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The Effects of Age, Cognition, and Health Numeracy on Use of a Patient Portal of an Electronic Medical Record (EMR)

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UNIVERSITY OF MIAMI

THE EFFECTS OF AGE, COGNITION, AND HEALTH NUMERACY ON USE OF A
PATIENT PORTAL OF AN ELECTRONIC MEDICAL RECORD (EMR)

By

Jessica Taha

A DISSERTATION

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Doctor of Philosophy

Coral Gables, Florida

June 2012

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Effects of Age, Cognition, and Health Numeracy on
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Diverse patient populations are increasingly using patient portals that are tethered to their electronic medical record (EMR). Patients using portals can view their medical history, review laboratory results and medication lists, and follow links to credible health information online. Many of the tasks performed with a portal depend on numeracy skill. For example, numeracy skill is needed in managing appointment dates and times, understanding medication dosage instructions, reviewing lab results, and interpreting health information from charts, tables, and graphs. However, there is no data available regarding the numeracy ability of patients and how this ability affects their use of a patient portal. Additionally, little is known about how other individual characteristics, such as age and cognition, impact the ability of patients to use the information contained in portals to manage their health.

The specific aims of this study were to: 1) examine the ability of middle-aged and older adults to use a patient portal of an EMR to perform common health management tasks; 2) examine the relationships between individual characteristics such as age, cognitive abilities, health numeracy, and task performance; 3) identify usability problems inherent in the use of patient portals; and 4) identify initial design solutions. This study evaluated the ability of 107 middle-aged and older adults (aged 40-85 years, $M = 58.87$, $SD = 11.89$) to use a simulated patient portal of an EMR to perform 15 common health

management tasks encompassing medication management, review/interpretation of lab/test results, and health maintenance activities. Results indicated that older adult participants had lower mean scores on the more complex tasks and overall performance than did the middle-aged adults. Individual characteristics such as age, cognitive variables, health numeracy, and Internet experience had a significant impact on performance for both the middle-aged and older adults. Individuals with lower verbal ability, executive functioning, reasoning skills, and health numeracy skills had lower performance. Overall, the findings indicated that demands on these skills should be considered in the design of patient portals. In addition, careful consideration needs to be given to health numeracy demands such as the presentation of numerical information and demands related to interpretation of mathematical information.

This research is unique and important in terms of addressing barriers to older adults' use of patient portals of EMRs. We must know more about these users and their preferences and usability problems if we expect them to adopt and successfully use these systems. Currently, the literature available on this topic is very limited. Results will also contribute to the existing literature on the health numeracy aspect of health literacy. Although there is a vast amount of literature on health literacy, there is only limited information about older adults and health numeracy. This project is very timely and of great public health significance because the number of older patients using patient portals tethered to an EMR is likely to increase as electronic records become more widely used.

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CHAPTER 1

INTRODUCTION

In the current health care environment, increasing amounts of health information are being disseminated to the public, with the assumption that they are able to effectively use such information to benefit their health. It has long been recognized that one's literacy is important for making informed healthcare decisions and that low literacy may limit an individual's capacity to function in the health care setting, affect physician-patient communication, and unintentionally lead to poor medical care (Ad Hoc Committee on Health Literacy, 1999; Schillinger et al., 2003). However, as much of the health information delivered to patients is expressed numerically, an understanding of numerical concepts – often referred to as “quantitative literacy” or “numeracy” – is perhaps as important for informed decision making as literacy (Reyna, Nelson, Han, & Dieckmann, 2009). One's numeracy skills have been shown to be associated with communication and medical care outcomes, including understanding of health information and risk statistics (Peters et al., 2006; Rothman et al., 2006; Schapira, Davids, McAuliffe, & Nattinger, 2004; Schwartz, Woloshin, Black, & Welch, 1997; Weinfurt et al., 2003), comprehension of data from medical studies (Schwartz, Woloshin, & Welch, 2005), and control of chronic disease (Estrada, Martin-Hryniewicz, Peek, Collins, & Byrd, 2004).

Poor numeracy skills are widespread. National surveys indicate that about half of the U.S. population has only very basic or below basic quantitative skills (Kirsch, Jungeblut, Jenkins, & Kolstad, 2002). Individuals with basic or below basic quantitative

skills are quite limited in what they can do with numerical information. For example, a person with below basic quantitative literacy skills is likely to only be able to locate numbers in a document and use them to perform simple quantitative operations (primarily addition) when the mathematical information is very concrete and familiar, while a person with basic quantitative literacy skills is likely to be able to locate easily identifiable quantitative information in a document and use it to solve simple, one-step problems when the arithmetic operation is specified or easily inferred (Hauser, Edley, Koenig, & Elliott, 2005; White & Dillow, 2005). In contrast, those with intermediate and proficient quantitative literacy skills are able to locate more abstract quantitative information in a document and solve problems where the arithmetic operation is not specified or easily inferred. Small clinical studies have indicated that 26% to 71% of individuals have inadequate health numeracy skill (Davids, Schapira, McAuliffe, & Nattinger, 2004; Lipkus, Samsa, & Rimer, 2001; Sheridan & Pignone, 2002; Sheridan, Pignone, & Lewis, 2003; Weiss et al., 2005; Woloshin, Schwartz, Moncur, Gabriel, & Tosteson, 2001). Poor numeracy is indiscriminating; studies have shown that even highly educated laypersons and health care professionals have an inadequate understanding of probabilities, risks, and other chance-related concepts (Estrada, Barnes, Collins, & Byrd, 1999; Lipkus, et al., 2001; Nelson, Reyna, Fagerlin, Lipkus, & Peters, 2008; Reyna, Lloyd, & Whalen, 2001; Sheridan & Pignone, 2002).

An emerging source of numerical health information for patients is the electronic personal health record (PHR). PHRs that are “tethered” to a patient’s electronic medical record (EMR) are transforming healthcare by providing patients with increased access to personal health information. Patients using portals have the ability to view their medical

history, review laboratory results and medication lists, communicate with their provider, and follow links to credible health information online (Yamin et al., 2011). Portal tasks relying on numeracy skills include managing appointment dates and times, understanding medication dosage instructions, reviewing lab results, and interpreting health information from charts, tables, and graphs.

To date, there is no data available regarding how the numeracy ability of patients, especially older patients, affects their use of a patient portal. A focus on older patients is important as these patients are increasingly expected to use electronic PHRs for a number of reasons. First, the population 65 and older in the United States reached 40.4 million in 2010 and is projected to increase to 55 million in 2020 (Administration on Aging [AOA], 2011). For persons reaching age 65, their average life expectancy is an additional 18.8 years, and during this time most will have at least one chronic condition and many will have multiple conditions (AOA, 2011). Due in part to the increased occurrence of chronic conditions, older persons average more office visits with doctors than do middle-aged adults. In 2007, those aged 65 and over averaged 7.1 office visits while persons aged 45-65 averaged only 3.7 office visits during that year (AOA, 2011). Health care can be an immense cost for many older adults. In fact, older Americans spent 13.2% of their total expenditures on health, more than twice the proportion spent by all consumers (AOA, 2011). Thus, it is critical that we determine cost-effective ways for the growing proportion of older adults to manage their health. As indicated by Kim et al. (2009), “due to the high incidence and prevalence of chronic conditions that generally require frequent monitoring and interventions, elderly people would benefit more [from PHRs than

younger adults] because the PHR system could enable more coordinated and cost-effective communication and health care delivery” (p. 4).

Despite the increasingly widespread use of patient portals, few studies have investigated the ability of patients to effectively use portals to manage their health. The limited data that are available indicate that patients encounter problems using portals. In a recent usability study of an electronic PHR, participants (aged 27 to 84) had difficulty performing common tasks such as finding lab results, making appointments, and interpreting medication instructions (Segall et al., 2011). This result is especially disconcerting as the analysis of several years of usage data from a widely used PHR indicated that viewing test results was the most-used feature (Silvestre, Sue, & Allen, 2009).

While limited data have indicated that usability problems occur, little is known about the factors that influence the ability of patients, and especially older adults, to perform common health management tasks using a portal. Older adults may experience problems using a patient portal for a number of reasons. First, some of the portal usability problems may be attributed to computer anxiety or limited computer skills in older patients (Lober et al., 2006). According to a recent Pew report (2010), there is still a digital divide – only 58% of adults ages 65-73 and 30% of adults age 74+ go online as compared to 76% of those ages 56-64, 81% of those ages 46-55, 86% of those ages 34-45, and 95% of those ages 18-33. Patients must be able to use a computer and the Internet to access a portal tethered to their EMRs, and lack of proficiency in this regard may hinder the performance of older adults. Problems with using the portal to perform common health management tasks may also arise due to natural changes in cognition that

occur as an individual ages. Abilities related to fluid intelligence – which is considered to be independent of education, experience, and learning and relates to the ability to think abstractly and solve problems – tend to decline with age (Horn & Cattell, 1967), yet these abilities are important to new learning (e.g., using a portal). Furthermore, older adults may have more problems using portals than younger adults due to the existence of lower health literacy in this group; it is well-documented this group is disproportionately affected by lower health literacy than younger individuals (Williams et al., 1995; Baker, Gazmararian, Sudano, & Patterson, 2000; Kutner, Greenberg, Jin, & Paulsen, 2006). In particular, the numeracy component of health literacy may be critical in governing effective use of a PHR as many of the tasks performed with a portal depend on numeracy skill. Health numeracy has been defined as “the degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions (Golbeck, Ahlers-Schmidt, Paschal, & Dismuke, 2005, p. 375).”

Given the increased emergence of patient portals and the need for a better understanding of how adults, and especially older adults, are able to use portals to manage their health, this study has four primary objectives: (1) to examine the ability of middle-aged and older adults to use a patient portal of an EMR to perform common health management tasks; (2) to examine the relationships between individual characteristics such as age, education, Internet experience, cognitive abilities, health literacy and health numeracy, and the performance of health management tasks and decision-making using a patient portal; (3) to identify usability problems inherent in the use of patient portals; and (4) identify initial design solutions.

There are both practical and theoretical reasons for conducting this research. From a practical standpoint, results from this study will yield important information about the ability of middle-aged and older patients to use a patient portal tethered to an EMR for health care tasks. We must know more about these users and their preferences if we expect patients to adopt these electronic systems. The outcomes from this research can help to identify design changes and interventions that can enable older patients to overcome barriers to use and to more efficiently utilize these portals to manage their health. Such changes may make adoption of these systems easier for all groups as the human factors literature generally indicates that design interventions that benefit older adults also benefit most user groups (e.g., Fisk, Rogers, Charness, Czaja, & Sharit, 2009). This project is timely and of great public health significance as the number of patients, and in particular older patients, using patient portals tethered to an EMR is likely to increase as electronic health records become more widely used.

From a theoretical perspective, this research expands the available literature regarding the health numeracy aspect of health literacy. As suggested by Donelle, Hoffman-Goetz, and Arocha (2007), separating one's prose from numeracy ability within the construct of health literacy may enable a clearer picture of how health literacy impacts health outcomes, especially the use of patient health information contained in an EMR. This research also provides information that expands our knowledge of the links between adults' cognition, health literacy and numeracy, and functional outcomes. A unique focus is on health care tasks that involve the use of technology such as patient portals of EMR systems.

Chapter 2 provides a review of the relevant literature. This chapter begins with an overview of the levels of literacy skills among American adults and, in particular, levels of proficiency in health literacy in the United States. National surveys of adult literacy and health literacy are summarized. Next, measures of health literacy used in clinical studies are discussed, along with the major findings obtained from these measures. The impact of health literacy on an individual, especially an older adult, to manage his or her health is reviewed. Next, general numeracy and health numeracy are defined and discussed. Measures specifically designed to assess health numeracy and results from these measures are outlined, followed by the effects of numeracy on issues related to one's health management. Subsequently, aging and cognition is discussed, as cognitive variables may have an impact on one's literacy and numeracy, which in turn may affect one's ability to effectively use information provided in a patient portal of an electronic medical record (EMR). Finally, literature on electronic personal health records (PHRs) and patient portals is reviewed. Chapter 2 concludes with a summary of the issues leading into this research, the conceptual model that guided the project, and the hypotheses that were investigated. Chapter 3 details the research methods used; Chapter 4 presents the results of the study; and Chapter 5 discusses the implications of the findings.

CHAPTER 2

LITERATURE REVIEW

2.1 The Literacy of American Adults

Poor literacy is widespread in the United States. In 1992, the National Adult Literacy Survey (NALS) assessed the literacy of a sample of 26,000 U.S. adults (Kirsch et al., 2002). Literacy was defined as “using printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential” (Kutner et al., 2006, p.2). Participants were measured in their proficiency on three literacy scales: prose literacy (i.e., ability to search, comprehend, and use information from continuous texts such as brochures and news stories), document literacy (i.e., ability to search, comprehend, and use information from non-continuous texts such as payroll forms and food labels), and quantitative literacy (i.e., ability to identify and perform computations either alone or sequentially, using numbers embedded in printed materials such as determining the amount of interest on a loan from an advertisement). Performance on these scales was categorized into five levels, with Level 1 representing the lowest performance ability. Results in the sample were generalized to the entire population of the United States.

The results of this survey revealed that 21-23% of respondents, or approximately 40 to 44 million U.S. adults, demonstrated skills in the lowest level (Level 1) of prose, document, and quantitative literacy, and another 25-28% of those surveyed, representing about 50 million adults nationwide, exhibited skills in the next higher level of proficiency (Level 2) on each of the literacy scales (Kirsch et al., 2002). Interestingly, across these

three literacy scales, 66-75% of adults in the lowest level and 93-97% in the second lowest level described themselves as being able to read or write English “well” or “very well.” However, only approximately one-third of survey participants, or about 61 million adults nationwide, scored in the Level 3 range on each of the literacy scales, and only 18-21% of respondents, or 34 to 40 million adults, scored in the two highest (Level 4 and Level 5) levels of prose, document, and quantitative literacy.

As could be expected, adults with fewer years of education were more likely to perform in the lower literacy levels than those who completed high school or received some type of postsecondary education (Kirsch et al., 2002). For example, while 75-80% of adults with 0 to 8 years of education scored in Level 1 on each of the three scales, only 16-20% of adults with a high school diploma and 4% of adults with a four year college degree are in Level 1 on the three scales. Low literacy was especially prevalent in older adults, with 44% of those aged 65 or older scoring in the lowest reading skill level. Results showed that older adults were more likely than middle-aged and younger adults to exhibit low literacy skills; adults over the age of 65 had average literacy scores that ranged from 56 to 61 points below the scores of adults 40 to 54 years of age (Kirsch et al., 2002). Results also indicated that Black, American Indian/Alaskan Native, Hispanic, and Asian/Pacific Islander adults were more likely than White adults to perform in the lowest two literacy levels (Kirsch et al., 2002).

In 2003, the National Assessment of Adult Literacy (NAAL) measured the literacy of 19,000 adults in the United States, covering the same content and using the same definition of literacy that was used in the NALS. The results were generalized to the whole U.S. population. This assessment not only examined the current literacy levels

of the nation's adults, but also examined the changes in literacy between 1992 and 2003. For this national survey, the National Research Council's Board on Testing and Assessment (BOTA) Committee on Performance Levels for Adult Literacy recommended a new set of performance levels for the prose, document, and quantitative scales (Kutner et al., 2006). Instead of measuring performance on a scale of Level 1 to Level 5 as in the NALS, the results of the NAAL of prose, document, and quantitative literacy were reported using four levels: Below Basic, Basic, Intermediate, and Proficient.

Results from the NAAL (Kutner et al., 2006) indicated that many adults had below basic literacy levels across the three scales: 30 million had below basic prose literacy, 27 million had below basic document literacy, and 46 million had below basic quantitative literacy. Results also indicated some significant changes in adult literacy between 1992 and 2003. During this time, the percentage of adults with proficient prose literacy decreased from 15% to 13%. On the document literacy scale, the percentage of adults with below basic literacy declined from 14% to 12% and the percentage with proficient literacy declined from 15% to 13%, while the percentage of adults with intermediate literacy rose from 49% to 53%. Finally, on the quantitative scale, the percentage of adults with below basic literacy declined from 26% to 22% while the percentage with intermediate literacy increased from 30% to 33%.

Overall, results from national surveys such as the NAAL and NALS indicate that adult literacy in the United States is rather poor, and that minorities and older adults generally seem to exhibit lower literacy skills than other segments of the population. Having inadequate literacy can result in negative consequences, as using written information is an important part of everyday life. Literacy is especially important when

dealing with issues related to one's health, as many health-related activities rely on the ability to read and understand written information. For example, doctors may give patients written information about preventative health practices; adults who take medications must be able to understand labels explaining dosages, timing for taking their medications, and warnings about interactions and side effects; and older adults must be able to make decisions about Medicare supplementary insurance and prescription drug benefits (Kutner et al., 2006). Thus, one's "health literacy" is an important factor in effectively managing one's health.

2.2 Health Literacy

Health literacy has been defined in a number of ways (see Table 2.1). As noted by Buchbinder et al. (2011), each of these definitions "fundamentally includes reference to an individual's capacity to seek, understand, and use health information (Jordan, Buchbinder, & Osborne, 2010), although many also consider the interaction between an individual's skills or abilities, and education, health, and social and cultural influences (Nielson-Bohlman, Panzer, Hamlin, & Kindig, 2004)." Similar to the literacy troubles of American adults seen in the NALS or NAAL, many adults also experience difficulty with health literacy. In 2004 the Institute of Medicine (IOM) issued their landmark report *Health Literacy: A Prescription to End Confusion*, in which it was revealed that approximately 90 million adults in the U.S. have difficulty understanding and acting on health decisions.

Table 2.1 Definitions of health literacy (Buchbinder et al., 2011)

<i>Definition</i>	<i>Source</i>
Health literacy is the cognitive and social skills that influence people's motivation and ability to gain access to, understand, and use information in ways which promote and maintain good health.	World Health Organization (Nutbeam, 1998)
Health literacy is a constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the healthcare environment. Patients with adequate health literacy can read, understand, and act on healthcare information.	Ad hoc Committee on Health Literacy for the Council of Scientific Affairs, American Medical Association (1999)
The degree to which individuals have the capacity to obtain, process, and understand basic information and services needed to make appropriate decisions regarding their health. Health literacy also encompasses the educational, social, and cultural factors that influence the expectations and preferences of the individual and the extent to which those providing healthcare services can meet those expectations and preferences.	Institute of Medicine (Nielson-Bohlman et al., 2004)
The capacity of an individual to obtain, interpret, and understand basic health information and services in ways that are health-enhancing	National Consumers Council (Sihola & Lennard, 2004)
Health literacy is the ability to make sound health decisions in the context of everyday life - at home, in the community, at the workplace, the healthcare system, the market place, and the political arena.	Kickbusch (2001)

In the 2003 NAAL, a component specifically designed to measure health literacy was used for the first time in a large-scale national assessment. The health literacy scale consisted of 12 prose, 12 document, and 4 quantitative literacy items designed to reflect the definition of health literacy as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (HHS, 2000; IOM, 2004). Health literacy was assessed across three domains of health and health care information and services: clinical, prevention, and navigation of the health care system. Of the 28 health literacy tasks, 3 items represented the clinical domain, 14 represented the prevention domain, and 11 represented the navigation of the health care system domain. Participants were evaluated on tasks such as understanding dosing instructions for medication, identifying signs and symptoms of health problems that should be addressed with a health professional, and determining eligibility for public insurance or assistance programs. As in the prose, document, and quantitative literacy scales assessed in the NAAL, performance on the

health literacy scale was assessed as Below Basic, Basic, Intermediate, and Proficient.

Table 2.2 displays examples of tasks that an individual could be expected to perform at each of the four levels of health literacy ability.

Table 2.2 NAAL health literacy ability levels and corresponding tasks (Adapted from Kutner et al., 2006)

Ability Level (Score)	Examples of Tasks
Proficient (310-500)	<p>Calculate an employee's share of health insurance costs for a year, using a table that shows how the employee's monthly cost varies depending on income and family size.</p> <p>Find the information required to define a medical term by searching through a complex document.</p> <p>Evaluate information to determine which legal document is applicable to a specific health care situation.</p>
Intermediate (226-309)	<p>Determine a healthy weight range for a person of a specified height, based on a graph that relates height and weight to body mass index (BMI).</p> <p>Find the age range during which children should receive a particular vaccine, using a chart that shows all the childhood vaccines and the ages at which children should receive them.</p> <p>Determine what time a person can take a prescription medication, based on information on the prescription drug label that relates the timing of the medication to eating.</p> <p>Identify three substances that may interact with an over-the-counter drug to cause a side effect, using information on the over-the-counter drug label.</p>
Basic (185-225)	<p>Give two reasons a person with no symptoms of a specific disease should be tested for the disease, based on information in a clearly written pamphlet.</p> <p>Explain why it is difficult for people to know if they have a specific chronic medical condition, based on information in a one-page article about the medical condition.</p>
Below Basic (0-184)	<p>Identify how often a person should have a specified medical test, based on information in a clearly written pamphlet</p> <p>Identify what is permissible to drink before a medical test, based on a set of short instructions.</p> <p>Circle the date of a medical appointment on a hospital appointment slip.</p>

The distribution of adults among the levels of health literacy is similar, though not identical, to the distribution of adults among the levels of the prose, document, and quantitative literacy scales (Kutner, Greenberg, & Baer, 2005). Of the 19,000 adults who participated in this assessment, the majority (53%) had “intermediate” health literacy, indicating that they should be able to interpret or apply information that was presented in complex graphs, tables, or other health-related texts or documents (Kutner et al., 2006).

Only 12% of the sample of U.S. adults was found to have “proficient” health literacy which is required for drawing abstract inferences, comparing or contrasting multiple pieces of information within complex texts or documents, or applying abstract or complicated information from texts or documents. Twenty-one percent of respondents were found to have “basic” health literacy, meaning they only had the skills necessary to perform simple and everyday literacy activities, and 14% had “below basic” health literacy, or no more than the most simple and concrete health literacy skills (Kutner et al., 2006). As indicated in Table 2.2, individuals who fall into “basic” and “below basic” health literacy categories are typically able to, for example, identify what is permissible to drink before a medical test, based on a set of short instructions, or explain why it is difficult for people to know if they have a specific chronic medical condition, based on information in a one-page article about the condition. However, they likely could not determine what time a person can take a prescription medication based on information on the label that relates timing of medication to eating, nor would they be expected to find the information required to define a medical term by searching through a complex document.

Results of the 2003 NAAL indicated that White and Asian/Pacific Islander adults had higher average health literacy than Black, Hispanic, American Indian/Alaska Native, and Multiracial adults. Hispanic adults had lower average health literacy than adults in any other racial/ethnic group. Fourteen percent of White adults and 18% of Asian/Pacific Islander adults demonstrated health literacy at the “proficient” level, while only 2% of Black adults, 4% of Hispanic adults, 7% of American Indian/Alaska Native adults, and 3% of Multiracial adults were in the “proficient” level (Kutner et al., 2006). At the other

end of the health literacy spectrum, 9% of White adults, 24% of Black adults, 41% of Hispanic adults, 13% of Asian/Pacific Islander adults, 25% of American Indian/Alaska Native adults, and 9% of multiracial adults demonstrated “below basic” health literacy.

Results also indicated that adults age 65 and older had lower average health literacy than adults in younger age groups (Kutner et al., 2006). Twenty-nine percent of adults age 65 and older also had “below basic” health literacy, while levels of “below basic” health literacy ranged from 10% to 13% in all younger age groups (Kutner et al., 2006). In the group of adults aged 65 and older, only 3% exhibited “proficient” health literacy, while the percentage of adults with “proficient” skills in other groups ranged from 8% to 16%.

Overall, the data from the NAAL indicate that many American adults experience problems reading, understanding, and using health information. To further investigate health literacy skills, a number of health literacy measures have been developed for use in research studies. These measures have been used to examine the effects of health literacy on a wide range of health outcomes.

2.2.1 Health Literacy Measures

The most widely used health literacy measures in research studies are the Rapid Estimate of Adult Literacy in Medicine (REALM; Davis et al., 1993) and the Test of Functional Health Literacy in Adults (TOFHLA; Parker, Baker, Williams, & Nurss, 1995). Both tests are highly correlated with general vocabulary tests such as the Wide Range Achievement Test, Revised (WRAT-R; Jastak & Wilkinson, 1984). According to Baker (2006), neither test is a comprehensive assessment of an individual’s capacities; these tests “measure selected domains that are thought to be markers for an individual’s

overall capacity” (p. 880). The REALM is a 66-item word recognition and pronunciation test that measures the domain of vocabulary, while the TOFHLA measures reading fluency. The TOFHLA consists of a 50-item reading comprehension test and a 17-item numeracy component that consists of hospital forms and prescription bottles. The reading portion of the test includes passages on preparation for a medical procedure, the patient rights and responsibilities section of a Medicaid application form, and a standard hospital informed consent form, while the numeracy portion tests one’s ability to understand directions for taking medications, monitoring glucose, keeping clinic appointments, and obtaining financial aid. TOFHLA scores range from 0 to 100 and are categorized as follows: Inadequate (0-59), Marginal (60-74), and Adequate (75-100). Individuals who have “adequate” functional health literacy should be able to read, understand, and interpret most health texts. However, those who have “marginal” or “inadequate” functional health literacy will likely have difficulty reading, understanding, and interpreting most health materials. Because the TOFHLA can take 22 minutes to administer, a short version (S-TOFHLA) requiring only 12 minutes to administer and containing two prose passages and only four numeracy items was developed. However, based upon correlations with the REALM and the TOFHLA, these four numeracy items were later deleted, reducing the S-TOFHLA to just 36 reading-comprehension items.

2.2.2 Effects of Low Health Literacy on Health Outcomes

There are many ways in which health literacy affects an individual’s health. A report on the relationship between literacy and health outcomes indicated that people with lower literacy levels were generally 1.5 to 3 times more likely to have a poor outcome compared to those with higher literacy (DeWalt, Berkman, Sheridan, Lohr, & Pignone,

2004). Low literacy may limit an individual's capacity to function in the health care setting, affect physician-patient communication, and unintentionally lead to poor medical care (Ad Hoc Committee, 1999; Schillinger et al., 2003). Health literacy has been shown to be significantly associated with knowledge of matters relating to the use of services such as mammography (Davis et al., 1996), cervical cancer screening (Lindau et al., 2002), emergency department discharge instructions (Spandorfer, Karras, Hughes, & Caputo, 1995), "Heart Health Knowledge," (TenHave et al, 1997) and informed consent (Miller, O'Donnell, Searight, & Barbarash, 1996). Studies have also demonstrated that low health literacy is related to an increased risk of hospitalization (Baker, Parker, Williams, & Clark, 1998; Baker et al., 2002).

Several studies have demonstrated how low literacy limits the ability of an individual to understand information critical to managing his or her health. In a study of 2,659 patients at two public hospitals, 42% were unable to understand directions for taking medication on an empty stomach and 26% could not understand information on an appointment slip (Williams et al., 1995). Results of a study of 402 patients with hypertension and 114 with diabetes mellitus in general medical clinics at two public hospitals indicated that health literacy was strongly associated with patients' knowledge of their illness (Williams, Baker, Parker, & Nurss, 1998). Of those with diabetes, only 50% of those with inadequate literacy (as measured with the TOFHLA, score of 0-59) knew the symptoms of hypoglycemia compared with 94% of patients with adequate literacy (TOFHLA, score 76-100). Similarly, in the group of patients with hypertension, only 55% of those with inadequate literacy levels knew that a blood pressure reading of 160/100 mm Hg was high compared with 92% of patients with adequate literacy. In

another study of 483 patients with asthma, poor literacy skills were associated with less knowledge of asthma and improper metered-dose inhaler skills (Williams, Baker, Honig, Lee, & Nowlan, 1998).

2.2.3 Health Literacy and Aging

Several studies of health literacy in older adults have indicated that older adults have lower health literacy than younger adults. In Williams and colleagues' (1995) study of 2,659 patients at public hospitals, the prevalence of inadequate or marginal functional health literacy among those aged 60 years and older was 81.3% for English-speaking patients and 82.6% for Spanish-speaking patients, and was significantly higher ($p < .001$) than in younger patients.

In a study of 2,774 adults at least 65 years of age, Baker and colleagues (2000) used a short version of the Test of Functional Health Literacy in Adults (S-TOFHLA; Baker, Williams, Parker, Gazmararian, & Nurss, 1999) to examine whether the negative association between age and functional health literacy remains after adjusting for cognitive dysfunction (as measured by the Mini Mental State Examination [MMSE]; Folstein, Folstein, & McHugh, 1975), chronic medical problems, physical functioning, mental health, corrected visual acuity, and self-reported frequency of reading the newspaper. Results indicated that mean S-TOFHLA scores declined 1.4 points for every year increase in age; after adjusting for gender, race, ethnicity, and education, the S-TOFHLA declined 1.3 points for every increased year of age; and after adjusting for cognitive dysfunction the S-TOFHLA declined 0.9 points for every increased year of age. However, the relationship between age and functional health literacy did not change after adjusting for chronic medical problems, physical functioning, mental health, corrected

visual acuity and frequency of reading the newspaper. These findings suggest that age-related declines in cognitive function, as opposed to aging itself, may explain the inverse relationship between increasing age and functional health literacy (Baker et al., 2000).

To investigate the relationship between health literacy and cognitive abilities, Morrow et al. (2006) studied health literacy among middle-aged and older adults with chronic heart failure (CHF). They investigated whether health literacy in a sample of 314 community-dwelling adults with CHF was related to cognitive and sensory abilities and whether these relationships mediated the effects of demographic variables on literacy. Results of the study indicated that education and cognitive ability measures were independently associated with the S-TOFHLA score and explained age differences in health literacy. The relationship between cognitive abilities and health literacy identified in this study can help to identify strategies for aiding low literacy patients in caring for their health. The authors indicate that to be effective, “health communication should reduce demands on cognitive abilities (e.g., working memory) as well as on language-specific abilities (e.g., word knowledge) (p. 675).”

While many studies of literacy, and especially health literacy, have focused on the prose aspect of this skill, the quantitative facet of literacy is also important to examine. Much of the information that adults encounter on a daily basis is expressed numerically. From weather reports to nutrition labels to more complex health information provided by one’s doctor, understanding numeric information is arguably as important as understanding written text.

2.3 Numeracy

In the most general sense, numeracy is the ability to understand and use numbers. However, numeracy is a complex concept and researchers have defined it in various ways that reflect how it is being applied to the domain of the study (see Table 2.3). The concept of numeracy is often included within the broader concept of literacy (Davis, Kennen, Gazmararian, & Williams, 2005). Thus, numeracy is often referred to as quantitative literacy, or “the ability to locate numbers within graphs, charts, prose texts, and documents; to integrate quantitative information from texts; and to perform appropriate arithmetical operations on text-based quantitative data” (Bernhardt, Brownfield, & Parker, 2005, p. 6). Set in the health context, numeracy is referred to as health numeracy, and is conceptualized as a component of health literacy. In recent years, it has been noted that health numeracy is a critical skill in navigating the healthcare system, adequately evaluating medical information, and making medical decisions (U.S. Department of Health and Human Services, 2000).

Table 2.3 Definitions of numeracy and health numeracy (adapted from Reyna et al., 2007)

<i>Term</i>	<i>Definition</i>	<i>Source</i>
Numeracy	The term numeracy describes an aggregate of skills, knowledge, beliefs, dispositions, and habits of the mind - as well as the general communicative and problem-solving skills - that people need in order to handle real-world situations or interpretive tasks with embedded mathematical or quantifiable elements	Gal (1995, para. 9)
Numeracy	Numeracy, in the sense of knowledge and mastery of systems for quantification, measurement, and calculation, is a practice-driven competence rather than abstract academic knowledge of "mathematics." Proficiency in numeracy varies with people's backgrounds and experience.	Adelsward & Sachs (1996, p. 1186)
Numeracy	The specific aspect of literacy that involves solving problems requiring understanding and use of quantitative information is sometimes called numeracy. Numeracy skills include understanding basic calculations, time and money, measurement, estimation, logic, and performing multistep operations. Most importantly, numeracy also involves the ability to infer what mathematical concepts need to be applied when interpreting specific situations.	Montori & Rothman (2005, p. 1071)

Quantitative literacy	The knowledge and skills required to apply arithmetic operations, either alone or sequentially, using numbers embedded in printed materials.	Kirsch et al. (2002, pp. 3-4)
Health numeracy	The degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions.	Golbeck et al. (2005, p. 375)
Health numeracy	The individual-level skills needed to understand and use quantitative health information, including basic computation skills, ability to use information in documents and non-text formats such as graphs, and ability to communicate orally.	Ancker & Kaufman (2007, p. 713)

2.3.1 Numeracy Skills

Poor numeracy skills are pervasive in the United States. The National Assessment of Educational Progress (NAEP) provides a comprehensive evaluation of mathematical skills. The NAEP has two parts: a long-term trend assessment that has charted performance since 1973 and a main assessment that is periodically updated. In the most recent trends assessment, the average score for 12th-grade students was not significantly different than the average score for 12th-grade students in 1973 (Perie, Moran, & Lutkus, 2005). This indicates that although the amount and complexity of health-related numerical information has increased dramatically in recent years, the skills of young adults – who, as adults, will be expected to make use of this information – are no better than they were decades ago.

National surveys reveal that adults also have poor quantitative skills. As previously mentioned, the National Adult Literacy Survey (NALS) evaluated a nationally representative sample of approximately 26,000 adults on their prose, document, and quantitative skills (Kirsch et al., 2002). Twenty-two percent of adults performed at the lowest level of quantitative literacy, which involves performing simple arithmetical operations, and 25% performed at the next lowest level, which involves the ability to locate numbers and use them to perform a one-step operation. Almost half of the adults

sampled could not identify and integrate numbers in a lengthy text or perform a numerical task requiring two or more sequential steps. When examining results from the 2003 National Assessment of Adult Literacy (NAAL), the most comprehensive assessment of adult literacy since the NALS, similar poor quantitative literacy was found among the U.S. adult population. In fact, quantitative items on this assessment obtained the lowest level of performance: 22% of adults performed at the below-basic level on the quantitative scale, compared to 14% on the prose scale and 12% on the document scale (Kutner et al., 2006). These results indicate that 22% of adults would only be expected to have the simplest quantitative skills such as being able to add two numbers.

2.3.2 Health Numeracy

As noted by Reyna et al. (2009, p. 946), “health numeracy is a broad concept because numerical reasoning in the health domain involves several different tasks and skills.” Golbeck et al. (2005) developed a framework for health numeracy that incorporates the various skills involved and operationalizes health numeracy into four categories: (1) basic numeracy, which involves identifying numbers and making sense of quantitative data that does not involve manipulation of numbers; (2) computational numeracy, which involves counting, quantifying, computing, and performing simple manipulation of numbers, quantities, items, or visual elements in a health context; (3) analytical numeracy, which involves inference, estimation, and understanding proportions, percentages, frequencies, and often requires information to be integrated from multiple sources and formats; and (4) statistical numeracy, which involves understanding probability statements, having the skills to compare information presented on different scales (probability, proportion, percent), having the ability to critically

analyze quantitative health information such as life expectancy and risk, and understanding statistical concepts such as randomization.

