Designing Wellness Tools for and with Older Adults

Jonathan Joe

A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
University of Washington
2015

Reading Committee:
George Demiris, Chair
Hilaire Thompson
Anne M. Turner

Program Authorized to Offer Degree:
Biomedical Informatics and Medical Education

University of Washington

Abstract

Designing Wellness Tools for and with Older Adults

Jonathan Joe

Chair of the Supervisory Committee:
Professor George Demiris
Biomedical Informatics and Medical Education

Over the past few decades, the use of new technologies such as computing and internet technology, has expanded rapidly. The emergence of these new technologies has created opportunities for health related uses. With the growing older adult population, there has been increased interest in using tools to support aging, health, and wellness of the older adult population. While technologies have been used with older adults for purposes such as symptom management and cognitive training, many technologies are not designed with older adults in mind. While there have been some studies that look at the usability of a single component, there have been few studies looking at a technology platform that integrates several features together. Designing specifically for older adults is important since this population has its own unique health and information needs.

This dissertation includes 3 studies that exploring the wants and needs of older adults for integrated, multifunctional health and wellness tools. The first study seeks to understand the attitudes and preferences towards a multifunctional wellness tool via 3 focus group sessions. The

second study identifies usability issues of a popular, commercially available wellness tool to generate recommendations on what issues to avoid in newly designed wellness tools by usability testing a commercially available multifunctional wellness tool with 5 participants. This study also successfully used the novel method of instant data analysis for usability testing analysis, and discusses the results of both the use of the method and stability issues identified using IDA. The third and final study solicited the reactions and feedback of older adults to 5 scenarios and storyboards showing design ideas generated after the first two phases, and via participant sketches for their ideal wellness tool. Results from these studies help to better understand older adults' perceptions, attitudes and issues with potential wellness tools and inform the design of new effective and efficient systems for older adults. Factors that future designers should consider when creating new multifunctional wellness tools include older adults' unmet need of reliable health information, ease of use in multifunctional wellness tools and biophysical changes that may affect how they interface with new technologies.

Table of Contents

List of Figures

List of Tables

Designing Wellness Tools for and with Older Adults

Chapter 1: Introduction

Significance of Problem

Over the next two decades, the number of older adults aged 65 year or older in the United States is projected to grow rapidly, rising from 40 million individuals in 2010 to 72 million individuals in 2030(1), an 80% increase over the next 2 decades. In the subsequent decades, the number of older adults living in the US is expected to continue to grow. The proportion of older adults reporting chronic diseases has also trended upwards, with 92% of older adults reporting one or more chronic diseases in 2008, compared to 87% in 1998(2). Furthermore, 53% of older adults report impairments in vision, hearing, cognition or mobility. Importantly, impairments may be considered a progression between chronic disease and disability(3), such as a condition that causes mobility impairments progressing to the point where an individual cannot carry out the activities of daily living. As an individual ages, there is an increased likelihood of having multiple comorbidities or health problems, leading to an increasing need for health or health-related interventions(4) that meet older adults' unique wants and needs.

In contrast to a focus on disease, efforts have increasingly been geared towards promotion of wellness and well-being across the lifespan(5). Wellness consists of more than an absence of disease (physical wellness); it also includes other dimensions such as cognitive wellness, spiritual wellness, and social wellness which factor into an individual's overall wellness(6,7). For those aged 65 or older, relationships with family and friends was ranked as the second most important thing in life after their own health(8). Family and social contacts were two of the most substantial areas of importance in quality of life of older adults(9). The

prevalence of isolation among older adults has been estimated to be between 2 and 20 percent(10). In fact, the health–related risk of social isolation among older adults has been compared to smoking in the general population in terms of magnitude(11). Several studies support the association between social isolation and poor mental and physical health outcomes in older adults. Those individuals experiencing social isolation showing a higher incidence of depressive symptoms, worse cognition, poor sleep, and higher blood pressure(12–14). Consequently, there is an increased need for interventions to promote holistic wellness in older adults. This need for interventions is amplified by the continually growing older adult population and technology can play an important role in meeting this need.

