2014

Age, Performance and Retention Interval Effects on Acceptance of a Consumer Health Information Technology System

Stephen Andrew Ford

Louisiana State University and Agricultural and Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_theses

Part of the Mechanical Engineering Commons

Recommended Citation
https://digitalcommons.lsu.edu/gradschool_theses/1108

This Thesis is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Master's Theses by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
AGE, PERFORMANCE AND RETENTION INTERVAL EFFECTS ON ACCEPTANCE OF A CONSUMER HEALTH INFORMATION TECHNOLOGY SYSTEM

A Thesis
Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College, in partial fulfillment of the requirements for the degree of Master of Science

in
The Department of Mechanical and Industrial Engineering

by
Stephen “Drew” Ford
B.S., Louisiana Tech University, 2008
B.S., Louisiana Tech University, 2009
December 2014
ACKNOWLEDGMENTS

I would like to extend my sincerest thanks to my assistants Briana Saul, Sara Wren and Patricia Wyatt. Without their help in collecting data, recruiting and working with subjects and data entry, this thesis would never have reached completion.

I would also like to thank my classmates, colleagues, and dearest friends Kyle, Cristina, Heath, Ram, Manouj, Saif, Sid, and Nai. We slogged through the classrooms and many late night study sessions, but we did so together and without their support and friendship, graduate school would not have held the precious moments and memories that are so dear to me. Thank you for your continued support both academically and in life.

I would also like to thank my committee members Dr. Fereydoun Aghazadeh, for your help and guidance upon my arrival to LSU. Dr. Craig Harvey, for your class on computer human interaction which piqued my interest and led me to the career I have and love today. And finally, to my advisor, Dr. Laura Ikuma for her unwavering support and assistance through numerous edits, revisions, and tight deadlines. Without her help, this document would certainly not be what it is. Thank you all.

Finally, I would like to thank my wife, Alice, for her support and love while I wrote this thesis and worked full time. She gave me strength when it seemed too hard, motivation when it seemed bleak and her love when nothing else would do. I love you.
# TABLE OF CONTENTS

ACKNOWLEDGMENTS ........................................................................................................... ii

LIST OF TABLES .................................................................................................................. v

LIST OF FIGURES ............................................................................................................... vi

ABSTRACT ........................................................................................................................... vii

INTRODUCTION ................................................................................................................... 1
  Aging Population ................................................................................................................ 1
  Healthcare Costs ............................................................................................................... 3
  Motivation .......................................................................................................................... 6
  Research Goals ................................................................................................................ 7
  Research Questions .......................................................................................................... 7
  Scope .................................................................................................................................. 8
  Limitations ........................................................................................................................ 8

LITERATURE REVIEW ......................................................................................................... 9
  Cognitive Aging ................................................................................................................. 9
  Aging and Skill Acquisition ............................................................................................... 11
  Technology Acceptance Model ....................................................................................... 13
  Research Gaps ................................................................................................................ 17
  Research Model ............................................................................................................... 18

METHODS ............................................................................................................................ 20
  Experimental Design ....................................................................................................... 20
  Testing Materials ............................................................................................................. 23
  Testing Apparatus .......................................................................................................... 24
  Participants ....................................................................................................................... 25
  Experimental Procedure ................................................................................................. 26
  Analysis ............................................................................................................................ 29
  Hypotheses ....................................................................................................................... 31

RESULTS .............................................................................................................................. 33
  Demographics and Performance Task Variables ........................................................ 33
  UTAUT Constructs ......................................................................................................... 35
  Relationship between UTAUT Constructs ..................................................................... 38
  Hypotheses: ..................................................................................................................... 41

DISCUSSION .......................................................................................................................... 45
  Implications ..................................................................................................................... 48
  Limitations ....................................................................................................................... 49
  Future Research .............................................................................................................. 50

CONCLUSIONS ................................................................................................................... 51
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFERENCES</td>
<td>52</td>
</tr>
<tr>
<td>APPENDIX 1</td>
<td>57</td>
</tr>
<tr>
<td>APPENDIX 2</td>
<td>59</td>
</tr>
<tr>
<td>APPENDIX 3</td>
<td>60</td>
</tr>
<tr>
<td>APPENDIX 4</td>
<td>61</td>
</tr>
<tr>
<td>VITA</td>
<td>64</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1 UTAUT model construct definitions (Venkatesh et al., 2003) ...................................................... 16
Table 2 Variable table ................................................................................................................................. 20
Table 3 Means, standard deviations, and t-test p-values on variables by cohort ..................................... 34
Table 4 Means, standard deviations, and p-values for task time and errors across sessions ........... 35
Table 5 Reliability Analysis and Cronbach’s alpha ................................................................................. 35
Table 6 Construct averages and p-values between cohorts first session .............................................. 37
Table 7 Construct averages and p-values between cohorts second session ....................................... 37
Table 8 Wilcoxon test of UTAUT constructs across sessions .................................................................. 38
Table 9 Correlation of all test variables ................................................................................................. 39
Table 10. Stepwise regression analysis first session .................................................................................. 39
Table 11 Stepwise regression analysis second session ............................................................................. 40
Table 12 Hypothesis 1 outcome .............................................................................................................. 41
Table 13 Hypothesis 2 outcomes ............................................................................................................. 42
Table 14 Hypothesis 3 outcomes ............................................................................................................. 43
Table 15 Hypothesis 4 outcomes ............................................................................................................. 43
Table 16 Hypotheses 5 outcomes ............................................................................................................. 44
Table 17 Hypothesis 6 outcomes ............................................................................................................. 44
LIST OF FIGURES

Figure 1. Population age 65 to age 85 and older, 1980 - 2040 (US Census Bureau, 2004) ........... 2

Figure 2 CREATE's Model of technology- user system (Czaja et al., 2006) .................................. 5

Figure 3 Prevalence of cardiovascular disease sorted by age and gender ...................................... 6

Figure 4 Technology Acceptance Model (Davis, 1989) ................................................................. 14

Figure 5 UTAUT model (Venkatesh et al, 2003) ........................................................................... 17

Figure 6 Experimental Acceptance Model ..................................................................................... 19

Figure 7. Omron 10 Series+ BP791IT Blood Pressure Monitor ...................................................... 25

Figure 8. Mean Task times for each cohort and session ................................................................. 34
ABSTRACT

The older adult population will continue to place pressure on the financial and resource allocation of the healthcare industry as the over 65 population continues to grow. Health care expenditures to treat the aging population will continue to rise as older adults are more likely to have expensive chronic conditions. The future may lay with Consumer Health Information Technology which may allow the patients to have more control of their treatment schedule and self-management of their health and chronic conditions. However, older adults may exhibit cognitive declines that prohibit the learning and proper use of technology, and this assumption is a major inhibitor towards full implementation. This study used the Unified Theory of Acceptance and Use of Technology questionnaire to measure the acceptance of an over-the-counter blood pressure monitor. Twenty-six participants trained themselves to use the device and then measured their blood pressure and uploaded that data to a web software client for their potential healthcare givers for two sessions, one week apart. The results showed that older adults’ ability to perform tasks and limit errors after a retention period is worse when compared to younger adults. However, this performance decline after the retention interval did not result in a decline in the participants’ intention to use the device, showing that even with difficulty when using a novel medical device the older adults still rated that they would intend to use the device similarly to the younger cohort. These systems show the promise of ultimately relieving some of the cost burden and stress on the health industry by having more constant care and reducing hospital readmission rates but may require targeted training for older adults to better maintain task performance.
INTRODUCTION

The ever-growing aging population will continue to place pressure on the financial and resource allocation of the healthcare industry. Possible relief could be in the form of telehealth, telemedicine and eHealth systems, all terms considered to be under the umbrella term *Consumer Health Information Technology* or CHIT, whereby patients are empowered by these systems to self-manage their own condition and medical interventions. The performance and acceptance of CHIT systems by patients is of concern to medical providers and patients because of the technological complexity that tends to overwhelm older adults. Due to the complexity of new or novel technology older adults tend to struggle to learn and eventually use the technology (Bertera, Bertera, Morgan, Wuertz, & Attey, 2007; Charness & Boot, 2009).

**Aging Population**

According to the Administration on Aging (2010), in 1900, 4.1% of the United States population was comprised of people age 65 or older. In 2009, adults over 65 numbered 39.6 million or 12.9% of the total population, which means the older adult population of the U.S. has seen a tremendous growth of the older population as a percentage of the entire population. In the next decade and beyond, the population of older adults will continue to grow. By the year 2020, people aged 65 and older will swell to 72.1 million people that will comprise more than 20% of the total population in the United States. Figure 1 shows the increasing older adults population starting in 1980 and then projected to 2040.
Seniors over age 65 will continue to constitute a larger proportion of the total population because people are living longer and healthier lives. Older adults are living longer because of better health care and medication, declines in the incidence of diseases, and new technologies (Clark & Quinn, 2002). Better healthcare technology developed over the years has led to better treatments that allow older adults to live with chronic conditions. Hoffman (1996) found that the prevalence of older adults living with at least one chronic condition was at 80 percent and with 50 percent having at least two chronic conditions.
Healthcare Costs
The Agency for Healthcare Research and Quality (AHRQ, 2005) found that in 2004, the United States spent $1.9 trillion on health care – almost 17% of gross domestic product for that year. This averages to about $6,280 for each man, woman, and child. Health care expenditures to treat older adults (65+ years in age) is becoming an ever growing burden with the AHRQ (2005) report also finding that the cost of caring for older U.S. residents is three to five times greater than the cost of caring for younger adults, indicating the increased need for preventive health care directed toward aging U.S. residents. More than 2/3 of current health care costs are for treating chronic illnesses, and patients with multiple chronic conditions costs up to seven times more than a patient with only one condition, which is heavily skewed by age because of the high prevalence of the older adult population to have one or more chronic diseases. The older adults (age 65 and over) made up around 13 percent of the U.S. population in 2002, but accounted for 36 percent of total U.S. personal health care expenses. The average health care expense in 2002 was $11,089 per year for older adults but only $3,352 per year for working-age adults (ages 19-64) (Lehnert et al., 2011).