While Golbeck et al.'s (2005) framework focuses exclusively on the numeracy skills of the individual, Ancker and Kaufman's (2007) conceptual model of health numeracy incorporates components beyond the quantitative skills of the individual. They present the outcomes-oriented concept of "productive use of quantitative health information," which is "the effective use of quantitative information to guide health behavior and make health decisions" (p. 713), and depends on the interaction of three elements: (1) the health numeracy of the individual; (2) the oral communication skills of the provider; and (3) the quality and ease of use of information artifacts, such as websites and decision aids. The interaction of these three elements is shown in Figure 2.1. This model comes from a "distributed cognition" approach that "emphasizes both the social nature of cognition (such as doctor-patient communication) and the mediating effects of technology or other artifacts (such as how written instructions or website design guide the completion of a task)" (Ancker & Kaufman, 2007, p. 714).

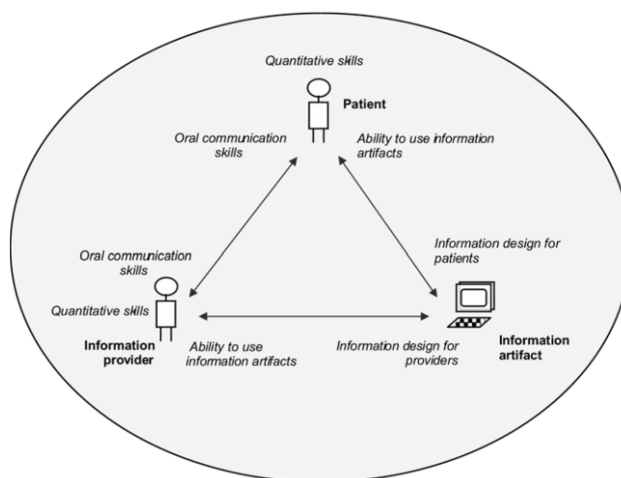


Figure 2.1 The components necessary for successful use of quantitative health information (Ancker & Kaufman, 2007)

2.3.3 Health Numeracy Measurement Instruments

The instruments that have been developed to specifically assess health numeracy are typically used in research studies and are not administered to nationally representative samples (Reyna et al., 2009). Numeracy measures can be divided into subjective and objective measures. Objective measures can be further divided into those that assess both literacy and numeracy (composite measures) or those that assess numeracy only, and into general or disease-specific measures.

The Test of Functional Health Literacy in Adults (TOFHLA) is a disease-general composite measure. As previously discussed, it contains 17 numeracy items that pertain to tasks commonly encountered in the health care setting, such as following instructions on a prescription label, determining whether blood glucose is within normal range, reading an appointment slip, and determining eligibility for financial aid. Although the TOFHLA tests reading comprehension and numeracy separately, it evaluates functional health literacy as a single measure comprised of both subscales. Thus, it provides an indirect measure of key numeracy skills that contribute to functional health literacy (Parker et al., 1995).

Like composite measures, integrative measures are composed of literacy and numeracy components. Examples of integrative measures are the Newest Vital Sign (Weiss et al., 2005) and the Nutritional Label Survey (Rothman et al., 2006). Unlike composite measures, the numeracy subscale scores in these integrative measures cannot be separated out because the tasks require reading comprehension skills and computation and quantitative reasoning skills together. For example, in the Nutritional Label Survey, people are asked to view a soda nutrition label and determine how many grams of total

carbohydrate are in the whole bottle. To answer this question correctly, one must determine the total carbohydrate content per serving and determine the number of servings per bottle by reading and identifying numbers contained in the label and determining which numbers are relevant to the question. They must then determine and apply the appropriate mathematical operation (Rothman et al., 2006). Thus, although such measures can test one's ability to perform realistic numeracy tasks, it is impossible to determine how much numeracy contributes to overall task performance.

A major shortcoming with composite and integrative measures is that they do not assess understanding of risk and probability (Reyna et al., 2009). Risks and probabilities are examples of ratio concepts (Reyna & Brainerd, 1994) and it has been found that ratio concepts such as fractions, percentages, decimals, and proportions are especially difficult for most adults to understand (Reyna & Brainerd, 2007). To test familiarity with probability and proportions, Schwartz, Woloshin, Black, and Welch (1997) developed a three-item general numeracy scale that measures participants' ability to indicate how many times out of 1000 coin flips a fair coin would be expected to land on heads, convert a percentage to a proportion (e.g., 1% to 10 in 1000), and convert a proportion to a percentage (e.g., 1 in 1000 to 0.1%). In their original study conducted among 287 female veterans, Schwartz et al. examined the relationship of general numeracy to understand the benefits of screening mammography. Although 96% of participants had graduated high school, only 16% answered all three questions correctly, and more than half answered zero or one question correctly. Using the same three questions, Woloshin et al. (2001) sampled 96 women patients between the ages of 50 and 79 and found that only 38% answered all three questions correctly. While the slightly better performance may be

related to a difference in education between the two samples—in the Schwartz et al study 36% had some college education while in the Woloshin et al study 77% had some college education—in both samples numeracy skill was poor. Thus, numeracy problems exist in populations with little as well as more formal education.

Lipkus, Samsa, and Rimmer (2001) expanded the Schwartz et al. (1997) numeracy measure by making a minor change to one of the three questions (assessing probability in the context of rolling a die instead of flipping a coin) and adding eight questions framed in a disease-general health context. In three samples of men and women aged 40 and over (a total of 463 participants), they found that between 15% and 21% of the participants correctly answered all three general numeracy questions and 29% to 34% of participants correctly answered all of the expanded numeracy questions. Although participants did better on the expanded numeracy scale items, mistakes were made on very simple questions such as indicating which numbers represented the highest risks using percentages and proportions. The authors indicate that these results should cause concern given that such tasks are inherent in many decision aids used to facilitate shared decision-making. Furthermore, as 84% to 94% of participants had some college education, the Lipkus et al. study showed once again that those with more formal education do not necessarily perform well on numeracy measures.

Compared with the general numeracy measures just discussed, the Medical Data Interpretation Test (Schwartz et al., 2005) assesses more advanced numeracy skills, such as the “ability to compare risks and put risk estimates in context (i.e., to see how specific data fit into broader health concerns and to know what additional information is necessary to give a medical statistic meaning)” (Schwartz et al., 2005, p. 291). For

example, in a series of questions respondents are asked to estimate a person's chance of dying from a heart attack in the next 10 years and then to estimate that same person's risk of dying for any reason in the next ten years. Reyna et al. (2009) note that to answer correctly, one must recognize that the risk of dying from all causes is greater than the risk of dying from a single cause, and that the test "requires a more sophisticated understanding of base rates, absolute risk, relative risk, knowledge of the kinds of information needed to assess and compare risks, and the ability to apply inferential reasoning to health information" (p. 955).

In a study of the health numeracy of 140 community-dwelling older adults (aged 50 to 90 years), it was shown that while 91% of the sample had "adequate" functional health literacy skills as measured by the S-TOFHLA (36 prose questions, 4 numeracy questions), there was a range of numeracy skills in the sample which depended on the numeracy scale used (Donelle, Hoffman-Goetz, & Arocha, 2007). Most participants (78.6%) attained a perfect score on the numeracy component of the S-TOFHLA. On the Schwartz et al. (1997) three-item general context numeracy scale, 55% answered 0 or 1 question correctly, 29% answered 2 questions correctly, and 16% answered all 3 questions correctly. On the Lipkus et al. (2001) eight-item health context numeracy scale, the mean score in this sample was 5.9, indicating that the majority of older adults in this study were able to correctly respond to health-based calculations of probabilities, percentages, and proportions. Increased age was determined to be inversely correlated with both general context and health context numeracy skills (Donelle, Hoffman-Goetz, & Arocha, 2007).

Subjective numeracy measures have also been developed, primarily as a means “to increase the feasibility and acceptability of measuring numeracy for respondents, because objective measures are arduous and aversive” (Reyna et al., 2009, p. 955). Woloshin et al. (2005) developed the first subjective numeracy measures, called the STAT-Interest and STAT-Confidence scales, to assess attitudes toward health-related statistics. The STAT-Interest scale contains five items that pertain to the level of attention given to medical statistics in the media and in the medical encounter, while the STAT-Confidence scale has three items that pertain to perceived ability to understand and interpret medical statistics. Although the Woloshin et al. (2005) participants reported generally high levels of interest and confidence in health-related statistics, the scales were only weakly correlated with the Medical Data Interpretation Test ($r = .26$ and $r = .15$, respectively).

The Subjective Numeracy Scale (SNS) developed by Fagerlin et al. (2007) consists of eight items: four questions that assess respondents’ beliefs about their skill in performing various mathematical operations and four questions that assess respondents’ preferences for presentation of numerical information. There are no right or wrong answers; participants answer each question on a 6-point Likert-type scale. Possible scores on the SNS range from 8 (for those participants rating themselves lowest on ability to perform mathematical tasks and preference for the use of numerical information) to 48 (for those participants rating themselves the highest on numeric abilities and preference for numerical information). The SNS has been demonstrated to be significantly correlated ($r = 0.63 - 0.68$) with the Lipkus et al. scale (Fagerlin et al., 2007).

While the aim in developing subjective numeracy tests has been to create a test that could be used as a proxy for objective measures, there are some shortcomings in use of subjective tests. It may not be useful to simply ask patients about their skills because of the stigma and shame associated with low literacy and numeracy (Marcus, 2006; Parikh, Parker, Nurss, Baker, & Williams, 1996), and their self-assessments are unlikely to be accurate (Dunning, Heath, & Suls, 2004). For instance, Sheridan, Pignone, and Lewis (2003) found that while 70% of subjects perceived themselves to be good with numbers only 2% answered three numeracy questions correctly.

2.3.4 Effects of Numeracy on Health

As “effective health care depends so critically on adequate patient understanding, numeracy has the potential to affect a variety of important outcomes, ranging from health decision making, health services utilization, and adherence to therapy to more distal outcomes including morbidity, health-related quality of life, and mortality” (Reyna et al., 2009, p. 956). For instance, it is likely that poor numeracy skill may lead to difficulty in understanding the risks of health behaviors and medical treatments, which could result in patients making treatment decisions that are incompatible with their own preferences (Fagerlin, Zikmund-Fisher, Ubel, Jankovic, Derry, & Smith, 2007). Nelson et al. (2008) note that low numeracy has been associated with self-reported poor health (Baker et al., 1997), poor health knowledge and disease self-management skills (Williams et al., 1998), health disparities (Sentell & Halpin, 2006), and choosing lower-quality health options (Hibbard, Peters, Dixon, Tusler, 2007).

Many studies have focused on the effects that literacy and numeracy can have on one’s health and health-related decision-making. However, with the emergence of new

health care technologies such as electronic medical records (EMRs), it may become increasingly important to understand the cognitive variables that impact one's ability to effectively use such technologies. Cognitive variables, such as memory, reasoning, concept formation, speed of processing, and executive functioning, may play an important role in one's decision-making abilities when using these technologies, especially for older adults who are likely to experience declines in these cognitive abilities.

2.4 Aging and Cognition

Cognitive abilities are often separated into two broad categories: fluid intelligence and crystallized intelligence (Horn & Cattell, 1967). Fluid intelligence requires online processing and mental manipulation (Verhaeghen, 2003) and includes abilities such as speed of processing, reasoning, working memory, and executive functioning.

Crystallized intelligence, on the other hand, is based upon experience and knowledge (Verhaeghen, 2003) and includes abilities such as verbal knowledge. There is a vast amount of cognitive aging literature that documents age-related declines in fluid abilities while crystallized abilities remain relatively intact (Schaie & Willis, 2002). Figure 2.2 illustrates the changes in cognitive abilities generally seen in normal aging, although it is important to note that there are large amounts of heterogeneity in cognitive aging.

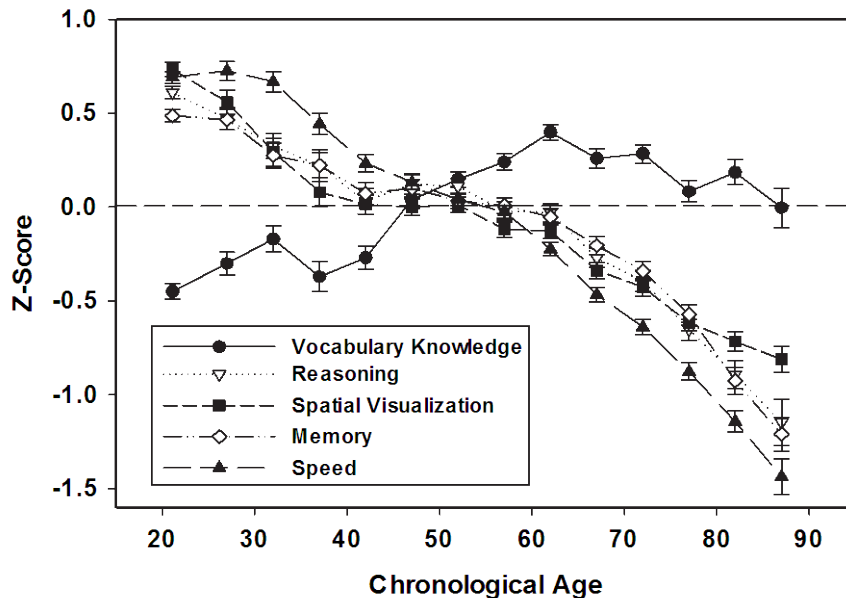


Figure 2.2 Cognitive abilities as a function of age based on data from studies by Salthouse and colleagues (e.g., Salthouse, 2009). Sample sizes ranged from 2369 to 4149 (figure from Salthouse, 2010).

2.4.1 Cognitive Abilities that Decline with Age

Executive functioning has been conceptualized as “a higher order cognitive construct that is involved in the self-regulation of goal-directed behavior and the effective organization and use of large amounts of information” (Drag & Bieliauskas, 2010, p. 80). Executive functioning encompasses concepts such as inhibition, working memory, and attentional capacity (Salthouse, Atkinson, & Berish, 2003). It has been demonstrated that executive functioning does not decline linearly across the lifespan but, instead, declines after the age of 60 (Treitz, Heyder, & Daum, 2007). Age-related declines found in tasks that require executive functioning may be related to a failure to implement the necessary strategies to successfully complete the tasks (Robbins et al., 1998).

Working memory is the cognitive resource “through which people manipulate and actively keep information available for on-line processing” (Wilson & Wolf, 2009, p. 319). Working memory is used in many complex cognitive tasks such as reading,

mathematics, reasoning, and problem solving, and is particularly important for tasks that require conducting simultaneous activities (Baddeley, 1992; Baddeley, 1996). Working memory places great demands on cognitive resources, and aging has been demonstrated to have a significant impact on working memory abilities (Babcock & Salthouse, 1990; Bopp & Verhaeghen, 2005; Sliwinski & Buschke, 1999).

There are also age-related changes in certain aspects of one's attention that may diminish the ability to function in complex cognitive situations (Drag & Bieliauskas, 2010). Aging leads to changes in inhibitory control, which may lessen older adults' ability to focus on information that is relevant to a task while inhibiting irrelevant information. This ability is termed "selective attention" and is generally thought to be age-sensitive (Barr & Giambra, 2000; McDowd & Craik, 1988; Mapstone, Dickerson, & Duffy, 2008; Plude & Doussard-Roosevelt, 1989), although these findings are not entirely consistent (Verhaeghen & Cerella, 2002). Older adults also have more difficulty than younger adults in an aspect of attention termed "divided attention" where tasks require one to "concurrently attend to and process information from multiple sources" (Drag & Beliauskas, 2010, p. 80).

Spatial ability is another cognitive variable that shows age-related declines. Both cross-sectional studies (e.g., Salthouse, 1992) and longitudinal studies (e.g., Willis & Schaie, 1986) have shown that older adults tend to have reduced spatial ability compared with younger adults. General spatial ability can be thought of as being composed of two subfactors: spatial visualization and spatial orientation. Spatial visualization is defined as the "ability to manipulate or transform the image of spatial patterns into other arrangements" (Ekstrom, French, Harman, & Dermen, 1976, p. 173), while spatial

orientation is defined as the “ability to perceive spatial patterns or to maintain orientation with respect to objects in space” (Ekstrom et al., 1976, p. 149). Age-related changes in these cognitive abilities can have a significant impact on one’s decision-making ability, especially in tasks that require understanding and manipulation of objects such as graphs or other pictorial types of information.

2.4.2 Aging and Decision-making

A common interest in both research on aging and research on decision-making is how individuals balance their cognitive resources and the demands of the task (Mata, Schooler, & Rieskamp, 2007). It has been argued that people have a collection of strategies to solve problems, and that they select the strategy to use based upon both cognitive constraints and the characteristics of the problem situation (e.g., Gigerenzer, Todd, & the ABC Research Group, 1999). Research on aging and strategy selection suggests that older adults select different cognitive strategies than younger adults. For example, older adults tend to select less cognitively demanding strategies compared with younger adults in arithmetic computation and memory tasks (Dunlosky & Hertzog, 1998, 2000; Geary, Frensch, & Wiley, 1993). Studies on aging and decision-making have shown that older adults use less information and view information longer than younger adults when making decisions (Johnson & Drungle, 2000) and have greater difficulties in understanding information concerning available options (Finucane, Mertz, Slovic, & Schmidt, 2005; Finucane et al., 2002). These age-related differences in decision-making behavior have been related to declines in fluid abilities (Finucane et al., 2005). For example, Broder (2003) showed that differences in fluid abilities are associated with the selection of decision strategies. Age-related changes in decision-making may be even

more pronounced when using computer-based technology to make decisions, as age-related changes in cognition have also been found to impact use of technology.

2.4.3 Age-related Changes in Cognition & the Impact on Use of Technology

Fluid abilities are associated with aptitude for learning new technologies (Hanson, 2010) and several studies have indicated that fluid abilities such as speed of processing and working memory are important to successful performance of technology-based tasks (e.g., Charness, Kelley, Bosman, & Mottram, 2001; Czaja et al., 2001; Sharit et al., 2003). Thus, age-related changes in fluid abilities may impact an older adult's ability to use technology. It has been demonstrated that measures of fluid intelligence are strong predictors of Internet use among older adults (Czaja et al., 2006; Czaja et al., 2010). In fact, studies have shown that many of the difficulties older users experience with Internet navigation (using the Search, Bookmarks, and History functions) are related to performing activities that rely on fluid components of cognition (Chadwick-Dias et al., 2007; Grahame et al., 2004; Meyer et al., 1997).

Age-related declines in spatial ability may also impact one's ability to effectively use new technologies. It has been noted that in studies examining spatial ability and computer-based information search, measures of spatial ability have shown significant relationships with measures of task completion time and error rate (Pak, Czaja, Sharit, Rogers, & Fisk, 2008) and age-related declines in spatial ability have been suggested as a potentially significant moderator of older adults' computer-based task performance (Kelley & Charness, 1995). Given the age-related declines in fluid and spatial abilities, using technologies that rely on these abilities, such as electronic medical records, is likely to be challenging for older adults.

2.5 Electronic Medical Records (EMRs)

Electronic medical records (EMRs) are an emerging type of electronic health record (EHR) systems. According to the Institute of Medicine (IOM) Committee on Data Standards for Patient Safety an EHR system includes: “(1) longitudinal collection of electronic health information for and about persons, where health information is defined as information pertaining to the health of an individual or health care provided to an individual; (2) immediate electronic access to person- and population-level information by authorized, and only authorized, users; (3) provision of knowledge and decision-support that enhance the quality, safety, and efficiency of patient care; and (4) support of efficient processes for health care delivery” (IOM, 2003, p.1). Under this broad definition, the EHR can take many forms. The International Organization for Standardization (ISO) gives other terms commonly used to describe different types of EHRs, as seen in Table 2.4

Table 2.4 Types of EHRs (Adapted from Häyrinen, Saranto, & Nykänen, 2008)

<i>Type of EHR</i>	<i>Definition</i>
Electronic medical record (EMR)	Generally focused on medical care; contains information entered by one or more hospital departments, e.g., ambulatory records, oncology records, cardiology records, etc.
Electronic patient record (EPR)	Contains all or most of patient’s clinical information from a particular hospital
Computerized patient record (CPR)	Contains all or most of patient’s clinical information from a particular hospital
Electronic health care record (EHCR)	Contains all patient health information
Personal health record (PHR)	Controlled by the patient and contains information at least partly entered by the patient
Computerized medical record	Created by image scanning of a paper-based health record
Digital medical record	A web-based record maintained by a health care provider
Clinical data repository	An operational data store that holds and manages clinical data collected from health service providers

Electronic client record	Scope is defined by health care professionals other than physicians, e.g., by physiotherapists or social workers
Virtual EHR	No authoritative definition
Population health record	Contains aggregated and usually de-identified data

The IOM notes the core functionalities of EHRs, which fall into eight categories: health information and data, results management, order entry/management, decision support, electronic communication and connectivity, patient support, administrative processes, and reporting and population health management (IOM, 2003). While many of these functions are used by physicians, individuals are becoming increasingly important users of electronic health information through personal health records (PHRs). As noted in the National Health Information Infrastructure (NHII) hearings, “Personal health records are a unique mechanism to engage individuals at different life stages in their own health, and [they are also] a novel platform for prevention activities that could include information, recommendations, and attitudinal and behavioral messages (Hearings, 2005).” PHRs may be able to help patients manage their health by providing information, enabling self-management functions needed to control acute and chronic illnesses and improving communication between physicians and patients (Cognetti & Cecere, 2003; Ueckert et al., 2003; Wald et al., 2004).

There are a variety of PHR models; the most basic is a “standalone” or “free-standing” PHR which requires manual entry from the patient to create and update his or her health record (Detmer, Bloomrosen, Raymond, & Tang, 2008). At the other end of the spectrum are “integrated,” “interconnected,” or “networked web-based” PHRs. These records are created with information from a variety of sources such as EHRs, pharmacy information, insurance claims, home diagnostic devices, as well as the patient. One way to conceptualize an integrated PHR is seen in Figure 2.2. In this model, the PHR at the

center is connected to different stakeholders who exchange information with patients. This can be adapted to fit other types of PHR systems (Kaelber, Jha, Johnston, Middleton, & Bates, 2008). For instance, some patients use “tethered” PHRs that connect with a single provider-based EHR system, offering them access to parts of their health record via web portals (Detmer et al., 2008). To model this tethered relationship, Figure 2.2 would be a hub and spoke model with just one spoke, from the PHR to the physician’s EHR.

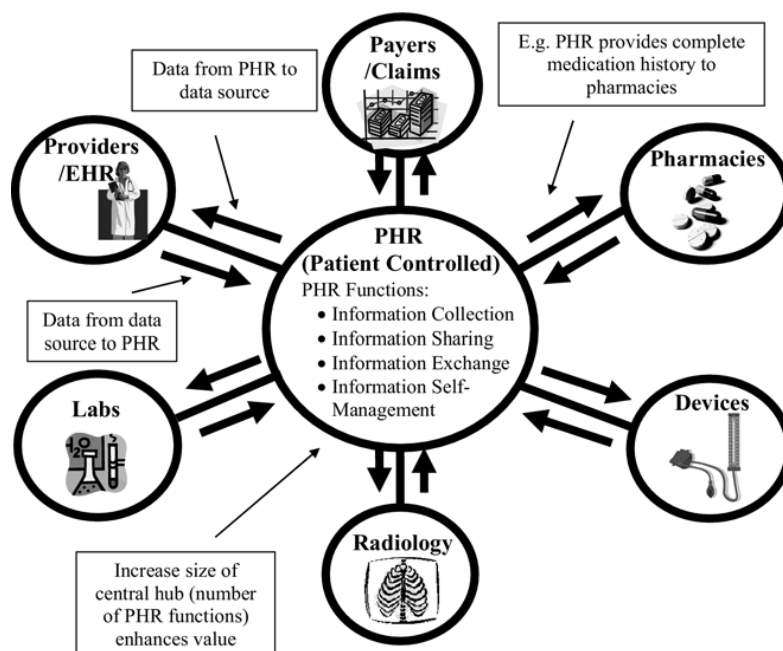


Figure 2.3 Hub and spoke model of a PHR system (Kaelber et al., 2008)

2.5.1 Patient Portal Usage

Diverse patient populations are increasingly using patient portals tethered to their EMR. To date, many of the studies on portals have focused on access and use, and in this regard disparities have been found. Specifically, it has been reported that older adults, less-educated adults, and African Americans, Latinos, and Filipinos were less likely than younger, more educated, and non-Hispanic Whites to request a password to use a patient

portal, but among those who did request a password older adults were more likely than younger adults to actually log on (Sarkar et al., 2011). Similar results pertaining to older adults have been found in other studies as well. For example, in a study exploring the differences in adoption and use by 74,368 patients, older patients were less likely to receive an activation code from their provider. However, those who did receive access were more likely to activate their account (Ancker et al., 2011). In another study, patients older than 65 years were found to use a PHR to a greater extent than patients aged 18-35 years (Yamin et al., 2011). Given the interest older patients exhibit in using portals and the fact that the proportion of the population that is older is continuing to grow, a question of particular importance concerns the capability of older adults to appropriately use the information contained in their PHRs. Effective use of a patient portal for health management is especially critical for this population due to their increased number of health conditions and doctor visits.

2.5.2 Barriers to Patient Portal Use

There are many ways in which patients can benefit from having access to their medical information. However, many records are not designed so that users can realize all of the potential benefits. As Tang and colleagues (2006) point out, the design of patient portals and the accompanying tools “is challenging because of the patients’ widely varying levels of general literacy and health literacy...Both terminology and data presentation must be adapted to the individual using the PHR, so that they realize optimal benefits (p. 123).”

To investigate some of the barriers to PHR comprehension and use, Keselman and colleagues (2007) sampled 104 individuals who had viewed their paper or electronic

health records within the previous year of the study. Their sample was self-selected, educated, and predominately White and female, so while the results may not represent the general patient population, they likely underestimate the barriers to comprehension which can be intensified by low health literacy. They found that while patients often wanted to view their records due to a desire to play an active role in their care, and that while for many patients viewing their records resulted in requesting specific care or changing self-care, they encountered some difficulties in their review. Forty-four participants had problems due to insufficient conceptual knowledge; 27 of these problems could be helped by pointers to general reference-type support, while 17 would require individualized decision support. They found that concepts related to lab tests seemed to require the most support: 15 participants asked for help understanding test purposes, result ranges and measurement units, and 9 asked for help understanding their individual results and data trends across time. Thirty-eight participants found professional language to be a barrier, with medical terminology cited most frequently as an area of difficulty and abbreviations and special codes in the records also causing problems for a significant number of participants.

Older adults may have even more difficulty using information in their personal health records and using patient portals due to changes in cognition, low health literacy, or physical impairments. To examine the obstacles encountered by a low-income elderly and disabled population in use of a PHR, Lober and colleagues (2006) collected data on usability for 38 residents in a publicly subsidized housing project with a mean age of 69 years. They found that the main barriers to use of a PHR in this population were computer literacy (63%) and computer anxiety (58%). “Computer literacy” was used to

describe such barriers as the need for help with turning on the computer or using a mouse or keyboard to log in, while “computer anxiety” was used to describe barriers for patients who were unwilling to do these tasks but had no apparent cognitive or physical barrier. The next most common barrier to use was cognitive impairment (34%); participants who experienced this barrier had problems accessing the website because of an inability to remember the password, user name, or URL of the personal health record. Health literacy barriers affected 29% of the participants, and included having questions about the content of the record such as diseases and conditions, medications, and terminology. Finally, 26% of the patients had physical impairments such as hearing and vision problems that limited their use of their PHR.

2.6 Summary of the Issues Leading to this Research

While health literacy has long been recognized as critical for managing one’s health, the numeracy aspect of health literacy is likely to assume an increasingly vital role in self-health management. The reason for this is based on the fact that the amount of health-related information delivered to patients is rising, due in part to health care technologies such as portals tethered to patients’ EMRs, and much of this information is expressed numerically. Thus, we must not only know more about the numeracy aspect of literacy, but also the potential impact that numeracy skill may have on one’s ability to use a patient portal.

As the proportion of older adults in the population is on the rise, older adults are a potential portal user group that is of particular interest. This group typically has more chronic health conditions than younger adults and, thus could greatly benefit from managing their health through use of this new technology. However, it is likely that

older adults may encounter problems using portals for a number of reasons including lower health literacy and numeracy, cognitive declines, and less experience with computers and the Internet. We must know more about these users and their preferences if we expect them to adopt these systems. Few studies, however, have investigated older adults' ability to use patient portals, and little is known about the factors that may impact older adults' effective use of portals to manage their health.

This research is intended to expand the available literature regarding the health numeracy aspect of health literacy, and also to expand the literature linking cognition, health literacy and numeracy, older adults and functional outcomes. The conceptual model guiding this work is shown in Figure 2.3. A unique focus of this research involves expanding this model to investigate the impact of these factors on health care tasks that involve the use of technology such as patient portals of EMR systems. In addition, this research will focus on the role of numeracy ability as this ability is likely, as argued, to take on greater significance when managing health through technological systems such as patient portals.

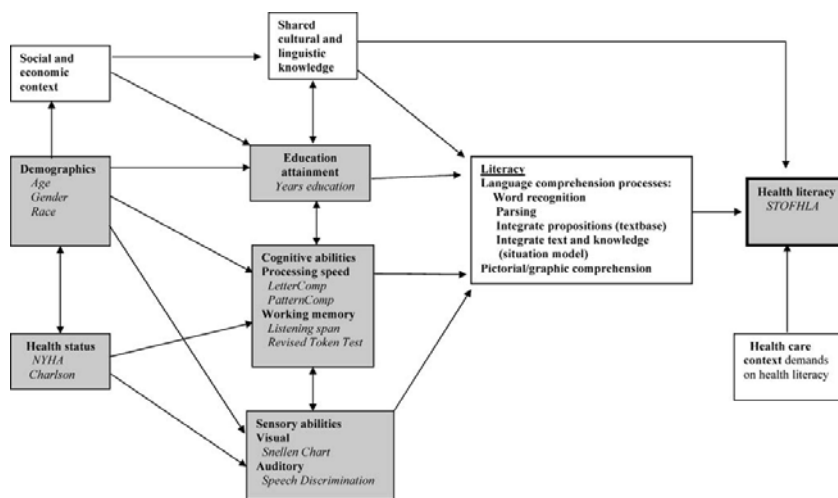


Figure 2.4 Conceptual model showing the health-related literacy framework (Morrow, Clark, Tu, Wu, Weiner, Steinley, & Murray, 2006) that guided this research

As outlined in Chapter 1, the primary objectives of this study are to: (1) examine the ability of middle-aged and older adults to use a patient portal of an EMR to perform common health management tasks; (2) examine the relationships between individual characteristics such as age, education, Internet experience, cognitive abilities, health literacy and health numeracy, and the performance of health management tasks and decision-making using a patient portal; (3) identify usability problems inherent in the use of patient portals; and (4) identify initial design solutions. In regard to these objectives, a number of hypotheses will be investigated. Specifically, it is hypothesized that:

- (1) There will be age-related differences in the execution of common health management tasks using a portal such that middle-aged participants will perform significantly better than older participants on a variety of tasks.
- (2) There will be age-related differences in numeracy ability similar to the age-related differences commonly seen in health literacy ability (i.e., older adults will demonstrate lower numeracy ability than middle-aged adults).
- (3) Consistent with the cognitive aging literature that indicates declines in fluid abilities but not crystallized abilities for older adults, the middle-aged participants will demonstrate significantly higher fluid cognitive abilities than the older participants, while the older participants will exhibit significantly higher crystallized cognitive abilities than the middle-aged participants.
- (4) After accounting for education and Internet experience, cognitive abilities will be found to be a significant factor in predicting performance on portal tasks such that those with lower cognitive abilities will perform at a lower level than those with higher abilities.

- (5) Even after taking into consideration the factors of education, Internet experience, and cognitive abilities, health numeracy will be a significant factor in predicting performance on portal tasks that require more complex numeracy skills.
- (6) Both Internet experience and numeracy will be strong predictors of the usability of the portal in regard to the participants' efficiency in completing the necessary steps required for task completion, however greater Internet experience will have the ability to compensate for low numeracy ability.

Ultimately, the overall objective of this research is to facilitate the development of a portal that will allow a wide range of adults to use the information contained in their electronic medical record to effectively manage their health.

CHAPTER 3

METHODS

3.1 Sample

Upon receiving study approval from the University of Miami's IRB, participants were recruited from the Miami area through placement of flyers in community organizations and senior centers and by word of mouth. Interested individuals contacted the study investigator by telephone. The study investigator provided an overview of the study and administered a telephone prescreening, which included screening questions (e.g., age, primary language) and the Wechsler Memory Scale III (WMS-III; Wechsler, 1997). Participants who were eligible and interested were scheduled for participation. All participants were required to be English-speaking and non-cognitively impaired as measured by a score greater than 26 on the Mini Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975), adjusted for age and education using the correction established by Mungas and colleagues (1996). Participants were not required to have any prior experience with computers, the Internet or patient portals. Study participants included 107 adults ranging in age from 40 to 85 years ($M = 58.87$, $SD = 11.89$). There were 56 middle-aged adults, aged 40-59, and 51 older adults, aged 60-85. Table 3.1 displays the demographic profile of the participants in the study. The sample was ethnically and educationally diverse, had fairly low incomes, and the majority reported to be in good to excellent health.

Table 3.1 Sample Characteristics

	<i>Total Sample</i>	<i>Middle-aged</i>	<i>Older</i>
Number	107	56	51
Age in years, <i>M(SD)</i>	58.87 (11.89)	49.36 (5.36)	69.33 (7.45)
Gender (%)			
Male	45.8	51.8	39.2
Female	54.2	48.2	60.8
Ethnicity (%)**			
Hispanic	23.4	16.1	31.4
Non-Hispanic White	25.2	12.5	39.2
Non-Hispanic Black	49.5	67.9	29.4
Non-Hispanic Other	1.9	3.6	0.0
Education (%)**			
High School or less	36.4	50.0	21.6
Some College	40.2	33.9	47.1
College Graduate/Post-graduate	23.4	16.1	31.4
Yearly Household Income (%)*			
Less than \$20,000	68.2	80.4	54.9
\$20,000 to \$49,999	16.8	12.5	21.6
\$50,000 or more	15.0	7.1	23.5
General Health (%)*			
Poor	1.9	3.6	0.0
Fair	19.6	26.8	11.8
Good	46.7	44.6	49.0
Very Good	24.3	19.6	29.4
Excellent	7.5	5.4	9.8

* $p < .05$, ** $p < .01$

Note: Non-Hispanic Other excluded from chi-square analysis; General Health tested as two groups: Fair/Poor and Good/Very Good/Excellent

3.2 Measures

3.2.1 Background Questionnaire

This questionnaire gathered demographic data such as gender, age, ethnicity, education, and income (Czaja et al., 2006a). It also gathered information on participants' perceptions of their health, their medical conditions, and medications taken. This questionnaire also assessed participants' attitudes toward computers (Czaja et al., 2006a; Jay & Willis, 1992). The Background Questionnaire is included in Appendix A.

