the same limited resources required to navigate through the environment safety” (as cited in Liu, Rau, and Gao, p.365). Interestingly, general mobile usage has also affected user behavior in terms of bidding for user attention. In a study by Nagata et al., compared to desktop search usage, mobile has a significant impact on user attention, limiting and declining overall task performance when multi-tasking several items at once (as cited in Liu, Rau, and Gao, p.365). In fact, a similar study by Oulasvirta, et al., found that “attention to the mobile device had to be interrupted by glancing at the environment up to 8 times during a subtask of waiting for a Web page to be loaded” (as cited in Liu, Rau, and Gao, p.365). The results of these research studies overall indicate that while mobile search is quite distinctive and different from traditional desktop search usage, the context and environment of using mobile devices can impact user memory and attention, as well as impact overall user behavior patterns. It will be interesting to see how the future of mobile usage and search will alter user behavior patterns—in particular, what patterns will stay the same and what new patterns will emerge.

Mobile Search Versus Desktop Search

How does mobile search differ from desktop search? This question has been answered from various researchers, and although there is a difference it appears that as Smart Phone devices and other mobile devices increase in speed and overall features,

some of the differences in search across these two platforms seem to diminish.

Astonishingly, mobile search volume more than doubled from 2011-2012 while search usage across both desktop and mobile has only increased 11% (Song, Ma, H. Wang, K. Wang, 2013). As stated, mobile devices are now considered the go-to source for many individuals and, as data plans continue to decrease in price, this statistic seems to be on par with the overall economy, at least here within the United States and European countries.

Of the three types of search queries (navigational, informational, transactional), Church, et.al., found that on mobile devices “informational queries accounted for 10.2% ... navigational queries 29.4%, and transactional queries 60.4%” (as cited in Liu, Rau, and Gao, p.365). Not surprisingly, the upward trend of transactional queries continues to rise as media (music, videos), online forms and databases are getting easier to utilize for mobile consumption. When analyzing mobile search logs within European countries, the same researchers found that user behavior tended to enter short queries at 2.1 words per query and focus more on the top search results listed on the first page of results (as cited in Church and Smyth, 2009). Similarly, a research study conducted by Kamvar and Baluja (2006) on Google’s mobile search engine revealed that users looked at fewer than 10% of search results meaning that “the click through rate across all [search] categories was consistently low which suggests users are relying heavily on snippets (search descriptions) for their information” (Kamvar and Baluja, 2006). Directly, on the Google mobile search engine, users who clicked through to follow the information scent only clicked on approximately 1.7 links per search query; however, the click-through rate

increased dramatically to 50% in 2007, probably due to the availability of faster Smart Phone devices. The same researchers also found that the average mobile search query length was short, at approximately 2.3 words per query in a 2006 report and 2.6 words per query in a 2007 report, which equated to 15.5 characters. Kamvar and Baluja tend to believe that “users may have learned how to form queries to get neither too many nor too few search results” on mobile devices (2006). Their theory may be correct especially as more users are starting to learn how to properly use search engines, and as search engines introduce new features such as suggestive search, autocomplete, and search trends to make it easier to search on mobile devices.

Similarly, a large-scale study looking at the direct differences between desktop and mobile search found that there is a major difference in the time of day searches are made between devices. In the report “Exploring and Exploiting User Search Behavior on Mobile and Tablet Devices to Improve Search Relevance”, researchers found that “the majority of desktop search occurs during normal working hours from 8AM to 5PM” whereas “mobile search volume continues to rise starting from 5AM till 10PM” (Song, Ma, H.Wang, K.Wang, 2013). Their most interesting results proved to be the analysis of the kinds of searches made during the day. For example, they were able to break down the most frequent search queries by the time of day. As a result, it was found that in the morning both mobile and desktop users tend to search for images and navigational queries, versus the evening when mobile users tend to search for adult, music and sports related topics. Conversely, desktop users tend to search for navigational, local and commerce related topics in the evening (Song, Ma, H.Wang, K.Wang, 2013). Overall

though, navigational searches are minimal on mobile devices; the thinking is that the wide variety of mobile apps like Google Maps assists with this type of search.

In a 2008 report from Yahoo!, researchers found the average search query to be 3.05 words, and although similar to Kamvar and Baluja's findings, they also found average query lengths to be much shorter on Apple iPhone devices at only 2.93 words in 2009 (Song, Ma, H. Wang, K. Wang, 2013). Additionally, of the searches that returned more than one page of results users "spent an average of 80 – 87 seconds on the search results page before requesting more results" (Kamvar and Baluja, 2006).

Perhaps the most fascinating research came from Kamvar, Kellar, Patel and Xu in their report entitled "Computers and iPhones and Mobile Devices, Oh My!" in which they examined iPhone user's Google mobile search logs for 35 days. Their research suggested two relevant pieces of information. First, iPhone users tended to use the same words per query as desktop searchers (2.93) compared to other mobile device users who used only 2.4 words per query (as cited in Song, Ma, H. Wang, K. Wang, 2013). Second, iPhone and desktop users tended to complete more search queries compared to other mobile device users "and exhibited similar query categories ... indicating a possibility that the information needs were more diverse on desktop and iPhone, whereas mobile users were more likely to issue simple navigational queries with a focused intent" (as cited in Song, Ma, H. Wang, K. Wang, 2013).

Aside from query length and types of searches conducted, a research study conducted by Liu, Rau, and Gao (2010), established that user context also impacts how a search is conducted and how users decide which search results to click. Four major

results came from their research study, which looked at how 48 participants used their mobile devices in real-world situations of conducting search in an airport and in the users home or office. First, when users searched for location-based information users clicked on search results less and the first search result proved to be the most important in providing the needed information. Second, as the pressure to find information increases, users are less likely to click on more than a few results. Similarly, in low-pressure situations users generally tend to explore more results. Third, users have a better memory recall of information when conducting information and navigational search queries. Finally, the first and second search result lead to overall higher user satisfaction, but only if those results provided what the user thought was helpful for the query entered.

Finally, a 2011 analysis of search on mobile devices from Treevan et al., indicated that local search differs a lot from mobile to desktop, as mobile users tend to enter more location and time based queries. Although this is not that surprising, it does indicate that geographic queries are becoming more important to people on the go. As stated earlier, it also suggests that context of mobile use is important to understand; even though mobile devices can be used on the go, they are also being used in stationary settings, which amplifies how mobile users decide when and where to use mobile search.

Understanding the Context of Mobile Search

The context in which an end-user utilizes their mobile device for search varies with each situation; what is seen as useful for older adults utilizing mobile search can be different from younger users. More often than not, users appear to use their mobile device for certain tasks only. Deciphering mobile search and general mobile usage trends among

seniors will be an interesting topic now and in the near future, especially as they continue to reach for these devices over traditional desktop computers.

In a large-scale study completed by Google, which surveyed participants 18-64 years of age over a 24-hour period to gain insight into consumer media behavior, found that of the three types of devices used today, desktop, tablets and smart phones have different usages. Although the study did not categorize trends by age group, the study was able to provide a solid understanding of how users utilize computer devices. Overall, the study concluded that context drives device choice and can be based on five situations. For instance, the type of device a user operates can be based upon a particular time of day; the amount of time needed or available; the end goal; location; and, general attitude (Google, "The New Multi-Screen World Study – Think with Google", 2012). Although not surprising, due to the nature of desktop computers which “keep us productive and informed”, they are primarily used in the office or home, with 69% of respondents using desktop computers in their own homes. Further, desktops are used for tasks that require a lot of time and focus, and therefore are seen as a serious tool compared to other devices (Google, "The New Multi-Screen World Study – Think with Google", 2012). Tablets however, “keep us entertained” with a surprising 79% of respondents indicating using them at home, more so than desktop computers. Many respondents of Google’s survey mentioned feeling an “unbounded sense of time” and are used primarily for “entertainment communication” (Google, "The New Multi-Screen World Study – Think with Google", 2012). Finally, smart phones help “keep us connected”, and although smart phones can be used anywhere, 60% of the time they are used at home versus 40% of the

time being used out of the home. A smart phone provides the sense of being able to quickly and immediately obtain information, and so “smartphone use is motivated by communication” (Google, "The New Multi-Screen World Study – Think with Google", 2012). However, research conducted by Komaki, Hara, Nishio (2012) found that 69% of searches are conducted in mobile contexts (p.247). Their research however, excluded older users and instead focused on users in their late twenties.

Similar results were found when researcher Anne Kaikkonen from Nokia conducted a global online survey for two months, which gathered data from 390 participants. Overall, it was found that in addition to using mobile devices at home, “using mobile Internet was common also when being on the move; traveling with public transport often means waiting and the mobile Internet is [a] good way to ‘kill time’ and create private space” (Kaikkonen, 2008). After conducting a qualitative diary study of mobile users, which focused on the intent of mobile search and information needs, Church and Smyth (2009) realized that mobile search could fall into one of three categories depending on the situation of the user. Church and Smyth listed “Informational, Geographical, Personal Information Management, and found that Geographical needs are very popular within the mobile space” (as cited in Komaki, Hara, Nishio, 2012).