The state of financial burden will only continue to rise as more and more baby-boomers reach retirement age, promoting federal and state governments to take action in attempts to curb the rising costs. One such method or avenue to alleviate the increasing strain on the health industry is to move some of the health management to the home and in the hands of the patient by way of consumer health information technology (CHIT). Or and Karsh (2011) have recognized the future may lie with at-home medical technology, telemedicine and eHealth. They state that in the near future all these branches will merge and be known as Consumer Health Information Technology (CHIT). The Science Panel on Interactive Communication and Health (Henderson et al., 1999) has described and defined CHIT as:
“The patient-focused interactive web or technology mediated applications that are designed to improve information access and exchange, change decision making, provide social and emotional support, and facilitate behavior changes that promote health and well-being.” (pg. 30)

Acceptance, implementation and use of CHIT’s can lead to better patient health outcomes, well-being, and quality of life, as well as lower hospital readmission rates and mortality and morbidity rates (Crossen-Sills, Toomey, & Doherty, 2009; Polisena, Coyle, Coyle, & McGill, 2009). Results of a 90-day pilot study conducted at VA Connecticut Healthcare System (VACT) showed that remote patient monitoring decreases healthcare costs and improves well-being of frail elderly veterans with complex co-morbidities residing at home (Noel, Vogel, Erdos, Cornwall, & Levin, 2004). However, most of the telemedicine initiatives do not survive the research phase or they become a failure in daily practice (Broens et al., 2007). Lack of CHIT acceptance and subsequent use is a significant concern for patients and healthcare organizations as they cannot reap the full benefits of using such systems unless both parties buy-in to the program (C.K.L. Or et al., 2008).

The Center for Research and Education on Aging and Technology Enhancement, CREATE (2006), whose mission is to promote technology adoption by the older population to improve life outcomes, found that older adults were less likely than younger adults to use technology in general, computers, and the World Wide Web. The results also found that the predictors of acceptance were computer anxiety, fluid intelligence, and crystallized intelligence. Also, the link between age and acceptance was moderated by the cognitive abilities, self-rated computer self-efficacy, and their anxiety when using novel technology (Czaja et al., 2006).

The CREATE research produced a model (Figure 2) to show the relationship between the factors in the Technology-User system. The model shows that the capability of the user makes up half of
the model’s main construct of “Degree of fit” and its direct relationship to the model outcomes while the technological system makes up the other half. The moderating factors of age, education and technical experience are shown to have effects on the Operator/user side of the model, which shows that the Capability is dependent on the individual’s moderating factors. The focus of this thesis is on the outcomes of Performance and Acceptance and the influence that the moderating factor of age may have on them. Research in the area of Acceptance has produced acceptance criteria that can be used to determine the probability of successful implementation of that technology.

![Diagram](image)

Figure 2 CREATE's Model of technology- user system (Czaja et al., 2006)
Heart disease is the leading cause of mortality in the United States, and it is the most common reason for hospital admission for people aged 65 years and older (Rich, 1997). The American Heart Association (2004) reports that nearly 65 million Americans have some form of cardiovascular disease (CVD). The most common include stroke, high blood pressure, congestive heart failure, congenital heart failure and a hardening of the arteries with the highest prevalence occurring in the over 75 group with over 65 closely behind (figure 3) (American Heart Association, 2004). The cost for Americans for CVD-related medical costs and disability amounted to $368 billion in 2005 (American Heart Association, 2004). Current treatments of heart disease require visits to cardiologists. Over 50% of home nursing visits related to heart failure and hypertension in the United States could be replaced by telehealth visits, with a significant cost savings (DelliFraine & Dansky, 2008).

Motivation
The aging population is becoming more accustomed to technology, as the older adults of tomorrow are the current young adults of today. The unique needs of older adults will not
necessarily disappear or diminish for two main reasons. First, the age related changes in perceptual, cognition, and psychomotor abilities all contribute to the age-related differences in technology outcomes of performance and acceptance. Such age related changes will continue in future generations; thus the technological outcomes will remain similar to that of previous generations. Second, new technology will always be unique to users as the ever-progressing advancement of technology continues to evolve over time. The largest user group of at home medical technology comes from the older adult population. This group typically suffers from chronic diseases that can lead to a wide array of perceptual, cognitive and motor disabilities; these disabilities may significantly disrupt their performance and safety when using such devices.

**Research Goals**

CHIT has the potential to bring healthcare costs down without sacrificing quality of care to the older adult population. However, older adults’ acceptance of CHIT’s is not fully understood. Using an off-the-shelf blood-pressure cuff and compatible web portal as the CHIT, this research will measure the acceptance and the factors that affect acceptance variability with the Unified Theory of Acceptance and Use of Technology model (Venkatesh, Morris, Davis, & Davis, 2003).

**Research Questions**

This thesis addresses the following questions:

1. Does the age of the individual influence performance when using the device?
2. Does age influence the acceptance of the device?
3. Does the performance of the participants using the CHIT device and software influence their eventual acceptance of the device?
4. Does a retention interval of 1 week for a repeat of the task affect the participants’ ability to perform and their acceptance?

5. Does the participant’s cognitive strength, as measured by the Digit Symbol Substitution test, influence task performance or acceptance?

Scope
There are many consumer products and devices; however, the scope of this research was to determine the relationship between performance and acceptance of an over-the-counter CHIT device. Age ranges were separated into two group cohorts of a young generation (18-35 years old) and an older generation (60 to 85 years old). The age range in between these two groups was excluded from the study. The Unified Theory of Acceptance and Use of Technology (UTAUT) theory construct of Actual Use (AU) was outside the scope of this thesis research because measuring the construct would require a longitudinal study where the participant would have to report their use of the device in question.

Limitations
The laboratory setting of the study is limiting in that the outside environmental effects and pressures could not be fully replicated. Motivation to use a healthcare device would probably be more pronounced with participants that have been prescribed the device because of actual health requirements. The older cohort was healthy and all were of working age, which may limit any differences that could be found compared to the younger cohort.
Cognitive Aging
As adults age they begin to show signs of cognitive decline by a reduced capability in working memory, fluid intelligence, perceptual speed and spatial ability (Baltes & Lindenberger, 1997; Bogartz, 1990; Czaja & Sharit, 1998). A number of internal and external factors influence cognitive performance and learning of which two of the main internal factors are the processing speed and the cognitive resources of the individual. Processing speed and cognitive resources of an individual show mediating effects from age-related declines (Chaffin & Harlow, 2005).

Cognitive resources are structured around memory and its different components consisting of: 

*Episodic*, specific autobiographical events; *Procedural*, learning associative relationships such as driving a car; *Semantic*, structured record of facts, meanings and overall acquired knowledge, and *Working memory*, a processing resource of limited capacity involved in the preservation of information while simultaneously processing the same or other information (Salthouse, 1996).

Of the many components of memory, the working memory component tends to show evidence of decrements due to declining resources from aging. That is, when information located in one’s memory must be processed, recalled or manipulated, significant differences between older adults and younger adults surfaced (Craik & McIntyre, 1986; Ghisletta, Kennedy, Rodrigue, Lindenberger, & Raz, 2010). The extent or magnitude of the differences between the younger and older adult groups’ working memory capacity is compounded with increases in task complexity and its strain on cognitive processing and manipulation of memorized information (Charness & Boot, 2009; Czaja & Sharit, 1998).
Cognitive Resources

The cognitive resources available or the individual’s capacity is important in working memory and performance. An individual’s cognitive performance is influenced by an individual’s cognitive workload (Kirschner, 2002). An individual’s cognitive workload is the intersection where task complexity and novelty meets the individual’s available cognitive resources. Cognitive performance, which is an individual’s ability to process, store and retrieve information, is degraded when an individual’s available resources are not sufficient to perform mental operations necessary to complete a task (Tomporowski, 2003). In cognitive performance, age-related differences are greater for complex tasks and tasks that place higher demands on limited resources (Salthouse, Mitchell, Skovronek, & Babcock, 1989). Because of age-related differences in cognitive performance, learning and retention of new knowledge, novel technology becomes difficult to learn and perform for older adults (Salthouse, 1996). Therefore, older adults may require more resources to carry out the same tasks as their younger counterparts and may need more trials or practice time to reach the same level of performance as younger adults (Mayhorn, 2004).

Retention of Knowledge and Learned Skills

Retention intervals tend to degrade cognitive skills for older adults if the skills were recently learned (Rodrique, Kennedy, Head, Williamson, & Raz, 2005). An empirical study on novices' learning by Ahmed, McKnight et al. (2005) evaluated the performance of novice users in initially learning to use a web-based search interface and their ability to retain the skill for later use. The results showed that novices' performance was better in the learning session. Their performance in the retention session declined significantly in terms of success score as they forgot the interface functionalities from the initial session to the retention session. A similar study was done by
Mykityshyn, Fisk et al. (2002) in which they were concerned with age-related effects on retention when using different mediums of training (print manual versus video) to use an at-home medical glucose meter. The older adults in the study that trained using the text-based manual had the worst performance out of all group and training combinations however, when the older adults used video training they performed at the same level of accuracy and timing as their younger counterparts. Overall the older adults' performance was more influenced by the retention interval; however, the benefit of the video training was maintained for the older adults over the retention interval of two weeks.

**Aging and Skill Acquisition**  
Older adults demonstrate that there are age-related differences in the acquisition and performance of computer procedures. Older adults require more time than younger adults to acquire new computer skills, they commit more errors when performing computer tasks and they also require more assistance to develop skills and confidence in using the computers (Echt & Morrell, 1998). The final performance level for newly acquired skills is generally lower for older adults than for younger adults (Fisk & Rogers, 2000).

Echt and Morrell (1998) suggested that age-related declines in cognitive resources, such as perceptual speed and verbal and spatial working memory, and other cognitive mechanisms, such as text comprehension, might play substantial roles in some of the age-related differences in computer skill acquisition. Working memory is considered to be the simultaneous processing and storage of information and is important when learning new skills (Horsky, Zhang, & Patel, 2005). As one grows older the performance of cognitive tasks are characterized by a general slowing of perceptual and motor processes involved in perceiving and responding to items and cues, especially as task complexity increases (Patel, 2003). Therefore, the perceived complexity
of computers and electronic devices by older adults due to the result of age-related decrements for older adults would only increase further as they age and technology continues to evolve (Chaffin & Harlow, 2005). As a result of increasing technology requirements and decreasing cognitive resources to meet it, older adults are reluctant to use or accept new technology (Dickinson, Eisma, & Gregor, 2011; Kang & Yoon, 2008). However, older adults are able to equal the performance of younger adults on new technology tasks when given additional time to practice (Westerman & Davies, 2000).