Technologies for Health

Over the past few decades, the use of computers and internet technologies has expanded rapidly. New technologies have led to use of new interventions to support health and wellness. For example, several studies have been conducted with older adults to use internet technologies to combat social isolation, and to alleviate feelings of loneliness and isolation(15,16). Interventions included online courses with interaction between participants(17), as well as computer, internet and email training to reduce loneliness and isolation among older adults(18–22). Furthermore, cognitive training programs have been shown to improve the cognitive abilities of older adults(23–25). These improved cognitive abilities on daily activities are sustained even when measured across years since the initiation of the intervention(26). The effectiveness of these interventions has led to interest in using computerized cognitive training in order to more widely and cheaply disseminate the intervention(27).

Within the United States, an increasing number of adults subscribe to mobile telephony services, rising from 44.2% penetration(28) in 2001 to 83% penetration(29) in 2007. Older adults, often viewed as laggards in technology adoption(30), have also adopted mobile telephones at a high rate. In the US, almost 70% of older adults use a mobile telephone, which is higher than desktop use (48%) and laptop use (32%) (29). Mobile phones have become increasingly ubiquitous among the population, and thus serve as an attractive platform for health and wellness interventions(31–33). Health and wellness interventions have ranged from giving feedback to patients based on their data(34–36), detecting worsening symptoms early resulting in a significantly reduced length of a hospital stay(37), to tracking wandering persons with dementia(38). Mobile phones have been used across many types of conditions including: symptom management to diminish the adverse effects of chemotherapy (39,40), management of diabetes via self-care advice alerts(35,41), and symptom monitoring and intervention reinforcement for exercise for chronic obstructive pulmonary disease(34,42). The connectivity of mobile phones has allowed personalized feedback based on data(36,43) and automated alerts to their healthcare provider(35,37).

While many more people are using mobile, computer and internet technologies, the usability of these technologies has been lagging for older adults, who have their own unique needs(44,45). As older adults age, they experience changes in attention and learning as well as declines in visual sharpness, fine motor control and dexterity, which can affect how they interface with technologies(45,46). Of these changes, visual deterioration is especially clear, with reduced contrast sensitivity and color sensitivity becoming more pronounced as people age (47,48). There is also reduced sensitivity to stimuli in the peripheral vision(49). In addition, the ability to estimate and perceive depth accurately decreases as people age, with more rapid declines occurring between the ages of 40 and 50(50). Visual declines may make technologies

more difficult to use. Furthermore, older adults are more risk-averse and have greater decreases in speed in performing tasks after making errors than younger age groups. Subsequently, older adults are less willing to try new methods when existing methods are still working, and they do not wish to be a burden on others by seeking help(51).Thus, it is especially important to design intuitive interfaces for older adults, so as to facilitate their use of new technologies. As the older adult population grows, life expectancy and healthcare costs are expected to increase. Technology may be a solution but to date it has not specifically addressed older adults' needs, so their needs should be explored.

Previous work has looked at the usability of a single technology component, such as chronic disease management(35), touchscreens (52), and health-related websites (44,53). Yet there have been a minimal number of studies that look at technologies that combine several of these components. While the usability of single-purpose tools is important, an integrated tool may be more attractive because it could reduce the need for additional training and integrate fragmented healthcare processes among the growing older adult population. Preliminary work needs to be carried out to establish the wants and needs of older adults to increase the perceived usefulness and effectiveness of such an integrated tool.

In summary, even though there is increased interest in older adult wellness and care, there has not been a concomitant increase in research for integrated health and wellness tools for older adults. Since older adults are often slow to adopt new technologies for a number of reasons, care needs to be taken into creating new technologies for their use. Previous research shows that older adults are willing to adopt new technologies if they are perceived as effective and useful(54–57). Preliminary work needs to be conducted to explore the attitudes, needs, preferences, and barriers towards an integrated technology tool for health and wellness. Designers of future tools can use results from these user studies for guidance so that that older

adults will want to use the wellness tools being designed, while minimizing frustration of older adults by avoiding barriers to use.

Statement of Study Purpose

There are three main objectives to this research:

Aim 1: To explore the attitudes, needs, preferences, and potential barriers to use of older adults towards a community-based, multifunctional, integrated technology tool for health, social interaction and entertainment.