In summary, the types of searches made on a desktop or mobile device are about the same, with the exception of mobile users making use of location-based searches more frequently compared to desktop, and the overall number of words and characters per search query is comparable between these two devices. It seems that the only major

difference between these two devices is the context of use. Although users have the ability to use mobile devices more freely on the go, it appears that they are also utilized regularly in stationary contexts.

Chapter 4: The Research Study – Observing Senior Citizens Using Mobile Search

Introduction

In general, the user interfaces (UI) for search engines have relatively remained the same since search became available on mobile devices – an empty search box to enter a search query and a list of sorted search results that appear on several paginated pages once the search query has been entered. This exploratory research study aims to look at how seniors, older adults age 55 and older, use mobile search engines on touch-based smartphones like the Apple iPhone. A variety of methodologies were used to obtain information from seniors, and the hypothesis that seniors use shorter search queries on mobile search compared to desktop search is explored, as is how and why they use mobile search compared to desktop search.

Research Questions

The following research questions were explored:

1. How do seniors use mobile search compared to desktop search?
2. Which search engine features do seniors use (e.g. Rich Snippets) and pay attention to after performing a search?
3. Where do seniors use mobile search, and how is search used across multiple devices?
4. What kind of information do seniors look for online?

Methodology

The research study ran for three months from April to June 2014. Two sets of participants were recruited to participate in the study. One set of participants were asked

to fill out an online survey regarding their mobile device and search usage, while another set of participants were invited to contribute to a short in-person interview and usability session, which included filling out a short System Usability Scale (SUS) form for each search engine used during the session. The in-person interview and usability session lasted for approximately one hour and tested popular search engines (Google, Yahoo! Search and MSN Bing) for usability problems and information search strategies among seniors. For both the online survey and fieldwork participants were recruited using a variety of techniques. Participants who completed the short online survey were found using social media posts on Facebook and LinkedIn, whereas participants who contributed to the in-person fieldwork study were found via Craigslist and friends and family members.

A total of fifteen senior participants, age 55 – 70, agreed to participate in the in-person interview and usability session of search engines, and all were at least somewhat familiar with touch screen mobile devices like the Apple iPhone or other similar tablet device. Each session was recorded using two software programs. For the recording of mobile search engine usage, the iPhone application ‘Magitest’ (<http://www.magitest.com>) was purchased and downloaded for \$49.99 from the iTunes store. In order to see what the participant was doing on the mobile device during the session, the desktop application ‘Reflector’ (<http://www.airsquirrels.com/reflector>) was purchased for \$11 from the software company Air Squirrels. Reflector is an AirPlay receiver that allows the researcher to wirelessly display an iPad or iPhone to a desktop or laptop computer. Doing so helps mirror the mobile device on a secondary screen without a complicated setup, and

allows the end-user to participate in the study without being bothered by the researcher. For the recording of desktop search engine usage, the software ‘Camtasia’ (<http://www.techsmith.com/camtasia.html>) was purchased for \$75 from the software company TechSmith.

For this study, an Apple iPhone 5s running iOS 7.1.2 was used for all mobile tasks. Additionally, the native Internet browser Safari was used for each task. For desktop tasks, a MacBook Pro running iOS 10.8.9 (Mountain Lion) with 8 GB of memory and a 2.6 GHz Intel Core i7 processor was used. Participants used the Firefox Internet browser for each task.

Field Study Protocol

During the one-hour study each participant was asked to complete four tasks using two popular search engines; two tasks were completed using one search engine on a mobile device, and two tasks were completed using a second search engine on a desktop computer. Every other participant received the same set of tasks using a different search engine as a way to help randomize the data set, and ensure that participants were not able to talk about their experience with another participant. See Table 1 for examination of task and search engine order. Although all participants completed four tasks, in the beginning of the study three participants completed a total of 8 tasks, four tasks on mobile and the same four tasks on the desktop. The order and number of total tasks given to participants changed to only four tasks when it was realized participants not only took longer than an hour (in some cases) to complete the session, but more importantly participants were learning and using the same set of keywords in their second round of

testing. As a result, data from the first three participants were not as solid as latter participants.

Tasks

Four tasks were given to all participants, plus one additional exploratory task.

Tasks were chosen based on information seniors would typically search online (entertainment, health, travel, and financial).

1. You and a friend want to see the movie ‘Transcendence’ tonight at the AMC Theatre in Tysons Corner, VA. What are the show times for tonight?
2. At a recent doctor’s visit, it was suggested that you might have COPD. What is COPD and how do you treat this condition?
3. Your daughter is getting married in Austin, Texas this August. Find the price of a round-trip ticket from BWI airport in Baltimore to Austin, Texas from Sunday, August 2 – Saturday, August 9.
4. Your financial advisor suggested that opening an online savings account would typically yield higher interest rates than traditional banks like PNC Bank. Find out which online bank offers the highest APY.

An additional exploratory task was also given to every participant to gauge how seniors would search for information online. Although this task was time-capped at three minutes, it allowed the participant to get comfortable with how the test would be administered. The exploratory task stated, “Use the web to show me something you’ve searched for recently. I want to see how you found the information.”

Table 1

Participant Matrix: Task and Search Engine Order

Participant Number	Desktop Search Engine Used	Task Order	Mobile Search Engine Used	Task Order
P01	Google	1-2-3-4	Yahoo!	3-1-4-2
P02	Bing	2-4-1-3	Google	1-2-3-4
P03	Yahoo!	3-1-4-2	Bing	4-2-3-1
P04	Google	1-2	Yahoo!	3-4
P05	Bing	1-2	Google	3-4
P06	Yahoo!	1-2	Bing	3-4
P07	Google	3-4	Yahoo!	1-2
P08	Bing	3-4	Google	1-2
P09	Yahoo!	3-4	Bing	1-2
P10	Google	1-2	Yahoo!	3-4
P11	Bing	1-2	Google	3-4
P12	Yahoo!	1-2	Bing	3-4
P13	Google	3-4	Yahoo!	1-2
P14	Bing	3-4	Google	1-2
P16	Google	1-2	Yahoo!	3-4

Note: Data from P15 was eliminated from the study, as recordings did not render.

The table above indicates that for desktop search engines, 6 participants were asked to use Google; 5 were asked to use Bing; and, 4 were asked to use Yahoo! Search. For mobile search engines, 6 participants were asked to use Yahoo! Search; 5 were asked to use Google; and, 4 were asked to use Bing. Contrastingly, all participants were given a balance of tasks to complete within the respected search engine. Although there is not a one-to-one ratio among desktop to mobile search engines, quite a few interesting results

still showed. Further research will need to be performed with this population, however, to see if results stay consistent.

Field Study Participants

A total of 15 participants, age 55 – 70, agreed to participate in the one-hour study. With the exception of one participant who spoke Spanish as their primary language, all other participants spoke English as their primary language, had some college education, and were familiar with mobile devices such as Smartphones and tablets. Out of 15 participants, 4 were between the ages of 55-59 years of age; 8 were between 60-64 years of age; and, 3 were between 65-69 years of age. Furthermore, only 3 participants were male. Career-wise, 8 participants were retired versus 7 who held current positions within the communications and science fields. No participants worked in any technical capacity that would distort the data set. When asked how much time on average is spent online daily, 9 participants noted spending 1-3 hours online daily and 5 participants noted spending 8+ hours. Of those participants who spent the most time online, most held full-time jobs. Moreover, only 5 participants indicated using a mobile device as their primary means of accessing the Internet. All participants indicated they felt comfortable to very comfortable using the Internet and search engines in general.

Aside from the short questionnaire participants completed at the start of the study, participants were also asked about their general usage of search engines and mobile devices. These questions provided a better understanding of the participants overall thoughts and usage habits of mobile devices.

Questions in the Online Survey

The purpose of the online survey was to get quick information from seniors who use or have used mobile search and desktop search in the past. The information gathered was intended to supplement data retrieved during the in-person interview sessions.

On average, the survey took approximately 5 minutes to complete and had a total of twenty questions. A few questions asked were the same as those in the ThinkMobile Google survey “The Mobile Movement: Understanding Mobile Users” conducted by Google and IPSOS OTX MediaCT in 2011. Twenty participants responded to the online survey, which was hosted on SurveyGizmo.

Table 2
Online Survey Questions

Number	Question
01	What is your age?
02	What is your gender?
03	What is your job function?
04	What is the highest educational degree you have completed?
06	Overall, how often do you use your mobile device for anything other than sending or receiving calls? Please think of anytime you may access the Internet, use apps, text message, etc.
07	Where do you use your mobile device? Select all that apply.
08	Aside from making or receiving calls, which of the following activities, if any, have you done on your mobile device in the past week? Select all that apply.
09	In general, which of the following media-related activities do you do while also using the Internet on your mobile device?
10	Over the past year, which of the following activities did you participate in while also using the Internet on your mobile device?
11	Which of the following Internet activities do you typically use your mobile device

- for?
- 12 Which of the following types of websites do you visit on your mobile device?
- 13 Which of the following search engines have you used in the past month using a desktop computer?
- 14 Which of the following search engines have you used in the past month using a mobile device?
- 15 Which of the following types of information do you typically look for using a search engine on a mobile device?
- 16 Which of the following types of information do you typically look for using a search engine on a desktop computer?
- 17 Why do you conduct searches on your mobile device (versus your desktop
- 18 Overall, explain your experiences with using desktop search engines: What do you find frustrating or complex? How easy to use do you find search engines?
- 19 Overall, explain your experiences with using mobile search engines: What do you find frustrating or complex? How easy to use do you find mobile search engines
- 20 Generally, what is your favorite search engine? Why?
- 21 How often do you start an activity (i.e. emailing, researching, shopping, etc.) on a mobile device, but continue it or finish doing it at a later time on a different device? Why?
-

Refer to Appendix C for the detailed survey response report.