3.2.2 Technology Experience Questionnaire

This questionnaire assessed use of common technologies such as ATMs, cell phones, and computers (Czaja et al., 2006b). Those who reported having experience with computers responded to questions concerning their frequency and duration of computer use. Those who reported having Internet experience responded to questions concerning their frequency and duration of Internet use, as well as where they use the Internet and what types of activities they perform on the Internet. The Technology Experience Questionnaire is provided in Appendix B.

3.2.3 Heart Disease Fact Questionnaire

The Heart Disease Fact Questionnaire (HDFQ; Wagner, Lacey, Chyun, Abbott, 2005) is a 25-item true/false questionnaire designed to assess respondents' knowledge of major risk factors for the development of coronary heart disease (CHD). Approximately half of the questions address diabetes-related CHD risk factors (e.g., "A person who has diabetes can reduce their risk of developing heart disease if they keep their blood pressure under control"). The HDFQ is readable to an average 13-year-old. This test was used in this study as a measure of participants' background health knowledge, as some of the portal tasks involved topics such as heart disease and diabetes. This questionnaire is included in Appendix C.

3.2.4 Health Literacy and Numeracy Measures

The Test of Functional Health Literacy in Adults (TOFHLA; Parker, Baker, Williams, & Nurss, 1995) was used to measure health literacy, while numeracy was measured using the Lipkus et al. (2001) Objective Numeracy measure and the Subjective Numeracy Scale (SNS; Fagerlin et al., 2007). As discussed in Chapter 2, the TOFHLA

consists of a 50-item reading comprehension test and a 17-item numeracy component that consists of hospital forms and prescription bottles. TOFHLA scores range from 0 to 100 and are categorized as follows: Inadequate (0-59), Marginal (60-74), and Adequate (75-100). Individuals who have “adequate” functional health literacy should be able to read, understand, and interpret most health texts. However, those who have “marginal” or “inadequate” functional health literacy will likely have difficulty reading, understanding, and interpreting most health materials. This test is presented in Appendix D.

The objective numeracy measure (also discussed in Chapter 2) developed by Lipkus, Samsa, and Rimer (2001) is a frequently used measure that consists of 11 questions: three general numeracy questions developed by Schwartz, Woloshin, Black, and Welch (1997) and eight additional questions that focus on numeracy in a health context (see Appendix E). The general questions assess one’s ability to convert a percentage to a proportion, convert a proportion to a percentage, and determine how many times out of 1000 rolls a fair die would come up an even number. The eight additional questions use similar mathematical operations as the general questions, but are phrased in the context of health risks. Correct answers are given 1 point, resulting in scores that range from 0 to 11.

As indicated in Chapter 2, the Subjective Numeracy Scale (SNS) developed by Fagerlin et al. (2007) is a self-report measure of perceived ability to perform various mathematical tasks and preference for the use of numerical versus prose information (see Appendix F). This subjective numeracy scale has been found to be significantly correlated ($r = 0.63 - 0.68$) with the objective numeracy measure developed by Lipkus et al. (Fagerlin et al., 2007). The SNS consists of eight items: four questions that assess

respondents' beliefs about their skill in performing various mathematical operations and four questions that assess respondents' preferences for presentation of numerical information. There are no right or wrong answers; participants answer each question on a 6-point Likert-type scale. Possible scores on the SNS range from 8 (for those participants rating themselves lowest on ability to perform mathematical tasks and preference for the use of numerical information) to 48 (for those participants rating themselves the highest on numeric abilities and preference for numerical information).

3.2.5 Cognitive Battery

The cognitive battery used in this study is comprised of cognitive tests that were selected from a larger cognitive battery (Czaja et al., 2006a). Inclusion of cognitive tests was based upon the test's ability to assess the cognitive processes necessary for use of the patient portal (see Table 3.2 for the cognitive abilities hypothesized to impact performance of each portal task). The battery was administered to participants in two parts: one part was conducted in a group-testing format and the other part is administered individually (Czaja et al., 2006a). The group portion (see Appendix G for the entire testing booklet, labeled "Day 1 Testing") contained the following measures: Paper Folding Test (Ekstrom, French, Harman, & Dermen, 1976); Cube Comparison Test (Ekstrom et al., 1976); Letter Sets Test (Ekstrom et al., 1976); Shipley Institute of Living Scale (Shipley, 1986); and the Number Comparison Test (Ekstrom et al., 1976). The individual portion (see Appendix H for the entire packet, labeled "Day 2 Testing") included: Mini-Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975); Trails A test (Reitan, 1958); Trails B test (Reitan, 1958); Digit-Symbol Substitution

(WAIS-III; Wechsler, 1981); a computerized version of the Stroop Color & Word Test (Stroop, 1935); and Animal Fluency (Rosen, 1980).

3.2.6 Usability Questionnaire

A usability questionnaire was developed for the study to assess how participants felt about using the patient portal simulation. There were two sections to this questionnaire. The first section contained seven questions to ascertain how participants felt in general about using a patient portal like the simulation they had just used (e.g., would it help them to perform health management tasks more quickly, would it be useful). The second section of the usability questionnaire contained 10 questions concerning the opinions of participants about their encounter with the simulated patient portal (e.g., was it difficult to locate information, were the numerical tables confusing). Each question was answered on a 5-point Likert scale (1 = agree; 5 = disagree). In addition, there was a yes/no question to assess whether they would use a patient portal like the simulation if it were available from their doctor. This questionnaire is included in Appendix I.

3.3 Patient Portal Simulation

The simulated patient portal was based on EPIC's MyChart, a portal that allows patients to schedule appointments, view test results and x-rays, renew prescriptions, send and receive emails from their health care providers, and link to health information from trustworthy sources. MyChart was chosen because of its widespread use; an estimated 50 million patients see healthcare providers who use the EPIC software system (Kaelber, Jha, Johnston, Middleton, & Bates, 2008). A thorough analysis of MyChart was completed to ensure that the simulation captured the relevant features of the system.

Figure 3.1 displays the homepage of the simulated patient portal, referred to as the CREATE (Center for Research and Education on Aging and Technology Enhancement) Patient Portal Simulation, which captured all of the relevant features of the existing MyChart system. The portal was populated with data for a fictitious patient referred to as “Pat.” Pat had conditions such as diabetes, high blood pressure, and high cholesterol. This enabled the simulated portal to be populated with a variety of information on which to base the tasks.

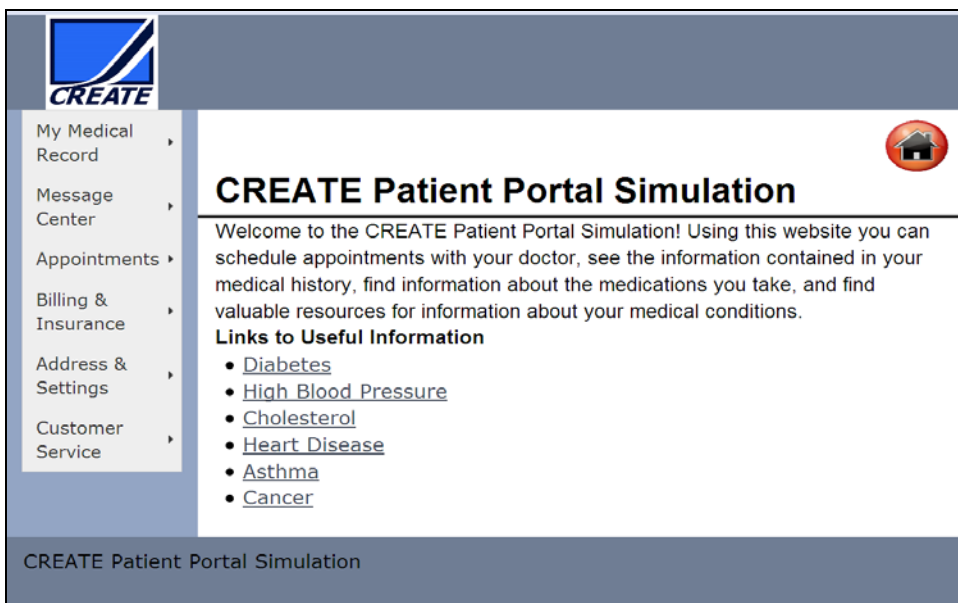


Figure 3.1 Homepage of the CREATE Patient Portal Simulation

3.4 Tasks

Fifteen tasks were developed to test participants’ performance on health-management tasks commonly carried out using a portal. Tasks were designed to assess performance across three core functions of patient portals: health maintenance activities (i.e., locating an upcoming appointment date and time or using a link to a website to read information about a condition), lab/test results activities (i.e., interpreting data from a cholesterol panel or complete blood count (CBC) test), and medication management

activities (i.e., following dose schedules). The tasks were designed to span the spectrum of numeracy ability proposed by Golbeck et al. (2005): basic numeracy, computational numeracy, statistical numeracy, and analytical numeracy. A task analysis was performed on each task to establish the elemental steps necessary to complete the task, and the cognitive skills needed to perform each elemental step in the task were determined.

To determine the task's difficulty, four independent raters were asked to evaluate each of the 15 tasks. The raters were asked to review all of the tasks and assign the value of "5" to the task/tasks that they determined to be the most complex and assign the value of "1" to the easiest task/tasks. The rest of the tasks were ranked in relation to these endpoints. The computation of Cronbach's alpha revealed a high inter-rater reliability ($\alpha = .842$). The four ratings given to each task were averaged to get an overall rating of the difficulty of that task. After averaging the four ratings for each task, the resulting weight given to the tasks ranged from 1.25 to 4.50. These weights were used in two different analyses.

First, based upon these weights, tasks were divided into two categories: 7 "simple" tasks (weights from 1.25 to 2.25) and 8 "complex" tasks (weights from 2.50 to 4.50). The separation of tasks into "simple" and "complex" categories was determined as follows. Initially, a median split was performed by first arranging the tasks in order from lowest difficulty rating to highest as follows: 1.25, 1.25, 1.50, 1.50, 2.00, 2.25, 2.25, 2.50, 3.00, 3.25, 3.50, 3.50, 3.75, 4.25, 4.50. The median task weight was 2.50, which corresponded to a task requiring participants to interpret the results of a cholesterol panel. As there were an odd number of tasks, this median task needed to be classified as either "simple" or "complex" to be included in the analysis. Based upon the literature that

indicated that finding lab/test results was a problem for many adults when using a patient portal (Segall et al., 2011), this task was categorized as “complex.” The total possible scores for simple and complex tasks were determined by summing the number of possible points in each category. Answers by participants that were left blank or incorrect were given a score of 0 points, partially correct answers were given 1 point, and completely correct answers were given 2 points. Thus, the maximum scores for the simple and complex task sets were 14 and 16, respectively.

Second, in a separate analysis, the weight given to the task was multiplied by the points the participant received on the task and then summed over all the tasks to determine an overall performance score for each participant. As in the first analysis, participants’ answers that were left blank or incorrect were given a score of 0 points, partially correct answers were given 1 point, and completely correct answers were given 2 points. The overall performance scores had a possible range of 0 to 80.5.

Table 3.2 summarizes the information relevant to the performance of each portal task: an abbreviated description of the task, the corresponding core portal function of the task, the elemental steps necessary to perform the task, the cognitive skills necessary to perform the task, the corresponding type of numeracy skill involved in performing the task, and the assigned difficulty rating (see Appendix K for the Response Sheet containing the complete tasks). The patient portal pages that were used to perform the tasks are shown in Figures 3.2 – 3.18. The captions below the figures explain the navigational path necessary to reach the particular pages, as well as the actions participants needed to perform to complete the tasks.

Table 3.2 Task summary information

Task	EMR Core Function	Type of Literacy/Numeracy	Elemental Tasks	Cognitive Skills	Difficulty Rating	Category
1 Find date and time of upcoming appointment	Health Maintenance	<u>Basic Numeracy</u> – identify numbers & make sense of quantitative data requiring no manipulation of numbers	Locate “Appointments” link, locate “Future Appointments” link, click on “Appointment Details,” read appointment slip, find date and time, write both down on answer sheet	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>Selective attention</i> needed to find link, <i>working memory</i> needed to hold onto the information while searching for the appropriate links, <i>processing speed</i> needed to support working memory	1.25	Simple
2 Follow instructions to "Create Your Plate"	Health Maintenance	<u>Computational Numeracy</u> – count, quantify, compute, and otherwise use simple manipulation of numbers, quantities, items, or visual elements;	Locate link to “Create Your Plate,” follow the sequence of steps, understand the direction to “put a line down the middle, then on one side cut it again so that you have three sections,” label the two small and one large sections properly	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>sequential reasoning</i> needed to follow steps, <i>spatial reasoning</i> needed to divide plate properly, <i>working memory</i> needed to hold onto the information while creating plate, <i>processing speed</i> needed to support working memory	3.25	Complex
3 Determine glucose level after lunch from information in a table	Lab/Test Results	<u>Basic Numeracy</u> – identify numbers & make sense of quantitative data requiring no manipulation of numbers	Locate link to glucose monitoring weekly summary, view table and locate the “average” row and “after lunch” column, write down number that is at the intersection of this row and column.	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to find the correct link, <i>working memory</i> needed to hold onto information while finding correct link, <i>processing speed</i> needed to support working memory, <i>focused attention</i> needed to find correct cell in the table	2.00	Simple
4 Determine the target range of glucose levels after meals from information in a table	Lab/Test Results	<u>Basic Numeracy</u> – identify numbers & make sense of quantitative data requiring no manipulation of numbers	Stay in glucose monitoring weekly summary, locate link to “view table of target glucose levels,” click on link, find the target for after meals from the table, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to find correct link, <i>working memory</i> needed to hold onto information while searching for link, <i>processing speed</i> needed to support working memory, <i>focused attention</i> needed to find target glucose after meals	1.50	Simple

5	Determine if glucose level is in proper range	Lab/Test Results	<u>Computational Numeracy</u> – count, quantify, compute, and otherwise use simple manipulation of numbers, quantities, items, or visual elements;	Compare the average level they had after lunch (answer to previous question) to what is given in the table, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>focused attention</i> and <i>reasoning</i> needed to compare the numbers, <i>working memory</i> needed to hold onto information while making the comparison, <i>processing speed</i> needed to support working memory	1.50	Simple
6	Locate the times/day for Metformin dose	Medication Management	<u>Basic Numeracy</u> – identify numbers & make sense of quantitative data requiring no manipulation of numbers	Locate link to medications, locate correct medication from list, read directions, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to find correct link, <i>working memory</i> needed to hold onto information while searching for link, <i>processing speed</i> needed to support working memory, <i>focused attention</i> needed to find correct medication from list	1.25	Simple
7	Determine how to manage missed Metformin dose	Medication Management	<u>Analytical Numeracy</u> – involves higher level concepts such as inference, estimation, proportions, percentages, frequencies, and equivalent situations; often requires information to be pulled from multiple sources and in multiple formats	Click on patient information link for Metformin, scan through document to find section on “Missed Dose,” read the information and determine whether Pat should take it now or wait for next regularly scheduled dose, write down answer	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> need for planning a solution, <i>reasoning</i> needed to determine where the link to that type of information might be, <i>selective attention</i> need to find correct link, <i>working memory</i> needed to hold onto information while searching through document, <i>processing speed</i> needed to support working memory, <i>spatial reasoning</i> needed to determine how close next dose is relative to last dose	4.25	Complex
8	Determine insulin dose from insulin dose schedule	Medication Management	<u>Analytical Numeracy</u> – involves higher level concepts such as inference, estimation, proportions, percentages, frequencies, and equivalent situations; often requires information to be pulled from multiple sources and in multiple formats	Locate link to insulin dose schedule, look at table to determine what amount of insulin is needed for that level of blood sugar at breakfast time, add to this amount the appropriate amount of insulin units for eating 40 grams of carbohydrates	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to find correct link, <i>working memory</i> needed to hold onto information while looking for the test results, <i>processing speed</i> needed to support working memory, <i>quantitative reasoning</i> needed to determine which mathematical operations to use	4.50	Complex

9	Read cholesterol panel	Lab/Test Results	<u>Basic Numeracy</u> – identify numbers & make sense of quantitative data requiring no manipulation of numbers	Locate the link to “Test Results,” locate cholesterol panel results in list of test results, write down the components, and the value for each component	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to find correct link, <i>working memory</i> needed to hold onto information while looking for the test results, <i>processing speed</i> needed to support working memory	2.50	Complex
10	Interpret HBP graph 1	Health Maintenance	<u>Statistical Numeracy</u> – involves an understanding of basic biostatistics involving probability statements, skills to compare information presented on different scales (probability, proportion, and percent), the ability to critically analyze health information such as life expectancy and risk, and an understanding of statistical concepts such as randomization and a “blind” study	Locate the link to “High Blood Pressure Health Risk Calculator,” view graph, locate the bar that represents risk of heart failure, comprehend that “2.1x” means “2.1 times greater than normal risk”, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> need for planning a solution, <i>selective attention</i> needed to find correct link, <i>working memory</i> needed to hold onto information while searching for the risk of heart failure, <i>processing speed</i> needed to support working memory, <i>focused attention</i> needed to pick out correct information from graph, <i>statistical (domain-specific) knowledge</i> needed to understand the information presented in the graph	3.75	Complex
11	Interpret HBP graph 2	Health Maintenance	<u>Statistical Numeracy</u> – involves an understanding of basic biostatistics involving probability statements, skills to compare information presented on different scales (probability, proportion, and percent), the ability to critically analyze health information such as life expectancy and risk, and an understanding of statistical concepts such as randomization and a “blind” study	Stay in the same link, view second graph located in link, locate the bar that represents the risk of heart failure and the bar that represents the risk of heart failure after lifestyle changes, comprehend that “1.0x” means that the risk has been reduced to the same level that is considered “normal risk,” write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>visual scanning</i> and <i>focused attention</i> needed to stay in the same link and look for further information, <i>working memory</i> needed to hold onto information while interpreting the information presented in the second graph, <i>processing speed</i> needed to support working memory, <i>focused attention</i> needed to find relevant information in the graph, <i>reasoning</i> needed to interpret information presented in the graph	3.00	Complex

12	Determine if CBC components are in standard range (yes/no question)	Lab/Test Results	<u>Computational Numeracy</u> – count, quantify, compute, and otherwise use simple manipulation of numbers, quantities, items, or visual elements	Locate the link to “Test Results,” find CBC results from list, click on the most recent test date, look at the value in the column “Your Value” for each component and compare it with the values in the column “Standard Range,” determine if the “Your Value” number is within the range given, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>selective attention</i> needed to locate correct link to information, <i>focused attention</i> and <i>working memory</i> needed to compare component values with standard ranges, <i>reasoning</i> needed to make comparisons, <i>processing speed</i> needed to support working memory	2.25	Simple
13	Determine which CBC components are not in standard range	Lab/Test Results	<u>Computational Numeracy</u> – count, quantify, compute, and otherwise use simple manipulation of numbers, quantities, items, or visual elements	Write down only those components that are outside of the standard range	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>focused attention</i> and <i>reasoning</i> needed to compare the numbers, <i>working memory</i> needed to hold onto information while making the comparison, <i>processing speed</i> needed to support working memory	3.50	Complex
14	Determine if Lymphocytes are increasing/decreasing from a graph	Lab/Test Results	<u>Analytical Numeracy</u> – involves higher level concepts such as inference, estimation, proportions, percentages, frequencies, and equivalent situations; often requires information to be pulled from multiple sources and in multiple formats	Stay in the link to blood test results, locate and click on the link to view graph, locate the line that represents “Lymphocytes,” look at the y-axis of the graph and determine if the value has been increasing or decreasing, write down response	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>visual scanning</i> and <i>focused attention</i> needed to stay in the same link and look for further information, <i>selective attention</i> needed to locate the link to graph, <i>reasoning</i> needed to understand the information presented in the graph	2.25	Simple

15	Determine if Monocytes are in standard range during a specified time period	Lab/Test Results	<u>Analytical Numeracy</u> – involves higher level concepts such as inference, estimation, proportions, percentages, frequencies, and equivalent situations; often requires information to be pulled from multiple sources and in multiple formats	Stay in the link to the line graph of blood components, convert the dates to the correct numerical dates given on the x-axis of graph, return to previous page to look at the value of the component “Monocytes” during that time, compare range in graph with value of standard range given in the table	<i>Verbal ability</i> needed to comprehend the question, <i>executive function</i> needed for planning a solution, <i>visual scanning</i> and <i>focused attention</i> needed to stay in the same link and look for further information, <i>number fluency</i> needed to convert the dates, <i>focused attention</i> needed to compare graph component with values from table, <i>reasoning</i> needed to determine if number is within the standard range	3.50	Complex
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CREATE Patient Portal Simulation

My Medical Record

Message Center

Appointments

Billing & Insurance

Address & Settings

Customer Service

Future Appointments

Click on a row to see more details about an upcoming appointment.

Date/Time	Description	Department
8/15/2011	Social work with Dr. Jay, LMSW	Behavioral Health
8/10/2011	Office visit with Dr. Deanzo, MD	Family Medicine

[Back to Home Page](#)

CREATE Patient Portal Simulation

Figure 3.2 Future Appointments page

This is the first portal page that was necessary to complete Task 1 (find date/time of appointment). Participants reached this page by choosing “Appointments” from the menu on the left side of the page, and then choosing “Future Appointments” from the list of options. Participants needed to choose the correct appointment (highlighted in blue in this figure) on this page and click on it to open the page with appointment details (see Figure 3.3).

CREATE Patient Portal Simulation

My Medical Record

Message Center

Appointments

Billing & Insurance

Address & Settings

Customer Service

Appointment Details

[General Information](#)

What: Office Visit with Dr. Deanzo, MD

When: Wednesday August 10, 2011; 10:00 AM

Where: FAMILY HEALTH CENTER
1611 NW 12 AVE, PARK PLAZA W
MIAMI, FL 33136

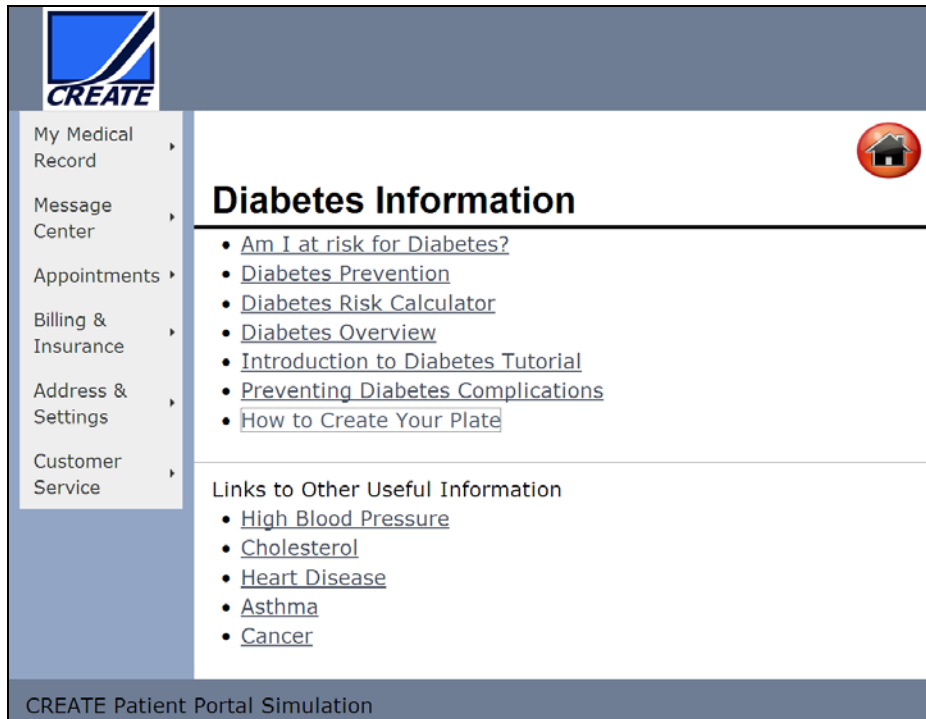
Phone: 305-555-5555

[Back to the Future Appointments List](#)

CREATE Patient Portal Simulation

Figure 3.3 Appointment Details page

This is the second portal page that was necessary to complete Task 1 (find date/time of appointment). Participants reached this page by clicking on the appointment shown in Figure 3.2. It was necessary to view this page to locate the time of the appointment.



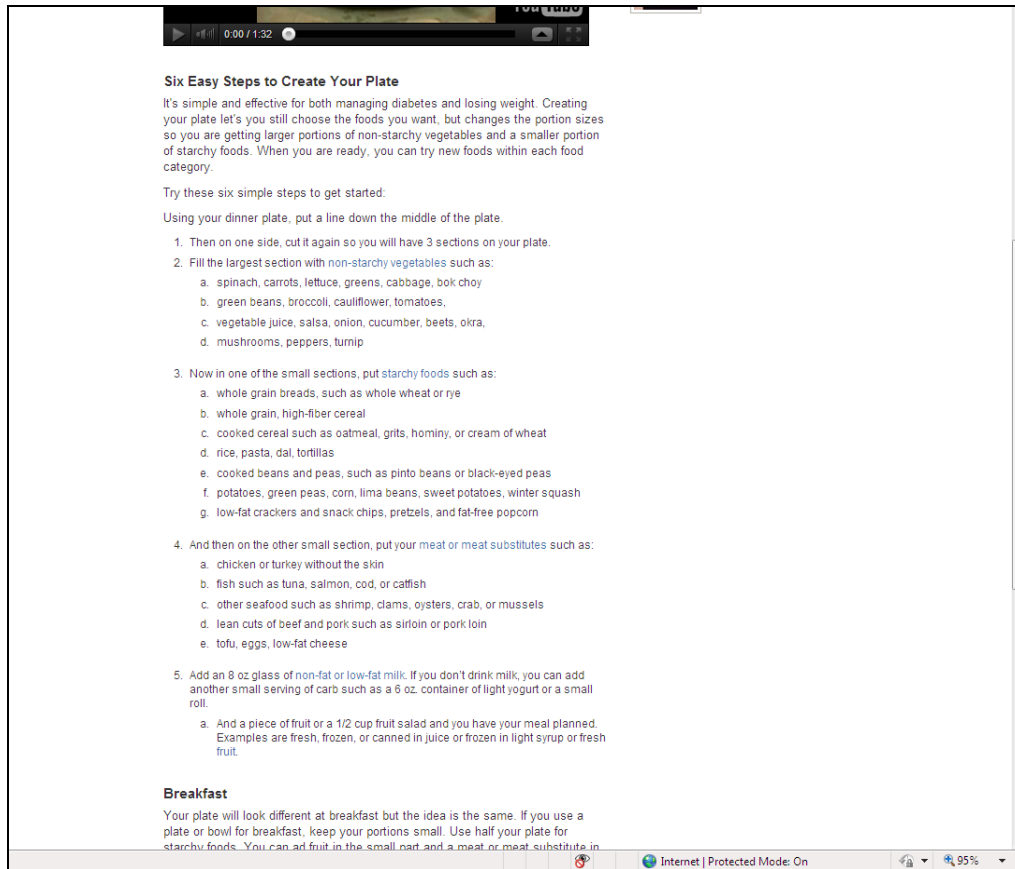
The screenshot displays the 'CREATE Patient Portal Simulation' interface. On the left is a vertical navigation menu with the following items: 'My Medical Record', 'Message Center', 'Appointments', 'Billing & Insurance', 'Address & Settings', and 'Customer Service'. The main content area is titled 'Diabetes Information' and features a home icon in the top right corner. Below the title, there are two sections of links:

- Diabetes Information Links:**
 - [Am I at risk for Diabetes?](#)
 - [Diabetes Prevention](#)
 - [Diabetes Risk Calculator](#)
 - [Diabetes Overview](#)
 - [Introduction to Diabetes Tutorial](#)
 - [Preventing Diabetes Complications](#)
 - [How to Create Your Plate](#)
- Links to Other Useful Information:**
 - [High Blood Pressure](#)
 - [Cholesterol](#)
 - [Heart Disease](#)
 - [Asthma](#)
 - [Cancer](#)

At the bottom of the page, the text 'CREATE Patient Portal Simulation' is visible.

Figure 3.4 Diabetes Information page

Reaching this portal page was the first step in completing Task 2 (Create Your Plate). Participants reached this page from the Homepage by clicking on “Diabetes” (see Figure 3.1 for Homepage). On the page shown here, participants had to click on the “How to Create Your Plate” link (which took them to an external page located on the American Diabetes Association website).



Six Easy Steps to Create Your Plate

It's simple and effective for both managing diabetes and losing weight. Creating your plate lets you still choose the foods you want, but changes the portion sizes so you are getting larger portions of non-starchy vegetables and a smaller portion of starchy foods. When you are ready, you can try new foods within each food category.

Try these six simple steps to get started:

Using your dinner plate, put a line down the middle of the plate.

- Then on one side, cut it again so you will have 3 sections on your plate.
- Fill the largest section with **non-starchy vegetables** such as:
 - spinach, carrots, lettuce, greens, cabbage, bok choy
 - green beans, broccoli, cauliflower, tomatoes,
 - vegetable juice, salsa, onion, cucumber, beets, okra,
 - mushrooms, peppers, turnip
- Now in one of the small sections, put **starchy foods** such as:
 - whole grain breads, such as whole wheat or rye
 - whole grain, high-fiber cereal
 - cooked cereal such as oatmeal, grits, hominy, or cream of wheat
 - rice, pasta, dal, tortillas
 - cooked beans and peas, such as pinto beans or black-eyed peas
 - potatoes, green peas, corn, lima beans, sweet potatoes, winter squash
 - low-fat crackers and snack chips, pretzels, and fat-free popcorn
- And then on the other small section, put your **meat or meat substitutes** such as:
 - chicken or turkey without the skin
 - fish such as tuna, salmon, cod, or catfish
 - other seafood such as shrimp, clams, oysters, crab, or mussels
 - lean cuts of beef and pork such as sirloin or pork loin
 - tofu, eggs, low-fat cheese
- Add an 8 oz glass of **non-fat or low-fat milk**. If you don't drink milk, you can add another small serving of carb such as a 6 oz. container of light yogurt or a small roll.
 - And a piece of fruit or a 1/2 cup fruit salad and you have your meal planned. Examples are fresh, frozen, or canned in juice or frozen in light syrup or fresh fruit.

Breakfast

Your plate will look different at breakfast but the idea is the same. If you use a plate or bowl for breakfast, keep your portions small. Use half your plate for starchy foods. You can add fruit in the small part and a meat or meat substitute in

Figure 3.5 Create Your Plate page

This page was necessary to answer Task 2 (Create Your Plate). This page was located on the American Diabetes Website (<http://www.diabetes.org/food-and-fitness/food/planning-meals/create-your-plate/>).

CREATE

- My Medical Record
- Message Center
- Appointments
- Billing & Insurance
- Address & Settings
- Customer Service

Test Results

Click on a row to see your home health monitoring results.


Type of Monitoring	Entered By
Glucose Weekly Summary	Test Patient
Blood Pressure Weekly Summary	Test Patient

Click on a row to see your laboratory test results.


Date	Test	Ordered By	Status
6/17/2010	Cholesterol Panel	Dr. Sim, MD	Final Result
6/17/2010	Complete Blood Count	Dr. Sim, MD	Final Result
6/12/2010	PHQ9 (Depression Testing)	Dr. Sim, MD	Final Result
3/15/2010	Complete Blood Count	Dr. Sim, MD	Final Result
12/10/2009	Complete Blood Count	Dr. Sim, MD	Final Result
6/16/2009	Complete Blood Count	Dr. Sim, MD	Final Result

Figure 3.6 Test Results page

Reaching this page was the first step in completing Task 3 (determine average glucose level after lunch). Participants reached this page by first choosing “My Medical Record” from the menu on the left side of the page and then choosing “Test Results” from the list of options. On the Test Results page, participants needed to click on “Glucose Weekly Summary” (the row highlighted in blue in the figure).



My Medical Record ▶
 Message Center ▶
 Appointments ▶
 Billing & Insurance ▶
 Address & Settings ▶
 Customer Service ▶



Glucose Monitoring Weekly Summary

	Breakfast		Lunch		Dinner	
	Before	After	Before	After	Before	After
Average	99	130	90	120	124	150
Low	80	100	78	92	98	106
High	125	150	112	163	130	172
No. of Readings	7	7	7	6	6	7


[View Table of Target Glucose Levels](#)

[Back to the Test Results List](#)

CREATE Patient Portal Simulation

Figure 3.7 Glucose Monitoring Weekly Summary page

This is the portal page that was necessary to complete Task 3 (determine glucose level after lunch). This page was reached by clicking on “Glucose Monitoring Weekly Summary” on the “Test Results” page (see Figure 3.6).



Target Blood Glucose Levels

Keeping your blood glucose on target can prevent or delay diabetes problems. The table below shows target blood glucose levels for most people with diabetes.

Target Blood Glucose Levels for People With Diabetes	
Before meals	70 to 130
1 to 2 hours after the start of a meal	Less than 180

[Close window](#)

CREATE Patient Portal Simulation

Figure 3.8 Target Blood Glucose Levels page

This is the portal page that was necessary to complete Task 4 (determine if glucose is in the target range). Participants reached this page by clicking on the link to “View Table of Target Glucose Levels” on the glucose monitoring weekly summary page (see Figure 3.7). To complete Task 5 (determining if glucose after lunch is in target range) participants had to compare the value in the table seen in this Figure with the value in the table seen in Figure 3.7.

The screenshot displays a patient portal interface. On the left is a vertical navigation menu with the following items: My Medical Record, Message Center, Appointments, Billing & Insurance, Address & Settings, and Customer Service. The main content area is titled 'Medications' and features a sub-header: 'Click on **About this Medication** to see more information about the medication. If you have no refills left for a prescription, you may want to [request a renewal](#).' Below this are three medication entries:

- METFORMIN HCL 1000 MG OR TABS**: Includes an 'About this medication' link, instructions '1 tablet by mouth twice daily', and was prescribed by Dr. Sim, MD on 6/25/2010. A 'Request a refill' link is at the bottom right.
- LIPITOR 80 MG OR TABS**: Includes an 'About this medication' link, instructions '1 tablet by mouth nightly', and was prescribed by Dr. Sim, MD on 6/17/2010. A 'Request a refill' link is at the bottom right.
- ASPIRIN 81 MG OR TBEC**: The entry is partially visible at the bottom of the screen.

Figure 3.9 Medications (Metformin) page

This is the portal page that was necessary to complete Task 6 (locating the instructions for taking Metformin). Participants reached this page by first choosing “My Medical Record” from the menu on the left side of the page and then choosing “Medications” from the list of options. To complete Task 7, participants needed to click on the “About this medication” link located in the Metformin prescription.