Aim 2: To examine usability issues and barriers, including navigation of a community based, integrated, multifunctional technology tool by testing a commercially available technology for older adults.

Aim 3: To explore and create scenarios and storyboards for a novel tool targeting health and wellness intended for older adults and solicit feedback on them.

Content of the Dissertation

The dissertation consists of four main parts. In chapter 2, study results are presented from 5 focus groups conducted with older adults to examine their attitudes towards multifunctional technology tools for wellness. This chapter includes their likes, dislikes, and what they would find to be a barrier or facilitator in use of such a tool. This study provides insight into key factors that could make a multifunctional wellness tool attractive for adults so as to encourage uptake.

In chapter 3, the findings are presented from a usability test conducted with a commercially available multifunctional wellness tool. Using a combination of instant data analysis and affinity mapping, themes were generated regarding the issues that participants had with the device. These themes were generated from participants as they performed tasks, and they suggested factors that future designers should avoid when design wellness tools for older adults.

In chapter 4, the results are presented from a study that solicited feedback on design ideas presented in the form of scenarios and storyboards. These design ideas were generated after taking into account the themes and conclusions from the studies presented in chapters 2 and 3. This chapter suggests ideas that should be taken into account when designing a wellness tool for this population, including what older adults may find attractive or unattractive.

Finally, this document briefly summarizes the results of all studies in chapter 5. Then, the challenges and opportunities related to wellness tools designed for older adults are discussed.

References for Chapter 1

1. US Census Bureau. The Next Four Decades: The Older Population in the United States: 2010 to 2050. 2010.

2. Hung WW, Ross JS, Boockvar KS, Siu AL. Recent trends in chronic disease, impairment and disability among older adults in the United States. BMC Geriatr [Internet]. BioMed Central Ltd; 2011 Jan [cited 2013 Feb 22];11(1):47. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3170191&tool=pmcentrez&rendertype=abstract

3. Verbrugge LM, Jette AM. The disablement process. Soc Sci Med [Internet]. 1994 Jan [cited 2013 Feb 22];38(1):1–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8146699

4. Anderson G, Horvath J. The growing burden of chronic disease in America. Public Health Rep [Internet]. 2004;119(3):263–70. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1497638&tool=pmcentrez&rendertype=abstract

5. McMahon S, Fleury A. Wellness A concept analysis. Nurs Forum. 2012;47(1):39–51.

6. Dunn HL. High-level wellness for man and society. Am J Public Health Nations Health [Internet]. 1959 Jun [cited 2013 Feb 22];49(6):786–92. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1372807&tool=pmcentrez&rendertype=abstract

7. Hoyman HS. Rethinking an ecologic-system model of man's health, disease, aging, death. J Sch Health [Internet]. 1975 Nov [cited 2013 Feb 25];45(9):509–18. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1042431

8. Bowling A. What things are important in people's lives? A survey of the public's judgements to inform scales of health related quality of life. Soc Sci Med [Internet]. 1995 Nov [cited 2013 Apr 23];41(10):1447–62. Available from: http://linkinghub.elsevier.com/retrieve/pii/027795369500113L

9. Farquhar M. Elderly people's definitions of quality of life. Soc Sci Med [Internet]. 1995 Nov [cited 2013 Apr 23];41(10):1439–46. Available from: http://linkinghub.elsevier.com/retrieve/pii/027795369500117P

10. Victor C, Scambler S. Being alone in later life: loneliness, social isolation and living alone. Rev Clin Gerontol [Internet]. 2000 [cited 2014 Feb 20];10(March 2001):407–17. Available from: http://journals.cambridge.org/production/action/cjoGetFulltext?fulltextid=66728

11. House JS. Social isolation kills, but how and why? Psychosom Med [Internet]. 2001;63(2):273–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11292275

12. Luanaigh CO, Lawlor BA. Loneliness and the health of older people. Int J Geriatr Psychiatry [Internet]. 2008 Dec [cited 2012 Nov 19];23(12):1213–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18537197

13. Helve J, Krause U. Loneliness, health and depression in older males. Acta Ophthalmol [Internet]. 2009 May 27 [cited 2013 May 10];50(6):896–900. Available from: http://doi.wiley.com/10.1111/j.1755-3768.1972.tb06628.x