Overall, the survey results state that seniors are comfortable using search engines on desktop and mobile. Although they typically do not start a task on mobile and complete it at a later time on another device, seniors tend to only search for particular items on mobile compared to desktop. For example, the majority of participants surveyed indicated looking up GPS directions, local business information, sending and receiving email, and reading news on a mobile device. Additionally, many seniors take advantage of downloading mobile apps; doing so takes them directly to one central location where trusted content can be found rather than using a search engine. Seniors also utilize mobile

devices to consume media such as listening to music or watching a video. Finally, Google was found to be the search engine of choice for both desktop and mobile search, compared to Yahoo! or Bing.

Observations and Results

Overall, participants of this exploratory research study completed the tasks with ease, regardless of the search engine provided. In several cases participants completed all four tasks within approximately 30 minutes, including time spent discussing their thought process.

Table 3

Tasks: Found and Reported on Mobile

Tasks	Google	Bing	Yahoo!
1 - Movie Show Times	3/3	2/2	2/3
2 - Define COPD	3/3	2/2	3/3
3 - Flight Ticket	2/3	3/3	4/4
4 - Online Savings	3/3	2/3	4/4
Percent Complete	91.6%	88%	92.8%

Table 3 indicates the overall success rate of tasks completed (found and reported) by participants on mobile devices. For example, on Task 1 using Yahoo! mobile search, 2 participants out of 3 successfully completed the task. Task 3 using Bing mobile search indicates that 3 out of 3 participants successfully completed the task. ‘Percent Complete’

shows that participants were most successful using Yahoo! mobile search (92.8%) compared to Bing (88%). However, the overall number of participants who utilized each search engine for the provided tasks should be taken into consideration. 14 participants utilized Yahoo! compared to 12 participants who utilized Google, and 10 participants who utilized Bing.

Table 4

Tasks: Found and Reported on Desktop

Tasks	Google	Bing	Yahoo!
1 – Movie Show Times	4/4	3/3	3/3
2 – Define COPD	4/4	3/3	3/3
3 – Flight Ticket	3/3	3/3	2/2
4 – Online Savings	3/3	2/3	1/2
Percent Complete	100%	91.6%	90%

Table 4 indicates the overall success rate of tasks completed (found and reported) by participants on desktop devices. For example, on Task 1 using Google search, 4 out of 4 participants successfully completed the task. Task 4 using Yahoo! search indicates that 1 out of 2 participants successfully completed the task. ‘Percent Complete’ shows that participants were most successful using Google (100%) compared to Bing (91.6%). However, the overall number of participants who utilized each search engine for the

provided tasks should be taken into consideration. 14 participants utilized Google compared to 12 participants who utilized Bing, and 10 participants who utilized Yahoo.

Task #1 Observations

When a user performs a search for a relatively simple question such as 7 times 5 or how many teaspoons in a tablespoon, the search engine results page (SERP) attempts to provide the answer in plain text at the top of the page without forcing users click into a results link. Google refers to this as a rich result ("Facts about Google and Competition"). These pages have come into heavier use in an attempt to move SERPs away from the traditional 'ten blue links' (Niccolai 2000) model of displaying results; with snippets of site text presented below each link with little context. The new model of a SERP is designed to understand and respond to a user's query with a contextually relevant answer (Moreville & Calender, 2010). Depending on the search query entered however, rich results do not always display; this is in part due to how web pages are tagged and indexed.

When users searched for movie show times using mobile search engines, 4 out of 7 users saw and reported a successful answer using rich results located at the top of the page. For the 3 users who did not find successfully find and report a movie show time, it was because their search query did not display a rich result. Compared to mobile, only three desktop users found and reported a movie show time as a result of a rich result; other users completely missed the data presented or rich results did not display due to the search query provided. P07, who used Bing for desktop indicated their overall

satisfaction with rich results displaying at the top of the page. P07 stated, “This is really nice. Bing on the mobile would have been great because it came right up. All the movies are listed and all the times are listed, and it gave me the rating”. Even if rich results were not always found and reported for this task, overall this was an easy task for users to complete on both mobile and desktop; 100% of desktop users successfully completed this task and 87.5% of mobile users (7 out of 8 users) successfully completed this task. Interestingly however, many users indicated that they would not use a desktop search engine to find movie show times, as this task is easier to look up using a mobile device search engine or with the help of a specific app such as the Fandango or AMC Theatre mobile app.

Task #2 Observations

Similar to the first task, reporting the definition and treatment of COPD often resulted in rich results. While this task was a straightforward task for all users to complete regardless of whether desktop or mobile search was used, several users who did obtain a rich result either projected one of two thoughts. First, a couple users who did read the COPD definition on desktop thought the information was an ad and decided that while the information seemed legitimate, they continued to find another website to confirm the rich result was correct. Second, every user stated that they would either search directly for, or go directly to, a nationally recognized medical website for any medical related questions. Users often mentioned the NIH (National Institute of Health) and WebMD websites as two credible medical resources. For the few users who did not receive a rich result based on their search query, a total of 2 users clicked on paid ads,

however only one user went back to the main SERP to confirm the information was correct after they realized they clicked on an ad. In conclusion, 100% of all users successfully completed this task on both desktop and mobile and there were no significant behavioral differences between each device group.

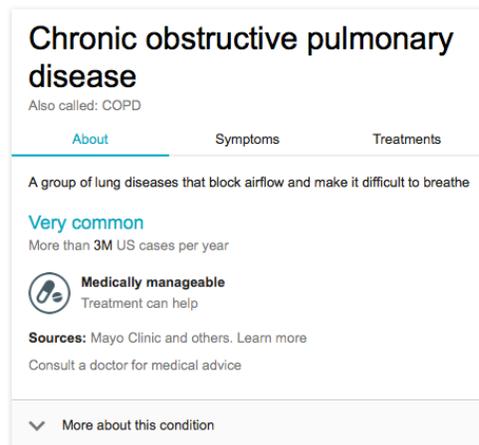


Figure 1. Google rich result for *COPD*.

Task #3 Observations

When found, seniors loved the additional features Google and Bing search provided when searching for flight times and prices. Locating this information at the top of the SERP sometimes but rarely displayed as a rich snippet, but when it did it proved useful. Only 1 participant, P05, however found this feature through their search query on mobile. The term entered to find and report the task information from the search results page was “cheapest ticket from bwi to aus”. Interestingly, most participants regardless of searching on mobile or desktop entered generic queries like “Travelocity”, “Expedia” or “Kayak” to directly go to a specific travel website, or in some cases an airport website or airline website. Those that completed this task using mobile all stated this task should be

searched for using a desktop computer or a tablet as screen space is much larger. P02 stated that they would not use their mobile device for such a task, and would rather use a desktop with a real keyboard because comparing flights can get complicated, and mobile devices are not meant to do such tedious research. P03 further explored this theme and indicated they would feel much more comfortable using their desktop computer at home to research and purchase airfare versus on a mobile device. Even though there was a 100% success rate of looking up a flight ticket and price on desktop and a 90% success rate on mobile, the vast majority of participants choose to go to websites like Travelocity or Expedia. Usability problems did plague a number of mobile participants who went to the aforementioned websites; it was clear the mobile web versions did not always streamline the process of flight and ticket price look-up. Out of all of the tasks, this task in particular took participants the longest to complete and had an average task-completion time of 6 minutes.

Task #4 Observations

Although it could have been the wording of this task, task four, researching online banks that have a high interest rate, appeared to stump many participants. As a result, the majority of participants entered the task almost word-for-word into the search engine. Of the ten participants who completed the task on mobile, there was a 90% success rate and of the 8 participants who completed the task on desktop, there was a 78% success rate. Although success rates are over 50% for each device, the average time-on-task was about 1-2 minutes longer on desktop compared to mobile. The reasoning could be that on mobile search queries were shorter. Queries such as “online savings” and “internet only

banks” were typically used on mobile search, versus longer queries of “online savings account rates compare” and “online banking apy rates compare”. Although search results did tend to stay consistent between both devices, mobile users were able to quickly pinpoint a specific blog that provided a useful interest (APY) comparison chart of banks offering online savings accounts.

Additional Observations

Type-ahead, or auto-suggest, was also heavily used particularly on mobile devices. Auto-suggest on mobile starts appearing almost automatically as soon as the user has entered two or three characters. Due to the small screen size on mobile devices, the prominence of auto-suggest displays in the users focal view point, as to make them think if they should go with one of the options presented. In the study, only a handful of users did not use the type-ahead or autosuggest feature. In those cases users were typing very quickly and did not see the suggestions, or they had a specific query in mind from the beginning and ignored the suggestions altogether.