Metformin controls diabetes but does not cure it. Continue to take metformin even if you feel well. Do not stop taking metformin without talking to your doctor.

Other uses for this medicine [Return to top](#)

This medication may be prescribed for other uses, ask your doctor or pharmacist for more information.

What special precautions should I follow? [Return to top](#)

Before taking metformin,

- tell your doctor and pharmacist if you are allergic to metformin or any other medications.
- tell your doctor and pharmacist what other prescription and nonprescription medications, vitamins, nutritional supplements, and herbal products you are taking. Be sure to mention the medications listed in the **IMPORTANT WARNING** section and any of the following: amiloride (Midamor, Moduretic); antihistamines; beta-blockers such as atenolol (Tenormin), labetalol (Normodyne), metoprolol (Lopressor, Toprol XL), nadolol (Corgard), and propranolol (Inderal); calcium channel blockers such as amlodipine (Norvasc), diltiazem (Cardizem, Dilacor, Tiazac, others), felodipine (Lexxel, Plendil), isradipine (DynaCirc), nicardipine (Cardene), nifedipine (Adalat, Procardia), nimodipine (Nimotop), nisoldipine (Sular), and verapamil (Calan, Isoptin, Verelan); cimetidine (Tagamet); digoxin (Lanoxin, Lanoxicaps); furosemide (Lasix); hormone replacement therapy; insulin or other medications for diabetes; isoniazid (INH, Nydrizid); medications for asthma and colds; medications for mental illness and nausea such as fluphenazine (Prolixin), mesoridazine (Serentil), perphenazine (Trilafon), prochlorperazine (Compazine), promethazine (Phenergan), thioridazine (Mellaril), thiothixene (Navane), trifluoperazine (Stelazine), and trifluromazine (Vesprin); medications for thyroid disease; morphine (MS Contin, Roxanol, others); nicotinic acid; oral contraceptives (birth control pills); oral steroids such as dexamethasone (Decadron, Dexone), methylprednisolone (Medrol), and prednisone (Deltasone); phenytoin (Dilantin, Phenytek); procainamide (Procanbid); quinidine (Quinidex); quinine; ranitidine (Zantac); triamterene (Dyazide, Maxzide, others); or trimethoprim (Proloprim, Trimplex). Your doctor may need to change the doses of your medications or monitor you carefully for side effects.
- tell your doctor if you have or have ever had any medical condition, especially those mentioned in the **IMPORTANT WARNING** section.
- tell your doctor if you are pregnant, plan to become pregnant, or are breast-feeding. If you become pregnant while taking metformin, call your doctor.
- if you are using the extended-release tablets, you should know that sometimes the tablet shell may appear in your stool. If this occurs, it is not harmful and will not affect the way the medication works.
- tell your doctor if you eat less or exercise more than usual. This can affect your blood sugar. Your doctor will give you instructions if this happens.

What special dietary instructions should I follow? [Return to top](#)

Be sure to follow all exercise and dietary recommendations made by your doctor or dietitian. It is important to eat a healthful diet.

What should I do if I forget a dose? [Return to top](#)

Take the missed dose as soon as you remember it. However, if it is almost time for the next dose, skip the missed dose and continue your regular dosing schedule. Do not take a double dose to make up for a missed one.

What side effects can this medication cause? [Return to top](#)

This medication may cause changes in your blood sugar. You should know the symptoms of low and high blood sugar and what to do if you have these symptoms. You may experience hypoglycemia (low blood sugar) while you are taking this medication. Your doctor will tell you what you should do if you develop hypoglycemia. He or she may tell you to check your blood sugar, eat or drink a food or beverage that contains sugar, such as hard candy or fruit juice, or get medical care. Follow these directions carefully if you have any of the following symptoms of hypoglycemia:

- shakiness
- dizziness or lightheadedness

[Double-click to change security settings](#) | 4/8 | 120%

Figure 3.10 Metformin Information page

This is the page that was necessary to complete Task 7 (determine how to manage a missed Metformin dose). Participants reached this external page (located on the MedlinePlus website; <http://www.nlm.nih.gov/medlineplus/druginfo/meds/a696005.html>) by clicking on the link “About this medication” in the prescription for Metformin (see Figure 3.9).

R_x ASPIRIN 81 MG OR TBEC
[About this medication](#)
 Instructions: 1 tablet by mouth daily
 Prescribed by Dr. Sim, MD on 10/12/2009

R_x ELTROXIN 50 MG OR TABS
[About this medication](#)
 Instructions: 1 tablet by mouth daily
 Prescribed by Dr. Sim, MD on 5/10/2009

R_x APIDRA INJECTION
[About this medication](#)
 Instructions: Inject 15 minutes before meal or within 20 minutes after starting a meal
 See Insulin Dose Schedule
 Prescribed by Dr. Sim, MD on 3/01/2009
[Request a refill](#)

Figure 3.11 Medications (Apidra Injection) page

Reaching this portal page was the first step in completing Task 8 (determine insulin dose). Participants needed to click on the link to “Insulin Dose Schedule” located in the Apidra injection prescription. The page seen in this figure is the same page seen in Figure 3.9; participants needed to scroll to the bottom to locate this medication.

CREATE

Insulin Dose Schedule

You should take 1 unit of insulin for every 10 grams of carbohydrates you eat. You should add to your usual dose based upon your blood sugar levels:
 If your blood sugar is greater than 120 points at breakfast, lunch or supper, add 2 units of insulin.
 If your blood sugar is greater than 150 points at breakfast, lunch or supper, add 4 units of insulin.
 If your blood sugar is greater than 180 points at breakfast, lunch or supper, add 6 units of insulin.

1 unit of insulin/10 grams carbohydrates at meals

If Blood Sugar is:	Breakfast	Lunch	Supper
> 120	+ 2	+ 2	+ 2
> 150	+ 4	+ 4	+ 4
> 180	+ 6	+ 6	+ 6

[Close window](#)

CREATE Patient Portal Simulation

Figure 3.12 Insulin Dose Schedule page

This is the portal page that was necessary to answer Task 8 (determine insulin dose). Participants reached this page by clicking on the link to “Insulin Dose Schedule” located in the Apidra prescription (see Figure 3.11).

The screenshot displays a medical portal interface. On the left is a vertical navigation menu with the following items: My Medical Record, Message Center, Appointments, Billing & Insurance, Address & Settings, and Customer Service. The main content area is titled 'CHOLESTEROL PANEL' and includes a home icon in the top right. Below the title is an 'About this test' link. A section titled 'Comments from the Doctor's Office' contains a message from Dr. Sim, MD, advising the patient to recheck cholesterol in 3-6 months. Below this is a 'Component Results' table with four rows: CHOLESTEROL (210 mg/dL), LDL CHOLESTEROL (141 mg/dL), HDL CHOLESTEROL (43 mg/dL), and TRIGLYCERIDES (183 mg/dL). A 'General Information' section at the bottom lists collection and result dates as 6/17/2010, ordered by Dr. Sim, MD, with a final result status.

Component	Your Value	Standard Range	Units
CHOLESTEROL	210	100-199	mg/dL
LDL CHOLESTEROL	141	0-99	mg/dL
HDL CHOLESTEROL	43	40-59	mg/dL
TRIGLYCERIDES	183	<< 150	mg/dL

Figure 3.13 Cholesterol Panel page

This is the portal page that was necessary to complete Task 9 (read a cholesterol panel). Participants reached this page by first choosing “My Medical Record” from the menu on the left side of the page, then choosing “Test Results” from the list of options. On the “Test Results” page (see Figure 3.6), participants had to click on “Cholesterol Panel” to view these results.

The screenshot displays the 'CREATE Patient Portal Simulation' interface. On the left is a vertical navigation menu with the following items: 'My Medical Record', 'Message Center', 'Appointments', 'Billing & Insurance', 'Address & Settings', and 'Customer Service'. The main content area is titled 'High Blood Pressure Information' and includes a home icon in the top right corner. Below the title, there is a list of links: 'High Blood Pressure Health Risk Calculator', 'Overview of High Blood Pressure', 'Interactive Tutorial on High Blood Pressure', 'Your Guide to Lowering High Blood Pressure', and 'Eating a Low Salt Diet to Control High Blood Pressure'. A section titled 'Links to Useful Information' contains links for 'Diabetes', 'Cholesterol', 'Heart Disease', 'Asthma', and 'Cancer'. The footer of the page reads 'CREATE Patient Portal Simulation'.

Figure 3.14 High Blood Pressure Information page

Reaching this page was the first step in completing Task 10 (interpret HBP graph 1). Participants reached this page by clicking on the link to “High Blood Pressure” information on the Homepage (see Figure 3.1). On this page, participants needed to click on the link to “High Blood Pressure Health Risk Calculator” to view the graph.

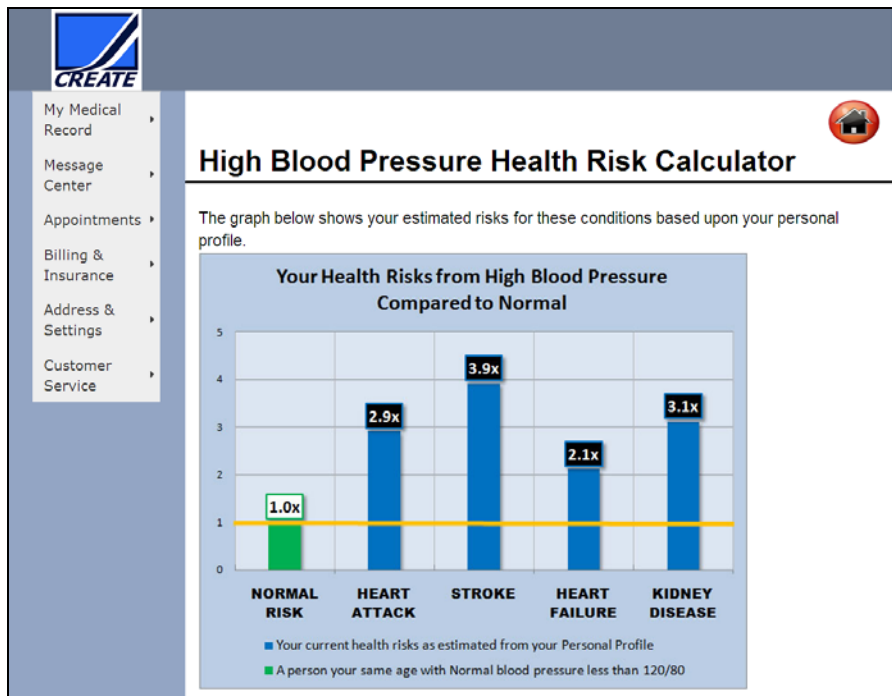


Figure 3.15 High Blood Pressure Health Risk Calculator (Graph 1) page
 This is the portal page that was necessary for completing Task 10 (interpreting HBP graph 1). Participants reached this page by clicking on the link to “High Blood Pressure Risk Calculator” seen in Figure 3.14.

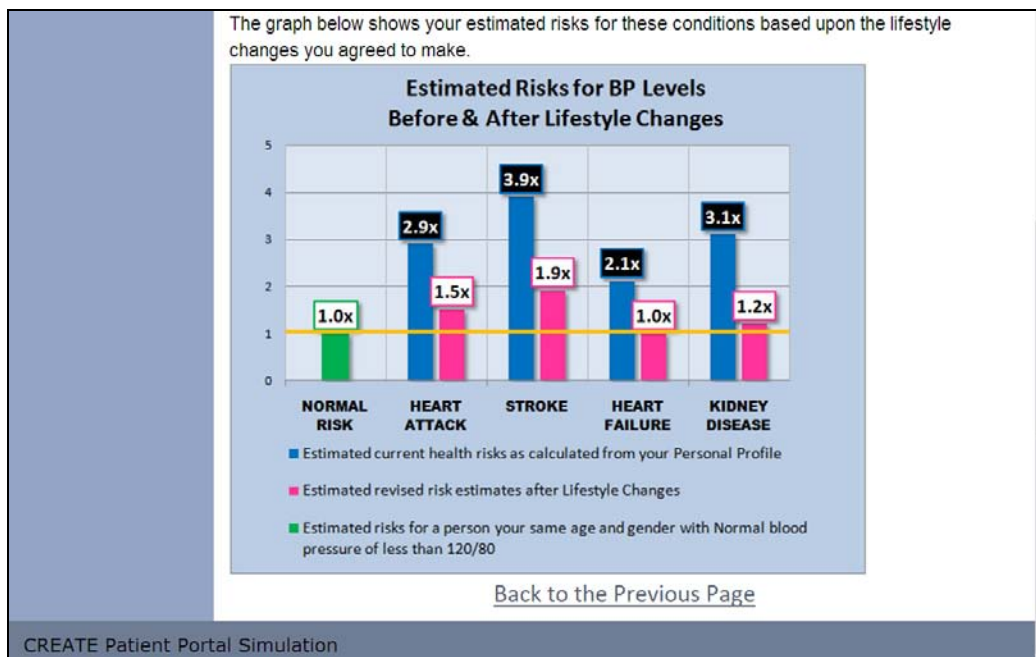


Figure 3.16 High Blood Pressure Health Risk Calculator (Graph 2) page
 This is the portal page that was necessary to complete Task 11 (interpret HBP graph 2). This graph was located on the same page that was necessary to complete Task 10; participants needed to remain on the same page and scroll down to view this graph.

COMPLETE BLOOD COUNT

[About this Test](#)

Comments from the Doctor's Office

Hi Test Patient,
If you have any questions please feel free to send me a message.
Regards,
DR. SIM, MD

Component Results

Component	Your Value	Standard Range	Units
HEMOGLOBIN	13.5	14.0 – 18.0	g/dl
HEMATOCRIT	56.3	42.0 – 52.0	%
RED BLOOD COUNT	3.9	4.7 – 6.1	x 10 ⁶ /ul
WHITE BLOOD COUNT	5.0	4.5 – 11.0	x 10 ³ /ul
NEUTROPHILS	46.5	45.0 – 76.0	%
LYMPHOCYTES	14.7	17.0 – 44.0	%
MONOCYTES	10.0	3.0 – 10.0	%
EOSINOPHILS	6.6	0.0 – 4.0	%
BASOPHILS	2.2	0.0 – 2.0	%
PLATELETS	412.0	140.0 – 415.0	x 10 ³ /ul

[View Historical Graph of Results](#)

[General Information](#)

Collected: 6/17/2010

Figure 3.17 Complete Blood Count page

This is the portal page that was necessary to complete Task 12 and Task 13. Participants reached this page by choosing “My Medical Record” from the menu on the left side of the screen, then choosing “Test Results” from the list of options. On the “Test Results” page (see Figure 3.6), participants needed to choose the correct CBC test from the list to view these results. On this page, participants needed to click on the link to “View Historical Graph of Results.”

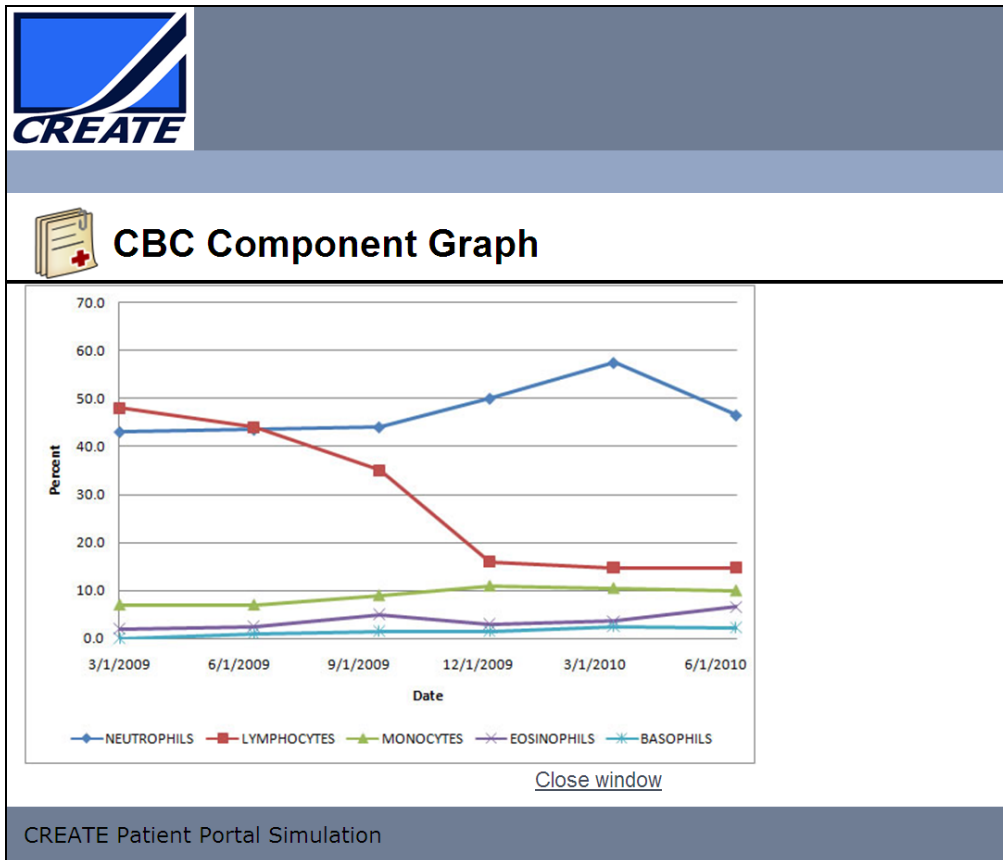


Figure 3.18 CBC Component Graph page

This is the portal page that was necessary to complete Task 14 and Task 15. Participants reached this page by clicking on the link to “View Historical Graph of Results” on the CBC test result page (see Figure 3.17).

3.5 Procedure

Participation in the study took place over two days. The first day was conducted on an individual basis or in small groups (4-9 people). Participants were asked to read and sign an IRB-approved informed consent. Participants were given the Background Questionnaire, Technology Experience Questionnaire, and Heart Disease Fact Questionnaire to complete. Next, they were administered the subjective numeracy and objective numeracy tests, followed by the group testing components of the cognitive battery. They were provided with breaks as needed. Participants were paid \$25 for their participation and provided with free parking.

On the second day, participants participated on an individual basis. The second day was divided into two parts. The first part consisted of a vision test, the individual testing components of the cognitive battery, and the TOFHLA. The MMSE that participants completed as part of the individual portion of the cognitive battery was used to screen for cognitive impairment, and only those participants who scored greater than 26 on the MMSE qualified to continue on to the second part of participation. The second part began with a tutorial on basic computer skills (such as using a mouse and scrolling). Irrespective of their prior computer experience, all participants worked through the tutorial to ensure that they had adequate knowledge of basic operations required for interacting with the simulated patient portal. They were then given a brief training session on how to use the portal. The script used for computer and portal training is provided in Appendix J.

Participants were told to pretend they were a relative of Pat and were to use the portal to help Pat manage his/her health. Participants were given a “Response Sheet” packet that contained the 15 tasks, with space provided below each question for them to record their answers (see Appendix K for Response Sheet). They were allowed up to two hours to complete all of the tasks. Each participant’s onscreen activities were recorded using a screen-capture utility (Morae 3.2 from TechSmith) that outputs his or her task performance to a digital movie. These videos were saved so that they could later be reviewed to assess any usability difficulties encountered by the participants while completing the tasks. Following the completion of the tasks, participants were asked to complete a usability questionnaire. At the completion of data collection, brief interviews were conducted with each participant. The emphasis in these interviews was on

determining the perceived benefits of using the portal and which aspects of the portal were difficult to use. Participants were paid \$40 for their participation and provided with free parking.

CHAPTER 4

RESULTS

4.1 Overview of Results

All analyses were conducted with IBM SPSS Statistics Version 19. Participants' self-reported Internet experience, participants' scores on measures of health literacy, subjective numeracy and objective numeracy, and cognitive measures, and participants' responses to the usability questionnaire were summarized using descriptive statistics. The correlation between subjective and objective numeracy scores was determined by using Pearson's r correlation. Differences in the measures of cognitive abilities between middle-aged and older adults were tested for significance with t-tests. Hierarchical regression models were used to examine the effects of various predictors on two outcomes: (1) task performance and (2) portal usability.

4.1.1 Task Performance

Three hierarchical regression models were constructed for predicting the effects of education, Internet experience, cognitive abilities, objective numeracy scores and age on task performance. In the first model, the dependent measure was performance on simple tasks; in the second model, the dependent measure was performance on complex tasks; and in the last model, the dependent measure was overall performance on all fifteen tasks. In all the models, the predictor variables were entered in the following order: education, Internet experience, cognitive abilities, objective numeracy, and age.

Education was entered first as a control variable in order to examine the impact of the variables of interest (Internet experience, cognitive abilities, objective numeracy, and

age) on one's ability to use a patient portal beyond the impact of one's education. This was done because it is likely that those with more education would perform better on the tasks than those with less education, regardless of their Internet experience, cognitive abilities, numeracy and age. Education is generally considered an important determinant of an individual's general knowledge and abilities, and thus should provide advantages for a large number of decision-making tasks. Furthermore, as indicated in Table 3.1, there were significant differences in education between the two age groups, and entering education first controlled for this variability. Internet experience was entered next because ability in using a web-based portal was expected to rely heavily on one's skills in using the Internet. Completing health management tasks using a portal necessitates clicking on links, scrolling, and being able to orient oneself within the portal; these are all types of skills that are necessary for effectively using the Internet. Cognitive abilities were then entered because it was hypothesized that even if one has an education and Internet experience, there are cognitive variables that could significantly impact one's abilities to effectively complete tasks using a new technology such as a patient portal. Numeracy ability was added to the models next to test the hypothesis that, due to the numeric nature of all of the portal tasks, numeracy would be an important factor even after controlling for one's education, Internet experience, and cognitive abilities. Finally, age was entered into the model to determine if there were other age-related variables that would affect task performance after controlling for the other variables. Across all of the models, an alpha level of 0.05 was chosen to test for significance of the predictor variables.

Due to the large number of cognitive measures, a correlation analysis was performed to determine which cognitive variables to use in the hierarchical models. While many of the cognitive measures were significantly correlated with the performance outcomes, the analysis revealed that the following measures were the most highly correlated with performance outcomes: Trails B (executive function), Shipley Institute of Living Scale (verbal ability), and Letter Sets Test (reasoning). These cognitive measures were thus selected for inclusion in the hierarchical models. A natural log transformation of Trails B (time score) was performed to normalize the results before inclusion in the models. The correlations between the selected cognitive variables and the performance outcomes are shown in Table 4.1, and the entire correlation matrix is displayed in Table 4.2.

Table 4.1 Correlations between the selected cognitive measures and performance outcome scores

	<i>Performance Score</i>		
	<i>Simple Tasks</i>	<i>Complex Tasks</i>	<i>Overall</i>
Letter Sets	0.558**	0.630**	0.648**
Shipley	0.521**	0.467**	0.510**
Trail B (Log of time)	-0.531**	-0.566**	-0.589**

**Correlation significant at the 0.01 level

Table 4.2 Correlations Matrix for Cognitive Measures and Performance Measures

	Paper Folding	Cube Comparison	Letter Sets	Shipley	Number Comparison	Digit Symbol	Trails B	Stroop	Animal Fluency	Simple Tasks	Complex Tasks	Overall Performance
Paper Folding	1.000	0.469**	0.393**	0.239*	0.247**	0.336**	-0.373**	0.133	0.377**	0.290**	0.347**	0.347**
Cube Comparison	---	1.000	0.213*	-0.056	0.269**	0.327**	-0.287**	0.035	0.330**	0.076	0.156	0.142
Letter Sets	---	---	1.000	0.456**	0.436**	0.512**	-0.603**	0.360**	0.347**	0.558**	0.630**	0.648**
Shipley	---	---	---	1.000	0.256**	0.148	-0.268**	0.116	0.310**	0.521**	0.467**	0.510**
Number Comparison	---	---	---	---	1.000	0.633**	-0.538**	0.190*	0.189	0.369**	0.370**	0.395**
Digit Symbol	---	---	---	---	---	1.000	-0.687**	0.343**	0.277**	0.414**	0.481**	0.496**
Trails B (Log of time)	---	---	---	---	---	---	1.000	-0.419**	-0.410**	-0.531**	-0.566**	-0.589**
Stroop	---	---	---	---	---	---	---	1.000	0.211*	0.264**	0.275**	0.282**
Animal Fluency	---	---	---	---	---	---	---	---	1.000	0.254**	0.267**	0.279**
Simple Tasks	---	---	---	---	---	---	---	---	---	1.000	0.761**	0.883**
Complex Tasks	---	---	---	---	---	---	---	---	---	---	1.000	0.974**
Overall Performance	---	---	---	---	---	---	---	---	---	---	---	1.000

*Correlation significant at the .05 level

**Correlation significant at the .01 level

4.1.2 Usability

To analyze portal usability and to determine the types of problems participants' encountered during completion of the tasks, Morae Version 3.2 usability software from TechSmith was used to record each participant's session while using the portal to complete the tasks. Each participant's session was captured as a digital movie, and a log was created of every webpage visited, in sequential order, by the participant as he or she completed the tasks. In addition, one recording was made that consisted of the performance of all 15 tasks, where each task completed in its most "optimal" sequence by navigating in the most direct manner possible to each page that contained the information necessary to complete the task. The "optimal" recording session, in which the 15 tasks were completed in the order in which the tasks were presented in the Response Sheet, was performed by the Principal Investigator. The data captured in the logs for the participants and for the "optimal" session were exported into SPSS for analysis so that data from the "optimal" recording could be compared with participants' data.

The first step in analyzing the usability data was to review the "optimal" recording to determine which pages in the portal were necessary to correctly answer each task. A total of 15 pages were established as necessary pages, corresponding to the locations of the answers for the 15 tasks. Participants' logs were reviewed to determine the number of necessary pages they viewed (0 to 15); the total number of pages they viewed, both in the portal and in links to external websites; the total number of correct pages they viewed (total number times they viewed the pages contained in the "optimal" recording, which contained the 15 necessary pages plus the pages that were required steps

in reaching the 15 necessary pages); the total number of wrong internal pages (pages contained in the portal that were not necessary for completing a task); the total number of wrong external pages (pages that were reached via links in the portal to websites containing pages that were not necessary for completing a task); and their overall navigational efficiency. Navigational efficiency was evaluated as a percentage of the correct pages viewed (the number of correct pages viewed divided by the total number of pages viewed and multiplied by 100). The closer to 100% a participant's percentage of correct pages viewed, the better the participant was at viewing only pages necessary for task completion, i.e., the participant navigated more directly to the necessary pages.

Two hierarchical regression models were constructed for predicting navigational efficiency and the number of necessary pages (out of 15) viewed, respectively. Initially, a correlation analysis was performed to determine the correlation between age, education, Internet experience, and objective numeracy and the two usability outcomes. The results of this analysis indicated that neither age nor education was significantly correlated with either of the usability outcomes, so these variables were not used in the hierarchical regression models. Table 4.3 displays the correlation between the selected variables and the usability outcomes.

Table 4.3 Correlations between Internet experience and numeracy and usability outcomes

	<i>Navigational Efficiency</i>	<i>Number of Necessary Pages Viewed</i>
Internet Experience	.375**	.555**
Numeracy	.374**	.527**

**Correlation is significant at the 0.01 level

In the hierarchical regression models constructed to predict the effects of Internet experience and numeracy on the usability outcomes, the variables were entered in the following order: Internet experience, then numeracy, and then the interaction between

Internet experience and numeracy. Internet experience was entered before numeracy for the same reason as rationalized in section 4.1.1. The interaction variable was added to these hierarchical models to test the hypothesis that Internet experience may have the ability to compensate for low numeracy skill, as it is possible that those with high Internet experience and low numeracy skills may be able to more effectively complete tasks using a patient portal than those with low Internet experience and low numeracy skills based upon their ability to determine how to navigate to the correct information in the portal. Cognitive variables, which were included in the hierarchical models constructed for predicting performance, were not included in these analyses, as the objective of these analyses was to determine the effect of the interaction between Internet experience and numeracy on usability. In addition, inclusion of cognitive variables would not have allowed for enough power to test for this interaction

4.1.3 Conditional Performance

The data from the log of the web pages viewed by each participant (captured with the Morae software and exported to SPSS) were also merged with data on the participant's score for each task to determine the level to which the participant completed a task (incorrect, partially correct, or correct) when he/she viewed the page that contained the information necessary to complete the task. This allowed for the creation of a usability variable termed "conditional performance" that was measured on a scale of 0 to 2 and indicated participants' mean score on tasks that they had the potential to complete because they had viewed the page that contained the information necessary to complete the task. Participants with a value closer to 2 for this variable completed more tasks correctly than participants with a value closer to 0. For example, if a participant viewed

the page containing the results of the cholesterol panel necessary to complete Task 9 and answered incorrectly, this participant would received a 0 value for the conditional performance variable, whereas a participant who answered partially correct would receive a value of 1, and a participant who answered completely correct would receive a value of 2 for the conditional performance variable. Tasks for which the correct page was not viewed were not included in the computation of the conditional performance score. This method allowed for distinction between a task not completed because the participant never located the correct information in the portal and a task not completed because a participant could not use the correct information he or she located to complete the task.

Conditional performance was not used as an outcome variable in hierarchical regression because it was not valid to compare participants' values for this variable, as it was not comprised of a consistent number of tasks among participants. For example, if a participant were only able to reach one necessary page his/her conditional performance score would be based on performance of only this one task. If another participant reached 10 necessary pages, his/her conditional performance score would be based upon the average of responses to those 10 tasks. Thus, it is possible that this second participant may obtain a lower value for conditional performance just because he/she looked at more information than the first participant.

To assess conditional performance in the sample, the frequency of necessary pages viewed among all participants was evaluated. The sample was then split into quartiles based upon the frequencies of total necessary pages viewed among all participants. One participant did not view a single necessary page (resulting in a missing

value for the total necessary pages variable for this participant), and was removed from this analysis. Among the remaining 106 participants, approximately 25% of participants viewed 0-8.5 necessary pages; 25% of participants viewed 9-11 necessary pages; another 25% of participants viewed 11.5-13 necessary pages; and the final 25% of participants viewed 13.5-15 necessary pages. Within each necessary page quartile, the conditional performance, objective numeracy, and Internet experience of participants were summarized using descriptive statistics.

It should be noted that the possibility for participants' to get a half-page value in the necessary pages variable is a result of the necessary pages variable associated with Simple Task 1 (finding date/time of upcoming appointment). To completely perform this task correctly, participants were required to view two distinct necessary pages. In completing Simple Task 1, if a participant only navigated to the first necessary page and did not click on the correct appointment to navigate to the next necessary page (the page containing the time of the appointment), he/she received a value of 0.5 for the necessary page variable for that task. Participants who also viewed the appointment details page received a value of 1 for necessary page variable associated with the task. This scoring method was followed to allow for evaluation of the necessary page variable on a common scale of 0 to 1 across tasks (Simple Task 1 was the only task that required more than one necessary page for correct completion).

4.2 Internet Experience

Twenty-two participants (11 middle-aged and 11 older adults) reported having no experience with the Internet. The remaining participants had varying levels of experience. Table 4.4 indicates how long the participants had been using the Internet, as

well as how often per week, on average, they used the Internet. To create a variable that captured the participants' overall Internet experience, the responses to the duration question (coded 1 to 4) were multiplied by the responses to the intensity question (coded 1 to 4), resulting in scores ranging from 1 to 16 for those participants who had Internet experience (participants with no prior Internet experience received a score of zero). This variable was used in the hierarchical regression models. Internet experience was significantly correlated ($p < .001$) with performance on the simple tasks ($r = .470$), performance on the complex tasks ($r = .522$), and overall performance ($r = .532$).

Table 4.4 Participants' Internet experience

	Total Sample (N = 107)	Middle-Aged (N = 56)	Older (N = 51)
Length of time using the Internet, <i>n</i> (%)			
Less than 6 months	12 (11.2%)	6 (10.7%)	6 (11.8%)
Between 6 months and 1 year	7 (6.5%)	4 (7.1%)	3 (5.9%)
More than 1 year, but less than 5 years	19 (17.8%)	14 (25.0%)	5 (9.8%)
5 years or more	47 (43.9%)	21 (37.5%)	26 (51.0%)
Hours/week using the Internet, <i>n</i> (%)			
Less than 1 hour	22 (20.6%)	13 (23.2%)	9 (17.6%)
Between 1 hour and 5 hours	27 (25.2%)	15 (26.8%)	12 (23.5%)
More than 5 hours, but less than 10 hours	13 (12.1%)	6 (10.7%)	7 (13.7%)
10 hours or more	23 (21.5%)	11 (19.6%)	12 (23.5%)

Note: Data for the 22 participants (11 middle-aged, 11 older) who reported having no Internet experience and are not included in this table

4.3 Heart Disease Fact Questionnaire

Scores on this measure ranged from 9 to 25 ($M = 19.19$, $SD = 3.78$). Scores were similar in both middle aged ($M = 18.20$, $SD = 3.92$) and older group ($M = 20.27$, $SD = 3.34$). A correlation analysis indicated that participants' performance on this measure was not significantly correlated to performance on either simple or complex tasks, nor was it significantly correlated to overall performance, so this variable was not used in hierarchical regression analysis.

4.4 Functional Health Literacy

TOFHLA scores in the sample ranged from 59 to 100 ($M = 88.28$, $SD = 9.823$); for the middle-aged group the scores ranged from 60 to 100 ($M = 90.29$, $SD = 8.542$) and for the older group the scores ranged from 59 to 99 ($M = 86.08$, $SD = 10.716$). There was not much variation in the scores, and most participants performed very well. Ninety-five participants (52 middle-aged and 43 older adults) had scores in the “Adequate” range (75-100). Of the remaining participants, one participant in the older group had a score in the “Inadequate” range (0-59), and eleven (4 middle-aged and 7 older adults) had scores in the “Marginal” range. Due to the lack of variability in TOFHLA score, this variable was not used in the hierarchical regression models.

4.5 Subjective and Objective Numeracy

Overall, subjective numeracy scores ranged from 14 to 48 ($M = 31.36$, $SD = 8.54$) and objective numeracy scores ranged from 0 to 11 ($M = 5.24$, $SD = 2.740$). There was a significant correlation between the two scores ($r = .430$, $p < 0.001$), however it was much smaller than the correlations ($r = 0.63 - 0.68$) reported by Fagerlin et al. (2007). Scores on both subjective and objective numeracy measures were not significantly different between the two age groups. In the middle-aged group, scores on the SNS ranged from 16 to 48 ($M = 30.09$, $SD = 7.75$), while in the older group scores on the SNS ranged from 14 to 48 ($M = 32.76$, $SD = 9.20$). On the objective numeracy measure, middle-aged participants had a range of scores from 1 to 11 ($M = 5.20$, $SD = 2.81$) while the older participants' scores ranged from 0 to 11 ($M = 5.29$, $SD = 2.69$). There was a higher correlation between subjective and objective numeracy in the middle-aged group ($r = .476$, $p < 0.001$) than in the older group ($r = .395$, $p < 0.01$). However, in both age

groups, the majority of participants (54.2%) correctly answered 5 or fewer objective numeracy questions, while subjectively rating their skills as quite high. Thus, most participants – regardless of age – tended to overestimate their numeracy ability. As the results indicated that the subjective measure was not a reliable proxy for one’s objective numeracy skill, subjective numeracy was not used as a variable in the hierarchical regression models; objective numeracy was used in the models. Objective numeracy was significantly correlated ($p < 0.001$) with performance on simple tasks ($r = .470$), performance on complex tasks ($r = .522$), and overall performance ($r = .656$).