Research on working memory has shown that with age comes a decline with functional capacity of working memory (Baltes and Lindenberger, 1997, Bogartz 1990). However, much discussion still exists on when adults experience the most dramatic decrease in cognitive function due to age, or worded in another way, the point when older adults begin to exhibit age related declines. This understanding has undergone changes with the rise of information for the young-old, that is, the age group of 55 to 75 years in age. In this group that makes up 15% of the population they are healthier and better educated than adults in the old-old, over 75 (Clark and Quinn, 2002). Studies of the performance decline in cognitive battery tests such as the Digit Symbol Substitution test, show a dramatic decrease in performance of adults as they move from the young-old and the old –old (Salthouse, 1992, and Gilmore, Royer and Gruhn 1983). Results from the studies also suggest that every day stresses from social, work commencements as well as life challenges may exacerbate age- related declines in cognitive functions. The young – old group is beginning to show age related declines yet they still may work full time and have life stresses that may strain the cognitive resources further than age-related declines alone.
Technology Acceptance Model
Technology acceptance has developed into an important concept across a broad field of research areas, such as marketing, ergonomics and psychology. Acceptance can be defined “as the approval or favorable reception and ongoing use of newly introduced devices and systems” (Arning & Ziefle, 2007). The concept of acceptance for this study is derived from the Technology Acceptance Model (TAM), which is considered to be the most influential theoretical approach in studying the determinants of information technology utilization (Holden & Karsh, 2010). The model was originally created by Davis (1989) as an adaptation to Theory of Reasoned Action tailored for the acceptance of information systems. The goal of TAM is to produce a model that can explain user acceptance behavior and the determinants that lead to the acceptance across many different technologies (Davis, Bagozzi, & Warshaw, 1989).

According to the technology acceptance model (TAM), perceived ease of use and usefulness are assumed to be strong determinants of the actual and successful utilization of technology (Figure 4). A user’s decision to use a new technical device or software package is determined by the behavioral intention to use the system. The perceived ease of use and perceived usefulness of a system in question are constructs that determine the behavioral intention. The construct of perceived ease of use describes “the degree to which a person believes that using a particular system would be free from effort”, while the perceived usefulness is “the degree to which a person believes that using a particular system would enhance his or her job performance” (Davis et al., 1989).
Melenhorst, Rogers and Caylor (2001) go on to show that the acceptance and eventual decision to use complex and novel technologies occur in terms of a cost-benefit analysis or a balancing act between the ease of use of a system versus the usefulness of the system. The users often will weigh their perceived usefulness (i.e., increase of productivity, safety, efficiency) of a device versus the perceived effort or costs required to master or use the device effectively (i.e., investment of time, effort and money). Users’ backgrounds and abilities vary immensely when using technology devices and therefore can lead to differences in technology acceptance across users. Cognitive ability and resources have significant direct effects on perceived usefulness, perceived ease of use, and subjective norms. Both perceived usefulness and subjective norms affect actual technology usage significantly.
Unified Theory of Acceptance and Use of Technology

Because of the TAM, in some instances, could only explain 40% of the actual acceptance (Keil, Beranek, & Konsynski, 1995) the model became limited in its ability to determine actual usage in further studies. In response to these limitations Venkatesh et al. (2003) combined many popular models of technology use to create the Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT includes many of the constructs from the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1974), Technology Acceptance Model (TAM) (Davis, 1989), Theory of Planned Behavior (TPB) (Ajzen, 1991), and the extended Technology and acceptance model (TAM2) (Venkatesh & Davis, 2000).

The Unified Theory of Acceptance and Use of Technology (UTAUT) model aims to explain user intentions to use a new computer technology and subsequent usage behavior (Venkatesh et al. 2003). The authors explored constructs from the eight base models through a standard questionnaire and the influence of the moderators through an empirical longitudinal study of new technology deployment in four organizations. They found some constructs more salient than others and produced a set of eight constructs to formulate their unified model. UTAUT holds that three key constructs, namely Performance Expectancy (PE), Effort Expectancy (EE), and Social Influence (SI) are direct determinants of Behavioral Intention (BI) to use and a fourth, Facilitating Conditions (FC) that influences only Actual Use (AU). The definitions of each construct can be found in table 1.
Table 1 UTAUT model construct definitions (Venkatesh et al., 2003)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>The degree to which an individual believes that using a particular system would improve his or her performance</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>The degree of simplicity associated with the use of a particular system</td>
</tr>
<tr>
<td>Social Influence</td>
<td>The degree to which an individual perceives that others believe he or she should use a particular system</td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>The degree to which an individual believes that an organizational and technical infrastructure exists to support the use of a particular system</td>
</tr>
<tr>
<td>Behavior Intention</td>
<td>The degree to which the user believes that they will use the device</td>
</tr>
</tbody>
</table>

The new proposed model UTAUT explained 70 percent of the observed variance in predicting user acceptance of information technology innovations where the previous models could only explain 40 percent (Davis, 1989; Wu, Zhao, Zhu, Tan, & Zheng, 2011). The new model also showed a strong correlation between behavioral intention and actual system use similar to the original Technology Acceptance model. The increase in variance explanation by the new model showed that the UTUAT is a superior model of acceptance than all the previous models. The model of UTAUT is shown in figure 5. Gender, age, previous experience with the technology, and whether the technology is being required by outside influences are shown to be moderators of the effect of the three key constructs on usage intention.
UTAUT was tested using the original data and found to outperform the eight individual models (Venkatesh et al., 2003). The UTAUT is a useful tool for predicting technology adoption and the factors that influence that adoption, thus allowing targeted programs to improve those factors that ultimately influence adoption (Venkatesh, Thong, & Xu, 2012).

**Research Gaps**
A meta-analysis of technology acceptance journal articles within the healthcare industry revealed that there is a considerable lack of focus on the patients or consumer health information technology devices (Holden & Karsh, 2010). The vast majority of health focused research is found on health professionals (e.g., administrators, doctors and nurses) and not on the patient.
None of the research had any findings that related to the aging population and the inherent limits of technology use and eventual acceptance. Czaja, Charness et al (2006) found that when it comes to technology, age-related changes in cognition have important implications for the design of these technical systems. Learning is closely tied to memory functioning and even the normal decline of memory through aging renders difficulties in learning. Cognitive abilities are thus related to technology adoption and should be included and taken into account when experimenting.

**Research Model**
The research model for the current experiment consisted of the three main constructs of the UTAUT that were found to influence the Behavioral Intention to use. Intention to use or adopt a technology is usually the endpoint research of acceptance. Actual Usage is difficult to determine because the time-frame to measure the Actual Use and acceptance varies between studies as well as the level of use that is considered to be “in use” by the participant is not consistent across the studies (Cane & McCarthy, 2009; Czaja et al., 2006; Despont-Gros, Mueller, & Lovis, 2005). The Behavioral Intention to use is a strong predictor of Actual Usage behavior and has been validated to influence acceptance (Huang, 2011;Venkatesh et al., 2003; Wu et al., 2011). Actual use was not included because it is outside the scope of the thesis. Previous research has validated that Behavioral Intention to use or adopt is sufficient in determining system usage or acceptance (Im, Hong, & Kang, 2011;Venkatesh et al., 2003; Wu et al., 2011). The construct of facilitating condition also was not included because it has been shown to only influence Actual Use, which as stated before is not included in this study, and none of the other constructs. Also, the experiments were conducted in a tightly controlled laboratory environment and were not subject to the “in the field” questions that make up the construct of Facilitating Conditions.
Performance of technology has been considered an outcome by Czaja et al. (2006) and also as a moderating effect of acceptance (Arning & Ziefle, 2007). The age, DSST score, initial task time and retention task time of the participant on the device were used as moderators of Performance Expectancy, Effort Expectancy and Social Influence on Behavioral Intention to use. The experimental model is shown in Figure 6.

![Figure 6 Experimental Acceptance Model](image-url)
METHODS

Experimental Design
This study used a mixed-factors design where age (cohort) was a between subjects factor. The retention interval is a within subjects factor where all participants performed the experiment at the first session and the second session one week later. Training to use the device occurred before the first session and was not repeated at the second session. Details of the variables are located in table 2.

<table>
<thead>
<tr>
<th>Table 2 Variable table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor name</strong></td>
</tr>
<tr>
<td><strong>Independent Variables</strong></td>
</tr>
<tr>
<td>Cohort</td>
</tr>
<tr>
<td>Retention Interval</td>
</tr>
<tr>
<td>Subjects</td>
</tr>
<tr>
<td><strong>Moderators</strong></td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Digit Symbol Substitution Test Score</td>
</tr>
<tr>
<td><strong>Dependent Variables</strong></td>
</tr>
<tr>
<td>Performance</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Acceptance Construct Scores</td>
</tr>
<tr>
<td>1. Performance Expectancy</td>
</tr>
<tr>
<td>2. Effort Expectancy</td>
</tr>
<tr>
<td>3. Social Influence</td>
</tr>
<tr>
<td>4. Behavioral Intention</td>
</tr>
</tbody>
</table>

Independent Variables

*Cohort:* Two levels of age were included in this study, young and old. A previous study by Fisk, Hertzog et al. (1994) found that younger adults perform better on cognitive performance and memory tasks than older adults. The same age ranges as used in their study were used for this
experiment. The younger group was between the ages of 18 to 25. The older group was from 60 to 70.

**Retention Interval:** The length of time after the initial training period was a within subjects factor. The initial trial was considered the first session and the trial one week later was the second session. The training material was removed before the participant attempted the task at the first session and was not there to be reviewed for the second session.

**Dependent Variables**

**Performance:** The performance of the tasks was broken into two subsets of data metrics, accuracy and speed. Speed was the length in time the participants needed to complete the given tasks correctly, and accuracy was the number or errors produced by the participant during the experiment. Errors were considered any omission of steps, steps out of order or extra steps and wrongly done steps by the participant. Time was measured using a stop watch and errors were noted through observing the participants at each session. These performance subsets were used to define how the participants performed when executing the tasks. The participants were told to focus on accuracy and not speed through the experiment. The focus on accuracy, rather than speed, better replicates actual use at home where patients would be more concerned with using the device correctly than quickly.