14. Dickinson WJ, Potter GG, Hybels CF, McQuoid DR, Steffens DC. Change in stress and social support as predictors of cognitive decline in older adults with and without depression. Int J Geriatr Psychiatry [Internet]. 2011 Dec [cited 2012 Nov 19];26(12):1267–74. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21370277

15. Findlay R a. Interventions to reduce social isolation amongst older people: where is the evidence? Ageing Soc [Internet]. 2003 Sep [cited 2012 Nov 14];23(5):647–58. Available from: http://www.journals.cambridge.org/abstract_S0144686X03001296

16. Dickens AP, Richards SH, Greaves CJ, Campbell JL. Interventions targeting social isolation in older people: a systematic review. BMC Public Health [Internet]. BioMed Central Ltd; 2011;11(1):647. Available from: http://www.biomedcentral.com/1471-2458/11/647

17. Swindell R. Technology and the over 65s? Get a life. Soc Altern [Internet]. 2001 [cited 2014 May 1];20(1):17–23. Available from: http://www98.griffith.edu.au/dspace/handle/10072/3803

18. White H, McConnell E, Clipp E, Bynum L, Teague C, Navas L, et al. Surfing the Net in Later Life: A Review of the Literature and Pilot Study of Computer Use and Quality of Life. J Appl Gerontol. 1999;18(3):358–78.

19. Slegers K, van Boxtel MPJ, Jolles J. Effects of computer training and Internet usage on the well-being and quality of life of older adults: a randomized, controlled study. J Gerontol B Psychol Sci Soc Sci [Internet]. 2008;63(3):P176–84. Available from: http://cat.inist.fr/?aModele=afficheN&cpsidt=26936262

20. White H, McConnell E, Clipp E, Branch LG, Sloane R, Pieper C, et al. A randomized controlled trial of the psychosocial impact of providing internet training and access to older adults. Aging Ment Health [Internet]. 2002 Aug [cited 2014 May 1];6(3):213–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12217089

21. Fokkema T, Knipscheer K. Escape loneliness by going digital: a quantitative and qualitative evaluation of a Dutch experiment in using ECT to overcome loneliness among older adults. Aging Ment Health. 2007;11(5):496–504.

22. Shapira N, Barak a, Gal I. Promoting older adults' well-being through Internet training and use. Aging Ment Health. 2007;11(5):477–84.

23. Mahncke HW, Connor BB, Appelman J, Ahsanuddin ON, Hardy JL, Wood R a, et al. Memory enhancement in healthy older adults using a brain plasticity-based training program: a randomized, controlled study. Proc Natl Acad Sci U S A [Internet]. 2006 Aug 15;103(33):12523–8. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1526649&tool=pmcentrez&rendertype=abstract

24. Ball K, Berch DB, Helmers KF, Jobe JB, Leveck MD, Marsiske M, et al. Effects of cognitive training interventions with older adults: a randomized controlled trial. JAMA [Internet]. 2002 Nov 13 [cited 2013 Mar 8];288(18):2271–81. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2916176&tool=pmcentrez&rendertype=abstract

25. Kueider AM, Parisi JM, Gross AL, Rebok GW. Computerized cognitive training with older adults: a systematic review. PLoS One [Internet]. 2012 Jan [cited 2012 Nov 15];7(7):e40588. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3394709&tool=pmcentrez&rendertype=abstract

26. Willis SL, Tennstedt SL, Marsiske M, Ball K, Elias J, Koepke KM, et al. Long-term effects of cognitive training on everyday functional outcomes in older adults. JAMA [Internet]. 2006 Dec 20;296(23):2805–14. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2910591&tool=pmcentrez&rendertype=abstract

27. Rebok GW, Carlson MC, Langbaum JBS. Training and maintaining memory abilities in healthy older adults: traditional and novel approaches. J Gerontol B Psychol Sci Soc Sci [Internet]. 2007 Jun;62 Spec No(I):53–61. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17565165

28. CTIA. Semi-Annual Wireless Industry Survey. 2011.

29. Smith A. Americans and Their Cell Phones [Internet]. 2011. Available from: http://pewinternet.org/Reports/2011/Cell-Phones.aspx