Furthermore, it was observed that a few mobile participants would often change the viewport of the iPhone to landscape mode. When the two participants who did this were asked their reasoning, they both indicated that turning the iPhone to landscape enables a better reading experience as the text size slightly increases.

Suggested Guidelines for Mobile Search

The following list provides suggested guidelines for improving the efficiency of mobile search. These suggestions are based on the exploratory research conducted with

seniors, and conclusions made from in-person and online interviews regarding mobile search behavior.

1. Continuous updates to overall search result order will be advantageous to all users. Seniors are often confused about why a certain result was provided or does not appear on the first page of results.
2. Rich results might be found and reported more often if they were placed a little bit below the first couple of results on mobile. Since the eye tends to gravitate towards the center of the screen, compared to the top of the screen on mobile, this placement could assist users in obtaining the information they need quicker and more efficiently.
3. Users were not expecting rich results and overlooked them in the search returns. As rich results become more common, users will expect to see rich results in SERPs. Coding for rich results should be taken into consideration when developing or redesigning a website or online service.
4. Mobile ads on some search engines are hard to decipher. Although they might generate a high click-through-rate (CTR), seniors tend to pause before clicking on a search result to decide whether or not the result is an ad or an organic result.
5. Although all participants utilized the type-ahead or autosuggestion feature on both desktop and mobile, they tended to use it as a spell-checking tool, or to refine an existing search query. Search engines should unobtrusively support live autocorrect inside of the autocomplete options.

Conclusions and Future Research

There is a growing trend with seniors going online to find information. Usability studies completed with older adults and seniors show that the majority of websites have usability issues due to a variety of reasons. Some of these usability issues reflect the fact that many web designers do not understand age related issues and “often assume that all users have perfect vision and motor control, and know everything about the Web” (Nielsen, 2002). While there is a fair amount of research involving seniors on the web, further research should be performed with older adults with mild to severe cognitive impairments as they relate to online information retrieval. Additional surveys with seniors asking their preferences on stylistic preferences would also be valuable.

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Appendix A: Introductory Script

Thank you so much for coming in today. My name is Nicole Kerber and I am a student in the Interaction Design and Information Architecture program the University of Baltimore, currently working on my master's thesis project.

I want give you a little background on my project. Senior citizens aged 55 and above, are nearly as likely as younger users to use a search engine to answer a specific question. Seventy-six percent of these “wired seniors” have used a search engine to find information, compared to 80% of all Internet users. In fact, searching for health related information is the second most popular activity seniors do online. However, most websites are not designed with seniors in mind, and are therefore difficult or frustrating to use. Since performing a search is the second most popular activity seniors do while online, my thesis project will be looking at how seniors use desktop and mobile search engines, as mobile technology such as smart phone and tablet usage computes to grow in popularity, especially for this segment of the population.

Today I will be asking you to perform a few tasks using a desktop or mobile optimized search engine like Google. Please note that these tasks are in no way testing you, and you cannot do anything wrong here today. They are only intended to test the usability of the search engine. The whole process should take one hour or less.

Each task will be visible on the computer screen [for desktop session] or printed on an index card [for mobile sessions]. Please read the task aloud, and then you can start to work. As you are working through the tasks, I'd like you to “think aloud”. What we are looking for is basically a running commentary about your thoughts as your move through the task.

If you have any questions, comments or areas of confusion while you are working, please tell me. I may not always be able to help you, but it is very important for us to note where questions come up. As you go through the tasks I may stop you and ask for clarification about your process or to find out what you are thinking at that moment. It is important that you tell me when you feel that each task is complete, and when you are ready to move onto the next task.

Do you have any questions for me begin we begin?

Thanks again for coming in today, I really appreciate your help.

Appendix B: Informed Consent

As part of a Master's level thesis study at the University of Baltimore, participants are being asked to evaluate the usefulness and effectiveness of an iPhone app designed for the Smithsonian Air and Space Museum. The results of this study are primarily for academic research and the Smithsonian Air and Space Museum but may be used for further publication outside of the University. Identifying data beyond your image and first name will not be shared.

The facilitator will walk you through a series of tasks, take notes and answer questions if possible. There are no right or wrong answers in this session. We are looking to evaluate the product only, and ensure that its design meets your needs. This session will be recorded.

These tests pose no known physical or psychological risks and have no harmful effects. If at any time during the test session you decide that you no longer wish to participate in this study, you may withdraw from participation at any time, for any reason, and without penalty.

If you have questions about this test, you may contact either of the following individuals:

Nicole Kerber
(Student Researcher)
nicole.kerber@ubalt.edu

Kathryn Summers, Ph.D
(Faculty Advisor)
ksummers@ubalt.edu

For questions about your rights as a research participant, please contact:

Dr. Eric Easton
(IRB Chair)
eeaston@ubalt.edu

Thank you for your participation.

YES, I consent to participate in a usability test activity as part of a master's thesis through the University of Baltimore. I understand this data will be used mostly for academic research but may also be included in future publications outside of the University.

YES, I permit the test facilitator to video record this session and take notes on my actions, comments and questions. I understand that the video and notes of this test will be used primarily for research purposes but may be included in future publications. I further

understand that at no point in time will my name be associated with a video of my test session.

YES, I agree that by signing this consent I am acknowledging that I am at least 55 years of age.