Table 4.5 indicates the number and percentage of participants within each age group and in the overall sample who correctly answered the items on the Lipkus et al. (2007) objective numeracy measure. As indicated in the table, both middle-aged and older participants did poorly on the general numeracy items: less than 25% could determine a simple probability, less than half could convert a percentage to a proportion, and less than 10% could convert a proportion to a percentage. In the total sample, 44.9% of participants answered 0 of the general numeracy items correctly, 36.4% correctly answered 1 item, 14.0% correctly answered 2 items, and only 4.7% correctly answered all 3 items. Participants performed much better on the expanded health-context numeracy items. Comparing participants’ performance on item 6 with their performance on item 7, it is noticeable that it was much easier for participants to work with percentages than it was for them to work with proportions.

The results of the participants’ performance within each age group on the Lipkus et al. (2007) objective numeracy measure are also displayed in Figure 4.1. For the most part, a higher percentage of older adults correctly answered the objective numeracy items

than middle-aged adults. This was not the case for items 4, 5, and 8, on which middle-aged adults out-performed older adults. The results for items 4 and 5 indicate that approximately 40% of older adults were unable to correctly determine the biggest risk of getting a disease, either when the information was presented as a proportion or when it was presented as a percentage.

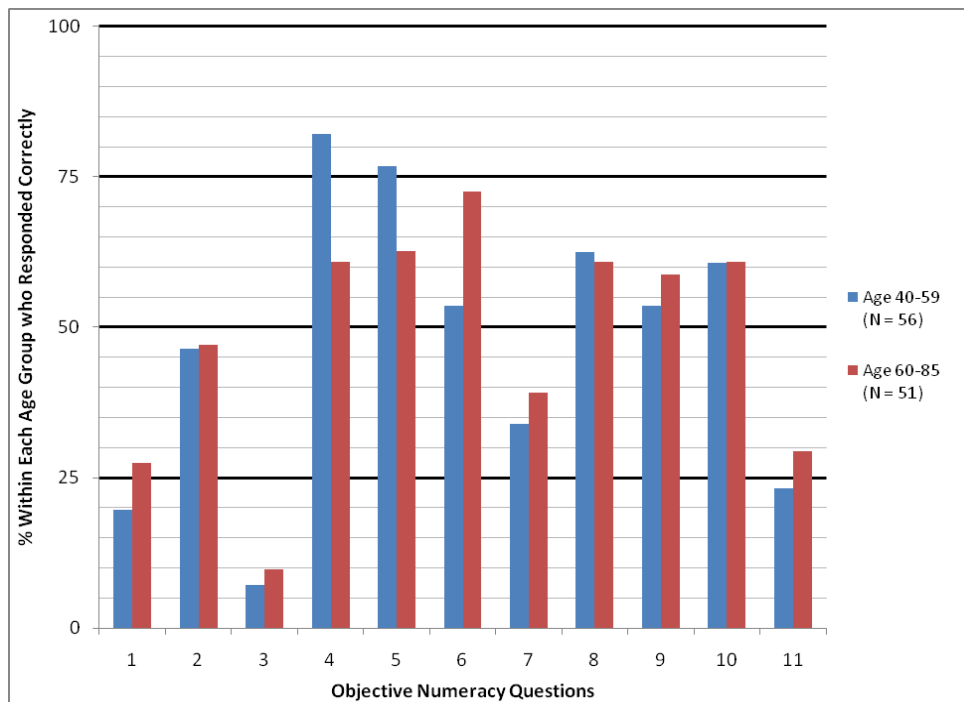


Figure 4.1 Comparison of performance on the Objective Numeracy measure between middle-aged and older adults

Table 4.5 Results of the objective numeracy measure

	<i>Middle-Aged (N = 56)</i>	<i>Older (N = 51)</i>	<i>Overall (N = 107)</i>	
General Numeracy Items, n (%)				
1	Imagine that we roll a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, or 6?) <i>Answer: 500 out of 1000</i>	11 (19.6%)	14 (27.5%)	25 (23.4%)
2	In the BIG BUCKS LOTTERY, the chance of winning a \$10 prize is 1%. What is your best guess about how many people would win a \$10 prize if 1000 people each buy a single ticket to BIG BUCKS? <i>Answer: 10 persons out of 1000</i>	26 (46.4%)	24 (47.1%)	50 (46.7%)
3	In ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car? <i>Answer: 0.1%</i>	4 (7.1%)	5 (9.8%)	9 (8.4%)
Expanded Health-Context Items, n (%)				
4	Which of the following numbers represents the biggest risk of getting a disease? Please mark an "X" on the line next to your choice. ___ 1 in 100, ___ 1 in 1000, ___ 1 in 10 <i>Answer: 1 in 10</i>	46 (82.1%)	31 (60.8%)	77 (72.0%)
5	Which of the following number represents the biggest risk of getting a disease? Please mark an "X" on the line next to your choice. ___ 1%, ___ 10%, ___ 5% <i>Answer: 10%</i>	43 (76.8%)	32 (62.7%)	75 (70.1%)
6	If Person A's chance of getting a disease is 1% in ten years, and person B's risk is double that of A's, what is B's risk? <i>Answer: 2%</i>	30 (53.6%)	37 (72.5%)	67 (62.6%)
7	If Person A's chance of getting a disease is 1 in 100 in ten years, and person B's risk is double that of A's, what is B's risk? <i>Answer: 2 out of 100</i>	19 (33.9%)	20 (39.2%)	39 (36.4%)
8	If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 100? <i>Answer: 10</i>	35 (62.5%)	31 (60.8%)	66 (61.7%)
9	If the chance of getting a disease is 10%, how many people would be expected to get the disease out of 1000? <i>Answer: 100</i>	30 (53.6%)	30 (58.8%)	60 (56.1%)
10	If the chance of getting a disease is 20 out of 100, this would be the same as having a ___% chance of getting the disease. <i>Answer: 20</i>	34 (60.7%)	31 (60.8%)	65 (60.7%)
11	The chance of getting a viral infection is .0005. Out of 10,000 people, about how many of them are expected to get infected? <i>Answer: 5 people</i>	13 (23.2%)	15 (29.4%)	28 (26.2%)

4.6 Cognitive Measures

Table 4.6 displays the mean and standard deviations of scores for participants in both age groups on all of the cognitive measures. As indicated in the table, the middle-aged participants scored higher than the older participants on every measure except for

the Shipley Institute of Living Scale (verbal ability), on which older adults scored higher than the middle-aged adults. These results are consistent with the cognitive aging literature that documents age-related declines in fluid abilities such as speed of processing, working memory, and executive functioning, while crystallized abilities such as vocabulary remain relatively intact (Schaie & Willis, 2002).

Table 4.6 Summary of participants' scores on the cognitive measures

	<i>Middle-Aged (N = 56)</i>		<i>Older (N = 51)</i>	
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
Paper Folding* (Spatial Ability)	6.07	3.55	4.76	2.63
Cube Comparison** (Spatial Ability)	18.11	4.85	13.90	4.34
Letter Sets (Reasoning)	13.18	5.37	11.20	4.97
Shipley** (Verbal Ability)	26.73	6.92	29.90	5.11
Number Comparison (Processing Speed)	40.73	11.17	39.59	8.68
Trails B (Log of time)** (Executive Function)	1.85	0.14	1.99	0.15
Digit Symbol Coding** (Processing Speed)	63.38	15.26	52.25	13.25
Stroop* (Working Memory)	61.11	2.83	56.00	14.93
Animal Fluency* (Verbal Fluency)	19.30	3.97	17.27	4.61

*Significant at the 0.05 level

**Significant at the 0.01 level

To test for significant differences between the middle-aged and older participants on the cognitive measures, t-tests were performed. There was a significant difference between the age groups on the Paper Folding Test ($t = 2.176$, $df = 100.89$, $p = 0.032$), the Cube Comparison Test ($t = 4.710$, $df = 105$, $p < 0.001$), Shipley Institute of Living Scale ($t = -2.673$, $df = 105$, $p = 0.009$), log transformation of Trail B ($t = -4.804$, $df = 105$, $p < 0.001$), Digit Symbol Coding ($t = 4.008$, $df = 105$, $p < 0.001$), Stroop Color and Word Test ($t = 2.404$, $df = 53.27$, $p < 0.020$), and Animal Fluency ($t = 2.446$, $df = 105$, $p = 0.016$). Note that in the Paper Folding Test and the Stroop Color and Word Test,

Levine's Test for equality of variance indicated that equal variances could not be assumed so adjustments were made to the degrees of freedom using the Welch-Satterthwaite method. Also, while middle-aged adults did not score significantly higher than older adults on the Letter Sets Test, the difference approached significance ($t = 1.976$, $df = 105$, $p = 0.051$).

4.7 Patient Portal Task Performance

Table 4.7 displays the performance of participants in both age groups and the overall sample on the 15 portal tasks. As previously discussed, each task was scored as incorrect (0 points), partially correct (1 point), or correct (2 points). Scores for the simple tasks ranged from 0 to 14 ($M = 9.07$, $SD = 4.04$). Overall, on simple tasks, there was no significant difference in the performance of the two age groups. In the middle-aged group the mean score for simple tasks was 9.45 ($SD = 3.68$), while in the older group the mean score was 8.67 ($SD = 4.41$). Figure 4.2 displays the percentage of participants in each age group who correctly completed each of the simple tasks. As indicated in Figure 4.2, less than 50% of participants in either age group were able to correctly complete the first simple task, which involved finding the date and the time of an upcoming appointment. Of those participants who wrote down the correct date of the appointment, 23.2% of middle-aged adults and 25.5% of older adults did not write down the time of the appointment. On all other simple tasks, at least 50% of participants were able to correctly complete the task. Simple Task 5, which involved finding the Metformin medication from a list of medications and locating the dosage instructions for the medication had the highest percentage of correct responses (over 75%) in both age groups.

Table 4.7 Performance on simple and complex tasks

	<i>Middle-Aged (N = 56)</i>			<i>Older (N = 51)</i>			<i>Overall (N = 107)</i>		
	<i>Not Correct</i>	<i>Partially Correct</i>	<i>Correct</i>	<i>Not Correct</i>	<i>Partially Correct</i>	<i>Correct</i>	<i>Not Correct</i>	<i>Partially Correct</i>	<i>Correct</i>
Simple Tasks, n (%)									
Date/time of appointment	12 (21.4%)	20 (35.7%)	24 (42.9%)	12 (23.5%)	21 (41.2%)	18 (35.3%)	24 (22.4%)	41 (38.3%)	42 (39.3%)
Glucose level after lunch	16 (28.6%)	1 (1.8%)	39 (69.6%)	15 (29.4%)	2 (3.9%)	34 (66.7%)	31 (29.0%)	3 (2.8%)	73 (68.2%)
Range of glucose after meals	28 (50.0%)	---	28 (50.0%)	22 (43.1%)	1 (2.0%)	28 (54.9%)	50 (46.7%)	1 (0.9%)	56 (52.3%)
Glucose in proper range	18 (32.1%)	---	38 (67.9%)	23 (45.1%)	---	28 (54.9%)	41 (38.3%)	---	66 (61.7%)
Times/day Metformin	10 (17.9%)	---	46 (82.1%)	9 (17.6%)	---	42 (82.4%)	19 (17.8%)	---	88 (82.2%)
CBC in standard range	14 (25.0%)	---	42 (75.0%)	19 (37.3%)	---	32 (62.7%)	33 (30.8%)	---	74 (69.2%)
Lymphocytes increasing/decreasing	19 (33.9%)	---	37 (66.1%)	24 (47.1%)	---	27 (52.9%)	43 (40.2%)	---	64 (59.8%)
Complex Tasks, n (%)									
Create your plate	5 (8.9%)	43 (76.8%)	8 (14.3%)	12 (23.5%)	26 (51.0%)	13 (25.5%)	17 (15.9%)	69 (64.5%)	21 (19.6%)
Missed Metformin dose	19 (33.9%)	1 (1.8%)	36 (64.3%)	24 (47.1%)	2 (3.9%)	25 (49.0%)	43 (40.2%)	3 (2.8%)	61 (57.0%)
Insulin dose schedule	44 (78.6%)	---	12 (21.4%)	43 (84.3%)	---	8 (15.7%)	87 (81.3%)	---	20 (18.7%)
Cholesterol panel	11 (19.6%)	7 (12.5%)	38 (67.9%)	14 (27.5%)	7 (13.7%)	30 (58.8%)	25 (23.4%)	14 (13.1%)	68 (63.6%)
HBP Graph 1	34 (60.7%)	14 (25.0%)	8 (14.3%)	36 (70.6%)	15 (29.4%)	---	70 (65.4%)	29 (27.1%)	8 (7.5%)
HBP Graph 2	34 (60.7%)	12 (21.4%)	10 (17.9%)	36 (70.6%)	11 (21.6%)	4 (7.8%)	70 (65.4%)	29 (27.1%)	8 (7.5%)
CBC not standard range	14 (25.0%)	27 (48.2%)	15 (26.8%)	19 (37.3%)	20 (39.2%)	12 (23.5%)	33 (30.8%)	47 (43.9%)	27 (25.2%)
Monocytes during time period	22 (39.3%)	---	34 (60.7%)	33 (64.7%)	---	18 (35.3%)	55 (51.4%)	---	52 (48.6%)

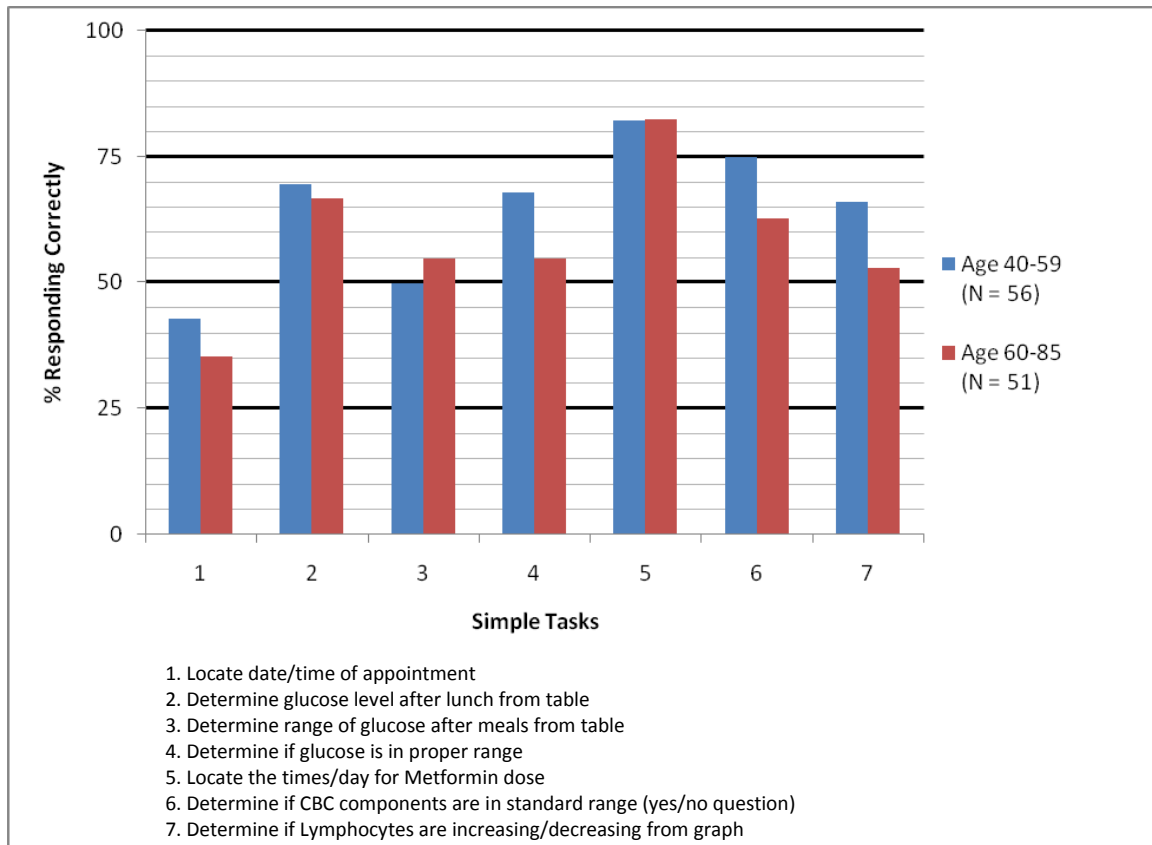


Figure 4.2 Comparison of simple task performance between middle-aged and older adults

Scores for the complex tasks ranged from 0 to 16 ($M = 6.79$, $SD = 4.00$). On complex tasks, there was a significant difference in performance between the age groups ($t = 2.243$, $df = 105$, $p = 0.027$). The middle-aged group had a higher mean score ($M = 7.61$, $SD = 3.85$) than the older group ($M = 5.90$, $SD = 4.01$). Figure 4.3 displays the percentage of participants in both age groups who correctly completed each of the complex tasks. This figure clearly indicates that participants had difficulties with these tasks. Approximately one-quarter or less of participants in either age group could correctly complete tasks that involved: following directions to create a plate according to recommendations of the American Diabetes Association; computing the amount of insulin Pat should take according to an insulin dose schedule; interpreting risk information from high blood pressure risk graphs; and determining blood components

that were out of standard range from a CBC test result. In fact, not one participant in the older age group was able to give a completely correct answer to Complex Task 5, in which participants were to use information in a graph to determine Pat's risk of heart failure compared with normal risk.

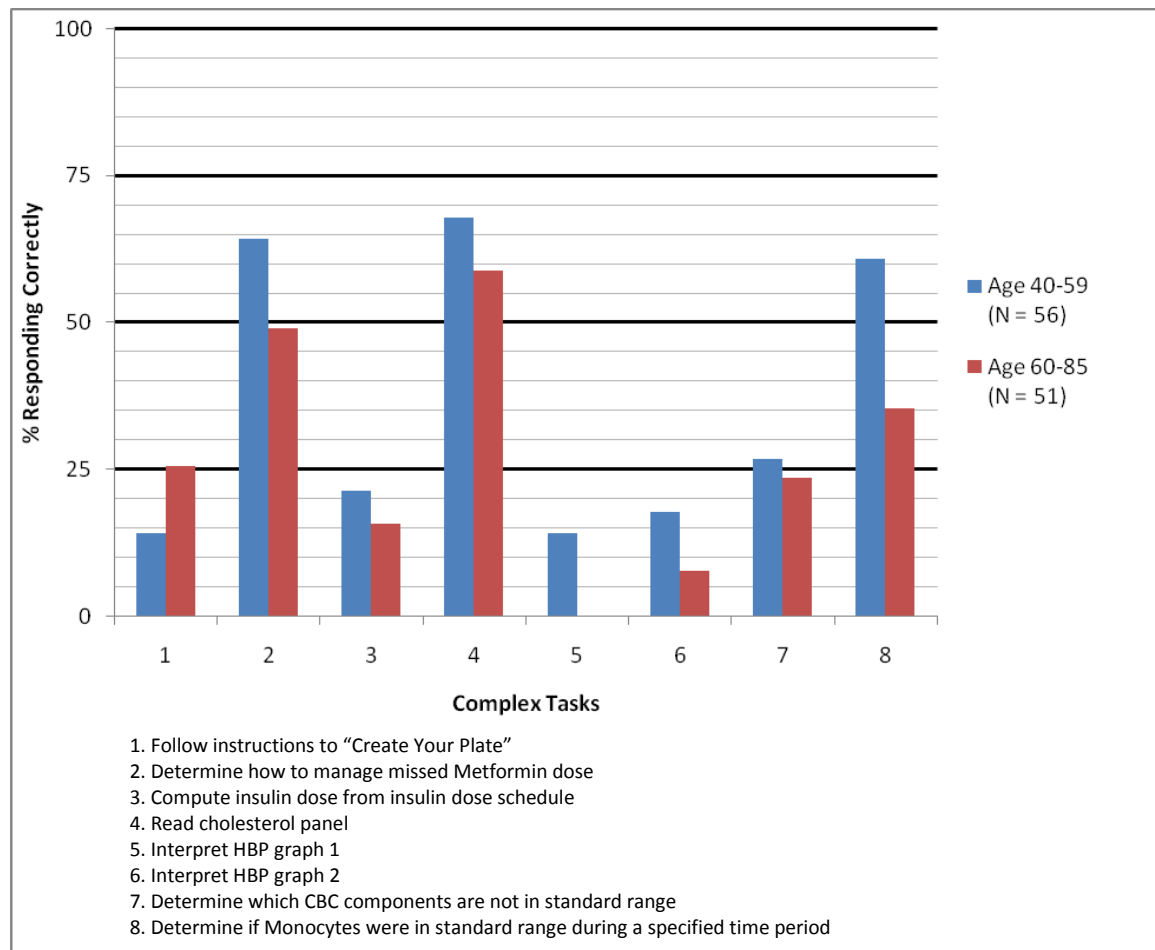


Figure 4.3 Comparison of complex task performance between middle-aged and older adults

In the entire sample, overall performance scores ranged from 0 to 80.5 ($M = 38.78$, $SD = 20.12$). There was a significant difference in overall performance between the two age groups ($t = 1.99$, $df = 105$, $p = 0.05$). The middle-aged group had a higher mean score ($M = 42.41$, $SD = 19.32$) than the older group ($M = 34.78$, $SD = 20.41$).

As indicated in Table 4.8, numeracy and age were not significant in the model for predicting performance on the simple tasks; therefore Model 3 was chosen as the final model. In the model for simple tasks (*adj. R*² = .465) education accounted for 8.6% of the variance in performance on simple tasks, and Internet experience resulted in a significant increment in *R*², accounting for an additional 16% of the variance. Finally, the addition of the cognitive ability measures accounted for an additional 25% of the variance. Examination of the cognitive variables indicated that Trails B was the most influential cognitive ability ($\beta = -.297$) followed closely by the Shipley Scale ($\beta = .276$). Letter Sets was not found to be significant in the model predicting performance on simple tasks.

Table 4.8 Hierarchical regression models for task performance

		<i>R</i> ²	Adj. <i>R</i> ²	ΔR^2	ΔF	DF	p-value
Simple Tasks							
	Model 1 ^a	0.086	0.068	0.086	4.867	2, 104	0.010
	Model 2 ^b	0.246	0.224	0.160	21.869	1, 103	0.000
	Model 3 ^c	0.495	0.465	0.249	16.447	3, 100	0.000
	Model 4 ^d	0.508	0.473	0.013	2.606	1, 99	0.110
	Model 5 ^e	0.515	0.475	0.007	1.415	1, 98	0.237
Complex Tasks							
	Model 1 ^a	0.041	0.023	0.041	2.243	2, 104	0.111
	Model 2 ^b	0.274	0.253	0.233	33.045	1, 103	0.000
	Model 3 ^c	0.544	0.516	0.269	19.668	3, 100	0.000
	Model 4 ^d	0.590	0.561	0.047	11.312	1, 99	0.001
	Model 5 ^e	0.627	0.597	0.037	9.644	1, 98	0.002
Overall Performance							
	Model 1 ^a	0.058	0.040	0.058	3.184	2, 104	0.046
	Model 2 ^b	0.290	0.270	0.233	33.761	1, 103	0.000
	Model 3 ^c	0.585	0.561	0.295	23.734	3, 100	0.000
	Model 4 ^d	0.621	0.594	0.036	9.323	1, 99	0.003
	Model 5 ^e	0.651	0.623	0.030	8.495	1, 98	0.004

- a. Education
- b. Education, Internet Experience
- c. Education, Internet Experience, Trails B, Shipley, Letter Sets
- d. Education, Internet Experience, Trails B, Shipley, Letter Sets, Objective Numeracy
- e. Education, Internet Experience, Trails B, Shipley, Letter Sets, Objective Numeracy, Age

The final model for predicting performance on complex tasks (Table 4.8, Model 5) was quite different. In this model, Internet experience, Trails B, Shipley Scale, Letter Sets, objective numeracy, and age were all significant predictors of performance on complex tasks, while education was not found to be significant in the model. In the final model for the complex tasks ($adj. R^2 = .597$), Internet experience accounted for 23.3% of the variance and cognitive abilities accounted for an additional 26.9% of the variance. After accounting for both Internet experience and cognitive abilities, the addition of objective numeracy accounted for an additional 4.7% of variance, and age accounted for an additional 3.7% of the variance beyond objective numeracy. Interestingly, in this model, Letter Sets was found to be the most influential cognitive ability ($\beta = .188$), followed closely by the Shipley Scale ($\beta = .158$) and then Trails B ($\beta = -.086$).

The final model (Table 4.8, Model 5) predicting overall performance ($adj. R^2 = .623$), education accounted for 5.8% of the variance, Internet experience accounted for an additional 23.3%, and cognitive abilities accounted for an additional 29.5%. After accounting for education, Internet experience, and cognitive variables, the addition of objective numeracy accounted for an additional 3.6%, and age accounted for an additional 3.0% of the variance beyond objective numeracy. In this model an examination of the cognitive abilities found that Shipley Scale was the most influential ($\beta = .204$) followed by Letter Sets ($\beta = .185$) and then Trails B ($\beta = -.123$).

4.8 Usability

4.8.1 Usability Questionnaire

Approximately 89% of all participants (91.1% middle-aged and 86.3% older adults) indicated that they would use a patient portal like the simulation if it were

available from their doctor. Of the twelve participants who indicated that they would not be interested in using a portal, five were middle-aged and seven were older. Among these 12 participants, a common reason given for not wanting to use the portal was that it was “confusing” or “difficult” to use. However, even though these 12 participants indicated that they would not use a patient portal, only one thought there was no potential benefit in using a portal. The other eleven participants who indicated that they would not use a portal acknowledged certain benefits that included having the ability to get test results or medication information without having to leave the house or call a doctor, to schedule and keep track of appointments, and to find information pertinent to health conditions from links in the portal.

Data from the usability questionnaire indicated that participants, both middle-aged and older, tended to have a positive opinion of patient portals in general. As indicated in section 3.2.6, participants responded to each question in the usability questionnaire using a five-point Likert scale (1 = Agree, 2 = Somewhat Agree, 3 = No Opinion, 4 = Somewhat Disagree, 5 = Disagree). To summarize the opinions of participants, those who responded either that they “Agree” or “Somewhat Agree” to items were combined to form a single group (reported here as those who “agree”). Ninety-four percent of participants agreed that a patient portal would improve their ability to perform health management tasks (i.e., review test and lab results, schedule a doctor’s appointment, or look for information about a medical condition), and 95% agreed that a patient portal would allow them to get information that would help them understand issues related to their health. Approximately 94% of participants agreed that the portal would help them perform a greater number of health management tasks than they currently do, and 89%

agreed that they would feel comfortable using a patient portal to communicate with their doctors. However, approximately 68% agreed that they would have concerns about privacy related to their health information when using a portal.

Many participants indicated that they experienced some difficulty while using the portal simulation: 40% agreed that it was difficult to navigate within the portal and 51% agreed that it was difficult to locate the information that they needed within the portal. However, 79% agreed that it was easy to use the portal to find information about an upcoming doctor's appointment and 85% agreed that it was easy to find information in the portal about medications. Table 4.9 summarizes participants' responses to questions regarding their difficulty in comprehending information contained in the simulation.

Table 4.9 Participants' feelings regarding comprehension of information contained in the portal simulation

	% Agree		
	Total Sample	Middle-Aged	Older
I thought that the numerical tables (e.g., the glucose tables) used in the portal were confusing.	31.8	25.0	39.2
I thought the graphs about health risks used in the patient portal were confusing.	25.2	21.4	29.4
I thought the graphs about blood test results used in the patient portal were confusing.	19.6	12.5	27.5
In general, I thought that the information I needed to answer the questions regarding health management tasks was difficult to understand.	22.4	19.6	31.4

Note: Percentages are those who either "Agreed" or "Somewhat Agreed" to the statements as opposed to those who had "No Opinion," "Somewhat Disagreed," or "Disagreed"

4.8.2 Morae Data

4.8.2.1 Usability Measures

The total number of pages viewed by participants ranged from 8 to 288 ($M = 84.62$, $SD = 40.36$) and the number of correct pages (pages contained in the optimal recording) viewed ranged from 1 to 151 ($M = 55.72$, $SD = 25.70$), indicating that many

participants viewed a large number of unnecessary pages, and also viewed the pages needed to complete the tasks repeatedly. The number of necessary pages viewed by participants ranged from 0 to 15 ($M = 10.32$, $SD = 3.76$). The number of wrong internal pages (pages in the portal that were not needed for completing tasks) ranged from 0 to 115 ($M = 15.78$, $SD = 14.69$) and the number of wrong external pages (pages unnecessary for completing tasks that were found in websites outside of the portal and reached via links contained in the portal) viewed ranged from 0 to 79 ($M = 13.12$, $SD = 12.34$). Navigational efficiency, measured by the percentage of correct pages viewed, ranged from 5.9% to 95.5% ($M = 66.9\%$, $SD = 15.85$). The percentages of both wrong internal pages and wrong external pages were calculated to determine to what extent participants were getting lost both inside and outside of the portal as they completed the tasks. The percentage of wrong internal pages viewed in the sample ranged from 0 to 62.5% ($M = 18.14\%$, $SD = 11.42$) and the percentage of wrong external pages ranged from 0 to 60.8% ($M = 14.97\%$, $SD = 12.06$).

4.8.2.2 Hierarchical Models for Predicting Usability Outcomes

As previously discussed, hierarchical regression models were used to analyze the effects of Internet experience and numeracy skill and the interaction of these two variables on the following usability outcomes: navigational efficiency and the number of necessary pages. Only the model predicting navigational efficiency had a significant interaction term. To test the interaction, the variables in this model were centered (i.e., put in deviation score form so that their means are zero; see Aiken & West, 1991) and the hierarchical regression model was re-tested with the centered variables.

Table 4.10 Hierarchical regression models for usability outcomes

	R^2	Adj. R^2	ΔR^2	ΔF	DF	p-value
Navigational Efficiency						
Model 1 ^a	0.140	0.132	0.140	17.161	1, 105	0.000
Model 2 ^b	0.198	0.183	0.058	7.476	1, 104	0.007
Model 3 ^c	0.230	0.207	0.032	4.237	1, 103	0.042
Necessary Pages						
Model 1 ^d	0.308	0.301	0.308	46.674	1, 105	0.000
Model 2 ^e	0.415	0.404	0.107	19.031	1, 104	0.000
Model 3 ^f	0.429	0.412	0.014	2.563	1, 103	0.112

- a. Centered Internet experience
- b. Centered objective numeracy
- c. Centered Internet experience x Centered objective numeracy
- d. Internet experience
- e. Objective numeracy
- f. Internet experience x Objective numeracy

As indicated in Table 4.10, Internet experience, objective numeracy and the interaction of these two variables were significant in predicting participants' navigational efficiency in completing the tasks, therefore Model 3 was chosen as the final model. In the model ($adj. R^2 = .207$), Internet experience accounted for 14% of the variance in navigational efficiency and objective numeracy accounted for an additional 6% of the variance in navigational efficiency. The interaction of these variables accounted for another 3.2% of the variance in navigational efficiency. Although these values are small, all were statistically significant.

To further investigate the significant interaction found in this model, the regression equation was restructured to express the regression of navigational efficiency on Internet experience at levels of objective numeracy (see Aiken & West, 1991). Levels were chosen at one standard deviation above and below the mean objective numeracy score. The resulting plot of the interaction is shown in Figure 4.4. Plotting this interaction revealed that among participants with low numeracy, high Internet experience resulted in higher navigational efficiency. Thus, Internet experience can help compensate for low numeracy skill in terms of one's ability to navigate efficiently in the portal.

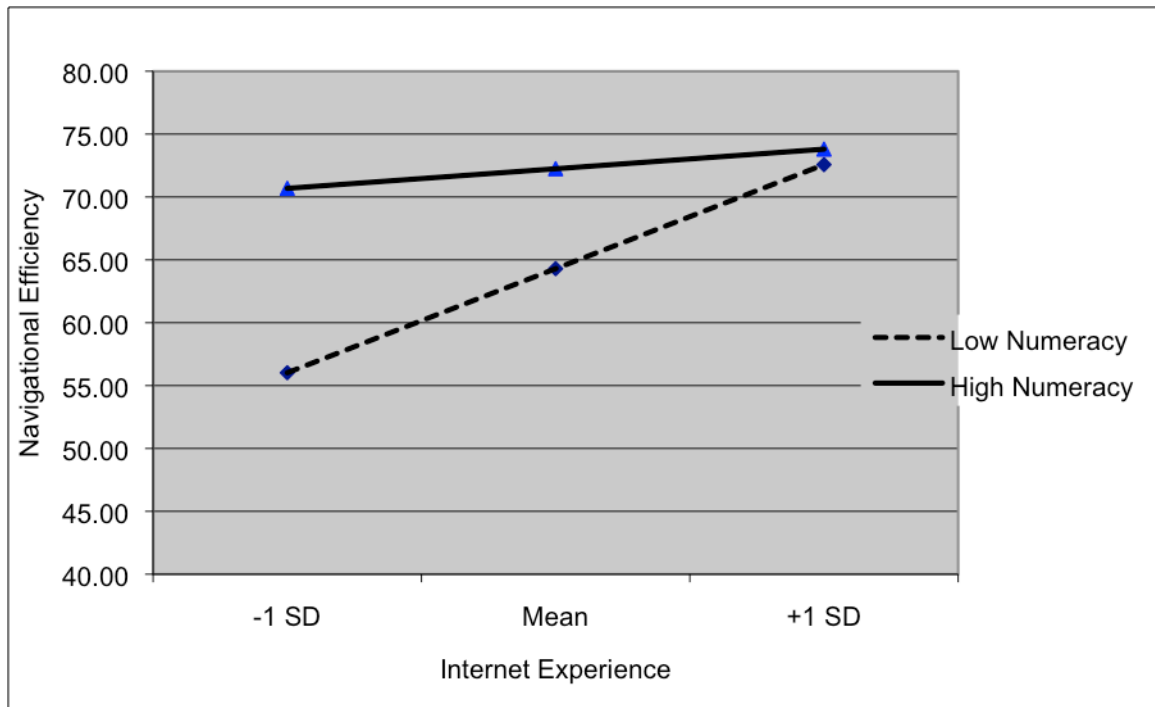


Figure 4.4 Interaction effect between Internet experience and objective numeracy on navigational efficiency

In the second hierarchical model, used to investigate the effects of Internet experience and objective numeracy on the number of necessary pages viewed, the interaction between Internet experience and objective numeracy skill was not significant. Therefore Model 2 was chosen as the final model. In this model ($adj. R^2 = .404$), Internet experience accounted for 31% of the variance in the number of necessary pages viewed and adding numeracy to the model resulted in a significant increment in R^2 , accounting for an additional 11% in the variance.