30. Smith A. Older Adults and Technology Use [Internet]. 2014. Available from: http://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/

31. Dikken C, Sitzia J. Patients' experiences of chemotherapy: side-effects associated with 5-fluorouracil + folinic acid in the treatment of colorectal cancer. J Clin Nurs [Internet]. 1998 Jul;7(4):371–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/9830978

32. Rollo ME, Ash S, Lyons-Wall P, Russell A. Trial of a mobile phone method for recording dietary intake in adults with type 2 diabetes: evaluation and implications for future applications. J Telemed Telecare [Internet]. 2011 Jan [cited 2012 Aug 15];17(6):318–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21844173

33. Joe J, Demiris G. Older adults and mobile phones for health: A review. J Biomed Inform [Internet]. Elsevier Inc.; 2013 Jun 25 [cited 2013 Aug 14];46(5):6–13. Available from: http://linkinghub.elsevier.com/retrieve/pii/S153204641300083X

34. Nguyen HQ, Gill DP, Wolpin S, Steele BG, Benditt JO. Pilot study of a cell phone-based exercise persistence intervention post-rehabilitation for COPD. Int J Chron Obstruct Pulmon Dis [Internet]. 2009 Jan;4:301–13. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2740952&tool=pmcentrez&rendertype=abstract

35. Durso SC, Wendel I, Letzt AM, Lefkowitz J, Kaseman DF, Seifert RF. Older adults using cellular telephones for diabetes management: a pilot study. Medsurg Nurs [Internet]. 2003 Oct;12(5):313–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14608688

36. Nguyen HQ, Wolpin S, Chiang K-C, Cuenco D, Carrieri-Kohlman V. Exercise and symptom monitoring with a mobile device. AMIA Annu Symp Proc [Internet]. 2006 Jan;1047. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1839516&tool=pmcentrez&rendertype=abstract

37. Scherr D, Kastner P, Kollmann A, Hallas A, Auer J, Krappinger H, et al. Effect of home-based telemonitoring using mobile phone technology on the outcome of heart failure patients after an episode of acute decompensation: randomized controlled trial. J Med Internet Res [Internet]. 2009 Jan [cited 2012 Oct 4];11(3):e34. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2762855&tool=pmcentrez&rendertype=abstract

38. Miskelly F. Electronic tracking of patients with dementia and wandering using mobile phone technology. Age Ageing [Internet]. 2005 Sep [cited 2012 Oct 4];34(5):497–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16107453

39. Larsen ME, Rowntree J, Young AM, Pearson S, Smith J, Gibson OJ, et al. Chemotherapy side-effect management using mobile phones. Conf Proc IEEE Eng Med Biol Soc [Internet]. 2008 Jan;2008:5152–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19163877

40. Weaver a, Young a M, Rowntree J, Townsend N, Pearson S, Smith J, et al. Application of mobile phone technology for managing chemotherapy-associated side-effects. Ann Oncol [Internet]. 2007 Nov [cited 2012 Oct 4];18(11):1887–92. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17921245

41. Lim S, Kang SM, Shin H, Lee HJ, Won Yoon J, Yu SH, et al. Improved glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous healthcare service, a new medical information system. Diabetes Care [Internet]. 2011 Feb [cited 2012 Oct 4];34(2):308–13. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3024339&tool=pmcentrez&rendertype=abstract

42. Liu W-T, Wang C-H, Lin H-C, Lin S-M, Lee K-Y, Lo Y-L, et al. Efficacy of a cell phone-based exercise programme for COPD. Eur Respir J Off J Eur Soc Clin Respir Physiol [Internet]. 2008 Sep [cited 2012 Oct 4];32(3):651–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18508824

43. McCall K, Keen J, Farrer K, Maguire R, McCann L, Johnston B, et al. Perceptions of the use of a remote monitoring system in patients receiving palliative care at home. Int J Palliat Nurs [Internet]. 2008 Sep;14(9):426–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19060793

44. Nahm E-S, Preece J, Resnick B, Mills ME. Usability of Health Web Sites for Older Adults. CIN Comput Informatics, Nurs [Internet]. 2004 Nov [cited 2012 Nov 18];22(6):326–34. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15602301