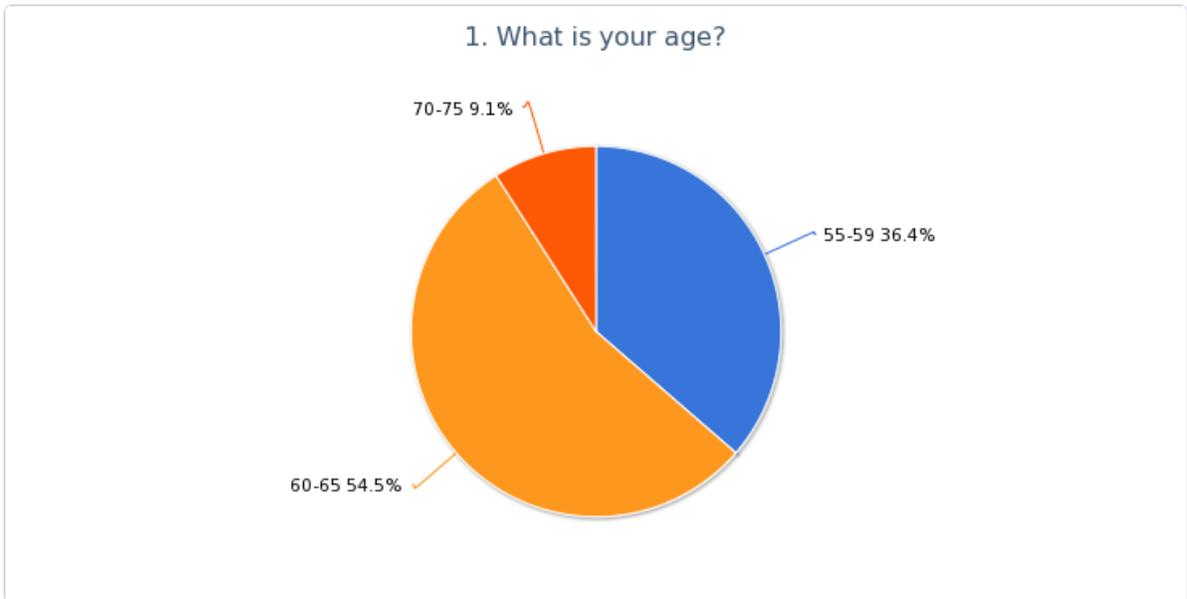
Print Name

Signature

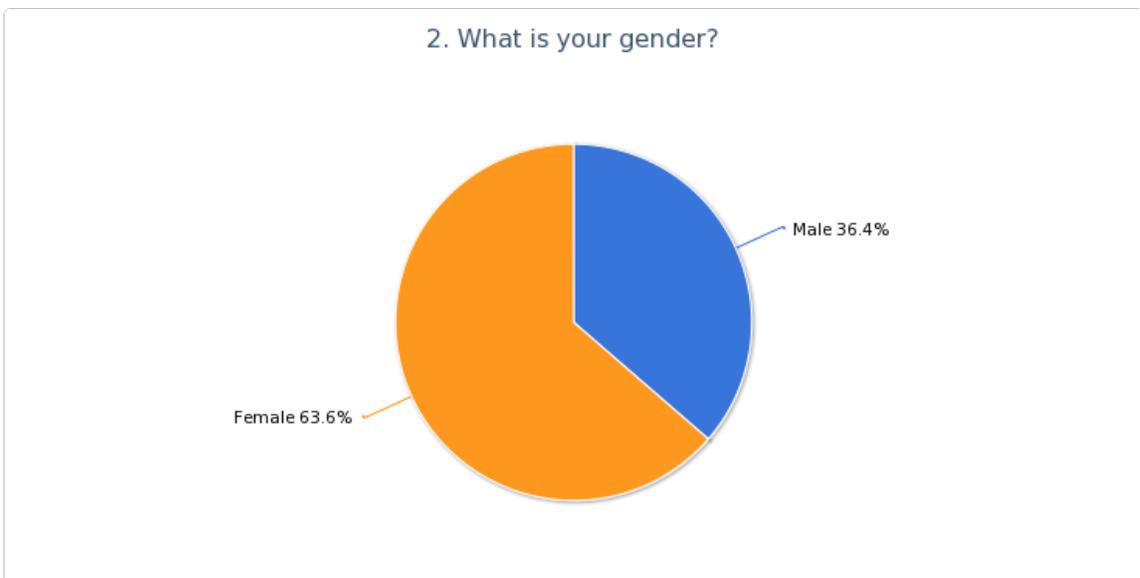
Date

Appendix C: Online Survey Results

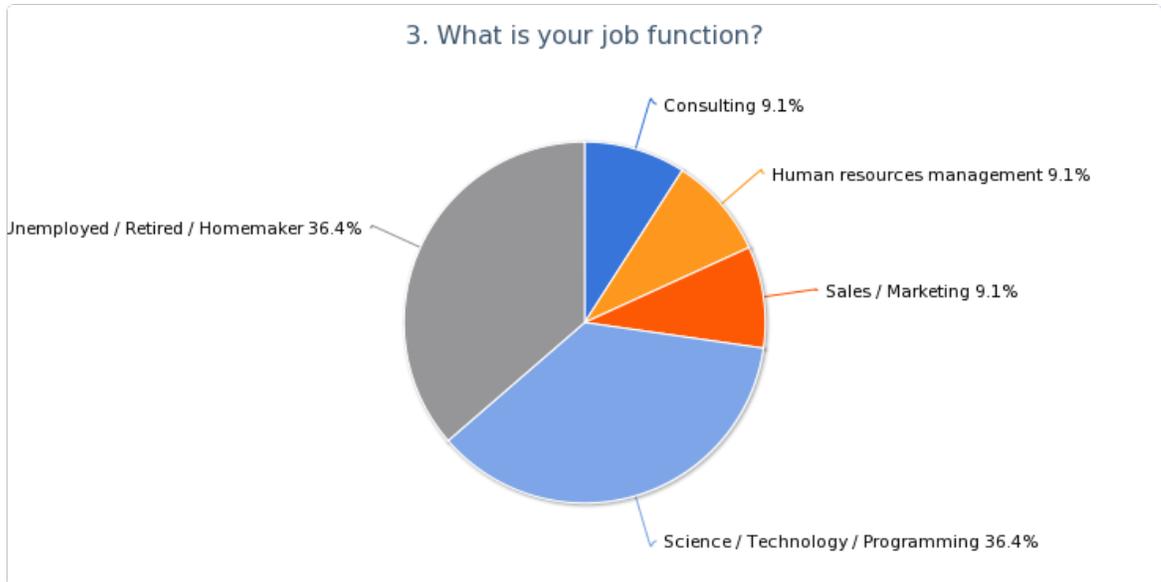
1. What is your age?



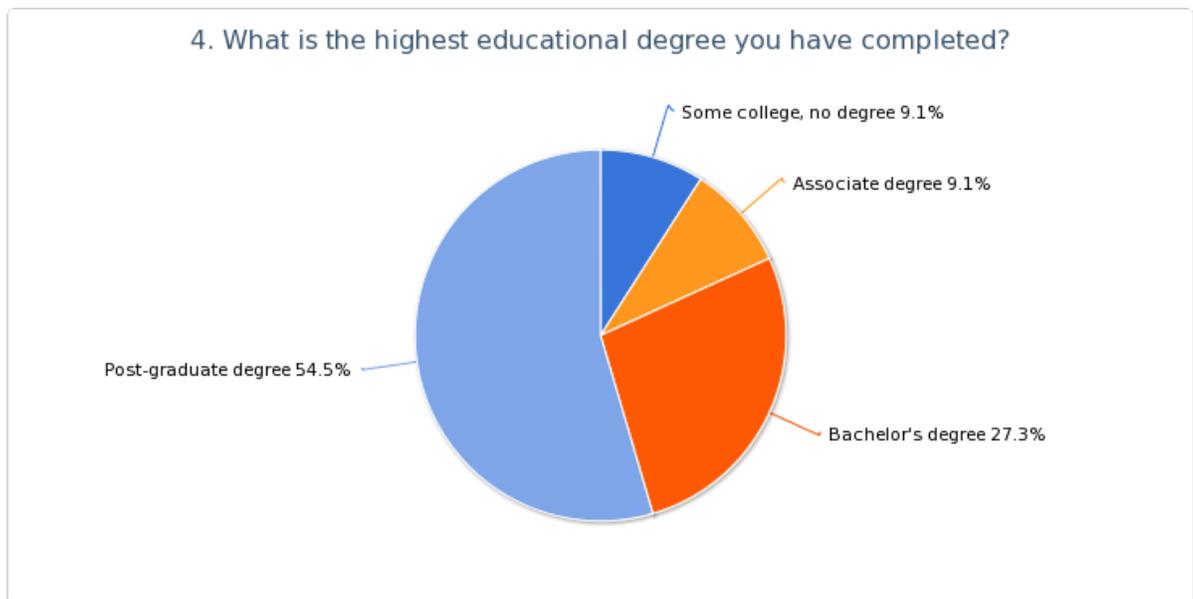
2. What is your gender?



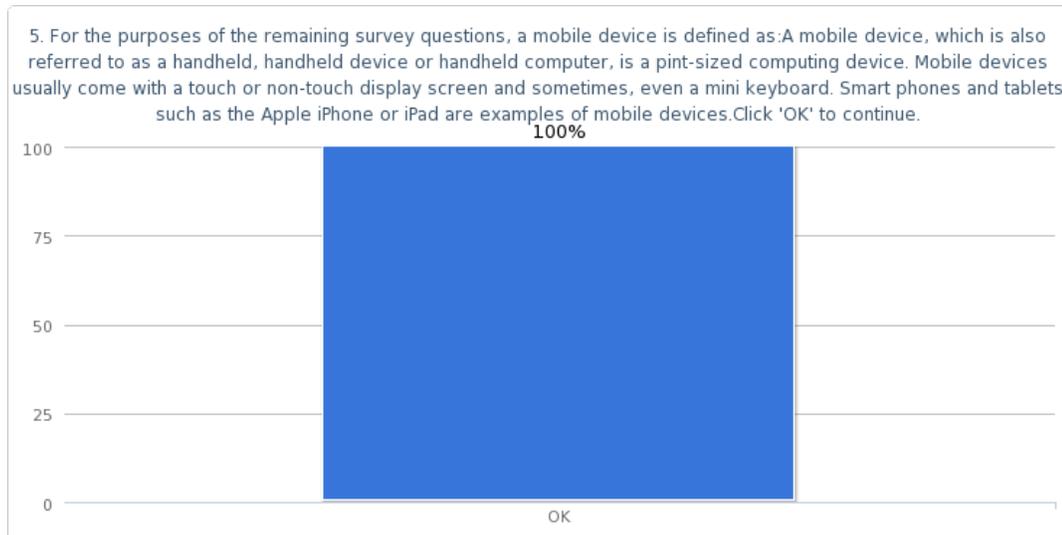
3. What is your job function?



4. What is the highest educational degree you have completed?



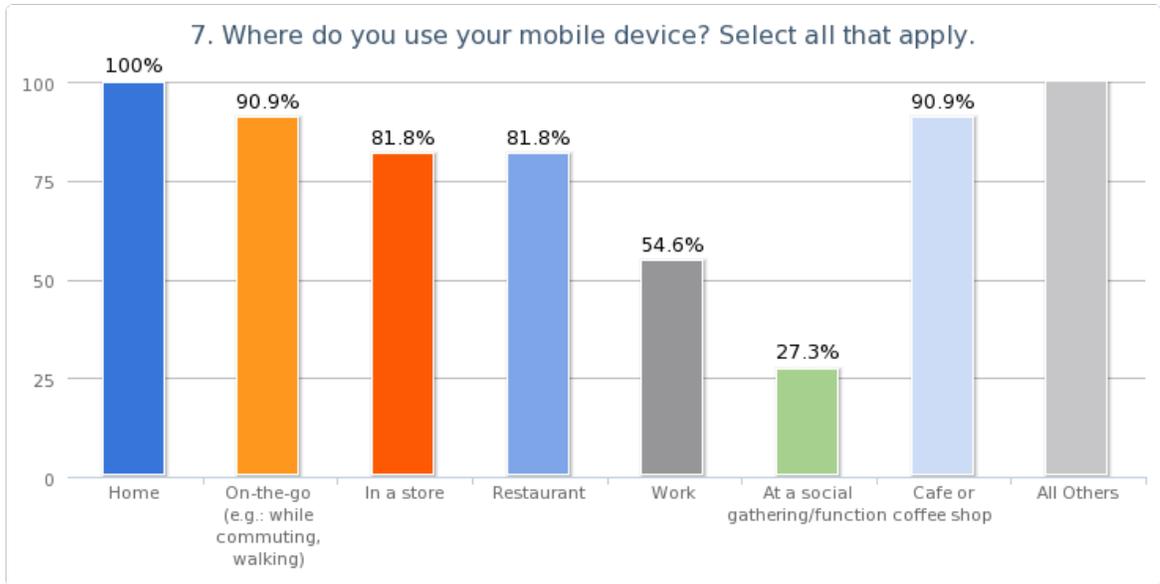
5. For the purposes of the remaining survey questions, a mobile device is defined as: A mobile device, which is also referred to as a handheld, handheld device or handheld computer, is a pint-sized computing device. Mobile devices usually come with a touch or non-touch display screen and sometimes, even a mini keyboard. Smart phones and tablets such as the Apple iPhone or iPad are examples of mobile devices. Click 'OK' to continue.