**Acceptance:** The participants’ perceptions to use or accept the device and technology system was measured through a modified Unified Theory of Acceptance and Use of Technology questionnaire (located in Appendix 4). The questionnaire used the constructs of Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Behavioral Intention (BI). Each question was measured on a 5-point Likert scale with a 1 being “Strongly Disagree” and a
5 being “Strongly Agree”. The questions for each construct were added to create a new aggregate variable for each construct and treated as variables in the data analysis. Behavioral Intention is the construct that measures the acceptance of the device by the user. The level of acceptance was the score from each of the questions from the Behavioral Intention (BI) construct added in total.

**Moderators**

**Cognitive Ability**: Cognitive ability correlates with better ability to learn new technology and perform at a higher level (Chaffin & Harlow, 2005; Chakraborty et al., 2008; Ghisletta et al., 2010). The Weschler Digit Symbol Substitution Test is a valid tool in measuring the cognitive ability of an individual (Gilmore, Royer, & Gruhn, 1983; MacDonald, Stigsdotter-Neely, Derwinger, & Backman, 2006). A participants’ chronological age is not the only predictor to novel device performance. Previous researchers have used cognitive tests as covariates to account for the variance between age groups and to determine if differences between the young and old comes from a function of old age (e.g., cognitive ability) instead of the chronological age (Gilmore et al., 1983; Mykityshyn et al., 2002).

**Age**: The chronological age of the participant moderates the predictor constructs of the UTAUT (Performance Expectancy, Effort Expectancy, and Social Influence) on the dependent construct Behavioral Intention to Use (Vekantesh et al, 2003). Venkatesh and colleagues were also able to find that Performance expectancy on Behavioral Intention to Use is higher for younger participants, however the constructs of Effort Expectancy and Social Influence were stronger for older participants (over 60 years).
Testing Materials

Questionnaires:

**Demographic:** A demographic questionnaire (Appendix 2) was given at the beginning of the testing session to gather background information of the participant. The questions included the participant’s age, gender, education level, frequency of computer use and heart health concern rating. The heart health concern rating was a single Likert question where the participant rated how strongly he/she agrees with the statement that he or she is concerned with personal heart health on a scale of 1 to 5.

**Wechsler Digit Symbol Substitution Test (DSST):** The extent of processing and memory declines with aging can be measured with the DSST, as there is clearly a general performance decline associated with age (Gilmore et al., 1983; MacDonald et al., 2006; Salthouse, 1992). The DSST (Appendix 3) is a pencil and paper test of psychomotor performance in which the participant is given a key grid of numbers and matching symbols and a test section with numbers and empty boxes. The participant matches symbols with their corresponding digit and requires the participant to remember where each symbol matches a digit. The test consists of 9 digit symbols that are matched with their corresponding numerical digit. The test was timed for 2 minutes where any answers written after the allotment of time given were not counted in the scoring of the test. The maximum score was 133 points. The test was used to measure the processing speed and working memory of the participants (Joy, Kaplan, & Fein, 2003) and was also used to render a deeper understanding of the age related decline differences more so than just the chronological age of the participant in the responses on the UTAUT.
**Unified Theory of Acceptance and the Use of Technology (UTAUT) Questionnaire:** The acceptance questionnaire was a modified form of the UTAUT designed by Venkatesh et al (2003). The questionnaire used a five point Likert scale from 1 being “strongly disagree” to 5 being “strongly agree.” The experimental model was modified by the author of this thesis to exclude superfluous constructs such as the *Facilitating Conditions* (FC) because the experiment used volunteers in a laboratory setting and *Actual Use* (AU) being outside the scope of the experiment. The subsequent model consisted of *Performance Expectancy* (4 items), *Effort Expectancy* (4 items), *Social Influence* (3 items) and *Behavioral Intention to Use* (3 items) with a total of 13 questions for the entire model. The responses in each construct was added together to form the aggregate total for the construct and that score will be used in the analysis. The questions for each construct can be found in Appendix 4.

**Testing Apparatus**
An Omron 10 Series+™ BP791IT (Tokyo, Japan) Blood Pressure monitor was used as the test device for this experiment (Figure 7). The blood pressure monitor has the capability to download the data on to a website for further processing, organization, storage and sharing with medical professionals. Microsoft® HealthVault™ is the software and online storage of data is provided for free at http://www.microsoft.com/en-us/healthvault/.
Figure 7. Omron 10 Series+ BP791IT Blood Pressure Monitor

Training Material

The manufacturer of the Omron 10 Series+™ BP791IT Blood Pressure monitor provides the instructions (training materials) in the package with the device. These training materials were the documents used by the participant to operate the device and perform the required outcomes. The training documents included with the device consist of the Operation Manual and Start-Up Guide, and the training material for the Microsoft HealthVault™ software was downloaded from their website. These documents were given to the participant before performing the required steps. The participants were allowed to study the material until they were ready to continue on to performing the required steps on the device; at which point the training material documents were removed from the participant for the remainder of the experiment. During the retention interval the participants did not have contact and were not able to study the training material.

Participants

This study was approved for human participants by Louisiana State University through their IRB process. Twenty-six (26) participants were included and evenly split between the cohorts (13 each). The younger cohort was recruited from the undergraduate population at Louisiana State University- Baton Rouge, Louisiana. The population of the younger cohort was incentivized,
after coordinating with some of the professors in the industrial engineering program, by the possibility of obtaining extra credit once completing the experiment. The older adult group was recruited from the staff and faculty of a local community college located in Bossier City, Louisiana. Their participation was strictly voluntary and thus, did not receive any compensation for inclusion in the study.

The age for the younger cohort had a mean of 21.3 years (s.d. = 2.59) and the older cohort had a mean of 63.5 years (s.d. = 3.23). The younger cohort consisted of 11 males (84.6%) and 2 females (15.4%), whereas the older cohort was made up of 4 males (30.7%) and 9 females (69.3%).

The criteria for exclusion were if the participant were pregnant or if undue harm or stress would occur when performing the operation of the blood pressure monitor. Anyone outside the age ranges, as shown previously for inclusion, was also excluded from the study. A benchmark score for the Digit-Symbol Substitution Test to set an exclusion criterion for cognitive strength was not included as previous research has not found a threshold score of what would be considered a “bad” score (Gilmore et al., 1983).

**Experimental Procedure**
All participants began by completing the informed consent form (Appendix 2), and then the demographic questionnaire (Appendix 3) and a Wechsler Digit Symbol Substitution Test (Appendix 4) was given to each participant before any testing took place. The participants then reviewed the training materials issued by the manufacturer and included with the device package along with a sheet of paper detailing the required tasks to be performed. The participants were told to review until they felt they were ready to perform the task assignment requirements without the training material. During this time participants were allowed to view and hold the
device but will not be allowed to begin the tasks. The readiness of the participant was completely up to him/her and his/her own comfort level to perform the required task assignments without the training materials present. Participants then performed the given task of measuring blood pressure and then storing the data on the software provided by the manufacturer. The correct path for the task was defined and all errors were noted by observing the participant while they attempted the task. After performing each task participants filled out the modified UTAUT to determine the user’s acceptance of the device. Each of the participants then returned after one week and repeated the experiment as performed previously without the training time allotment or training material present. The DSST and demographic questionnaire will only be issued on the first trial while the UTAUT will be issued at both.

Tasks

This research experiment used two separate functions of the Omron 10 Series+™ BP791IT and Microsoft HealthVault™ system. The Omron 10 Series+™ BP791IT is the hardware focus of the actual device system and the Microsoft HealthVault™ is the software focus of the system. The required tasks to be completed for this experiment was given to the participants on a sheet labeled “Required Outcome List” and are presented below. The participants had access to the required outcome list when studying the training material. The participants were able to choose when they felt they could perform the tasks on the “Required Outcome” list.

Required Outcome List
1. Set up device by selecting the current date and time
2. Perform blood pressure reading
3. Load data onto Healthvault™
4. Select “See Chart”
5. Select date range and view only the past week of data
After the retention interval of one week, the same required outcomes were repeated and measured, as was the case with the initial training period. The proper sequence to complete the required outcomes for the task was defined and presented below.

**Proper Task Steps**

1. Establish power connection via batteries or a/c plug-in

2. Set-up date and time on base unit
   a. If device is on, turn it off by pressing the “start/stop” button
   b. Press and hold the “Set” button until the screen displays a flashing “off”
   c. Press the set button again

   d. Set the Year
      i. Press the Up button to increase the year
      ii. Press the down button to decrease the year
      iii. Once the years is correct Press the “Set” button

   e. Set the Month
      i. Press the Up button to increase the month
      ii. Press the down button to decrease the month
      iii. Once the Month is correct press the “Set” button

   f. Set the Day
i. Press the Up button to increase the day

ii. Press the down button to decrease the day

iii. Once the Month is correct press the “Set” button

3. Place the User Selection switch to User A

4. Plug-in the cuff to the base unit

5. Place cuff around upper arm ½ in above elbow with the flow line going down the median of the arm.

6. Press the Start/Stop button to begin test

7. Turn Off monitor by Pressing the “start/stop” button

8. Attach USB cable from base unit to Computer (small end to the base unit and large end in the computer)

9. Follow on-screen prompts to Launch Microsoft Healthvault® Connection Center® program or by selecting Icon on desktop

10. Select view in Browser

11. Click “date range” tab

   a. select the date to one week prior by selecting the day on the calendar that will be displayed after

Analysis
The data was analyzed using the Statistical Package for the Social Sciences (SPSS) version 21 by way of VMware access through an account with Louisiana State University. Data was analyzed by comparing the two age groups by t-test for all the test variables DSST, Training Time, Task Time (both sessions) and Errors (both sessions) as the test variables. Results were considered
significant only if the probability value fell below the 0.05 convention. Cronbach’s alpha was calculated for each construct of the UTAUT model questionnaire to ensure internal consistency among items. The scores for each construct was the aggregate total of the Likert scores from each of the corresponding questions of that construct. Due to the ordinal nature of Likert scale responses, non-parametric test were used to uncover if significant differences exist. These totals were used as the construct variable in the analysis. A Mann-Whitney test was performed to uncover if differences were significant between cohorts and a Wilcoxon test was performed to uncover if differences were significant between sessions for each cohort. Spearman’s Rank correlations were then calculated to determine the link between, age, DSST, task time and errors from each session, and the constructs of the UTAUT.