4.8.2.3 Conditional Performance

Conditional performance, the variable used to capture the level to which participants' completed the tasks (not correct, partially correct, or correct) when they navigated to the necessary page that contained the answer, is shown in Figure 4.5. As indicated in this figure, participants who viewed 0 to 8.5 necessary pages had the lowest

conditional performance ($M = 0.954$, $SD = 0.512$), and participants who viewed 13.5 to 15 necessary pages had the highest conditional performance ($M = 1.548$, $SD = .297$).

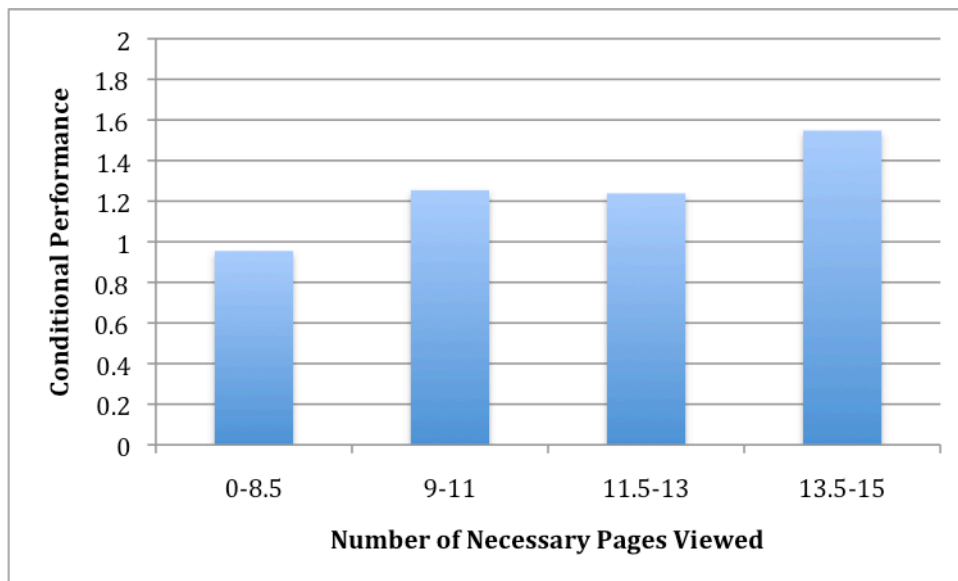


Figure 4.5 Conditional performance among participants (N = 106)

Table 4.11 summarizes participants' Internet experience and objective numeracy within the quartiles of necessary pages viewed. As indicated in this table, participants who viewed a higher number of necessary pages had both more Internet experience and higher objective numeracy than participants who viewed a lower number of necessary pages. Thus, it is difficult to determine if it was a participant's Internet experience or his/her objective numeracy skill that created higher conditional performance.

Table 4.11 Summary of participants' Internet experience and objective numeracy within the quartiles of necessary pages viewed

	<i>Number of Necessary Pages Viewed</i>			
	<i>0.0-8.5</i>	<i>9.0-11.0</i>	<i>11.5-13.0</i>	<i>13.5-15.0</i>
Conditional Performance	0.95	1.25	1.24	1.55
Objective Numeracy	3.46	4.93	5.38	7.42
Internet Experience	1.73	5.89	9.34	10.17

CHAPTER 5

DISCUSSION

As previously stated, the goals of this study were to: (1) examine the ability of middle-aged and older adults to use a patient portal of an EMR to perform common health management tasks; (2) examine the relationships between individual characteristics such as age, education, Internet experience, cognitive abilities, health literacy and health numeracy, and the performance of health management tasks and decision-making using a patient portal; (3) identify usability problems inherent in the use of patient portals; and (4) identify initial design solutions. In regard to these objectives, a number of hypotheses were investigated. Specifically, it was hypothesized that:

- (1) There would be age-related differences in the execution of common health management tasks using a portal such that middle-aged participants would perform significantly better than older participants on a variety of tasks.
- (2) There would be age-related differences in numeracy ability similar to the age-related differences commonly seen in health literacy ability (i.e., older adults will have lower numeracy than middle-aged adults).
- (3) Consistent with the cognitive aging literature that indicates declines in fluid abilities but not crystallized abilities for older adults, the middle-aged participants would demonstrate significantly higher fluid cognitive abilities than the older participants, while the older participants would exhibit significantly higher crystallized cognitive abilities than the middle-aged participants.
- (4) After accounting for education and Internet experience, cognitive abilities would be found to be a significant factor in predicting performance on portal tasks such

that those with lower cognitive abilities would perform at a lower level than those with higher abilities.

- (5) Even after taking into consideration the factors of education, Internet experience, and cognitive abilities, health numeracy would be a significant factor in predicting performance on portal tasks that require more complex numeracy skills.
- (6) Both Internet experience and numeracy would be strong predictors of the usability of the portal in regard to the participants' efficiency in completing the necessary steps required for task completion, however greater Internet experience would have the ability to compensate for low numeracy ability.

5.1 Hypothesis 1: Age-related Differences in Task Performance

While no age-related differences were found in performance of simple tasks, there were age-related differences found in the performance of complex tasks. Middle-aged participants performed significantly better on complex tasks and had significantly higher overall performance scores than the older participants. Hierarchical models indicated that age was a significant factor in predicting performance on complex tasks and overall performance of tasks even after accounting for education, Internet experience, cognitive abilities, and numeracy. The most obvious explanation for this age difference in performance was the finding, as discussed below, that the older participants had significantly lower fluid cognitive abilities than their younger (middle-aged) counterparts. As it was hypothesized that the more complex tasks were more demanding of fluid cognitive abilities (Table 3.2), performance on these tasks should have been more sensitive to age differences in cognitive abilities.

While middle-aged participants did achieve significantly higher scores for complex tasks and overall performance than the older participants, it should be noted that both age groups encountered problems using this portal, even for relatively simple tasks. For example, less than 50% of participants in either age group were able to correctly complete a task that involved finding the date and time of an upcoming appointment. This result strengthens the case that it is very important for designers of these systems to consider both the needs of middle-aged and older adults when developing these portals, and that simplicity in design is key for a wide range of user groups.

Although the results of this study showed that participants encountered difficulties in using the portal to perform common health management tasks, it is interesting to note the overwhelmingly positive response participants had regarding use of a portal. The fact that 91% of middle-aged participants and 86% of older participants indicated that they would use a portal like the simulation if it were available from their doctor demonstrates that many adults are ready and willing to accept this technology. It appears that if portals are made available, patients will have great interest in using them.

5.2 Hypothesis 2: Age-related Differences in Numeracy

It was hypothesized that older adults would have lower numeracy ability than middle-aged adults, as it is often reported that older adults have lower health literacy than middle-aged adults. Since numeracy is conceptualized as a component of literacy, it would be logical to assume that numeracy skill would be lower in those with lower literacy skill. However, this hypothesis was not supported by the results of this study; no significant difference was found in the numeracy ability of middle-aged and older participants. This result indicates that one's numeracy ability may be distinct from one's

literacy and, thus, numeracy should be evaluated separately from literacy. As mentioned previously, it has been suggested in the literature that “the reporting of health literacy without disaggregating prose from numeracy obscures health numeracy skill” (Donelle, Hoffman-Goetz, & Arocha, 2007, p. 652) and the results from this study clearly support this suggestion.

Providing further evidence that one’s numeracy and literacy should be evaluated separately, a discrepancy was found between health literacy and health numeracy skills in this sample. Approximately 89% of the participants in this study were determined to have “adequate” health literacy based on their TOFHLA scores, implying that they should be able to read, understand, and interpret most health texts. However, the sample had health numeracy scores that were quite low; 54.2% of participants could not correctly answer the majority of objective numeracy questions. This result indicates that if the health texts used by middle-aged and older adults in patient portals involve numeric concepts, they may encounter problems even if they are considered to have “adequate” health literacy. The high TOFHLA scores obtained in this study by both older participants and participants of diverse ethnicity are even more interesting when considering the extensive literature indicating that older populations and minorities are often found to have poor health literacy. This result points to the need for more sensitive measures of health literacy than the TOFHLA, one of the most widely used health literacy measures.

Results of the subjective and objective numeracy measures in this sample indicated a much smaller correlation ($r = .430$) between subjective and objective numeracy than the correlation ($r = .63 - .68$) reported between subjective and objective

numeracy in the literature (Fagerlin et al., 2007). Perhaps this difference is due to the sample used in this study; the higher correlation reported by Fagerlin et al. (2007) was found in a convenience sample taken from a hospital waiting area and cafeteria, while the results found here were from a diverse sample of community-dwelling adults. Because the sample used in this study was not taken from a hospital setting, it is possible that participants had less experience with numeracy in the health care setting than participants used in the Fagerlin study.

Most of the participants in this study tended to overestimate their numeracy skill, which implies that both middle-aged and older adults may believe that they can comprehend and use the numeric information provided in the portal correctly when, in fact, they cannot. This misconception could result in false assumptions for both middle-aged and older portal users that could easily lead to serious problems such as taking medications incorrectly or believing that abnormal test results are in the proper range. However, the older participants in this study had a weaker correlation between their subjective and objective numeracy scores ($r = .395$) than the middle-aged participants ($r = .476$), indicating that older portal users may be at higher risk for such problems.

5.3 Hypothesis 3: Age-related Differences in Cognitive Abilities

Participants' scores on cognitive measures supported the hypothesis that middle-aged participants would outperform older adults on measures of fluid intelligence, while older adults would outperform middle-aged adults on measures of crystallized intelligence. Middle-aged participants did in fact score higher than older participants on every cognitive measure except the Shipley Institute of Living Scale (a measure of the crystallized ability of verbal knowledge), on which the older participants scored

significantly higher than the middle-aged participants. Based upon the literature relating declines in fluid abilities to problems using new technologies, results of the cognitive measures imply that older users have a more difficulties using patient portals. These results are especially noteworthy in that the comparisons in age groups was between middle-aged and older adults as opposed to younger and older adults, with significant age-group differences still found for all the fluid cognitive ability measures. Thus, these results highlight how older adults may be potentially much more vulnerable than even middle-aged adults to inability to complete portal tasks that are cognitively demanding.

5.4 Hypothesis 4: Cognitive Abilities Predicting Performance

The hypothesis that cognitive abilities would predict performance after controlling for education and Internet experience was supported by the results of this study. The hierarchical models used to predict participants' performance on the simple and complex tasks and overall performance provide some insights into the types of cognitive abilities that affect task performance using patient portals, as it was determined that the cognitive abilities predicting performance vary according to task type. On simple tasks, it was determined that executive functioning was the most influential cognitive predictor, followed closely by verbal ability. Since there were no age-related differences found in performance of simple tasks and since older adults had higher verbal ability than middle-aged participants, this result may indicate that for simple tasks, higher verbal ability can compensate for lower executive functioning.

In contrast to the cognitive abilities predicting performance on simple tasks, the hierarchical models used to predict performance on complex tasks indicated that reasoning was the most influential cognitive ability for predicting performance, followed

by verbal ability and then executive functioning. Perhaps older adults are at a disadvantage for performing more complex portal tasks because of the decline in reasoning ability or in cognitive abilities that support reasoning (such as working memory and visiospatial skill) associated with age. This result also suggests that older adults with little or no decline in reasoning ability may be able to perform as well as younger adults on complex health-related tasks. In fact, this result was found (Sharit et al., 2008; Czaja et al., 2010) for tasks that were performed by searching for health-related information on the Internet.

For predicting overall performance across tasks, verbal ability was the most influential cognitive ability, followed by reasoning and then executive functioning. This is an interesting and unexpected result as verbal ability is a measure of crystallized intelligence, which was found to be higher in older participants; yet older participants had significantly lower overall performance scores than middle-aged adults. This result suggests that higher crystallized abilities may not be able to compensate for age-related declines in fluid abilities, such as reasoning and executive functioning, for tasks that require using technological systems such as portals as these systems may exact extra demands on fluid cognitive abilities as discussed below.

Across all three models predicting task performance, Internet experience was determined to account for a large percentage of the variance in performance: 16% for simple tasks, and 23% for both complex tasks and overall performance. That Internet experience accounted for a rather substantial increase in the percentage of variance in performance between simple and complex tasks, and the fact that older adults did not perform as well as younger adults on tasks where performance was more strongly

predicted by Internet experience, may indicate that, as suggested by the literature, there are fluid abilities inherent in using the Internet to perform more complex tasks. Perhaps more complex tasks require the user to have more spatial orientation while navigating through the portal and solutions require more executive functioning. In general, compared to the simple tasks, many of the complex tasks required participants to execute more of a search strategy and to filter out unnecessary information. For instance, the complex task that involved creating a plate according to diabetic guidelines required the participant to first determine the correct location of the link to that information in the portal (and filter out links leading to irrelevant information), then click on multiple links to get to the correct page where the information was located, and finally to scroll down to the section of the page where the directions were listed. Clearly this type of portal task would be much easier for someone who not only had more prior Internet experience, but also had the cognitive resources necessary for planning the appropriate strategy for task completion. In contrast, one of the simple tasks regarding finding the dosage instruction for a medicine required the participant to click on a menu button labeled “Medications” and then simply read the instructions given on the page.

5.5 Hypothesis 5: Numeracy as a Predictor of Task Performance

It was hypothesized that numeracy would be a significant factor in predicting task performance even after accounting for education, Internet experience and cognitive ability. While results did not support this hypothesis for performance of simple tasks, the hypothesis was supported by results of this study for performance of complex tasks and overall performance; when numeracy was added to the model after entering the other predictors, it accounted for an additional 4.7% of the variance in complex tasks and 3.6%

of the variance in overall performance. This result shows the importance of numeracy skill in completing complex tasks and in overall performance of tasks using a portal, above and beyond one's education, Internet experience, and cognitive abilities. That numeracy skill was not found to exhibit age-related declines indicates that both middle-aged and older users, regardless of education, Internet experience, and cognitive abilities are at risk for encountering problems using portals to complete tasks. This result is especially disconcerting given the generally poor numeracy skills seen in both middle-aged and older adults.

5.6 Hypothesis 6: Internet Experience and Numeracy as Predictors of Usability

The hypothesis that Internet experience and numeracy would predict usability was supported by results of this study. Not only were these two factors significant in predicting navigational efficiency, but also the interaction between Internet experience and numeracy was found to be significant in predicting navigational efficiency such that the effect of numeracy was mediated by Internet experience, with the positive effect of Internet experience on performance being demonstrated by participants with low numeracy as opposed to participants with high numeracy. This result supports the hypothesis that greater Internet experience can help compensate for low numeracy skill. As results indicated that numeracy skill was poor among both middle-aged and older participants, this result is encouraging, as it implies that Internet training could result in a greater usability for those who may encounter problems due to low numeracy.

5.7 Recommendations to Increase Usability of Patient Portals

Results from this study can be used for developing interventions that may enhance the usability of patient portals for older adults. For example, Internet experience was

determined to have a significant impact on task performance. This could be expected, as many of the functions of the portal require skills that are consistent with the skills necessary for Internet use (i.e., scrolling, clicking on links, and closing windows). One implication is that health care providers should identify patients, especially older adults, with little or no prior Internet experience and provide instructional resources that could facilitate their proper use of the functions in their patient portals. The hierarchical regression model constructed to predict the effects of Internet experience and objective numeracy on navigational efficiency indicated that Internet experience can help compensate for low numeracy, further strengthening the argument for the value of Internet training in portal users with limited prior Internet experience.

Implications for design changes to increase the usability of portals come from the findings that, depending on task complexity, verbal ability, reasoning, and executive function have varying degrees of impact on performance. Developers of patient portals need to be aware that deficits in these cognitive abilities may make it difficult for users to locate and understand the information in the portal and build in aids that can help compensate for cognitive deficits. As verbal ability was found to be the strongest cognitive ability to predict overall performance, the addition of info-buttons to help explain technical terms and providing search aids within the patient's health record may make portals easier to use.

The impact of numeracy on predicting performance strongly suggests that careful consideration needs to be given to the presentation of numerical information in patient portals. Scores on the objective numeracy measure revealed the prevalence of low numeracy skills in this sample of middle-aged and older adults; almost 45% of

participants answered none of the general numeracy items correctly while less than 5% of participants were able to correctly answer all 3 general numeracy items. Thus, numerical information contained in patient portals must be presented on an extremely simplified level, requiring almost no interpretation on the part of users. For instance, 25% of middle-aged participants and 39.2% of older participants found the numerical tables to be confusing. It should be noted that these tables were not unusual in their numeracy demands, but rather were representative of the types of tables patients encounter in a portal. Based upon the results of the Lipkus et al. (2007) numeracy measure, it is surprising that the percentage of participants reporting confusion with numerical tables was not even greater. Perhaps this result shows that many of the participants did not even realize that they did not correctly comprehend the information presented in the tables. Tables displaying numeric information in the portal must be formatted to provide information in a way that is more readily understood by those with low numeracy. Numbers given in a table or in a list of lab results that are out of the proper range for the patient could be highlighted to call attention to the fact that they are too high or too low, and audio and/or video explanations could be added to help patients understand and interpret this and other types of numeric information.

Findings from the objective numeracy measure also point to the importance of the format for presenting risk information in portals. More than 60% of participants were able to determine the chance of getting a disease when the information was presented as a percentage, while only 36% were able to correctly determine the chance of getting a disease when this same information was presented as a proportion. This indicates that if

risk information is to be presented to patients through a portal, the majority of users may more easily interpret the information if it is presented as a percentage.

Analysis of the usability data captured with the Morae system indicates other areas for design change. The necessary pages that were most frequently missed by participants were pages that had to be reached via links in the portal and not accessed through the menu. For instance, many of the links to health information relevant to the patient's condition were only located on the homepage, causing problems for even participants with high levels of Internet experience. This type of information might be more readily accessible if links were located in the "Current Health Issues" section under "My Medical Record." That way, a user could look up this information without having to go back to the homepage after looking at a list of their current conditions.

Furthermore, links that take the user from a table of test results to a related graph or from a medication listing to more information about that medication need to be highlighted to call attention to the fact that they are there. The importance of this design change is clearly indicated in the following result: while approximately 87% of participants viewed the necessary page containing the CBC results, almost 62% of participants did not click on the link located directly below the results to "View Historical Graph of Results." This result may also point to the importance of using clear and simple language in the portal. It is possible that participants did not see the link, but it is also possible that they did see it and did not click on it because they did not understand the terminology "historical graph."

Some of the usability data presented in the results should be interpreted cautiously. For instance, the large number of total pages viewed by some participants,

the number of wrong internal pages and the number of wrong external pages may not necessarily indicate that the participants were lost or confused in navigating the portal. As participants were not given explicit instructions to only look at pages that they thought would be necessary for task completion, it is possible that some participants were just curious about the portal and wanted to see all the types of information it contained.

5.8 Limitations of the Study

There are a number of limitations of this study that should be noted. First, the sample was relatively small. Due to budget and time constraints, it was not feasible to recruit more than 107 participants for this study. However, the overall sample was diverse in terms of gender, ethnicity, education, Internet experience, and age. This diversity may make the results of this study more generalizable to patients who are likely to use patient portals.

Some other limitations resulted from the unbalanced nature of the tasks. Because the tasks were designed to be ecologically valid, there were not an equal number of tasks within each of the three core portal functions (i.e., medication management, health maintenance, and lab/test result tasks). Furthermore, there was not an equal number of tasks tapping into the types of numeracy skills (i.e., basic, computational, analytical, statistical) required to complete the tasks nor was there an equal number of simple/complex difficulty within each of the core functions. Because of the unbalanced nature of tasks, it was not possible to investigate the effects of different types of numeracy skill on task performance. Also due to the nature of the tasks, conditional performance could not be statistically analyzed; this would have been an interesting usability measure to explore.

Finally, it is important to point out that participants had limited exposure to the portal, as the task performance assessments were limited to one occasion. This could potentially be a limitation of the study as it is likely that portal users will get better at using the portal to complete tasks with more experience.

5.9 Recommendations for Future Research

This study lays the groundwork for a variety of future studies. Areas for future research could be based upon implementing some of the suggested design changes and evaluating the effects of such changes on usability. First, as this study showed that the cognitive abilities that predicted performance varied by task, decision aids could be specifically developed to support the cognitive functions necessary for the type of task a patient is trying to perform (e.g., aids could focus on executive function and verbal ability for simple tasks, while aids could focus on reasoning in addition to verbal ability and executive function for more complex tasks). Decision aids could also be created that take into account the relative importance of cognitive abilities that were determined to predict overall performance (verbal ability then reasoning and then executive function). Studies could examine whether performance on tasks is improved with different types of decision aids such as glossaries and info buttons to help explain unfamiliar terms.

Other future studies could focus on determining the types of aids could be built into portals to help users who may have limited numeracy, as this study indicated that numeracy is an important predictor of performance on portal tasks. The fact that numeracy ability was determined to significantly impact performance even after accounting for education, Internet experience, and cognitive abilities indicates that the format of numerical information provided to users should be redesigned to display it in a

very simplified way (e.g., highlighted if out of the patient's standard range, audio/visual aids or info buttons added). The portal could then be tested with participants across a range of numeracy skills to see if these changes help or hinder task performance. Testing interventions with users with higher numeracy skills than the participants who participated in this study would help to ensure that design changes accommodate all users.

In future studies, tasks could be developed in a more balanced way in order to allow for examination of the types of numeracy that predict performance on types of tasks (e.g., does analytical numeracy skill predict performance on medication management tasks more than computational numeracy skill). Furthermore, more control over the order in which the tasks were performed would allow for more usability outcomes to be tested. Because the participants were not required to answer tasks in a specific order, it is difficult to determine if participants who viewed a large number of portal pages were lost or just interested in looking around the portal.

Finally, outside of the laboratory setting, health care providers who are just beginning to offer patients access to portals tethered to their EMRs could identify those patients with limited Internet experience and provide further instructional resources as well as "how-to" guides to these patients along with their log-in codes. Also, a brief test to assess the numeracy of the patient could be administered at log-in and the results could be used to tailor the information to meet the numeracy skill level of the patient. Studies could then investigate the ability for these patients to effectively use the portal to determine the effects of training and/or tailoring of information based upon numeracy

skill. Ultimately, studies should also look at the impact of portal use on health behaviors and outcomes.

In conclusion, the results of this study provide much data to expand the existing literature on patient portals, especially regarding factors that influence effective use of portals for health management tasks by middle-aged and older adults. This type of information is critical to improving upon portal systems and increasing the usability of portals not just for older users, but also for users across all age groups. Returning to Anker and Kaufman's (2007) model for successful use of quantitative health information (presented in Figure 2.1), one will recall that an individual's ability to productively use information is dependent, in part, on the proper design of the information artifact (in this case, the patient portal). The great potential of patient portals to deliver important health information to patients lies in the capacity for information to be tailored to meet the needs of the individual using the PHR. Krist et al. (2011) note that preventive care recommendations given to patients through their PHRs are already personalized according to the established guidelines, but point out that content and presentation of the PHR could be further personalized based upon other factors including race/ethnicity, socio-economic status, literacy and numeracy. Results from this study strongly suggest that tailoring the content of PHRs to meet the needs of both middle-aged and older users is necessary for users to effectively use portals to perform common health management tasks.

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APPENDIX A: CREATE Background Questionnaire

BACKGROUND QUESTIONNAIRE



FOR CREATE PERSONNEL USE ONLY	DATE: ___/___/___
SUBJECT ID: _____	
ASSESSOR ID: _____	

Please answer the following questions. All of your answers will be treated confidentially. Any published document regarding these answers will not identify individuals with their answers. **If there is a question you do not wish to answer, please just leave it blank and go on to the next question.** Thank you in advance for your help.

Demographics Questionnaire

Gender: Male ₁ Female ₂ Birth Date (mm/dd/yyyy): ___/___/____ Age: ____

1. What is your highest level of education?

- ₁ No formal education
- ₂ Less than high school graduate
- ₃ High school graduate/GED
- ₄ Vocational training
- ₅ Some college/Associate's degree
- ₆ Bachelor's degree (BA, BS)
- ₇ Master's degree (or other post-graduate training)
- ₈ Doctoral degree (PhD, MD, EdD, DDS, JD, etc.)

2. Current marital status (check one)

- ₁ Single
- ₂ Married
- ₃ Separated
- ₄ Divorced
- ₅ Widowed
- ₆ Other (please specify) _____

3. Do you consider yourself Hispanic or Latino?

- ₁ Yes
- ₂ No

3 a. If "Yes", how would you describe yourself?

- ₁ Cuban
- ₂ Mexican
- ₃ Puerto Rican
- ₄ Other (please specify) _____

4. How would you describe your primary racial group?

- ₁ No Primary Group
₂ White Caucasian
₃ Black/African American
₄ Asian
₅ American Indian/Alaska Native
₆ Native Hawaiian/Pacific Islander
₇ Multi-racial
₈ Other (please specify) _____

5. In which type of housing do you live?

- ₁ Residence hall/College dormitory
₂ House/Apartment/Condominium
₃ Senior housing (independent)
₄ Assisted living
₅ Nursing home
₆ Relative's home
₇ Other (please specify) _____

6. How many people excluding yourself are living with you in your home? _____

7. Which category best describes your yearly household income. Do not give the dollar amount, just check the category:

- | | |
|--|--|
| <input type="checkbox"/> ₀₁ Less than \$5,000 | <input type="checkbox"/> ₀₈ \$50,000 - \$59,999 |
| <input type="checkbox"/> ₀₂ \$5,000 - \$9,999 | <input type="checkbox"/> ₀₉ \$60,000 - \$69,999 |
| <input type="checkbox"/> ₀₃ \$10,000 - \$14,999 | <input type="checkbox"/> ₁₀ \$70,000 - \$99,999 |
| <input type="checkbox"/> ₀₄ \$15,000 - \$19,999 | <input type="checkbox"/> ₁₁ \$100,000 or more |
| <input type="checkbox"/> ₀₅ \$20,000 - \$29,999 | <input type="checkbox"/> ₁₂ Do not know for certain |
| <input type="checkbox"/> ₀₆ \$30,000 - \$39,999 | <input type="checkbox"/> ₁₃ Do not wish to answer |
| <input type="checkbox"/> ₀₇ \$40,000 - \$49,999 | |

8. Is English your primary language?

- ₁ Yes
₂ No

8 a. If "No", What is your primary language? _____

Occupational Status

1. What is your primary occupational status? (Check one)

- ₁ Work full-time
- ₂ Work part-time
- ₃ Student
- ₄ Homemaker
- ₅ Retired
- ₆ Volunteer worker
- ₇ Seeking employment, laid off, etc.
- ₈ Other (please specify) _____

2. Do you currently work for pay?

- ₁ Yes, Full-time
- ₂ Yes, Part-time
- ₃ No

If Full or Part-time

2 a. What is your primary occupation? _____

2 b. During a typical week, how many hours do you work? _____

If retired:

3. What was your primary occupation? _____

4. What year did you retire? _____

If Volunteer:

5. During a typical week, how many hours do you volunteer? _____

Health Information

1. In general, would you say your health is:

₁ ₂ ₃ ₄ ₅
 Poor Fair Good Very good Excellent

2. Compared to other people your own age, would you say your health is:

₁ ₂ ₃ ₄ ₅
 Poor Fair Good Very good Excellent

3. How satisfied are you with your present health?

₁ ₂ ₃ ₄ ₅
 Not at all Not very Neither satisfied Somewhat Extremely
 satisfied satisfied nor dissatisfied satisfied satisfied

4. How often do health problems stand in the way of your doing the things you want to do?

₁ ₂ ₃ ₄ ₅
 Never Seldom Sometimes Often Always

5. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? Please indicate your choice of response by placing an "X" in the appropriate response box.

	Limited a lot ₁	Limited a little ₂	Not limited at all ₃
a. Bathing or dressing yourself			
b. Bending, kneeling, or stooping			
c. Climbing one flight of stairs			
d. Climbing several flights of stairs			
e. Lifting or carrying groceries			
f. Moderate activities , such as moving a table, pushing a vacuum cleaner, bowling, or playing golf			

	Limited a lot ₁	Limited a little ₂	Not limited at all ₃
g. Vigorous activities , such as running, lifting heavy objects, or participating in strenuous sports (e.g., swimming laps)			
h. Walking more than a mile			
i. Walking one block			
j. Walking several blocks			

6. For each of the following conditions please indicate if you have ever had that condition in your life, have the condition now at this time, or never had the condition. Please indicate your choice of response by placing an "X" in the appropriate response box.

Condition	In your lifetime ₁	Now ₂	Never ₃
a. Arthritis			
b. Asthma or Bronchitis			
c. Cancer (other than skin cancer)			
d. Diabetes			
e. Epilepsy			
f. Heart Disease			
g. Hypertension			
h. Stroke			
i. Other significant illnesses (please list up to 3)			

CES-D

Next is a list of the ways you might have felt or behaved over the past week. Tell me how often you have felt this way **during the past week**. Please indicate your choice of response by placing an "X" in the appropriate response box.

During the past week...	Rarely or none of the time (< 1 day)	Some or a little of the time (1-2 days)	Occasionally or moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.				
2. I did not feel like eating; my appetite was poor.				
3. I felt that I could not shake off the sad feelings even with help from my family or friends.				
4. I felt that I was just as good as other people.				
5. I had trouble keeping my mind on what I was doing.				
6. I felt depressed.				
7. I felt that everything I did was an effort.				
8. I felt hopeful about the future.				
9. I thought my life had been a failure.				
10. I felt fearful.				
11. My sleep was restless.				
12. I was happy.				
13. I talked less than usual.				

During the past week...	Rarely or none of the time (< 1 day)	Some or a little of the time (1-2 days)	Occasionally or moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
14. I felt lonely.				
15. People were unfriendly.				
16. I enjoyed life.				
17. I had crying spells.				
18. I felt sad.				
19. I felt that people dislike me.				
20. I could not get "going."				

Computer Questionnaire

Please indicate the extent to which you agree or disagree with each of the following statements by placing an "X" in the appropriate response box.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. I feel comfortable with computers.					
2. Learning about computers is worthwhile and necessary subject.					
3. Reading or hearing about computers would be (is) boring.					
4. I know that if I worked hard to learn about computers, I could do well.					
5. Computers make me nervous.					
6. I don't care to know more about computers.					
7. Computers would be (are) fun to use.					
8. I don't feel confident about my ability to use a computer.					
9. Computers are <u>not</u> too complicated for me to understand.					
10. I think I am the kind of person who would learn to use a computer well.					
11. I think I am capable of learning to use a computer.					
12. Learning about computers is a waste of time.					
13. Computers are confusing.					
14. Computers make me feel dumb.					
15. Given a little time and training, I know I could learn to use a computer.					

Medication Information Form

In this section we would like you to list the medications that you take. Below is an example of how to fill out the form. If you take Ibuprofen for Arthritis two times a day, you would fill the form out as show below. Please fill out each field completely. There is space for up to eight different medications. If you take more than eight medications regularly, please list the most important medications.

Name of Medication	Reason for taking medication	How often do you take this medication? (Please select only one)
Ex. <i>Ibuprofen</i> _____ _____	<i>Arthritis</i> _____ _____	<input checked="" type="checkbox"/> Daily <u>2</u> times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed

Name of Medication	Reason for taking medication	How often do you take this medication? (Please select only one)
1. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
2. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
3. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
4. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed

Name of Medication	Reason for taking medication	How often do you take this medication? (Please select only one)
5. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
6. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
7. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed
8. _____ _____ _____	_____ _____ _____	<input type="checkbox"/> Daily _____ times/day <input type="checkbox"/> Weekly _____ times/week <input type="checkbox"/> Monthly _____ times/month <input type="checkbox"/> As Needed

APPENDIX B: CREATE Technology Experience Questionnaire

TECHNOLOGY EXPERIENCE QUESTIONNAIRE



FOR CREATE PERSONNEL USE ONLY	DATE: ___ / ___ / ___
SUBJECT ID: _____	
ASSESSOR ID: _____	

TECHNOLOGY AND COMPUTER EXPERIENCE QUESTIONNAIRE

The purpose of this set of questions is to assess your familiarity and experience with technology. Please indicate your choice of response by placing an "X" in the appropriate response box.

1. Within the last year, please indicate how much you have used any of the technologies listed below.

	Not sure what it is	Never	Once	Occasionally	Frequently
1. Answering machine					
2. Automated airport check-in kiosk					
3. Automated parking payment kiosk					
4. Automated telephone menu system					
5. Automated teller machine (ATM)					
6. Automated ticket purchase kiosk					
7. Books on tape or compact disk (CD)					
8. Basic cell phone to make calls					

	Not sure what it is	Never	Once	Occasionally	Frequently
9. Computer/Video game (e.g., Wii, PlayStation, Nintendo, XBox)					
10. Digital photography (e.g., camera, camcorder)					
11. Drive-through banking					
12. Email					
13. Fax machine					
14. Fitness device (e.g., pedometer, pulse meter, treadmill)					
15. Home security system					
16. In-car navigation system (e.g., GPS, OnStar)					
17. In-store automated kiosk (e.g., self-checkout, price scanner, item locator)					
18. Electronic book-reader (e.g., Kindle)					
19. Microwave oven					

	Not sure what it is	Never	Once	Occasionally	Frequently
20. MP3/iPod music player					
21. Personal digital assistant (PDA)					
22. Programmable devices (e.g., lights, thermostat, sprinkler, coffee maker or food processor)					
23. Recording and playback device (e.g., CD, DVD, VCR)					
24. Remote control to start the car					
25. Smart phone with Internet access					
26. Telephone					
27. TV set-top box (e.g., program TV, pay-per-view movies, music stations, TiVo)					
28. Videophone					

2. Have you had any experience with computers?

- ₁ Yes (Continue)
- ₂ No (Go to Page 6)

3. How long have you been using the computer?
- ₁ Less than 6 months
 - ₂ Between 6 months and 1 year
 - ₃ More than 1 year, but less than 5 years
 - ₄ 5 years or more
4. When did you last use a computer?
- ₁ This past week
 - ₂ More than 1 week ago, but within the last month
 - ₃ More than 1 month ago, but within the last year
 - ₄ More than 1 year ago
5. On average, about how many hours a week do you use the computer?
- ₁ Less than one hour a week
 - ₂ Between 1 hour and 5 hours a week
 - ₃ More than 5 hours, but less than 10 hours a week
 - ₄ 10 hours or more a week
6. Where do you use a computer? (check all that apply)
- ₁ Community center
 - ₂ Friend or relative's house
 - ₃ Home
 - ₄ Public library
 - ₅ Work
 - ₆ Other (specify): _____

INTERNET QUESTIONNAIRE

The purpose of this set of questions is to assess your familiarity and experience with the Internet. Please indicate your choice of response by placing an "X" in the appropriate response box.