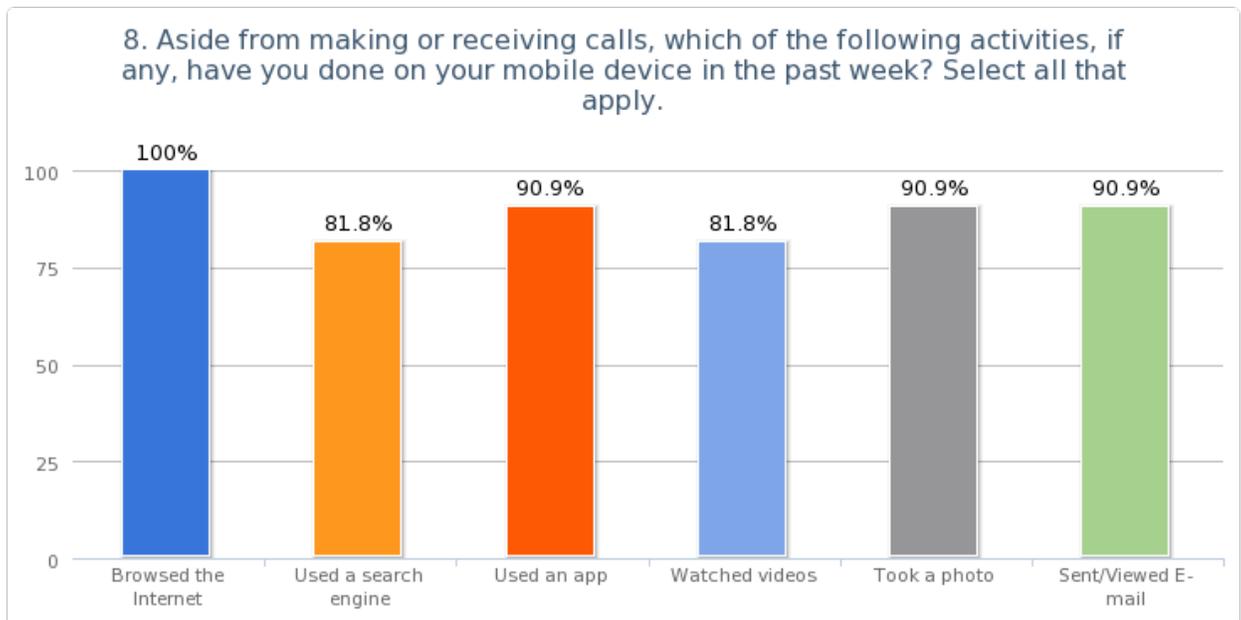
6. Overall, how often do you use your mobile device for anything other than sending or receiving calls? Please think of anytime you may access the Internet, use apps, text message, etc.

- 5-10 times per day
- Constantly
- Daily
- Daily, not quite hourly.
- Daily, not quite hourly.
- Numerous times daily.
- Too much
- Use my phone very frequently to play games, check scores for sports, Facebook and other apps
- Daily and every 20 minutes at least
- Not often. Do not use text message but play card games on mobile phone
- Multiple times per day to access: text messages, Google maps, internet searches, send & receive photos, comparison shop, controller for video/audio house system

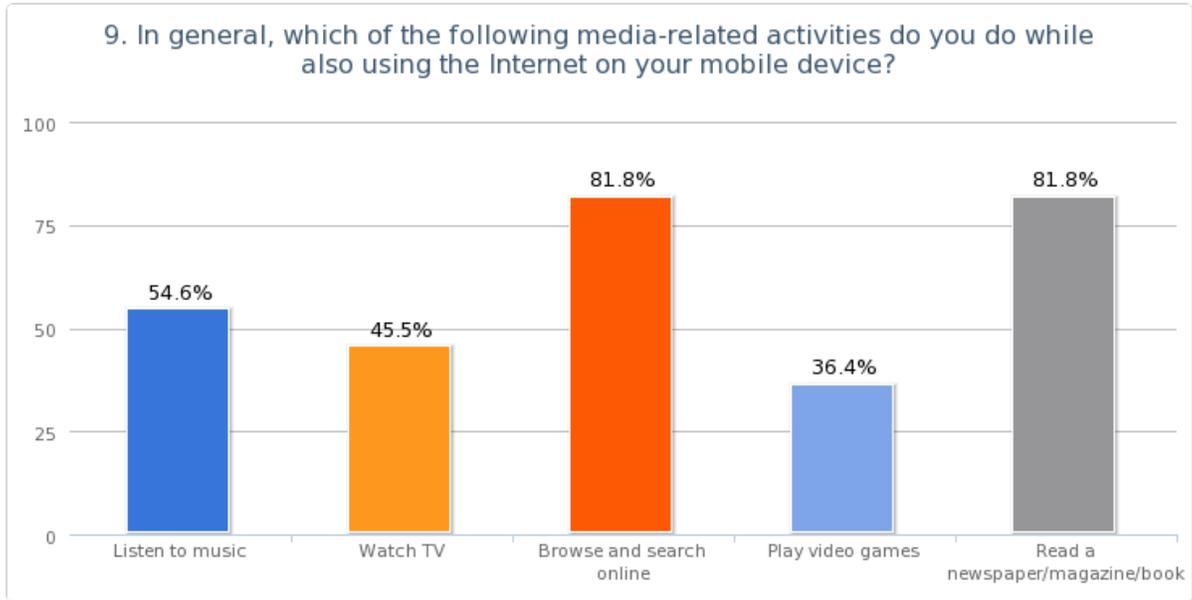
7. Where do you use your mobile device? Select all that apply.



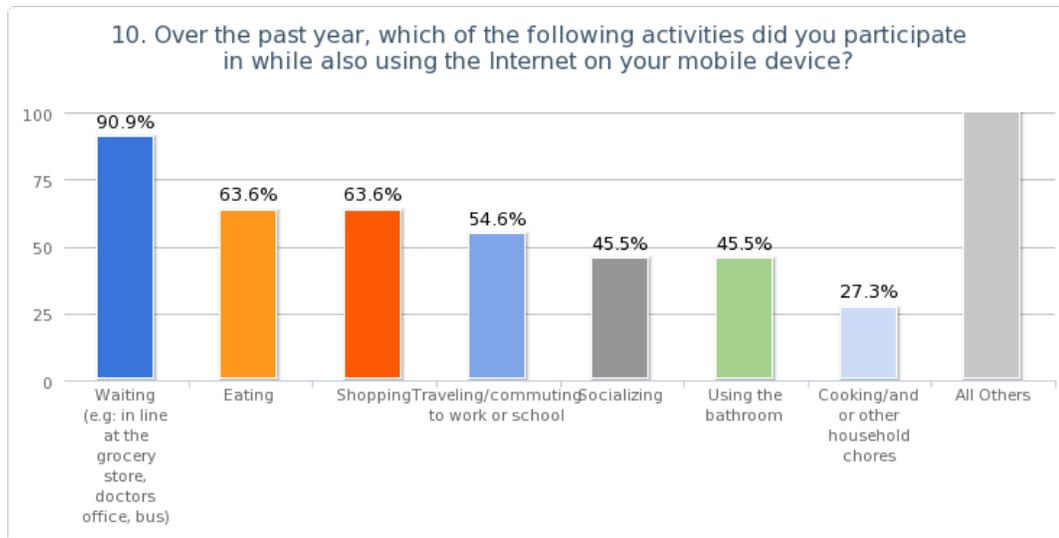
8. Aside from making or receiving calls, which of the following activities, if any, have you done on your mobile device in the past week? Select all that apply.



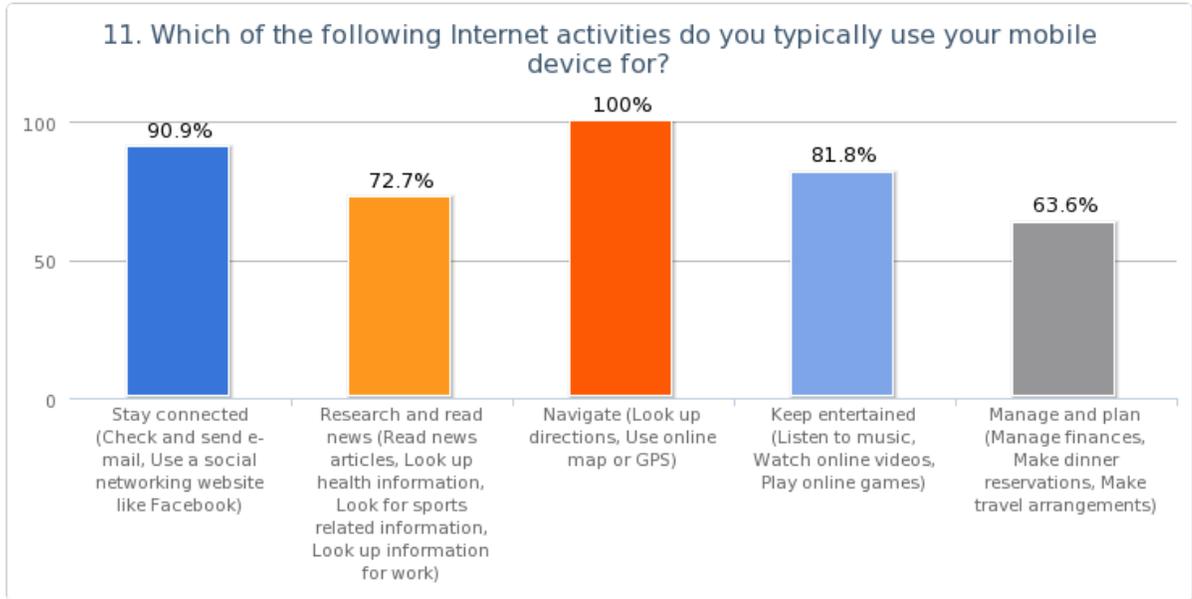
9. In general, which of the following media-related activities do you do while also using the Internet on your mobile device?