Finally, a stepwise multiple regression was performed to determine the predictive nature and relationship of the test model variables as shown previously in Figure 6. Behavioral Intention to Use was used for the dependent variable of the regression analysis for each session. Performance Expectancy, Effort Expectancy and Social Influence were used as the independent variables or predictor variables. Moderator variables were the DSST, chronological age and the participant’s task time. Dummy variables were created to determine the interactions effects of each moderating variable with each predictor variable on to Behavioral Intention to Use for each session. Each moderator and the predictors of the UTAUT were standardized to their z-scores and then multiplied together to create the interaction variable for each session. These variables were then included into the regression model.
The regression model for each session was as follows

\[ y_{1,2} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_1 m_1 + \beta_5 x_2 m_1 + \beta_6 x_3 m_1 + \beta_7 x_1 m_2 + \beta_8 x_2 m_2 + \beta_9 x_3 m_2 + \beta_{10} x_1 m_3 + \beta_{11} x_2 m_3 + \beta_{12} x_3 m_3 + \epsilon \]

Where “\( y_{1,2} \)”: Behavioral Intention to Use for the first and second session

\( \beta_0, \beta_1, \beta_2... \beta_{12} \) are constants produced from the regression analysis

"\( x_1 \)”: Performance Expectancy

"\( x_2 \)”: Effort Expectancy

"\( x_3 \)”: Social Influence

"\( m_1 \)”: Age

"\( m_2 \)”: Task time for each session respectively

"\( m_3 \)”: Digit Symbol Substitution Test (DSST) score

The variance of each regression analysis is defined as \( R^2 \) and is the amount of explained variance of the dependent variable from the regression model. The significant variables from the model were then included in the final regression equation.

**Hypotheses**

**H_1**: There is no difference between initial session and second session task time and errors for each cohort.

**H_A**: There will be a significant increase between the initial session task time and errors, and second session task time and errors for each cohort.

**H_2**: There is no difference between constructs ratings of the UTAUT between the first and the second session for either cohort
H1: The difference between the initial constructs of the UTAUT and retention constructs will be significant for each cohort.

H3: There is no relationship between the predictor constructs of the UTAUT and the Behavioral Intention to Use

H3a: Performance Expectancy will have a positive influence on Behavioral Intention to Use at each session.

H3b: Effort Expectancy will have a positive influence on Behavioral Intention to Use at each session.

H3c: Social Influence will have a positive influence on Behavioral Intention to Use first at each session.

H4: Age does not moderate any of the constructs of the UTAUT onto Behavioral Intention to use at each session

H4a: The positive effect of performance expectancy on the intention to use is moderated by age at each session

H4b: The positive effect of performance expectancy on the intention to use is moderated by age at each session

H4c: The positive effect of performance expectancy on the intention to use is moderated by age at each session.

H5: Task time will not moderate any of the constructs of the UTAUT onto Behavioral Intention to Use at each session

H5a: The positive effect of performance expectancy on the intention to use is moderated by task time at each session

H5b: The positive effect of performance expectancy on the intention to use is moderated by task time at each session

H5c: The positive effect of performance expectancy on the intention to use is moderated by task time at each session

H6: The DSST score will not moderate any of the predictor constructs of the UTAUT onto Behavioral Intention to Use at each session.

H6a: The positive effect of performance expectancy on the intention to use is moderated by DSST at each session

H6b: The positive effect of performance expectancy on the intention to use is moderated by DSST at each session

H6c: The positive effect of performance expectancy on the intention to use is moderated by DSST at each session
RESULTS

Demographics and Performance Task Variables
Training time, the time the participants took to familiarize themselves with the device operation, manufacture’s manual and task list, were similar (p < .462) with each cohort taking just over 20 minutes to complete their training to their own comfort level. The length of time to finish the required task at the initial session and after the retention interval session were averaged according to each cohort, and the results are shown in Figure 8. The initial task times for each cohort were not significantly different (p = .967). A paired sample t-test was performed to discern differences between sessions for each cohort. The younger cohort took 5.71 minutes (SD = 2.99) to complete their task at the first session and was able to maintain a similar time at the second session with a time of 5.66 minutes (SD = 2.39). However, the task time after the retention interval increased significantly (p = .013) for the older cohort at 7.88 minutes (SD = 2.3). Older adults took 2.22 minutes or 39.2% longer at the second session than the first. The difference between cohorts at the second session was also significant (p = .024) as the older cohort took longer than the younger cohort. The older adults took 39.2% longer than the younger group at the second session.

The amount of errors followed the same trend as task times for each cohort across sessions. The younger cohort was able to maintain a similar amount of errors at the second session as compared to their first session (p = .374). The older cohort, on the other hand, did produce more errors at the second session as compared to their first session (p = .013). At the first session the difference between the two groups was not significant (p = .634). However, the older cohort produced on average 39% more errors during the second test session when compared to the younger cohort (p = 0.007). Table 3 and Table 4 show all test variables with their mean, standard
deviation and the level of significance of the difference between cohorts (Table 3) or session (Table 4) for that variable.

![Figure 8](image_url)

**Figure 8. Mean Task times for each cohort and session**

**Table 3 Means, standard deviations, and t-test p-values on variables by cohort**

<table>
<thead>
<tr>
<th></th>
<th>Younger Cohort</th>
<th></th>
<th>Older Cohort</th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Heart Health Concern rating</td>
<td>3.77</td>
<td>1.31</td>
<td>4.23</td>
<td>0.93</td>
<td>0.308</td>
</tr>
<tr>
<td>Age</td>
<td>23.31</td>
<td>2.59</td>
<td>63.54</td>
<td>3.23</td>
<td>0.00**</td>
</tr>
<tr>
<td>DSST Score</td>
<td>62.54</td>
<td>9.89</td>
<td>51.08</td>
<td>11.61</td>
<td>0.012*</td>
</tr>
<tr>
<td>Training Time</td>
<td>22.73</td>
<td>6.53</td>
<td>20.39</td>
<td>9.23</td>
<td>0.462</td>
</tr>
<tr>
<td>Task Time 1st Session</td>
<td>5.71</td>
<td>2.92</td>
<td>5.66</td>
<td>1.63</td>
<td>0.967</td>
</tr>
<tr>
<td>Amount of Errors 1st Session</td>
<td>1.08</td>
<td>0.954</td>
<td>1.31</td>
<td>1.43</td>
<td>0.634</td>
</tr>
<tr>
<td>Task Time 2nd Session</td>
<td>5.66</td>
<td>2.39</td>
<td>7.88</td>
<td>2.31</td>
<td>0.024*</td>
</tr>
<tr>
<td>Amount of Errors 2nd Session</td>
<td>0.692</td>
<td>1.03</td>
<td>1.923</td>
<td>1.11</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

*Significant, p < .05, ** Significant p < .01
Table 4 Means, standard deviations, and paired t-test p-values for task time and errors across sessions

<table>
<thead>
<tr>
<th></th>
<th>1st session</th>
<th>2nd session</th>
<th>p -value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td><strong>Younger Cohort</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task time</td>
<td>5.71</td>
<td>2.92</td>
<td>5.66</td>
</tr>
<tr>
<td>Amt. of errors</td>
<td>1.08</td>
<td>0.95</td>
<td>0.69</td>
</tr>
<tr>
<td><strong>Older Cohort</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task time</td>
<td>5.66</td>
<td>1.63</td>
<td>7.88</td>
</tr>
<tr>
<td>Amt. of errors</td>
<td>1.31</td>
<td>1.43</td>
<td>1.92</td>
</tr>
</tbody>
</table>

*significant p < .05

**UTAUT Constructs**
A reliability analysis was performed to test the general reliability of the constructs of the UTAUT instrument. Numbers greater than 0.7 are considered acceptable in technology acceptance literature and any score above a 0.8 is considered “Good” (Venkatesh 2000, Venkatesh et al 2003). The results are summarized in Table 5. The UTAUT constructs appear to have a good degree of reliability for the constructs of Performance Expectancy, Effort Expectancy and Behavioral Intention to Use as they all are at .80 and above, or “Good” to “Excellent”. However, Social Influence is close to .70 for both sessions but it will be considered “acceptable” for this study.

Table 5 Reliability Analysis and Cronbach’s alpha

<table>
<thead>
<tr>
<th>Reliability</th>
<th>No. of Items</th>
<th>1st Session</th>
<th>2nd Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>4</td>
<td>0.79</td>
<td>0.873</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>4</td>
<td>0.931</td>
<td>0.925</td>
</tr>
<tr>
<td>Social Influence</td>
<td>3</td>
<td>0.677</td>
<td>0.689</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>3</td>
<td>0.931</td>
<td>0.97</td>
</tr>
</tbody>
</table>
The remaining dependent variables were from the UTAUT model and were collected after test sessions in the form of the standardized UTAUT questionnaires. The constructs that were pertinent for this study, as shown in the test model (figure 6), were the Performance Expectancy, Effort Expectancy, Social Influence and Behavioral Intention to use. The score for each construct is the simple addition of all the questions under that construct and analyzed in aggregate. The average score for each construct by each cohort is presented in Table 6 and Table 7 for each session respectively. A Mann-Whitney test was used to compare each group’s ratings of the constructs. First session construct values produced significant differences between the cohorts for Effort Expectancy, Social Influence and Behavioral Intention to use. The younger cohort rated Effort Expectancy and Behavioral Intention to use significantly higher than the older cohort and significantly lower for Social Influence. Meaning that the younger group found that the device was easier to use, more likely to use and believes they would need more support group around them than the older cohort. At the second session, only one such difference existed with the older cohort rating Effort Expectancy significantly lower than the younger cohort. Meaning that the older cohort found that the device was not as easy to use compared to the younger cohort.

Differences between first session responses to the constructs of the test UTAUT and the second session were analyzed by using the Wilcoxon test for each cohort. The Wilcoxon was used for its applicability for ordinal data or non-parametric data of paired data points.
The test produces that the only significant difference comes from the younger cohort for Performance Expectancy ($p = .035$) and Effort Expectancy ($p = .017$) where they rated both constructs significantly lower at the second session.