1. Have you had any experience with the Internet?
 - ₁ Yes
 - ₂ No (Skip the rest of the questionnaire)

2. How long have you been using the Internet?
 - ₁ Less than 6 months
 - ₂ Between 6 months and 1 year
 - ₃ More than 1 year, but less than 5 years
 - ₄ 5 years or more

3. When did you last use the Internet?
 - ₁ This past week
 - ₂ More than 1 week ago, but within the last month
 - ₃ More than 1 month ago, but within the last year
 - ₄ More than 1 year ago

4. On average, about how many hours a week do you use the Internet?
 - ₁ Less than one hour a week
 - ₂ Between 1 hour and 5 hours a week
 - ₃ More than 5 hours, but less than 10 hours a week
 - ₄ 10 hours or more a week

5. Where do you use the Internet? (check all that apply)
 - ₁ Community center
 - ₂ Friend or relative's house
 - ₃ Home
 - ₄ Public library
 - ₅ Work
 - ₆ Other (specify): _____

6. How often have you done the following activities using the Internet in the past year? Please indicate your choice of response by placing an "X" in the appropriate response box.

	Never	Once	Occasionally	Frequently
1. Banking/Money management (e.g., pay bills online, buy or sell stocks)				
2. Communication (e.g., email, instant messaging, blog, twitter)				
3. Community information (e.g., find information about community events or religious services)				
4. Education (e.g., online degree or training program, search for educational courses or materials, use instructional software)				
5. Employment (e.g., post resume or search for information about employment)				
6. Entertainment (e.g., buy tickets, find information about shows, events or hobbies)				
7. Government (e.g., download government forms, find information about benefits and programs)				
8. Health (e.g., find information about an illness, order medication or health product)				

	Never	Once	Occasionally	Frequently
9. News (e.g., find information about the weather, read the newspaper)				
10. Shopping (e.g., buy clothes, search for product information)				
11. Travel (e.g., make reservations, search for maps or travel information)				

APPENDIX C: Heart Disease Fact Questionnaire

FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____ - _____ -- _____ -- _____

ASSESSOR ID: _____

HEART DISEASE FACT QUESTIONNAIRE

Please answer all questions by checking the appropriate boxes.

1. A person always knows when they have heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

2. If you have a family history of heart disease, you are at risk for developing heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

3. The older a person is, the greater their risk of having heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

4. Smoking is a risk factor for heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

5. A person who stops smoking will lower their risk of developing heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

SUBJECT ID: _____ - _____ -- _____ -- _____

6. High blood pressure is a risk factor for heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
7. Keeping blood pressure under control will reduce a person's risk for developing heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
8. High cholesterol is a risk factor for developing heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
9. Eating fatty foods does not affect blood cholesterol levels. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
10. If your "good" cholesterol (HDL) is high you are at risk for heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
11. If your "bad" cholesterol (LDL) is high you are at risk for heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

SUBJECT ID: _____ - _____ -- _____ -- _____

12. Being overweight increases a person's risk for heart disease. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW
13. Regular physical activity will lower a person's chance of getting heart disease. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW
14. Only exercising at a gym or in an exercise class will lower a person's chance of getting heart disease. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW
15. Walking and gardening are considered exercise that will help lower a person's chance of developing heart disease. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW
16. Diabetes is a risk factor for developing heart disease. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW
17. High blood sugar puts a strain on the heart. ₁ ₂ ₃
 TRUE FALSE I DON'T KNOW

SUBJECT ID: _____ - _____ -- _____ -- _____

18. If your blood sugar is high over several months it can cause your cholesterol level to go up and increase your risk of heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
19. A person who has diabetes can reduce their risk of developing heart disease if they keep their blood sugar levels under control. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
20. People with diabetes rarely have high cholesterol. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
21. If a person has diabetes, keeping their cholesterol under control will help to lower their chance of developing heart disease. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
22. People with diabetes tend to have low HDL (good) cholesterol. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW
23. A person who has diabetes can reduce their risk of developing heart disease if they keep their blood pressure under control. ₁ ₂ ₃
TRUE FALSE I DON'T KNOW

SUBJECT ID: _____ - _____ -- _____ -- _____

24. A person who has diabetes can reduce their risk of developing heart disease if they keep their weight under control.

 1 2 3

TRUE

FALSE

I DON'T
KNOW

25. Men with diabetes have a higher risk of heart disease than women with diabetes.

 1 2 3

TRUE

FALSE

I DON'T
KNOW

APPENDIX D: Test of Functional Health Literacy in Adults (TOFHLA)



Test of Functional Health Literacy in Adults

Large Print Version
English, 14 point font

SUBJECT ID: _____

DATE: ____/____/____

ASSESSOR ID: _____

Test of Functional Literacy in Adults
TOFHLA
NUMERACY

HAND PATIENT PROMPT FOR EACH QUESTION. THEN READ EACH QUESTION, AND RECORD RESPONSES. STOP AT THE END OF 10 MINUTES.

PREFACE FIRST QUESTION WITH:

"These are directions you or someone else might be given at the hospital. Please read each direction to yourself. I will ask you some questions about what it means."

PREFACE SUCCEEDING QUESTIONS WITH:

"Have a look at this one" OR "Here is another direction you might be given."

PROMPT 1:

If you take your first tablet at 7:00 am, when should you take the next one?

N-1	
(1)	(0)

And the next one after that?

N-2	
(1)	(0)

What about the last one for the day, when should you take that one?

N-3	
(1)	(0)

PROMPT 2

Could you take that medicine on July 10, 1993?

N-4	
(1)	(0)

PROMPT 3:

If you began taking your medicine Tuesday, when should you take it next?

N-5	
(1)	(0)

What day would you take it after that?

N-6	
(1)	(0)

PROMPT 4

If this were your score, would your blood sugar be normal today?

N-7	
(1)	(0)

PROMPT 5:

When is your next appointment?

N-8	
(1)	(0)

Where should you go?

N-9	
(1)	(0)

PROMPT 6:

How many of those pills should you take?

N-10	
(1)	(0)

PROMPT 7:

How many times can you get that prescription refilled?

N-11	
(1)	(0)

When is the date of issue?

N-12	
(1)	(0)

When is six months from the date of issue?

N-13	
(1)	(0)

PROMPT 8:

If you eat lunch at 12:00 noon, and you want to take this medicine before lunch, what time should you take it?

N-14	
(1)	(0)

If you forgot to take it before lunch, what time should you take it?

N-15	
(1)	(0)

PROMPT 9:

Let's just say the last time you came to the clinic was on Jul 12, 1992. When would you have to reapply for financial aid?

N-16	
(1)	(0)

PROMPT 10:

Let's say that after deductions, your monthly income and other resources are \$1,129. And, let's say you have 3 children. Would you have to pay for your care at that clinic?

N-17	
(1)	(0)

Total Raw Score

--

<p>COMMENTS</p>

Test of Functional Literacy in Adults
TOFHLA
READING COMPREHENSION

HAND PATIENT THE READING COMPREHENSION PASSAGES TO BE COMPLETED. FOLD BACK THE PAGE OPPOSITE THE TEXT SO THAT THE PATIENT SEES ONLY THE TEXT.

PREFACE THE READING COMPREHENSION EXERCISE WITH:

“Here are some other medical instructions that you or anybody might see around the hospital. These instructions are in sentences that have some of the words missing. Where a word is missing, a blank line is drawn, and 4 possible words that could go in the blank appear just below it. I want you to figure out which of those 4 words should go in the blank, which word makes the sentence make sense. When you think you know which one it is, circle the letter in front of that word, and go on to the next one. When you finish the page, turn the page and keep going until you finish all the pages.”

STOP AT THE END OF 12 MINUTES

PASSAGE A: X-RAY PREPARATION

PASSAGE B: MEDICAID RIGHTS AND RESPONSIBILITIES

PASSAGE C: HOSPITAL CONSENT FORM

PASSAGE A

Your doctor has sent you to have a _____ X-ray.

- a. stomach
- b. diabetes
- c. stitches
- d. germs

You must have an _____ stomach when you come for _____.

- | | |
|-----------|--------|
| a. asthma | a. is. |
| b. empty | b. am. |
| c. incest | c. if. |
| d. anemia | d. it. |

The X-ray will _____ from 1 to 3 _____ to do.

- | | |
|---------|-----------|
| a. take | a. beds |
| b. view | b. brains |
| c. talk | c. hours |
| d. look | d. diets |

THE DAY BEFORE THE X-RAY.

For supper have only a _____ snack of fruit, _____ and jelly,

- | | |
|-----------|-----------|
| a. little | a. toes |
| b. broth | b. throat |
| c. attack | c. toast |
| d. nausea | d. thigh |

with coffee or tea.

After _____, you must not _____ or drink

- | | |
|--------------|----------|
| a. minute, | a. easy |
| b. midnight, | b. ate |
| c. during, | c. drank |
| d. before, | d. eat |

anything at _____ until after you have _____ the X-ray.

- | | |
|---------|--------|
| a. ill | a. are |
| b. all | b. has |
| c. each | c. had |
| d. any | d. was |

THE DAY OF THE X-RAY.

Do not eat _____.

- a. appointment.
- b. walk-in.
- c. breakfast.
- d. clinic.

Do not _____, even _____.

- | | |
|-----------|------------|
| a. drive, | a. heart. |
| b. drink, | b. breath. |
| c. dress, | c. water. |
| d. dose, | d. cancer. |

If you have any _____, call the X-ray _____ at 616-4500.

- | | |
|---------------|---------------|
| a. answers, | a. Department |
| b. exercises, | b. Sprain |
| c. tracts, | c. Pharmacy |
| d. questions, | d. Toothache |

PASSAGE B

I agree to give correct information to _____ if I can receive Medicaid.

- a. hair
- b. salt
- c. see
- d. ache

I _____ to provide the county information to _____ any

- | | |
|----------|--------------|
| a. agree | a. hide |
| b. probe | b. risk |
| c. send | c. discharge |
| d. gain | d. prove |

statements given in this _____ and hereby give permission to

- a. emphysema
- b. application
- c. gallbladder
- d. relationship

the _____ to get such proof. I _____ that for

- | | |
|-----------------|----------------|
| a. inflammation | a. investigate |
| b. religion | b. entertain |
| c. iron | c. understand |
| d. county | d. establish |

Medicaid I must report any _____ in my circumstances

- a. changes
- b. hormones
- c. antacids
- d. charges

within _____ (10) days of becoming _____ of the change.

- | | |
|----------|----------|
| a. three | a. award |
| b. one | b. aware |
| c. five | c. away |
| d. ten | d. await |

I understand _____ if I DO NOT like the _____ made on my

- | | |
|---------|---------------|
| a. thus | a. marital |
| b. this | b. occupation |
| c. that | c. adult |
| d. than | d. decision |

case, I have the _____ to a fair hearing. I can _____ a

- | | |
|-----------|------------|
| a. bright | a. request |
| b. left | b. refuse |
| c. wrong | c. fail |
| d. right | d. mend |

hearing by writing or _____ the county where I applied.

- a. counting
- b. reading
- c. calling
- d. smelling

If you _____ TANF for any family _____, you will have to

- | | |
|----------|--------------|
| a. wash | a. member, |
| b. want | b. history, |
| c. cover | c. weight, |
| d. tape | d. seatbelt, |

_____ a different application form. _____, we will use

- | | |
|-----------|-------------|
| a. relax | a. Since, |
| b. break | b. Whether, |
| c. inhale | c. However, |
| d. sign | d. Because, |

the _____ on this form to determine your _____.

- | | |
|-----------|-------------------|
| a. lung | a. hypoglycemia. |
| b. date | b. eligibility. |
| c. meal | c. osteoporosis. |
| d. pelvic | d. schizophrenia. |

PASSAGE C

It has been explained to _____ that during the course of the

- a. my
- b. me
- c. he
- d. she

_____ or procedure, unforeseen conditions may be _____

- | | |
|--------------|--------------|
| a. syphilis | a. revealed |
| b. hepatitis | b. depressed |
| c. colitis | c. directed |
| d. operation | d. notified |

that necessitate an extension of the _____ procedure(s) or

- a. appendix
- b. another
- c. original
- d. addict

different procedure(s) than those _____ forth in paragraph 2.

- a. get
- b. set
- c. see
- d. go

I, therefore, _____ and request that the above named

- a. exercise
- b. authorize
- c. energize
- d. pressurize

_____, his assistants or attending physicians _____ such

- | | |
|---------------|------------|
| a. infection, | a. perform |
| b. pregnant, | b. smear |
| c. insurance, | c. onset |
| d. physician, | d. stress |

procedures as are necessary and _____ in the exercise of professional judgment.

- undesirable
- emergency
- desirable
- diagnosis

The authority _____ under this Paragraph 3 shall _____

- | | |
|------------|------------|
| a. granted | a. pretend |
| b. treated | b. extend |
| c. tested | c. recede |
| d. X-rayed | d. proceed |

to treating all conditions that _____ treatment and are not known

- reason
- refer
- require
- relate

_____ the time the operation or _____ is commenced.

- | | |
|-------|----------------|
| a. us | a. cholesterol |
| b. be | b. menopause |
| c. or | c. gonorrhea |
| d. at | d. procedure |

TOFHLA Numeracy
14 point font - English

Prescription Bottle Labels and Prompts
(to be laminated)

The prescription bottle labels for items 1, 2, 3, 6, 7, & 8 should be duplicated, cut to size, laminated, and taped on an actual prescription bottle that can be handed to the patient to read.

The prompts for items 4, 5, 9, & 10 should be duplicated on card stock (heavy paper), cut to size, and laminated to be handed to the patient to read.

1. GARFIELD IM 16 Apr 93
FF941858 Dr. LUBIN, MICHAEL

PENICILLIN VK
250MG 40/0
Take one tablet by mouth four
times a day

02 (4 of 40)

2. GARFIELD IM 16 Apr 92
FF941861 Dr. LUBIN, MICHAEL

AMOXICILLIN LIQ
125MG/5ML 15OML 1/0

Refrigerate-Shake well; discard
after March 15, 1993

02 12 (1 of 1)

3. GARFIELD IM 16 Apr 93
FF941860 Dr. LUBIN, MICHAEL

METHOTREXATE
2.5 MG 10/0

Take every third day.

08 11 14 31 (1 out of 10)

6. GARFIELD IM 16 Apr 93
FF941860 Dr. LUBIN, MICHAEL

TETRACYCLINE
250 MG 40/0

Important: Finish all this
medication unless otherwise
directed by prescriber

02 03 04 11 31 (4 of 40)

7. GARFIELD IM 28 Dec 92
FF941857 Dr. LUBIN, MICHAEL

PHENOBARBITAL
30 MG 90/2

After two refills or six months
from date of issue, this
prescription can only be refilled
by authority of physician.
(2 refills)

01 08 (9 of 90)

8. GARFIELD IM 16 Apr 93
FF941862 Dr. LUBIN, MICHAEL

DOXYCYCLINE

100 MG 20/0

Take medication on empty
stomach one hour before or
two to three hours after a
meal unless otherwise
directed by your doctor.

02 11 (0 of 20)

4. Normal blood sugar is 60 - 150.

Your blood sugar today is 160.

5.

CLINIC APPOINTMENT

CLINIC: Diabetic

LOCATION: 3rd floor
a.m.DAY: Thurs. DATE: April 2ndHOUR: 10:20
p.m.

Issued by

YOU MUST BRING YOUR PLASTIC CARD WITH YOU

9. For clinic care, you only must apply once each six months.

10. You can get care at no cost if after deductions your monthly income and other resources are less than:

\$ 581 for a family of one	\$ 1,196 for a family of four
\$ 786 for a family of two	\$ 1,401 for a family of five
\$ 991 for a family of three	\$ 1,606 for a family of six.

APPENDIX E: Objective Numeracy Measure

FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____ - _____ -- _____ -- _____

ASSESSOR ID: _____

OBJECTIVE NUMERACY TEST

Please try to answer all of the following questions as best you can. If you cannot answer a question, please leave it blank.

1. Imagine that we roll a fair, six-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, or 6)?

_____ times out of 1,000

2. In the BIG BUCKS LOTTERY, the chance of winning a \$10 prize is 1%. What is your best guess about how many people would win a \$10 prize if 1000 people each buy a single ticket to BIG BUCKS?

_____ person(s) out of 1,000

3. In ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?

_____ %

SUBJECT ID: _____ - _____ -- _____ -- _____

4. Which of the following numbers represents the biggest risk of getting a disease? Please mark an "X" on the line next to your choice.

___ 1 in 100

___ 1 in 1000

___ 1 in 10

5. Which of the following numbers represents the biggest risk of getting a disease? Please mark an "X" on the line next to your choice.

___ 1%

___ 10%

___ 5%

6. If Person A's chance of getting a disease is 1% in ten years, and person B's risk is double that of A's, what is B's risk?

7. If Person A's chance of getting a disease is 1 in 100 in ten years, and person B's risk is double that of A's, what is B's risk?

SUBJECT ID: _____ - _____ -- _____ -- _____

8. If the chance of getting a disease is 10%, how many people would be expected to get the disease:

A. Out of 100?

B. Out of 1000?

9. If the chance of getting a disease is 20 out of 100, this would be the same as having a _____% chance of getting the disease.

10. The chance of getting a viral infection is .0005. Out of 10,000 people, about how many of them are expected to get infected?

APPENDIX F: Subjective Numeracy Measure

FOR CREATE PERSONNEL USE ONLY

DATE: ___/___/___

SUBJECT ID: _____ - _____ -- _____ -- _____

ASSESSOR ID: _____

SUBJECTIVE NUMERACY TEST

For each of the following questions, please check the box that best reflects **how good you are at doing the following things**:

1. How good are you at working with fractions?

 1 2 3 4 5 6

Not at all
good

Extremely
good

2. How good are you at working with percentages?

 1 2 3 4 5 6

Not at all
good

Extremely
good

3. How good are you at calculating a 15% tip?

 1 2 3 4 5 6

Not at all
good

Extremely
good

SUBJECT ID: _____ - _____ -- _____ -- _____

4. How good are you at figuring out how much a shirt will cost if it is 25% off?

 1

 2

 3

 4

 5

 6

Not at all
good

Extremely
good

For each of the following questions, please check the box that **best reflects your answer**:

5. When reading the newspaper, how **helpful** do you find tables and graphs that are parts of a story?

 1

 2

 3

 4

 5

 6

Not at all
helpful

Extremely
helpful

6. When people tell you the chance of something happening, do you prefer that they use **words** (e.g., “it rarely happens”) or **numbers** (e.g., “there is a 1% chance”)?

 1

 2

 3

 4

 5

 6

Always
prefer
words

Always
prefer
numbers

SUBJECT ID: _____ - _____ -- _____ -- _____

7. When you hear a weather forecast, do you prefer predictions using **percentages** (e.g., “there will be a 20% chance of rain today”) or predictions using only **words** (e.g., “there is a small chance of rain today”)?

 1 2 3 4 5 6

Always
prefer
percentages

Always
prefer
words

8. How **often** do you find numerical information to be useful?

 1 2 3 4 5 6

Never

Very Often

APPENDIX G: Day 1 Testing Booklet

DAY 1 TESTING



FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____ - _____ - _____ - _____

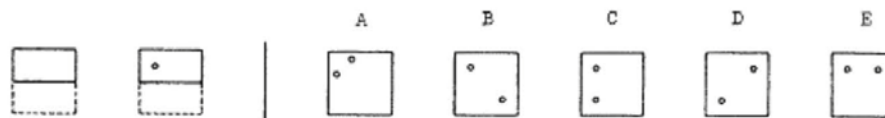
ASSESSOR ID: _____

THIS PAGE IS LEFT BLANK INTENTIONALLY

Paper Folding Test

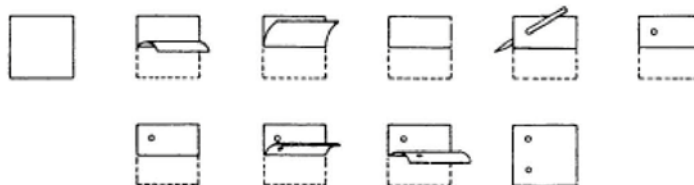
In this test you are to imagine the folding and unfolding of pieces of paper. In each problem in the test there are some figures drawn at the left of a vertical line and there are others drawn at the right of the line. The figures at the left represent a square piece of paper being folded, and the last of these figures has one or two small circles drawn on it to show where the paper has been punched. Each hole is punched through all the thicknesses of paper at that point. One of the five figures at the right of the vertical line shows where the holes will be when the paper is completely unfolded. You are to decide which one of these figures is correct and draw an X through that figure.

Now try the sample problem below. (In this problem only one hole was punched in the folded paper.)



The correct answer to the sample problem above is C and so it should have been marked with an X. The figures below show how the paper was folded and why C is the correct answer.

In these problems all of the folds that are made are shown in the figures at the left of the line, and the paper is not turned or moved in any way except to make the folds shown in the figures. Remember, the answer is the figure that shows the positions of the holes when the paper is completely unfolded.



Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have 3 minutes for each of the two parts of this test. Each part has 1 page. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

THIS PAGE IS LEFT BLANK INTENTIONALLY


Part 1 (3 minutes)

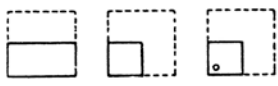
					A	B	C	D	E
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									


DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO **STOP.**


THIS PAGE IS LEFT BLANK INTENTIONALLY

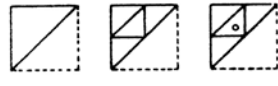
Part 2 (3 minutes)

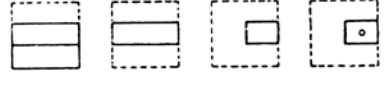
11 


12 

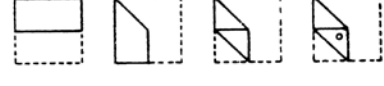
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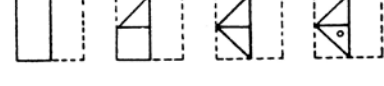
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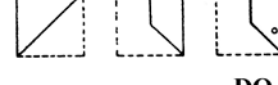
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

















































16 

17 

18 

19 

20 

A	B	C	D	E
				
				
				
				
				
				
				
				
				
				

**DO NOT GO BACK TO PART 1, AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO. STOP**

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Cube Comparison Test

Wooden blocks such as children play with are often cubical with a different letter, number, or symbol on each of the six faces (top, bottom, four sides). Each problem in this test consists of drawings of pairs of cubes or blocks of this kind. Remember, there is a different design, number, or letter on each face of a given cube or block. Compare the two cubes in each pair below.

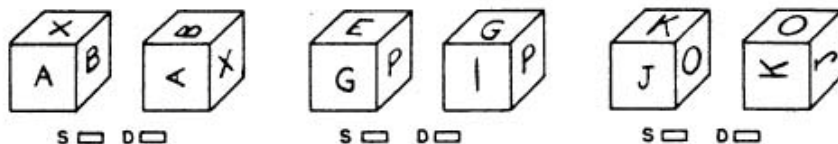


The first pair is marked D because they must be drawings of different cubes. If the left cube is turned so that the A is upright and facing you, the N would be to the left of the A and hidden, not to the right of the A as is shown on the right hand member of the pair. Thus, the drawings must be of different cubes.

The second pair is marked S because they could be drawings of the same cube. That is, if the A is turned on its side the X becomes hidden, the B is now on top, and the C (which was hidden) now appears. Thus the two drawings could be of the same cube.

Note: No letters, numbers, or symbols appear on more than one face of a given cube. Except for that, any letter, number or symbol can be on the hidden faces of a cube.

Work the three examples below.



The first pair immediately above should be marked D because the X cannot be at the peak of the A on the left hand drawing and at the base of the A on the right hand drawing. The second pair is "different" because P has its side next to G on the left hand cube but its top next to G on the right hand cube. The blocks in the third pair are the same, the J and K are just turned on their side, moving the O to the top.

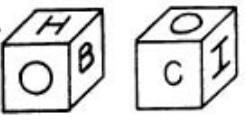
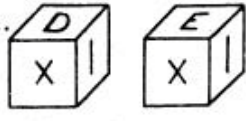
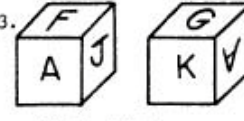
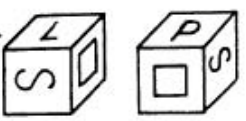
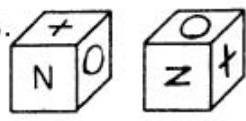
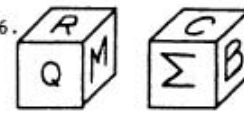
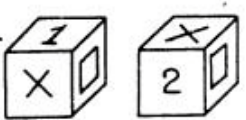
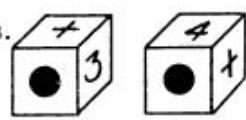
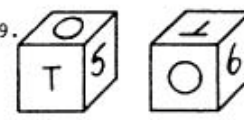
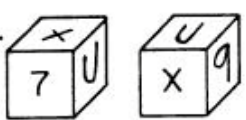
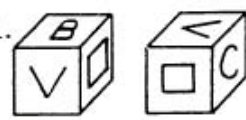
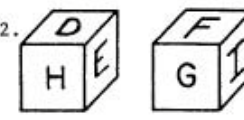
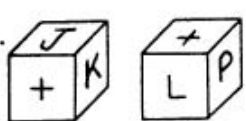
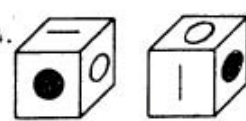
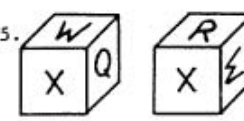

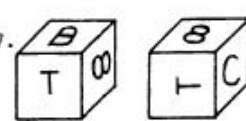
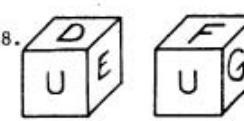


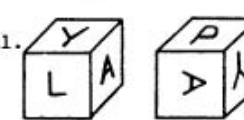
Your score on this test will be the number marked correctly minus the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you have some idea which choice is correct. Work as quickly as you can without sacrificing accuracy.

You will have 3 minutes for each of the two parts of this test. Each part has one page. When you have finished Part 1, STOP.

DO NOT TURN THE PAGE UNTIL YOU ARE ASKED TO DO SO.

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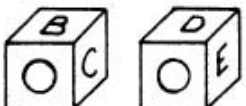
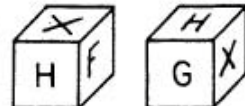
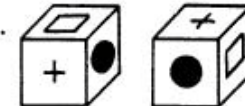
Part I (3 minutes)

1.  2.  3. 
4.  5.  6. 
7.  8.  9. 
10.  11.  12. 
13.  14.  15. 
16.  17.  18. 
19.  20.  21. 

DO NOT GO ON TO THE NEXT PAGE UNTIL ASKED TO DO SO **STOP**.

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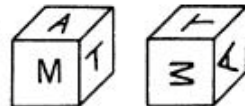
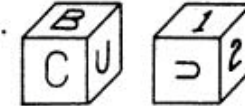
Part 2 (3 minutes)

22.  23.  24. 

S D

S D

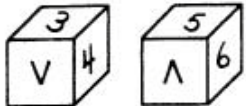
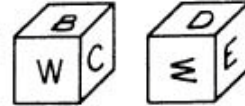
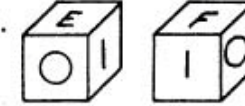
S D

25.  26.  27. 

S D

S D


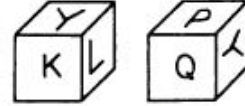

S D

28.  29.  30. 

S D

S D

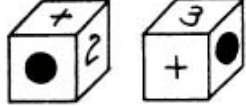
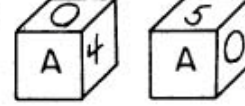

S D

31.  32.  33. 

S D

S D




S D

34.  35.  36. 

S D

S D




S D

37.  38.  39. 

S D

S D

S D

40.  41.  42. 

S D

S D

S D

**DO NOT GO BACK TO PART 1 AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO**

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Letter Sets Test

Each problem in this test has five sets of letters with four letters in each set. Four of the sets of letters are alike in some way. You are to find the rule that makes these four sets alike. The fifth letter set is different from them and will not fit this rule. Draw an X through the set of letters that is different.

NOTE: The rules will not be based on the sounds of sets of letters, the shapes of letters, or whether letter combinations form words or parts of words.

Examples:

A.	NOPQ	DEFL	ABCD	HIJK	UVWX
B.	NLIK	PLIK	QLIK	THIK	VLIK

In Example A, four of the sets have letters in alphabetical order. An X has therefore been drawn through DEFL. In Example B, four of the sets contain the letter L. Therefore, an X has been drawn through THIK.

Your score on this test will be the number of problems marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the letter sets.

You will be allowed 7 minutes for each of the two parts of this test. Each part has 1 page. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

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Part 1 (7 minutes)

- | | | | | | |
|-----|------|------|------|------|------|
| 1. | QPPQ | HGHH | TTTU | DDDE | MLMM |
| 2. | BCDE | FGHI | JKLM | PRST | VWXY |
| 3. | BVZC | FVZG | JVZK | PWXQ | SVZT |
| 4. | BCEF | FGIJ | STWX | CDFG | PQST |
| 5. | BCCB | GFFG | LMML | QRRQ | WXXW |
| 6. | AAPP | CCRR | QQBB | EETT | DDSS |
| 7. | ABDC | EGFH | IJLK | OPRQ | UVXW |
| 8. | CERT | KMTV | FHXZ | BODQ | HJPR |
| 9. | PABQ | SEFT | VIJW | COPD | FUZG |
| 10. | CFCR | JCVC | CGCS | CLXC | KCWC |
| 11. | XDBK | TNLL | VEGV | PFCC | ZAGZ |
| 12. | CAEZ | CEIZ | CIOZ | CGVZ | CAUZ |
| 13. | VEBT | XGDV | ZIFX | KXVH | MZXJ |
| 14. | AFBG | EJFK | GKHM | PSQT | RWSX |
| 15. | KGDB | DFIM | KIFB | HJMQ | LHEC |

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Part 2 (7 minutes)

16.	ABCX	EFGX	IJKX	OPQX	UVWZ
17.	LNLV	DTFL	CLNL	HRLL	LLWS
18.	ABCE	EFGI	IJKM	OPQT	UVWY
19.	GFFG	DCCD	STTS	RQQR	MLLM
20.	DCDD	HGHH	MMLM	QQQR	WWVW
21.	FEDC	MKJI	DCBA	HGFE	JIHG
22.	BDBB	BFDB	BHBB	BBJB	BBLB
23.	BDCE	FHGI	JLKM	PRQS	TVWU
24.	BDEF	FHIJ	HJKL	NPQR	SVWX
25.	NABQ	PEFS	RIJV	GOPK	CUWG
26.	DEGF	KLHJ	NOQP	PQSR	TURS
27.	AOUI	CTZR	JHTN	PBRL	RTVH
28.	BEPW	HJTX	KNRZ	KOSV	WREM
29.	RRBR	QQAR	FTEF	JXIJ	SSCS
30.	QIFB	CGIJ	BCOR	ZRED	JIFC

**DO NOT GO BACK TO PART 1 AND
DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.**

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SHIPLEY INSTITUTE OF LIVING SCALE**Instructions:**

In the test below, the first word in each line is printed in capital letters. Opposite it are four other words. Circle the *one word* which means the *same thing*, or most nearly the same thing, as the first word. If you don't know, guess. Be sure to circle the *one word* in each line that means the same thing as the first word.

EXAMPLE:

LARGE red big silent wet

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

1)	TALK	draw	eat	speak	sleep
2)	PERMIT	allow	sew	cut	drive
3)	PARDON	forgive	pound	divide	tell
4)	COUCH	pin	eraser	sofa	glass
5)	REMEMBER	swim	recall	number	defy
6)	TUMBLE	drink	dress	fall	think
7)	HIDEOUS	silvery	tilted	young	dreadful
8)	CORDIAL	swift	muddy	leafy	hearty
9)	EVIDENT	green	obvious	skeptical	afraid
10)	IMPOSTOR	conductor	officer	book	pretender
11)	MERIT	deserve	distrust	fight	separate
12)	FASCINATE	welcome	fix	stir	enchant
13)	INDICATE	defy	excite	signify	bicker
14)	IGNORANT	red	sharp	uninformed	precise
15)	FORTIFY	submerge	strengthen	vent	deaden
16)	RENOWN	length	head	fame	loyalty
17)	NARRATE	yield	buy	associate	tell
18)	MASSIVE	bright	large	speedy	low
19)	HILARITY	laughter	speed	grace	malice
20)	SMIRCHED	stolen	pointed	remade	soiled

GO TO THE NEXT PAGE

21)	SQUANDER	tease	belittle	cut	waste
22)	CAPTION	drum	ballast	heading	ape
23)	FACILITATE	help	turn	strip	bewilder
24)	JOCOSE	humorous	paltry	fervid	plain
25)	APPRISE	reduce	strew	inform	delight
26)	RUE	eat	lament	dominate	cure
27)	DENIZEN	senator	inhabitant	fish	atom
28)	DIVEST	dispossess	intrude	rally	pledge
29)	AMULET	charm	orphan	dingo	pond
30)	INEXORABLE	untidy	involatile	rigid	sparse
31)	SERRATED	dried	notched	armed	blunt
32)	LISSOM	moldy	loose	supple	convex
33)	MOLLIFY	mitigate	direct	pertain	abuse
34)	PLAGIARIZE	appropriate	intend	revoke	maintain
35)	ORIFICE	brush	hole	building	lute
36)	QUERULOUS	maniacal	curious	devout	complaining
37)	PARIAH	outcast	priest	lentil	locker
38)	ABET	waken	ensue	incite	placate
39)	TEMERITY	rashness	timidity	desire	kindness
40)	PRISTINE	vain	sound	first	level

STOP

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

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Number Comparison Test

This is a test to find out how quickly you can compare two numbers and decide whether or not they are the same. If the numbers are the same, go on to the next pair, making no mark on the page. If the numbers are not the same, put an X on the line between them. Several examples are given below with the first few marked correctly. Practice for speed on the others.

659 ____ 659	7343801 ____ 7343801
73845 <u>X</u> 73855	18824 ____ 18824
1624 ____ 1624	705216831 ____ 795216831
438 <u>X</u> 436	971 ____ 971
4821459 ____ 4814259	446014721 ____ 446014721
658331 ____ 656331	5173869 ____ 5172869
11653 ____ 11652	6430017 ____ 6430017
617439428 ____ 617439428	518198045 ____ 518168045
1860439 ____ 1860439	55179 ____ 55097
90776105 ____ 90716105	63216067 ____ 63216057

Your score will be the number marked correctly minus the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you have some idea whether or not the numbers are the same.

You will have 1½ minutes for each of the two parts of this test. Each part has one page. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

STOP

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

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Part 1 (1½ minutes)

Make an X on the line between the numbers that are not the same.