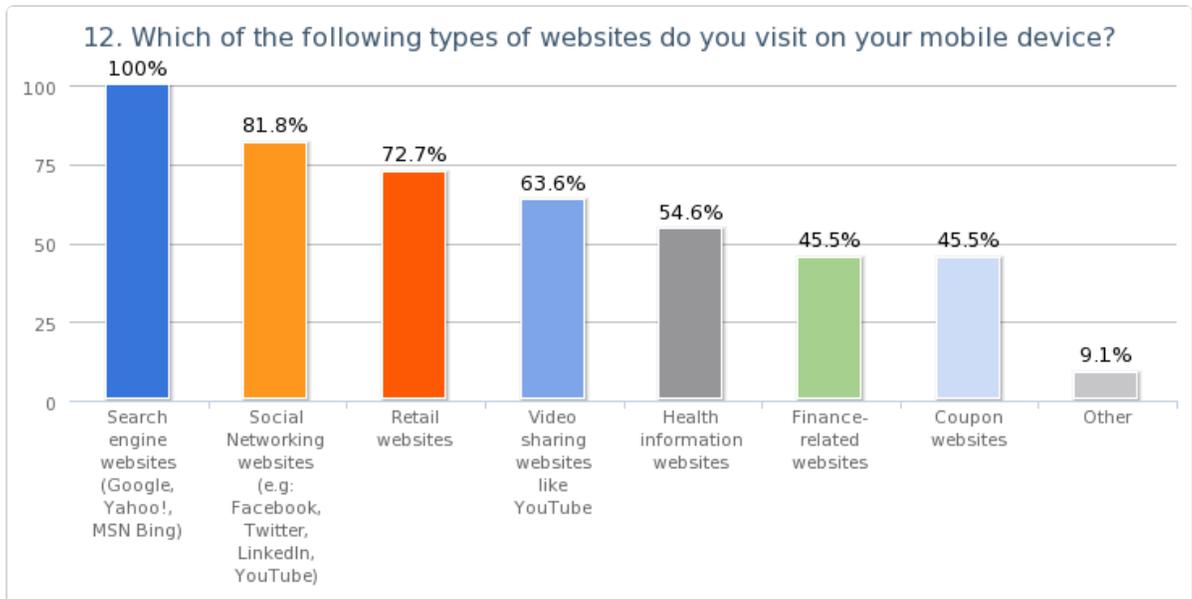
10. Over the past year, which of the following activities did you participate in while also using the Internet on your mobile device?



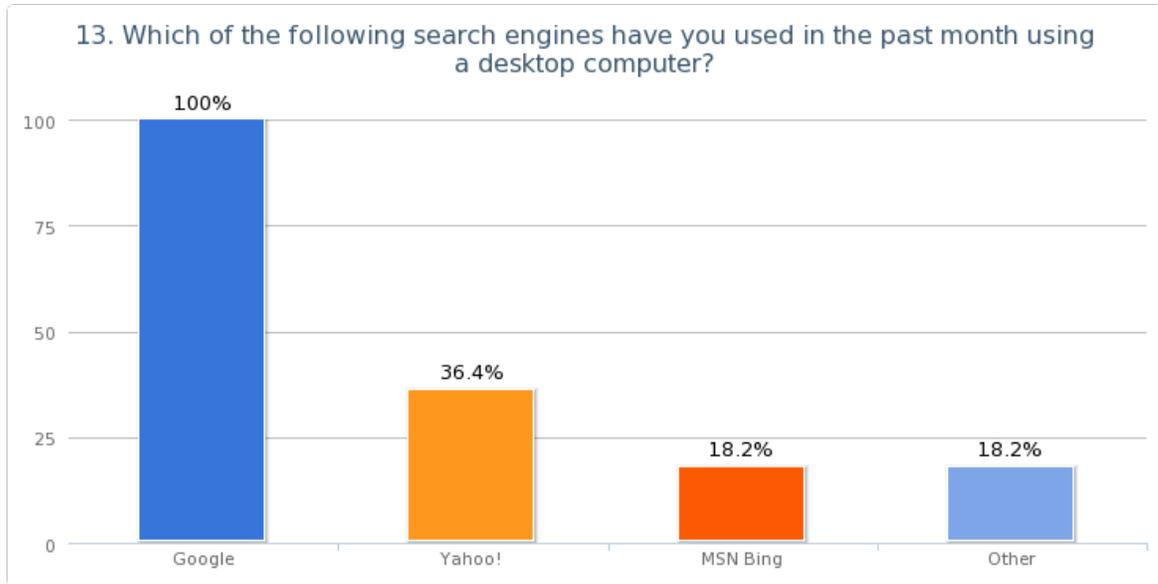
11. Which of the following Internet activities do you typically use your mobile device for?



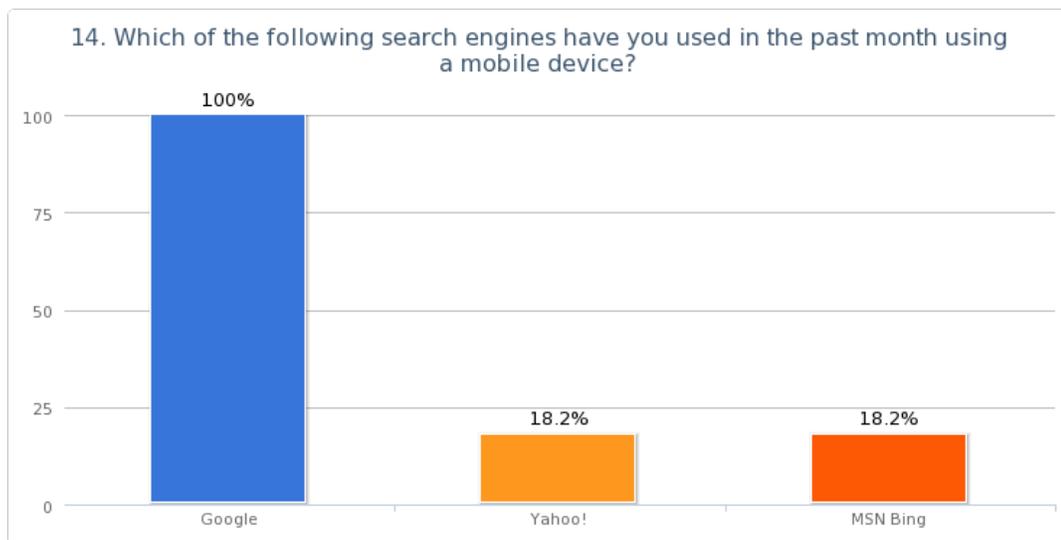
12. Which of the following types of websites do you visit on your mobile device?



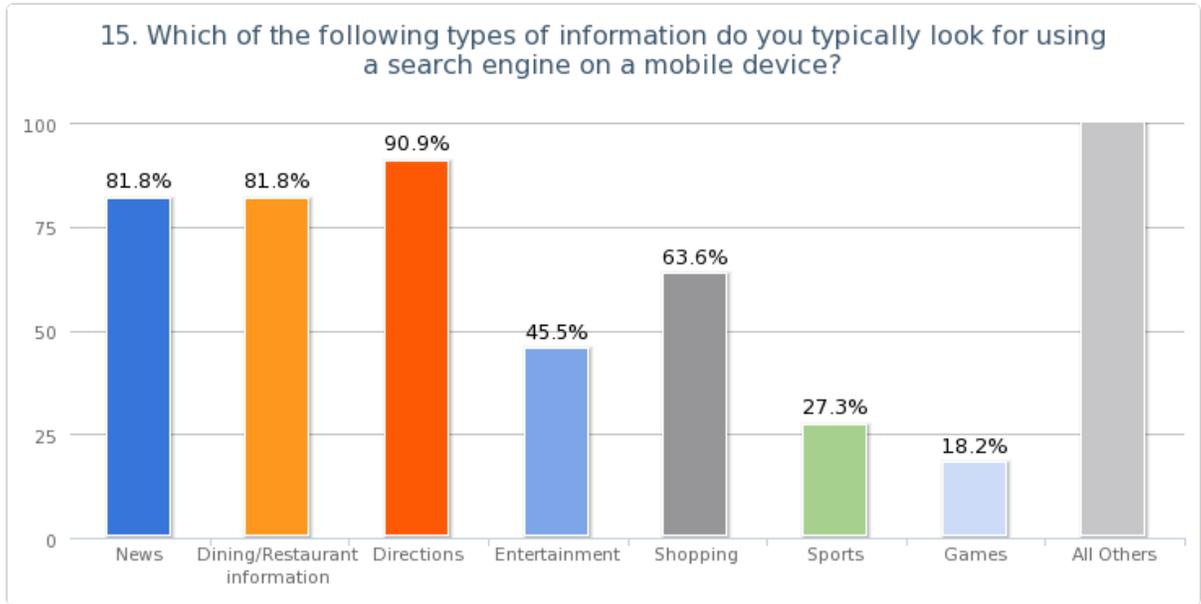
13. Which of the following search engines have you used in the past month using a desktop computer?