Table 6 Construct averages and p-values between cohorts first session

<table>
<thead>
<tr>
<th>Construct</th>
<th>Younger Cohort</th>
<th>Older Cohort</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Performance Expectancy</td>
<td>14.77</td>
<td>2.83</td>
<td>13.69</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>16.3*</td>
<td>3.98</td>
<td>12.54</td>
</tr>
<tr>
<td>Social Influence</td>
<td>7.15</td>
<td>1.57</td>
<td>8.46</td>
</tr>
<tr>
<td>Behavioral Intention to Use</td>
<td>11.07</td>
<td>2.95</td>
<td>9.077</td>
</tr>
</tbody>
</table>

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

Table 7 Construct averages and p-values between cohorts second session

<table>
<thead>
<tr>
<th>Construct</th>
<th>Younger Cohort</th>
<th>Older Cohort</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Performance Expectancy</td>
<td>16</td>
<td>3.06</td>
<td>13.85</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>18.46</td>
<td>2.15</td>
<td>14.92</td>
</tr>
<tr>
<td>Social Influence</td>
<td>7.69</td>
<td>1.44</td>
<td>8.077</td>
</tr>
<tr>
<td>Behavioral Intention to Use</td>
<td>11.15</td>
<td>3.11</td>
<td>9.54</td>
</tr>
</tbody>
</table>

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

Meaning that the younger cohort felt that the device was less useful and harder to use at the second session compared to the first. The results are found in Table 8.
A Spearman correlation analysis was conducted to determine the relationship between all test data at each session. The nonparametric Spearman correlation technique is useful here with the ordinal nature of the responses that may violate distribution assumptions for parametric tests. The results of this analysis are presented in Table 9. The constructs of the UTAUT at the first session did not produce any significant results that were correlated with the Behavioral Intention to Use. However, the second session constructs were all significantly correlated towards Behavioral Intention to Use. The DSST was negatively correlated with Social Influence at each session \((r = -.453\) and \(r = -.484\) respectively) and the amount of errors at the second session \((r = -.395)\). Effort expectancy second session was also negatively correlated with amount of errors second session \((r = -.492)\). Age is negatively correlated with task time and amount of errors at the second session only. Also, age is negatively correlated to DSST and Effort Expectancy at both sessions.
Table 9 Correlation of all test variables

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Age</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 DSST Score</td>
<td></td>
<td>-.435*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Training Time</td>
<td></td>
<td></td>
<td>-.146</td>
<td>.077</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Task Time 1st Session</td>
<td>.041</td>
<td>-.342</td>
<td>.008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Amount of Errors 1st Session</td>
<td>.121</td>
<td>.009</td>
<td>.261</td>
<td>.240</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Task Time 2nd Session</td>
<td>.528**</td>
<td>-.283</td>
<td>-.065</td>
<td>.273</td>
<td>.120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Amount of Errors 2nd Session</td>
<td>.459*</td>
<td>-.395*</td>
<td>-.051</td>
<td>.114</td>
<td>.112</td>
<td>.579**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Performance Expectancy 1st Session</td>
<td>.041</td>
<td>-.294</td>
<td>-.075</td>
<td>.131</td>
<td>.175</td>
<td>.106</td>
<td>.136</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Effort Expectancy 1st Session</td>
<td>-.392*</td>
<td>-.062</td>
<td>-.203</td>
<td>-.110</td>
<td>-.226</td>
<td>-.335</td>
<td>-.211</td>
<td>.317</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Attitude towards Technology 1st Session</td>
<td>-.157</td>
<td>-.160</td>
<td>-.024</td>
<td>.054</td>
<td>.135</td>
<td>.022</td>
<td>.204</td>
<td>.659**</td>
<td>.306</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Social Influence 1st Session</td>
<td>.316</td>
<td>-.453*</td>
<td>-.132</td>
<td>.217</td>
<td>-.285</td>
<td>.173</td>
<td>.212</td>
<td>.222</td>
<td>-.163</td>
<td>.221</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Behavioral Intention to Use 1st Session</td>
<td>-.313</td>
<td>-.063</td>
<td>.120</td>
<td>.263</td>
<td>.125</td>
<td>-.287</td>
<td>-.237</td>
<td>.345</td>
<td>.323</td>
<td>.314</td>
<td>.225</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Performance Expectancy 2nd Session</td>
<td>-.110</td>
<td>-.165</td>
<td>-.217</td>
<td>.207</td>
<td>.093</td>
<td>.061</td>
<td>.051</td>
<td>.811**</td>
<td>.327</td>
<td>.773**</td>
<td>.287</td>
<td>.438**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Effort Expectancy 2nd Session</td>
<td>-.490*</td>
<td>.066</td>
<td>-.299</td>
<td>-.015</td>
<td>.276</td>
<td>-.345</td>
<td>-.492*</td>
<td>.349</td>
<td>.591**</td>
<td>.240</td>
<td>-.052</td>
<td>.361</td>
<td>.561**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Social Influence 2nd Session</td>
<td>.296</td>
<td>-.484*</td>
<td>-.306</td>
<td>.291</td>
<td>-.272</td>
<td>-.055</td>
<td>.011</td>
<td>.397*</td>
<td>-.048</td>
<td>.172</td>
<td>.709**</td>
<td>.279</td>
<td>.417*</td>
<td>.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Behavioral Intention to Use 2nd Session</td>
<td>-.104</td>
<td>-.263</td>
<td>-.076</td>
<td>.273</td>
<td>.035</td>
<td>-.063</td>
<td>-.077</td>
<td>.665**</td>
<td>.208</td>
<td>.639**</td>
<td>.374</td>
<td>.632**</td>
<td>.847**</td>
<td>.529**</td>
<td>.580**</td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).
**Relationship between UTAUT Constructs**

The Unified Theory of Acceptance and Use of Technology (UTAUT) theorizes that the constructs of Performance Expectancy, Effort Expectancy and Social influence all predict and account for up to 70% of the variance of Behavioral Intention to Use (Venkatesh et al, 2003).

Behavioral Intention to Use is the extent of which the participant believes that they would use the device and, for this study, is considered the point of acceptance. A stepwise regression analysis was used to determine the relationship between the constructs of the UTAUT model for each session. A stepwise regression model was selected as it adds and removes variables both forward and backward one at a time based on the significance criteria placed in the analysis. Performance Expectancy, Effort Expectancy and Social Influence were entered as the independent variables, and the moderating variables DSST, age and task time, were entered as the newly formed interaction variables that are the multiplication results of each moderating and independent variable. Behavioral Intention to Use was entered as the dependent variable.

The stepwise regression test model of the first session was significant, $R^2 = .166$, $F(5,20) = 4.762$, $p = .039$. Therefore the resultant regression model is said to account for approximately 17% of the variance found in the dependent variable. The model’s only variable that was significant was the age moderating variable interacting with Effort Expectancy ($\beta = 0.407$, $p = .039$). All predictor variables were insignificant ($p > .105$). The results of the first session stepwise regression analysis can be found in Table 10. The regression equation for the first session is shown in equation 2.

$$BI = 10.695 + .407(Age \times EE)$$ (2)
Stepwise linear regression was again performed on the second session variables to determine the predictive relationships of the constructs of the UTAUT model. The second session test model was a significant test model, $R^2 = .606$, $F(5,20) = 11.272$, $p < .000$. Therefore the resultant regression model accounts for approximately 61% of the variance of the dependent variable Behavioral Intention to Use second session. The variables that were significant were Performance Expectancy ($\beta = .527$, $p < 0.008$) and Social Influence ($\beta = .379$, $p < 0.015$). The results from the second session stepwise regression analysis are listed in Table 11. The regression equation from the second session model is shown in equation 3, where BI is the Behavioral Intention to Use, PE is the Performance Expectancy and SI is Social Influence.

### Table 10. Stepwise regression analysis first session

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
<th>$R^2$ (adj. $R^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>-</td>
<td>-</td>
<td>0.283</td>
<td>1.562</td>
<td>0.132</td>
<td></td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>-</td>
<td>-</td>
<td>0.306</td>
<td>1.687</td>
<td>0.105</td>
<td></td>
</tr>
<tr>
<td>Social Influence</td>
<td>-</td>
<td>-</td>
<td>0.193</td>
<td>1.031</td>
<td>0.313</td>
<td></td>
</tr>
<tr>
<td>Age*PE</td>
<td>-</td>
<td>-</td>
<td>-0.123</td>
<td>-0.73</td>
<td>0.473</td>
<td></td>
</tr>
<tr>
<td>Age*EE</td>
<td>1.612</td>
<td>0.739</td>
<td>0.407</td>
<td>2.182</td>
<td>0.039*</td>
<td></td>
</tr>
<tr>
<td>Age*SI</td>
<td>-</td>
<td>-</td>
<td>-0.133</td>
<td>-0.702</td>
<td>0.491</td>
<td></td>
</tr>
<tr>
<td>Task time*PE</td>
<td>-</td>
<td>-</td>
<td>0.145</td>
<td>0.73</td>
<td>0.473</td>
<td></td>
</tr>
<tr>
<td>Task time*EE</td>
<td>-</td>
<td>-</td>
<td>-0.159</td>
<td>-0.839</td>
<td>0.411</td>
<td></td>
</tr>
<tr>
<td>Task time*SI</td>
<td>-</td>
<td>-</td>
<td>-0.008</td>
<td>-0.044</td>
<td>0.966</td>
<td></td>
</tr>
<tr>
<td>DSST*PE</td>
<td>-</td>
<td>-</td>
<td>0.293</td>
<td>1.624</td>
<td>0.118</td>
<td></td>
</tr>
<tr>
<td>DSST*EE</td>
<td>-</td>
<td>-</td>
<td>0.258</td>
<td>1.154</td>
<td>0.26</td>
<td></td>
</tr>
<tr>
<td>DSST*SI</td>
<td>-</td>
<td>-</td>
<td>0.002</td>
<td>0.01</td>
<td>0.992</td>
<td></td>
</tr>
</tbody>
</table>