639 ___ 639	414982 ___ 415982
4714306 ___ 4715306	60971 ___ 60971
65382 ___ 65372	16253948 ___ 16253948
710 ___ 710	42018591760 ___ 43018591760
43210573 ___ 43210573	647107569 ___ 647107569
6182653905221 ___ 6182653905221	721532992531 ___ 721582992531
43270105338 ___ 43276105338	341798301 ___ 341798701
27109816843 ___ 27109816853	80537051248 ___ 80537051248
519605 ___ 519605	5911306581491 ___ 5911306581491
923452170687 ___ 923452170687	83614081 ___ 83614081
370543141 ___ 310543141	49471307 ___ 47471307
2570665292 ___ 2570665292	6082649875 ___ 6082647875
32018591670 ___ 32018691670	5930582136 ___ 5730582136
5471075693 ___ 5471075683	236031794137 ___ 236031294137
621532992531 ___ 621582992531	805731195 ___ 805131195
24179830 ___ 24179830	48210435512 ___ 48210435612
70537051248 ___ 70537057248	405176841309 ___ 405176841309
7361408 ___ 7361708	80145349786 ___ 80145349796
39471307 ___ 39471507	53210573 ___ 53210573
508264987503 ___ 508264987503	718265390521 ___ 718265390521
4930582136 ___ 4930582136	5327010538 ___ 5327010538
136031794137 ___ 136031794137	37109816843 ___ 37189816843
705731195 ___ 705736195	619605 ___ 619505
38210435512 ___ 38210535512	123452170687 ___ 123452190687

STOP

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

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Part 2 (1½ minutes)

Make an X on the line between the numbers that are not the same.

7573 ___ 7573	289414 ___ 289414
347820 ___ 349820	17906 ___ 17906
4951 ___ 4951	16719581024 ___ 16719581024
4573043 ___ 4571043	16719581024 ___ 16719581024
37501243 ___ 37501243	3965701746 ___ 3665701746
125093562816 ___ 125093562816	135299235127 ___ 135299235127
8350107234 ___ 8350107234	13897143 ___ 13897145
34861890172 ___ 3486170172	84215073508 ___ 84216073508
506915 ___ 596915	941856031195 ___ 941856431195
786071254329 ___ 786071255329	8041638 ___ 8041438
41345073 ___ 41345073	70317494 ___ 70317494
925660752 ___ 925660752	35789462806 ___ 35789562806
16719581023 ___ 16717581023	6312850395 ___ 6312850795
3965701745 ___ 3965701745	731497130632 ___ 731497130632
135299235126 ___ 135299235136	591137508 ___ 591167508
13897142 ___ 13897142	21553401284 ___ 21553401284
84215073506 ___ 84215073507	1251373807 ___ 1251373307
941856031194 ___ 941846031194	903148671504 ___ 903148671504
8041637 ___ 8071637	68794353108 ___ 68754354108
70317493 ___ 70317493	37501235 ___ 37501235
35789462805 ___ 35789462805	125093562817 ___ 125093562817
6312850394 ___ 6312850394	8350107235 ___ 8350107235
731497130631 ___ 731497130681	34861890173 ___ 34861840173
591137507 ___ 591127507	506916 ___ 506616

STOP

PLEASE DO NOT TURN THE PAGE UNTIL INSTRUCTED TO DO SO.

APPENDIX H: Day 2 Testing Booklet

DAY 2 TESTING



FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____

ASSESSOR ID: _____

Note:

1. Staple this booklet after the administration of the testing
2. Make sure to include the following (total 18 pages):
 - ◆ Cover page (1 page)
 - ◆ Vision (1 page)
 - ◆ MMSE (6 pages)
 - ◆ Trail making A & B (4 pages)
 - ◆ Digit symbol (1 page)
 - ◆ Stroop Color & Word Test (4 pages)
 - ◆ Animal Fluency (1 page)

Vision

Near: _____

Far: _____

Mini-Mental Status Examination

ORIENTATION

(Write down participant's answer. Score 1 point for each correct response)

1. What year is it? _____
2. What season is it? _____
3. What is the day of the month? _____
4. What day of the week is it? _____
5. What month is it? _____

SCORE _____ (Maximum score = 5 points)

(Write down participant's answer. Score 1 point for each correct response)

6. What state are we in? _____
7. What county are we in? _____
8. What city are we in? _____
9. What building are we in right now? _____
10. What floor are we on? _____

SCORE _____ (Maximum score = 5 points)

REGISTRATION

11. **I am going to name three objects, and I would like you to repeat them after me "Apple," "Table," "Penny"** (say the 3 words, taking 1 second to say each).

(Write down participant's answer for the FIRST trial. Score 1 point for each correct response. Only the score for the first trial should be scored. Repeat the words until the subject learns all 3 words for a maximum of 6 trials. If the words are not learned, score as a 7 to indicate that the subject never learned the words)

First trial a. _____ b. _____ c. _____

Number of trials _____

SCORE _____ (Maximum score = 3 points)

Score as "7" when not learned, and do not add it when computing the Total score for the test.

ATTENTION AND CALCULATION

12. **I am going to ask you to do some subtraction. Think of number 7. I want you to start from 100 and count backwards by 7 until I tell you to stop.** (Stop after 5 subtractions).

(Score 1 point for each correct subtraction. Enter the numbers given by the subject below, with the scoring of 1 or 0 in parenthesis)

Start from 100,

_____()
 _____()
 _____()
 _____()
 _____()

SCORE A _____ (Maximum score = 5 points)

(Alternate—only if subject can not, or will not perform calculation:)

Please spell "world" backwards.

(Score 1 point for each letter in the correct order. Write down what the subject says verbatim)

SCORE B _____ (Maximum score = 5 points)

(Only the highest of these two scores A or B will become a part of the total score)

SCORE A OR B _____ (Maximum score = 5 points)

RECALL

13. **Do you remember that a few minutes ago I asked you to repeat the name of three objects after me? Can you tell me what they were?**

(Write down participant's answer. Score 1 point for each correct recall)

a. _____ b. _____ c. _____

SCORE ____ (Maximum score = 3 points)

LANGUAGE

14. Hold a wooden pencil where the patient can clearly see it, say:
What is this?
SCORE _____ (1 point)
15. Hold a wristwatch, most preferably worn on the wrist, and say:
What is this?
SCORE _____ (1 point)
16. **Repeat the phrase: "No 'ifs', 'ands', or 'buts'."** (One trial only)
SCORE _____ (1 point)
17. **I am going to ask you to do something for me. Listen carefully because I can only say it once.**

Take this paper in your right hand	Score A _____
Fold it in half	Score B _____
Put it on your lap	Score C _____

(Score 1 point for each stage. Total for Scores A, B, and C for a Maximum Score = 3; 1 point per command)
SCORE _____ (Maximum score = 3)

18. **I want you to read this card and do what it says.**
(Show the subject the phrase, "CLOSE YOUR EYES" written on either an unlined paper or printed on a card)
SCORE _____ (1 point)

19. **Now, please write any sentence you want on this sheet of paper.**
(Sentence must contain a subject and a verb, and make sense)
SCORE _____ (1 point)

20. **Please copy this design for me exactly as it is.**
(Show subject the intersecting pentagons. Give 1 point if all sides and angles are preserved and if the intersecting sides form a quadrangle.)
SCORE _____ (1 point)

NOTE: The Total Score is the sum of the score for all the items. These scores appear next to the line, SCORE underlined to avoid confusion with the multiple trial ones.

TOTAL SCORE _____ (30 points possible)

21. Did the subject show any signs of illiteracy or physical impairments that would hinder performance on any of the items of this test?

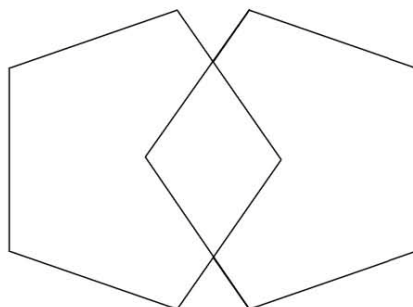
1	()	Yes
2	()	No

If Yes, Explain. (Write the item numbers and elaborate).

Notes:

CLOSE YOUR EYES

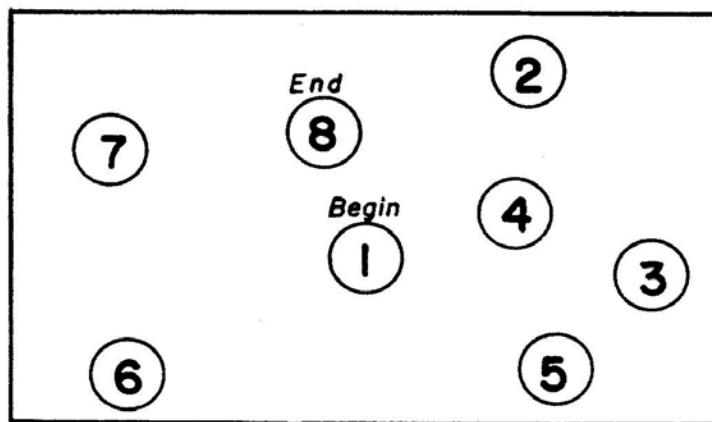
Copy this Design:

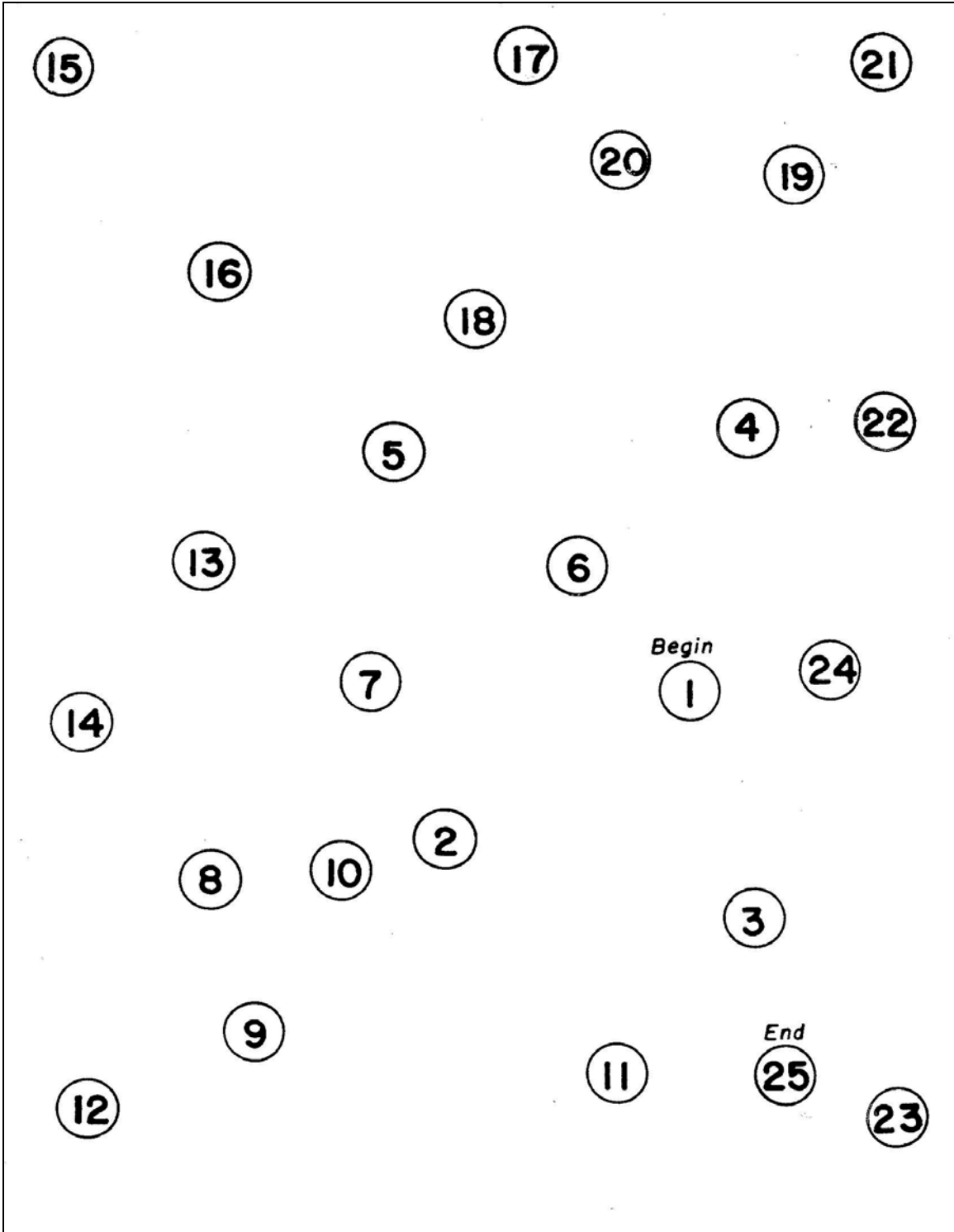


TRAIL MAKING

Part A

SAMPLE

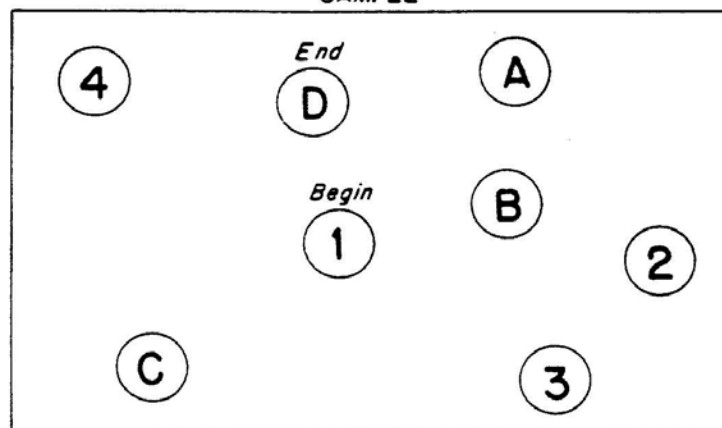


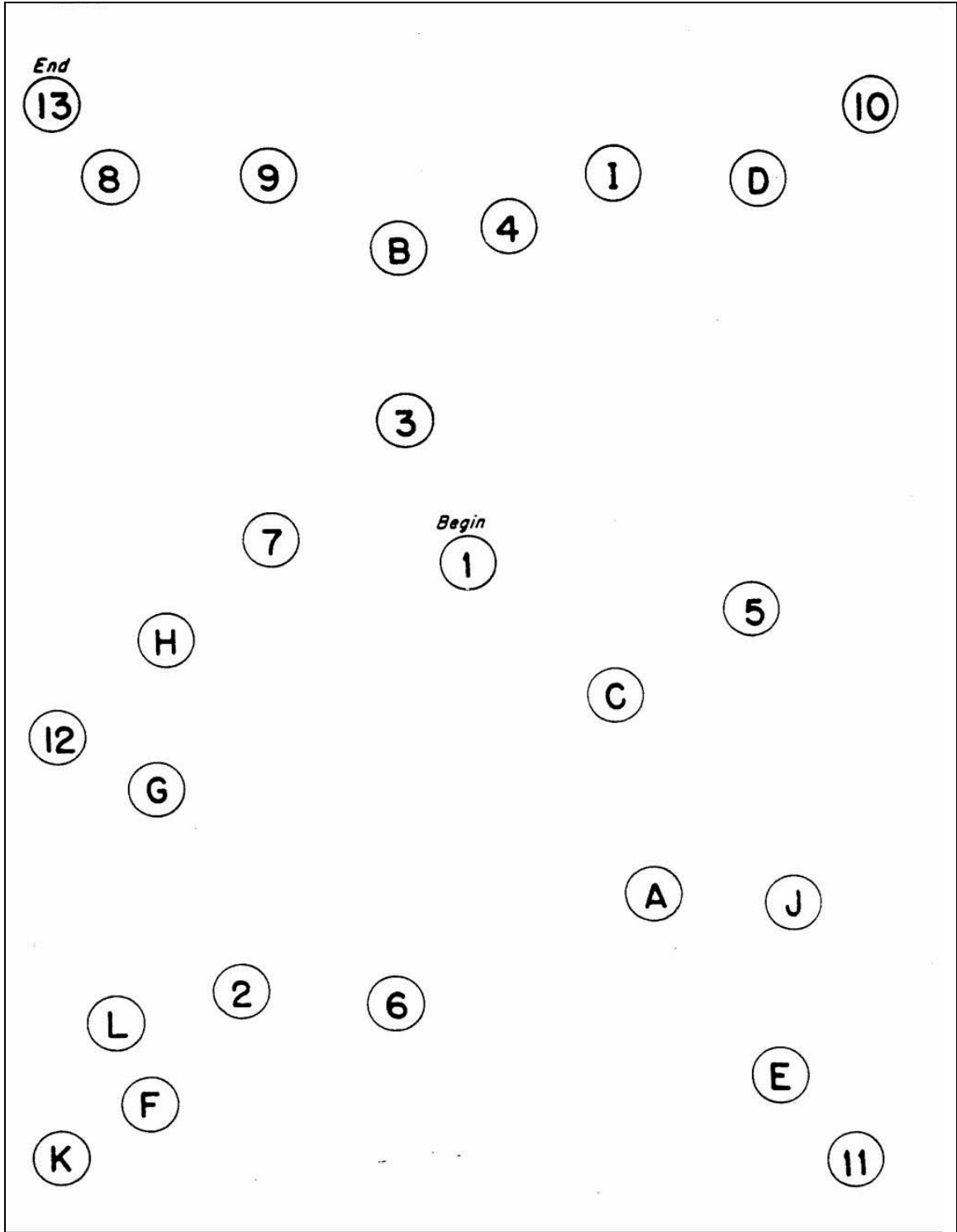


TRAIL MAKING

Part B

SAMPLE





STROOP SPAN RESPONSE SHEET

- For Yes/No decision, print Y for "Yes" and N for "No"
- For Color Recall, print:
R for "Red" – Y for "Yellow" – B for "Blue" – G for "Green"
- Answers in parentheses for the practice trials (see Stroop Span Scoring document for the correct answers for experimental trials)

PRACTICE 1:

Task	Trial 1	Additional Trials-only if less than 6 correct responses in Trial 1; repeat until at least 6 correct responses in a trial.	Trial 2	Trial 3
Yes/No	(Y)		(Y)	(Y)
Yes/No	(N)		(N)	(N)
Yes/No	(Y)		(Y)	(Y)
Yes/No	(Y)		(Y)	(Y)
Yes/No	(N)		(N)	(N)
Yes/No	(N)		(N)	(N)
Yes/No	(Y)		(Y)	(Y)
Yes/No	(N)		(N)	(N)

PRACTICE 2:

Task	Trial 1	Trial 2	Trial 3
Yes/No	(N)	(Y)	(N)
COLOR RECALL	(B)	(G)	(B)

Additional Trials-only if fewer than 2 trials correct. Repeat until at least 2 correct trials.

Task	Trial 4	Trial 5	Trial 6
Yes/No	(N)	(Y)	(N)
COLOR RECALL	(B)	(G)	(B)
Task	Trial 7	Trial 8	Trial 9
Yes/No	(N)	(Y)	(N)
COLOR RECALL	(B)	(G)	(B)

PRACTICE 3:

Task	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Yes/No	(Y)	(N)	(Y)	(Y)	(N)
Yes/No	(N)	(N)	(N)	(N)	(N)
COLOR RECALL	(G)	(G)	(Y)	(G)	(G)
COLOR RECALL	(B)	(R)	(B)	(B)	(R)

Additional Trials-only if fewer than 2 trials correct. Repeat until at least 2 correct trials.

Task	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
Yes/No	(Y)	(N)	(Y)	(Y)	(N)
Yes/No	(N)	(N)	(N)	(N)	(N)
COLOR RECALL	(G)	(G)	(Y)	(G)	(G)
COLOR RECALL	(B)	(R)	(B)	(B)	(R)
Task	Trial 11	Trial 12	Trial 13	Trial 14	Trial 15
Yes/No	(Y)	(N)	(Y)	(Y)	(N)
Yes/No	(N)	(N)	(N)	(N)	(N)
COLOR RECALL	(G)	(G)	(Y)	(G)	(G)
COLOR RECALL	(B)	(R)	(B)	(B)	(R)

EXPERIMENTAL TRIALS:

Level	Task	Trial 1	Trial 2	Trial 3
1	YES/NO			
	COLOR RECALL			
2	YES/NO			
	YES/NO			
	COLOR RECALL			
	COLOR RECALL			
3	YES/NO			
	YES/NO			
	YES/NO			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
4	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			

Level		Trial 1	Trial 2	Trial 3
5	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
6	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	YES/NO			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			
	COLOR RECALL			

Stroop Score = _____

Span Score = _____

ANIMAL FLUENCY: English Version**INSTRUCTIONS:**

- I. "Now we are going to do something a little bit different. I want you to tell me as many **ANIMALS** as you can. Ready? Begin." (Allow 60 seconds).

15	
30	
45	
60	

TOTAL = _____

APPENDIX I: Usability Questionnaire

FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____ - _____ -- _____ -- _____

ASSESSOR ID: _____

USABILITY QUESTIONNAIRE

For each of the following statements, please check the box that best reflects in **general** how you feel about using a patient portal like the one you used today to perform health management tasks (for example, reviewing test and lab results, scheduling a doctor's appointment, or looking for information about a medical condition):

1. A patient portal would help me to perform health management tasks more quickly.

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

2. A patient portal would improve my ability to perform health management tasks.

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

SUBJECT ID: _____ - _____ -- _____ -- _____

3. A patient portal would allow me to get information that would help me understand issues related to my health.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

4. A patient portal would help me to perform a greater number of health management tasks than I currently do.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

5. I would feel comfortable using a patient portal to communicate with my doctor.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

6. I would have concerns about privacy related to my health information when using a patient portal.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

SUBJECT ID: _____ - _____ -- _____ -- _____

7. A patient portal would be useful to me.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

For each of the following statements, please check the box that best reflects how you feel about **the experience you just had** using the patient portal.

1. I thought it was difficult to locate the information that I needed within the patient portal.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

2. I thought the language used in the health information websites that I accessed through the patient portal (for example, WebMD) was confusing.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

3. I thought it was difficult to navigate within the patient portal—I was getting lost.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

SUBJECT ID: _____ - _____ -- _____ -- _____

4. I thought that the font/size of the text used in the patient portal was too small.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

5. I thought it was easy to use the patient portal to find information about my next doctor's appointment.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

6. I thought that the numerical tables (for example, the glucose tables) used in the patient portal were confusing.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

7. I thought it was easy for me to find the information in the patient portal about my medications.

 1 2 3 4 5

Agree

Somewhat
AgreeNo
OpinionSomewhat
Disagree

Disagree

SUBJECT ID: _____ - _____ -- _____ -- _____

8. I thought the graphs about health risks used in the patient portal were confusing.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

9. I thought the graphs about blood test results used in the patient portal were confusing.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

10. In general, I thought that the information I needed to answer the questions regarding health management tasks was difficult to understand.

 1

 2

 3

 4

 5

Agree

Somewhat
Agree

No
Opinion

Somewhat
Disagree

Disagree

11. If a patient portal like the one you used today was available from your doctor for you to use, would you use it? (Check Yes or No)

 1

Yes

 2

No

APPENDIX J: Computer and Patient Portal Training Script

EMR Study: Computer and Patient Portal Training

Before we begin, I would like to mention that some of the subject matter that we will go through may seem elementary to you. If this is the case, please bear with me as different people have different amounts of computer experience. For our research study, it is important that we provide exactly the same training for everybody.

Basic Computer Training

The first thing we are going to do is go through a short tutorial on how to use a mouse to interact with a computer. I will start the tutorial for you. You just need to read and follow the instructions on each screen. I will be here to help you and to answer any questions that you may have.

(Open <http://create.med.miami.edu/PRISM/mousetraining/index.htm>; close when participant finishes tutorial)

Do you have any questions?

Patient Portal – The Basics

Now let's talk about something called a "patient portal." The word "portal" means "door" or "entrance." A patient portal is like a door for you to see your medical record on the Internet. As you probably know, medical records have always been written on paper and kept in folders in a doctor's office. Now, instead of keeping all of this information on papers in a folder, doctors may be keeping this information stored on a computer. Because these medical records are stored electronically instead of in a paper folder, they are referred to as "electronic medical records."

What a patient portal allows you to do is look at and review some parts of your medical record. These portals also allow you to communicate with your doctor online. Using a patient portal, you can look at test results (such as blood test and x-rays), renew your medications, schedule medical appointments, and send emails to and receive emails from your doctor. A patient portal also contains links

to the Internet so that you can get important health information from trusted sources. Now I am going to show you how a patient portal works.

Normally, a person would be able to see their medical information through a patient portal by going to a website on the Internet and putting in a code. However, today we will not be looking at any of your personal information. Instead, will be using a patient portal that we created, and that contains the medical records of a made-up patient. The way we will get into this portal is simply by opening up a webpage.

(Open <http://create.med.miami.edu/pps>)

Patient Portal Demonstration

The page the portal opens up to is known as the “home page.” You can come back to this page at any time by clicking the picture of the house in the top right corner of any page. When using this patient portal, if you get confused or lost, you may want to use the home button to take you back to the home page. Also, you can always return to the previous page by clicking the “Back” button.

(Show participant the back button)

Do you remember in the computer training we showed you that links are usually identified by a word or series of words that is a different color or underlined? Well, on this page, you’ll see that there are “Links to Useful Information.” The categories are “Diabetes,” “High Blood Pressure,” “Cholesterol,” “Heart Disease,” “Asthma,” and “Cancer.” If you click on “Diabetes,” the link takes you to a page with links to information on diabetes.

(Click on the link to “Diabetes” to show participant)

At the top of this page are links that take you to information about diabetes on the Internet. You can click on any of these links for more information, and the webpage will pop-up on top of your patient portal screen. When you are done with the webpage, you can close it by clicking on the “x” on the top right corner of the screen. You can also click on one of the other categories on the bottom of the screen for links to information about those conditions.

(Click on the link to "High Blood Pressure" to show participant)

When using these links it is important to remember that they are just one feature of the patient's record and that they do not contain any personal information about the patient. These are websites that anyone can visit on the Internet. If you are looking for personal medical information in the record (e.g., test results), the only way for you to access it is through the menu of your personal patient portal. This is the feature we will talk about next.

Do you have any questions?

Let's go back to the home screen by clicking the home icon in the top right corner.

(Click on the home icon)

The menu on the left can take you to more information within your medical record. If you scroll over the top button labeled "My Medical Record," a sub-menu appears with links to the following choices: "Health Summary," "Test Results," "Medications," "Allergies," "Vaccines," "Preventive Care," "Medical History," "Current Health Issues," and "Wallet Card."

There are sub-menus for all of the buttons in the menu that you can see by scrolling over each button.

(Scroll over each button and read sub-menu options to the participant)

I will show you one of the links by putting the cursor over the button that says "My Medical Record" and clicking on "Health Summary."

Not all of the information on a page is always displayed on the screen. Do you recall that in the training we showed you how to scroll? On a page like this one, scrolling lets you see information that is hidden outside the frame of the screen. When using the patient portal, always remember to scroll down to see all of the information on the page.

Do you have any questions?

Patient Portal Practice

Now let's return to the home page by clicking on the house icon and try a couple examples of how you can use the patient portal to answer questions. I will show you how to answer the first example question. Then I will help you while you try the second example question. Finally, you will be able to try a third example by yourself.

(Hand participant the sheet with example problems)

Today you are going to use a fictitious patient health record. You are going to pretend that this fictitious medical record belongs to a patient named Pat, and that you are a relative of Pat. Your objective is to use this patient portal to help Pat manage his/her health.

Look at Example 1 – Does Pat have to take the Lipitor medication with food?

To begin, you would go to the menu on the left side of the screen. Put your cursor over the menu button labeled "My Medical Record." One of the links is labeled "Medications;" click on this link. On this page, you can scroll down and see a list of all of the medications Pat uses. In each prescription, you can see the instructions for taking this medication. The prescription for Lipitor says "1 tablet by mouth nightly." These instructions don't say anything about taking it with food. However, there is also a link labeled "About this medication." If you click on this link, it takes you to a page where you can read more information about this medication. Let's click on this link. You are now in a health reference library which can link you to information about this medication on the Internet. Click on the link. If you scroll down, you'll see there is a section titled "How do I take it?" Here it says you may take it with or without food. You should write under the question for Example 1 – "No, Pat can take it with or without food."

Now let's try Example 2 – What were the results of Pat's last Hemoglobin A1C test?

I am going to walk you through it. Start on the home page by clicking the home icon I described to you earlier. Go to the button on the menu labeled "My

Medical Record.” In the sub-menu, click on the button labeled “Test Results.” Now scroll down until you see the test result for Hemoglobin A1C in the table. Click on that row. Now scroll down and you can see Pat’s result and the standard range for that result. Write your answer on the example sheet in the space provided below the question.

Now you try Example 3 – How many times per day should Pat take the Eltroxin medication?

Try this one on your own. I am here to help you if you get stuck.

Do you have any questions before you begin the tasks?

EXAMPLE 1

Does Pat have to take the Lipitor medication with food?

EXAMPLE 2

What were the results of Pat's last Hemoglobin A1C test?

EXAMPLE 3

How many times per day should Pat take the Eltroxin medication?

APPENDIX K: Response Sheet

FOR CREATE PERSONNEL USE ONLY

DATE: ___ / ___ / ___

SUBJECT ID: _____ - _____ -- _____ -- _____

ASSESSOR ID: _____

Response Sheet

We would like you to use a patient portal of an EMR to find the answers to questions related to information found in a fictitious medical record.

Pretend that this fictitious medical record belongs to a patient named Pat, and that you are a relative of Pat. Your objective is to use this patient portal to help Pat manage his/her health.

Please remember not to enter any personal information in any website that you might find in links you find on the Internet. Also, you do not have to watch any online videos or tutorials to get the answers to any of the following questions.

Please use the space provided below each question to record your answers.

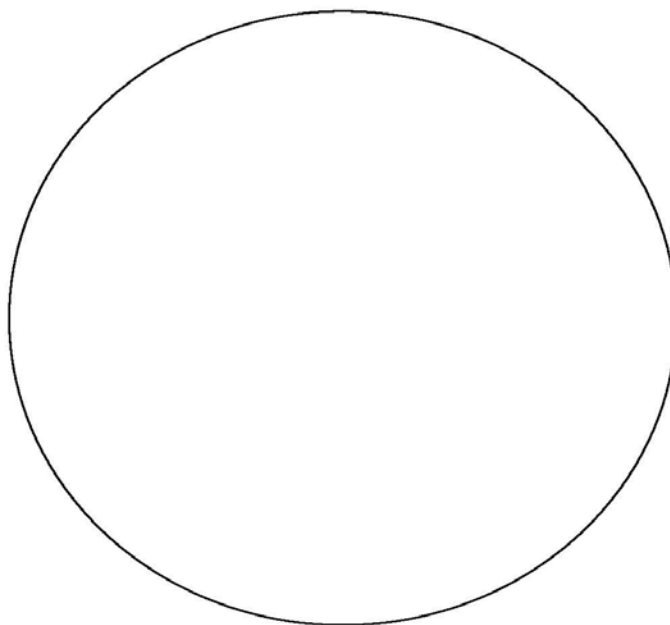
SUBJECT ID: _____ - _____ -- _____ -- _____

Pat has an appointment with a new doctor scheduled soon, but cannot remember the date of the appointment. Fortunately, this information is available for you in the patient portal.

What is the date and time of Pat's next doctor's appointment?

SUBJECT ID: _____ - _____ -- _____ -- _____

Eating a well-balanced diet is an important part of managing Pat's diabetes. Pat's doctor discussed the six steps to create a balanced plate and included a link to this information in Pat's patient portal. Pretend the circle below is a dinner plate. Divide the plate according to the instructions given in the link ("How to Create Your Plate"). Label each section of the plate with the category of food that should be put in that section, and include three examples of foods that belong in that category.



SUBJECT ID: _____ - _____ -- _____ -- _____

Pat discussed with the doctor the importance of closely monitoring glucose levels before and after meals and Pat has been entering this information into the health record. Use the link in the patient portal to the glucose monitoring weekly summary to answer the following questions.

What was Pat's average glucose level after lunch?

Pat's doctor has included in the health record a table of Pat's target glucose levels for before and after meals. Use the information in this table and the information in the glucose monitoring weekly summary to determine if Pat's average glucose levels are on target.

In what range should Pat's glucose level be after meals?

Is Pat's average glucose level after lunch in the range it should be?

SUBJECT ID: _____ - _____ -- _____ -- _____

In addition to eating right and monitoring glucose levels, Pat's doctor has also discussed the importance of taking medications and insulin according to a planned schedule. All of the medications Pat currently takes are listed in the "Medications" section of the patient portal. Use the information found on this page to answer the following questions.

How many times per day should Pat take Metformin?

Pat missed a dose of Metformin and realized that it was missed two hours before the next scheduled dose. What should Pat do?

Pat checks his/her blood sugar just before eating. Pat takes 1 unit of insulin (Apidra injection) for every 10 grams of carbohydrates eaten. Along with basic dosage instructions, Pat's doctor has also included a schedule in the patient portal that indicates the amount of insulin that should be added to the usual dose based upon blood sugar levels. Use the link to the insulin dose schedule to answer the following question.

Pat's blood sugar is 284 and Pat ate 40 grams of carbohydrate at breakfast. How much total insulin does Pat need to take?

SUBJECT ID: _____ - _____ -- _____ -- _____

Having diabetes can increase levels of cholesterol. While cholesterol is important for our bodies, high levels of it in our blood can be very dangerous. The results of Pat's last cholesterol test are available for review in the patient portal.

What are the components reported in the cholesterol test and what were Pat's levels for each component?

SUBJECT ID: _____ - _____ -- _____ -- _____

During Pat's last visit the doctor explained that high blood pressure can lead to health problems such as heart attack, stroke, heart failure and kidney disease. Based upon Pat's personal profile (age, gender, height, weight, and current blood pressure), the doctor created a graph of Pat's estimated risks for these conditions and put the graph in the patient portal of Pat's health record. Use the link to "High Blood Pressure Health Risk Calculator" to view the graph and answer the following questions.

What does the first graph show about Pat's risk of heart failure compared with the normal risk?

Pat's doctor said that the risk for these serious health problems can be lowered by making lifestyle changes. Pat agrees to lose 10 pounds and eat a healthy diet. The difference these lifestyle changes will make in Pat's health risks is seen in the second graph.

What does the second graph show about Pat's risk of heart failure compared with the normal risk?

SUBJECT ID: _____ - _____ -- _____ -- _____

Pat has been getting Complete Blood Count (CBC) tests on a regular basis. These test results are available for review in Pat's patient portal. Please use the CBC results to answer the following questions.

Consider Pat's most recent blood test.

A) Were all of Pat's blood components within the standard range?

B) If not, which components were not within the standard range?

SUBJECT ID: _____ - _____ -- _____ -- _____

The CBC results for Pat's past six blood tests are shown in a graph in the patient portal to allow Pat to see changes that occur over time. Use the link to this graph to answer the following questions.

Has Pat's level of Lymphocytes been increasing or decreasing over time?

Was Pat's level of Monocytes within the standard range during the period from June 1, 2009 to September 1, 2009?