14. Which of the following search engines have you used in the past month using a mobile device?

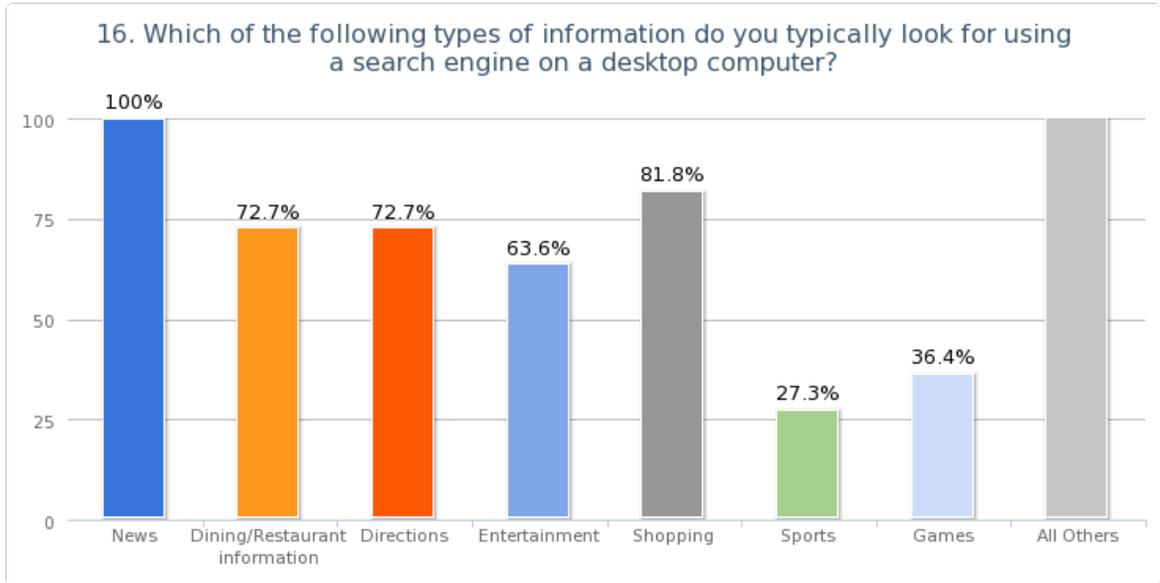


15. Which of the following types of information do you typically look for using a search engine on a mobile device?

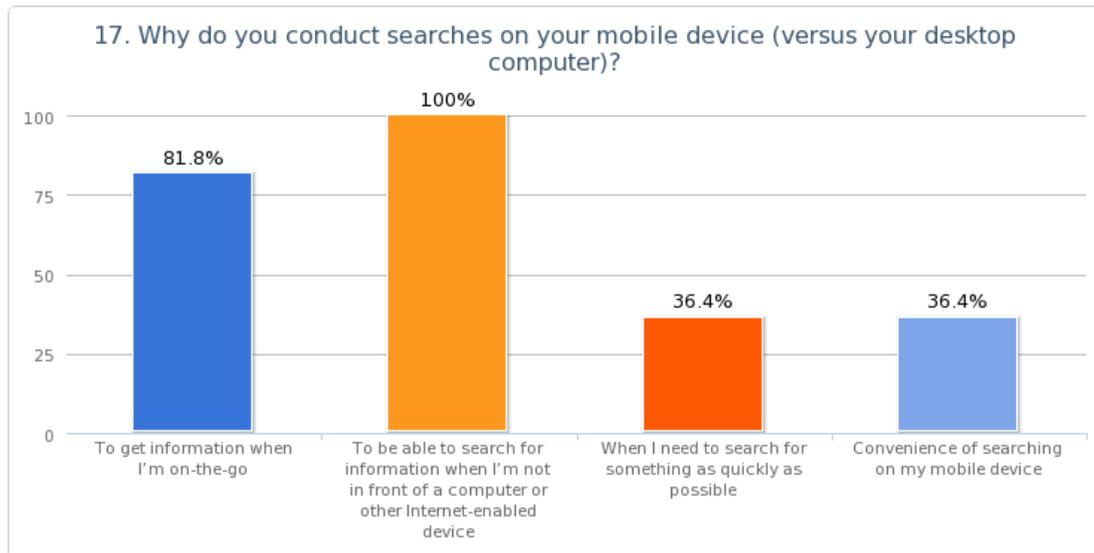


Value	Count	Percent
News	9	81.8%
Dining/Restaurant information	9	81.8%
Directions	10	90.9%
Entertainment	5	45.5%
Shopping	7	63.6%
Sports	3	27.3%
Games	2	18.2%
Food-related (recipes)	2	18.2%
Technology	4	36.4%
Medical/Health	6	54.6%
Finance	4	36.4%
Business information, products or services	8	72.7%
Educational	3	27.3%
Other	0	0.0%

16. Which of the following types of information do you typically look for using a search engine on a desktop computer?



17. Why do you conduct searches on your mobile device (versus your desktop computer)?



18. Overall, explain your experiences with using desktop search engines: What do you find frustrating or complex? How easy to use do you find search engines?

- I generally use only Google -- and am usually very satisfied
- I see no big differences.
- Sometimes the information is too involved and doesn't give enough detail.
- There are too many features or options.
- What makes you think that I use a desktop computer? I do not own one. So this is a frustrating question
- I prefer Google over the other engines. Use is easy. At times I find comparison-shopping difficult.
- My experience has been good. If there was one that combined all the features of the rest, then that would work well. I like the look and feel of Opera, but it doesn't have the search box in the toolbar like Firefox does. I like Firefox for that reason, but it doesn't have the appearance of web 2.0 as Opera, Chrome or Explorer do. I do not use Explorer as it's too non-progressive in its usability.
- No frustrations on the whole except search order does not always yield most relevant information especially when it comes to finding restaurants or other commercial enterprises.
- Sometimes info is too broad and things are not as the page gives you the impression it is. Too many advertisements.
- Search engines have begun showing you what paying advertisers want you to see, not what you asked to see.
- Inputting queries and repurposing search results on the desktop is easier, especially for more complex searches. It is also more convenient on my tablet, but more practical on the mobile phone when I'm mobile. Mobile is better, in my case, for shopping and navigation (GPS)

19. Overall, explain your experiences with using mobile search engines: What do you find frustrating or complex? How easy to use do you find mobile search engines?

- Google and Yahoo are the two that I've used and I quit Yahoo because it was too slow. Google is excellent, but slow on my phone.
- More than anything I shy away from doing much searching on my iphone -- the screen size is too bothersome. I currently use an android tablet -- but find it a bit slow for my taste
- Don't often use mobile search engines, usually only on my ipad. They can be slow at times and don't always get the information I need. Seems more streamlined than desktop.
- No frustrations on the whole except search order does not always yield most relevant information especially when it comes to finding restaurants or other commercial enterprises. Paid aggregations seem to trump the website listings for the small restaurant/store.
- Please see answer to 18. The smaller the form-factor, the more difficult. I find it to conduct complex searches, or manage results from concurrent searches.

20. Generally, what is your favorite search engine? Why?

- Depends on what I am trying to do
- Google
- Google - easy, on point responses.
- Google - pretty reliable
- Google. Don't like Bing politics.
- Google. I feel most comfortable using Google.
- Google. It's very comprehensive.
- Google. Used to using it and seem to get relevant results.
- I have two: DuckDuckGo for the desktop, which affords some minimal amount of anonymity, and Google for the tablet and cell, because it's what's there and I'm familiar with it.
- None, currently. None reflect my preferences for what is displayed. Search engines have begun showing you what paying advertisers want you to see, not what you asked to see. For example, if you ask to see black T-shirts for men the engine will show you red tank tops for women.
- Google -- I have been known to thank the Google Gods -- there is virtually nothing I can't find on Google

21. How often do you start an activity (i.e. emailing, researching, shopping, etc.) on a mobile device, but continue it or finish doing it at a later time on a different device? Why?

- 75% of the time
- Maybe once daily.
- No more that 7% of the time and more likely less than 5% of searches.
- Not often. Can't think of any time I've done this.
- Not usually.
- Not very often unless traveling. Many times my mobile battery goes dead when searching.
- Often
- On occasion -- same reason as #19
- Rarely. I no longer begin the operations on a mobile device. Small screen.
- Usually don't finish on another device.