*significant $p < .05$

PE is Performance Expectancy, EE is Effort Expectancy, SI is Social Influence and DSST is Digit Symbol Substitution Test
\[ BI = -4.719 + .562(PE) + .379(SI) \] (3)

Table 11 Stepwise regression analysis second session

<table>
<thead>
<tr>
<th>Predictor</th>
<th>B</th>
<th>SE</th>
<th>( \beta )</th>
<th>t</th>
<th>p</th>
<th>( F )</th>
<th>( p )</th>
<th>( R^2 ) (adj. ( R^2 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>0.527</td>
<td>0.182</td>
<td>0.559</td>
<td>2.897</td>
<td>0.008*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>-</td>
<td>-</td>
<td>0.005</td>
<td>0.027</td>
<td>0.979</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Influence</td>
<td>0.908</td>
<td>0.344</td>
<td>0.379</td>
<td>2.643</td>
<td>0.015*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age*PE</td>
<td>-</td>
<td>-</td>
<td>-0.071</td>
<td>-0.497</td>
<td>0.618</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age*EE</td>
<td>-</td>
<td>-</td>
<td>-0.111</td>
<td>-0.816</td>
<td>0.425</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age*SI</td>
<td>-</td>
<td>-</td>
<td>0.059</td>
<td>0.445</td>
<td>0.658</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task time*PE</td>
<td>-</td>
<td>-</td>
<td>-0.16</td>
<td>-1.219</td>
<td>0.227</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task time*EE</td>
<td>-</td>
<td>-</td>
<td>-0.238</td>
<td>-1.784</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Task time*SI</td>
<td>-</td>
<td>-</td>
<td>-0.038</td>
<td>-0.268</td>
<td>0.786</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSST*PE</td>
<td>-</td>
<td>-</td>
<td>0.134</td>
<td>1.111</td>
<td>0.259</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSST*EE</td>
<td>-</td>
<td>-</td>
<td>0.105</td>
<td>0.717</td>
<td>0.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DSST*SI</td>
<td>-</td>
<td>-</td>
<td>-0.047</td>
<td>-0.319</td>
<td>0.757</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*significant \( p < .05 \)

PE is Performance Expectancy, EE is Effort Expectancy, SI is Social Influence and DSST is Digit Symboly Substitution Test

Performance Expectancy is the extent to which the participants believes that using the device would be helpful in accomplishing their goal (in this case monitoring their blood pressure) thus, in the second session test model, the results showed that any increase in the participants perception that using the device would be beneficial in their health monitoring would lead to higher acceptance and intention to use the device. Social Influence is the participants’ belief that using the device would be supported by close friends, family and colleagues at work. As with
Performance Expectancy, this result showed that participants’ belief that they would have support from the important people in their life would make them more likely to use the device.

**Hypotheses**

**H₁**: There is no difference in task time and errors between initial session and second session for each cohort.

Hypothesis 1 is only marginally supported as only the older cohort showed a significant difference between the first test session and the second test session. The older cohort took significantly longer to complete the task at the second session as compared to their first session time (p = .013). The older cohort did not produce more errors at the second session as compared to their first session. Results are listed in Table 12.

<table>
<thead>
<tr>
<th>Task time</th>
<th>Younger Cohort</th>
<th>Older Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Errors</td>
<td>Fail to reject</td>
<td>Rejected</td>
</tr>
</tbody>
</table>

**H₂**: There is no difference between constructs ratings of the UTAUT between the first and the second session for either cohort

Only the younger cohort had any significant differences between the first session’s UTAUT and their second session. The younger cohort’s Performance Expectancy and Effort Expectancy both decreased significantly at the second session. Performance Expectancy is the degree of usefulness the device can provide and Effort Expectancy is the degree of ease of use of the device. These results show that younger adults felt the device became less useful and harder to use at the second session as compared with the first. Results are listed in Table 13.
Table 13 Hypothesis 2 outcomes

<table>
<thead>
<tr>
<th></th>
<th>Younger Group</th>
<th>Older Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>Reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>Reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>Social Influence</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>Behavioral Intention to Use</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
</tbody>
</table>

**H3**: There is no relationship between the predictor constructs of the UTAUT and the Behavioral Intention to Use

**H3a**: Performance Expectancy will have a positive influence on Behavioral Intention to Use at each session.

**H3b**: Effort Expectancy will have a positive influence on Behavioral Intention to Use at each session.

**H3c**: Social Influence will have a positive influence on Behavioral Intention to Use first at each session.

The results marginally support the hypothesis. The regression analysis for the first session does not find any connection between the predictor variables of the UTAUT with the dependent variable Behavioral Intention to Use at the first session. However, for the second session, the regression analysis found that the Performance Expectancy ($\beta = .559$, $p = .008$) and Social Influence ($\beta = .379$, $p = .015$) were positively predictive of Behavioral Intention to Use. These constructs together account for approximately 61% of the variance found in Behavioral Intention to Use. Results are listed in Table 14.
**Table 14 Hypothesis 3 outcomes**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>First Session</th>
<th>Second Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>H3a</td>
<td>Fail to reject</td>
<td>Reject</td>
</tr>
<tr>
<td>H3b</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H3c</td>
<td>Fail to reject</td>
<td>Reject</td>
</tr>
</tbody>
</table>

**H4:** Age does not moderate any of the constructs of the UTAUT onto Behavioral Intention to use at each session

**H4a:** The positive effect of performance expectancy on the intention to use is moderated by age at each session

**H4b:** The positive effect of performance expectancy on the intention to use is moderated by age at each session

**H4c:** The positive effect of performance expectancy on the intention to use is moderated by age at each session.

Age was found to moderate Effort Expectancy at the first session. The interaction effect between these two variables shows that the effect of Effort Expectancy on Behavioral Intention to Use depends on the age of the individual. If the participant is older, how high they rate Effort Expectancy was strongly related to Behavioral Intention to Use. Results are listed in Table 15.

**Table 15 Hypothesis 4 outcomes**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>First Session</th>
<th>Second Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>H4a</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H4b</td>
<td>Reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H4c</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
</tbody>
</table>

**H5:** Task time will not moderate any of the constructs of the UTAUT onto Behavioral Intention to Use at each session

**H5a:** The positive effect of performance expectancy on the intention to use is moderated by task time at each session
**H5b:** The positive effect of performance expectancy on the intention to use is moderated by task time at each session

**H5c:** The positive effect of performance expectancy on the intention to use is moderated by task time at each session

The participants’ task time did not moderate any of the constructs at either session. Results are listed in Table 16.

**Table 16 Hypotheses 5 outcomes**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>First Session</th>
<th>Second Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>H5a</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H5b</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H5c</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
</tbody>
</table>

**H6:** The DSST score will not moderate any of the predictor constructs of the UTAUT onto Behavioral Intention to Use at each session.

**H6a:** The positive effect of performance expectancy on the intention to use is moderated by DSST at each session

**H6b:** The positive effect of performance expectancy on the intention to use is moderated by DSST at each session

**H6c:** The positive effect of performance expectancy on the intention to use is moderated by DSST at each session

The participants’ DSST score did not moderate any of the constructs at either session. Results are listed in Table 17.

**Table 17 Hypothesis 6 outcomes**

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>First Session</th>
<th>Second Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>H6a</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H6b</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
<tr>
<td>H6c</td>
<td>Fail to reject</td>
<td>Fail to reject</td>
</tr>
</tbody>
</table>
DISCUSSION

The purposes of this study were to determine if performance when using a novel medical device had any resulting effect on the participants’ acceptance and intent to use the medical device, and whether age related deficiencies in performance after a retention period could be related to the participants’ acceptance and intent to use the medical device. Previous research on acceptance of medical technology has not attempted to understand the link between age related performance decrements and acceptance on consumer medical technology.

Task performance results showed that, for the younger cohort, task time (speed) and amount of errors (accuracy) did not degrade after the one week interval. The older cohort did match the younger group in task time at the first session however, after the one week interval, the older cohort experienced a significant time degradation from the initial session. The older cohort took, on average, an additional 2 minutes to complete the task. The degradation for the older cohort was significant between sessions. This finding partially supports $H_1$ for the older cohort’s performance did degrade across sessions but younger cohort’s performance remained similar. The older cohort also took significantly longer than the younger cohort at the second session. The performance and accuracy degradation by the older cohort is consistent with previous studies’ findings of older adults’ usage of technology. For instance, other studies found that older adults require more time to complete tasks and perform more errors than younger adults during initial training and retention testing for technology-related tasks such as PDAs (Mayhorn, Lanzolla, Wogalter, & Watson, 2005) and blood glucometers (Mykityshyn, Fisk, & Rogers, 2002).

The difference between sessions for each construct was analyzed to determine if, after a one-week interval, either cohort would respond differently to the UTAUT – especially for Behavioral
Intention to Use, the point of acceptance for this study. Only the younger cohort had any significant difference between sessions for any of the constructs. Therefore $H_2$ is only partially supported. The younger cohort rated Performance Expectancy and Effort Expectancy significantly lower at the second session compared to the first. This means that the younger cohort, after coming back from the retention interval, perceived that using the device would require more effort and the device would be less useful. However, this finding was not mirrored with the older age cohort who had a large increase in task time at the second session compared to the younger group which was hypothesized to influence UTAUT construct ratings. This may be because older adults are more concerned with actively addressing their health needs as they age. This study did ask the participants to rate their Heart Health Concern on a 5 point Likert scale, however no significant difference was found between cohorts.

The UTAUT regression model for this study was only partially supported. The regression analyses done for the first session did not reveal any significant predictive results or relationships from any of the UTAUT predictors (Performance Expectancy, Effort Expectancy and Social Influence). The second session regression analysis found that Performance Expectancy and Social Influence did significantly predict the Behavioral Intention to use, but not Effort Expectancy. These results only partially supported $H_3$. Performance Expectancy can be thought of as the “perceived usefulness” of the device and Social Influence is the perceived support structure of the participant. These results show that thinking the device would be helpful to accomplish goals and having strong support from friends and family positively influences a participant’s intention to use the device. Being at the second session, participants may be relying more on their memory and their ability to use the device which may explain whether their perceived device usefulness and support structure became significant.
The chronological age of participants has been shown to be a moderating factor in previous studies on the predictors of the UTAUT (Venkatesh et al. 2003, Venkatesh et al, 2012). For this study age was only found to moderate Effort Expectancy at the first session. The effect shows that for older participants the link between Effort Expectancy and Behavioral Intention to Use became stronger at the first session. H4 pertained to the moderating effects of age on the predictor constructs and is found to be only partially supported as only Effort Expectancy from the first session was found to have any moderating effect with age. Stated in another way, for older adults the easier a device is to use at first trial the more likely he/she would rate that they would use the device.

Task time was hypothesized to moderate the constructs of the UTAUT but did not influence any construct at either session. H5 is therefore not supported. This result may be due to the fact that participants were asked to concentrate on accuracy and take their time to complete the required task. By having the participants concentrate on accuracy allowed the participants to take the amount of time he/she felt was need to perform the task and not rush through it. This was done so to better simulate the unique nature of medical devices as perceived by a potential patient in their own home. Medical technology is different than information technology in that instead of pertaining to one’s job performance, as is the case with most pervious acceptance studies (Venkatesh et al, 2012), medical technology is directly related to one’s health and wellbeing. Thus, participants may be more determined to use the device to better his/her health or feel, that given time, they would be able to use the device at its full potential.

Individual differences of test participants have been shown to moderate constructs of the UTAUT however, very little research has been done on the differences of participants’ cognitive strength and how it relates to acceptance. In this study, the Digit Symbol Substitution Test,
DSST, was used as a measure of the strength of the participants’ cognitive ability as it has been shown to be a good barometer of performance (Hoyer, et al. 2004). The DSST was included in the regression analysis as a moderator for all constructs at each session but did not produce any significant interaction for either session. Thus, H6 is not supported. This result provides that the cognitive strength of the participant, as measured by the DSST, does not influence the participants’ acceptance of the medical device.

Ultimately, this study’s goal was to determine if performance of a task on a medical device has any influence or relation to the acceptance. Previous research on the acceptance of medical technology did not include personal moderating factors such as cognitive strength. Cognitive strength, as measured by the DSST, in this study did not moderate any of the constructs of the UTAUT but did correlate to the performance at the second session where participants had to retain their knowledge to perform the required tasks. The results showed that there is a difference between the cohorts for Task Time at the second session where the older cohort took longer to finish the task. However, the performance difference found did not translate into any predictive nature towards the participants’ belief that they would use the device. As well as age related deficiencies, as measured by the DSST, no link was found between cognitive ability and acceptance. The lack of any relationship between task time and cognitive strength with Behavioral Intention to Use could come from the nature of the device. Being a medical device, the desire to use in order to better one’s health could trump any frustrations and difficulty in using the device.

**Implications**

This study shows that older participants took longer to perform the task after a week retention period of non-use. The retention period could be thought of as the length of time that the patient
would bring the device home to use themselves. Older adults do not retain their performance level after the one week retention interval with an increase in time on task and amount of errors. The performance decline and difference between the younger cohort was found to not be associated with the cognitive strength of the individual and thus must have some other underlying cause. Manufacturers of at-home consumer health devices should devise a quick reference guide or “cheat-sheet” to support older adults with their needing to review the entire manual included with the device. The manufactures could also design the device to automate many of the steps to limit the amount of steps that the individual would need to remember to adequately use the device to its full potential. Also, prescribing doctors or health facilities should take an active role in training older adults to better retain operational skills by way of different training modalities (i.e., one on one teaching, video training, etc.).

Limitations
Limitations of this study exist with the small sample size of only 26 total participants. Previous studies using the unified theory of acceptance and use of technology (UTAUT) have given out over 100 questionnaires (Venkatesh et al 2003) for their studies to give more power to their results. The UTAUT was originally developed for IT acceptance in one’s workplace and may not be suited, as its current state, for medical technology. Also, the older adults may not have been a true representative sample of the older ailing population as they all possessed at least some college education and, because they were all employees of a community college, where more familiar with technology as they used computers on a daily basis. The older adults also were all still of working age with an average of 63.5 years old and all still working full time. Also, a previous study has shown that DSST scores, a measure of cognitive strength, decline as one ages with the largest and deepest decline occurring after one reaches the age of 70 (Salthouse, 1992).
Therefore, the older adults could be considered to be too “young” and healthy for being representative of the target market of at home medical devices.

**Future Research**
Future research could be undertaken to attempt to reveal other predictors or moderators that may explain more of the variance found in behavioral intention to use and to make the UTAUT more appropriate for medical technology or create an entirely new model. Participants could be recruited from health centers when they are prescribed the devices. In this study, the participants were selected from a college student population and full time work force that probably did not produce an accurate representation of the ailing population. A more representative sample of older adults where they are above retirement age and experience more health issues may produce results that show more of a distinction between older adults and younger adults in performance which may in turn produce results that differ in the UTAUT. Research might also examine whether different modalities of and targeted training for older adults would help augment and improve performance and therefore the acceptance after an initial training period. Furthermore, using
CONCLUSIONS

As the baby boomers age and healthcare costs continue to rise, more and more individuals may try to monitor their own health in the convenience of their homes. However, older adults may have trouble learning and using novel technology even if it were to benefit their health. This study showed that older adults’ ability to perform tasks after a retention period is lacking when compared to younger adults. However, this performance decline after the retention interval did not result in a decline in the participants’ intention to use the device, showing that even with difficulty when using a new novel medical device the older adults still rated that they would intend to use the device similarly to the younger cohort. Older adults may struggle with learning and performing on novel technology but, when the device is related to improving their health, they still rate that they would use the device despite performance issues.
REFERENCES


APPENDIX 1

1. Study Title
The differences of age-related performance across a one week interval and its correlation to the Unified Theory of Acceptance and Use of Technology (UTAUT) on an at home medical device and eHealth system.

2. Performance Site
LAB room 3413 Patrick Taylor Hall, Louisiana State University and Agricultural and Mechanical College - Baton Rouge, Louisiana & Bossier Parish Community College, Bossier City Louisiana.

3. Investigators
Dr. Laura Ikuma, Advisor (225) 578-5364
Drew Ford, Grad student (318) 540-9600

4. Purpose of Study
The purpose of this thesis study is to determine the Acceptance and performance of an at home medical device over a 1 week period.

5. Subject Inclusion
Individuals in two age groups
Group A (ages 18-28)
Group B (ages 60+)

6. Number of participants
30

7. Study Procedures
The study will be conducted on two days separated by one week. On the first day, participants will fill out a demographic questionnaire, perform a 90 second memory test, study an operating manual to use device, then perform assigned tasks on the device and finally answer a multi-part questionnaire on their feelings towards using the device. One week later the test will be repeated only for using the device and filling out the questionnaire.
Initial testing period would take between 1 and 1½ hours
Second testing period would take 30 minutes

8. Benefits
Group A will receive extra credit in their classes with approval of their professors
Group B will not have any direct benefit

8. Risks
The blood pressure cuff is automatic in its function and will inflated and constrict around the upper arm of the participant which may cause undue stress and discomfort

9. Right to refuse
Participants may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board,(225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Participant Signature____________________________________________________________Date_______________

10. Privacy Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless law requires disclosure.
APPENDIX 2

Demographic questionnaire

Participant # ________

1. Age: ________

2. Gender: ___ Male ___ Female

3. Which category best describes your educational status?
   a) Did not finished high school
   b) High school
   c) Some college
   d) 2-year degree
   e) 4-year degree
   f) Grad school

4. How often do you use a computer?
   a) Hardly ever
   b) Rarely
   c) Sometimes
   d) Often
   e) Daily

5. Are you familiar with home automatic Blood pressure devices?
   a) Yes:
   b) No

6. Do you currently or ever used an at home blood pressure device?
   a) Yes
   b) No
APPENDIX 3

Digit Symbol--Coding

```
1 2 3 4 5 6 7 8 9
```

Sample Items

```
2 1 3 7 2 4 8 2 1 3 2 1 4 2 3 5 2 3 1 4
5 6 3 1 4 1 5 4 2 7 6 3 5 7 2 8 5 4 6 3
7 2 8 1 9 5 8 4 7 3 6 2 5 1 9 2 8 3 7 4
6 5 9 4 8 3 7 2 6 1 5 4 6 3 7 9 2 8 1 7
9 4 6 8 5 9 7 1 8 5 2 9 4 8 6 3 7 9 8 6
2 7 3 6 5 1 9 8 4 5 7 3 1 4 8 7 9 1 4 5
7 1 8 2 9 3 6 7 2 8 5 2 3 1 4 8 4 2 7 6
```
## APPENDIX 4

1. **I find the device useful in my health management.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

2. **Using the device enables me to accomplish tasks more quickly.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

3. **Using device increases my productivity.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

4. **Using the device increases my ability to have accurate results.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

5. **My interaction with the device is clear and understandable.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

6. **It is easy for me to become skillful at using the device.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

7. **I find the device easy to use.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

8. **Learning to operate the device is easy for me.**
   - 1. Strongly Disagree
   - 2. Somewhat Disagree
   - 3. Neutral
   - 4. Somewhat Agree
   - 5. Strongly Agree

9. **People who influence my behavior would want me to use the device.**

10. **People who are important to me would want me to use the device.**

11. **I can finish a task using the device, if there is no one around to tell me what to do as I go.**

12. **I can complete a task using the device, if I can call someone for help if I get stuck.**

13. **I can complete a task using the device, if I have a lot of time to complete the job for which the software is provided.**

14. **I feel apprehensive about using the device.**

15. **It scares me to think that I could lose a lot of information using the device by hitting the wrong key.**

16. **I hesitate to use the device for fear of making mistakes I cannot correct.**

17. **The device is somewhat intimidating to me.**
<table>
<thead>
<tr>
<th></th>
<th>1. <strong>Strongly Disagree</strong></th>
<th>2. <strong>Somewhat Disagree</strong></th>
<th>3. <strong>Neutral</strong></th>
<th>4. <strong>Somewhat Agree</strong></th>
<th>5. <strong>Strongly Agree</strong></th>
</tr>
</thead>
</table>
VITA

Drew Ford began his academic career at Louisiana Tech University where he obtained two degrees, one in Biomedical Engineering and another in Electrical Engineering in 2009. In 2010 he enrolled in the graduate school for his Masters of Science in Industrial Engineering. He is currently working full time at Hewlett-Packard as a Usability engineer in Plano, Texas.