45. Hawthorn D. Possible implications of aging for interface designers. Interact Comput [Internet]. 2000 Apr;12(5):507–28. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0953543899000211

46. Carmeli E, Patish H, Coleman R. The aging hand. J Gerontol A Biol Sci Med Sci [Internet]. 2003 Feb;58(2):146–52. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12586852

47. Owsley C, Sekuler R, Siemsen D. Contrast sensitivity throughout adulthood. Vision Res [Internet]. 1983 Jan;23(7):689–99. Available from: http://www.ncbi.nlm.nih.gov/pubmed/6613011

48. Helve J, Krause U. The Influence of Age on Performance in the Panel D-15 Colour Vision Test. Acta Ophthalmol [Internet]. 2009 May 27 [cited 2013 May 10];50(6):896–900. Available from: http://doi.wiley.com/10.1111/j.1755-3768.1972.tb06628.x

49. Cerella J. Age-related decline in extrafoveal letter perception. J Gerontol [Internet]. 1985 Nov [cited 2013 May 10];40(6):727–36. Available from: http://www.ncbi.nlm.nih.gov/pubmed/4056329

50. Bell B, Wolf E, Bernholz CD. Depth Perception as a Function of Age. Int J Aging Hum Dev [Internet]. 1972 Jan 1;3(1):77–81. Available from: http://baywood.metapress.com/openurl.asp?genre=article&id=doi:10.2190/0RQM-RRNK-A8GN-X99J

51. Akatsu H, Miki H. Usability research for the elderly people. Oki Tech Rev (Special Issue Hum … [Internet]. 2004 [cited 2012 Nov 2];71(199):54–7. Available from: https://oki.com/en/otr/2004/n199/pdf/otr-199-R15.pdf

52. Murata A, Iwase H. Usability of Touch-Panel Interfaces for Older Adults. Hum Factors J Hum Factors Ergon Soc [Internet]. 2005 Dec 1 [cited 2012 Nov 19];47(4):767–76. Available from: http://hfs.sagepub.com/cgi/doi/10.1518/001872005775570952

53. Ellis RD, Kurniawan SH. Increasing the Usability of Online Information for Older Users: A Case Study in Participatory Design. Int J Hum Comput Interact [Internet]. 2000 Jun [cited 2012 Nov 19];12(2):263–76. Available from: http://www.tandfonline.com/doi/abs/10.1207/S15327590IJHC1202_6

54. Selwyn N, Gorard S, Furlong J, Madden L. Older adults' use of information and communications technology in everyday life. Ageing Soc [Internet]. 2003 Sep [cited 2013 Aug 11];23(5):561–82. Available from: http://www.journals.cambridge.org/abstract_S0144686X03001302

55. Selwyn N. The information aged: A qualitative study of older adults' use of information and communications technology. J Aging Stud [Internet]. 2004 Nov [cited 2013 Aug 27];18(4):369–84. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0890406504000477

56. McCreadie C, Tinker A. The acceptability of assistive technology to older people. Ageing Soc [Internet]. 2005 Jan [cited 2013 Sep 9];25(1):91–110. Available from: http://www.journals.cambridge.org/abstract_S0144686X0400248X

57. Chen K, Chan a. HS. A review of technology acceptance by older adults. Gerontechnology [Internet]. 2011 Jan 1 [cited 2013 Sep 9];10(1). Available from: http://gerontechnology.info/index.php/journal/article/view/1464

Chapter 2: Older Adults' Attitudes and Preferences Regarding a Multifunctional Wellness Tool: A Pilot Study*

Abstract

Objective: To examine older adults' attitudes towards multifunctional technology tools and specific preferences and expectations that would maximize their utility and usability.

Methods: We held 3 focus groups sessions for this pilot study to determine perceptions of older adults towards multifunctional wellness tools, including usefulness and barriers to use. Areas discussed included features that would be wanted or unwanted, form factor, and context of use. Recordings were transcribed and qualitative content analysis was performed.

Results: Fourteen older adults participated in the focus group sessions. Participants viewed potential uses for wellness tools with regard to their health and health information positively, as they felt currently available tools were lacking. In addition, participants felt that a single-user, smaller, portable device would be more useful than a non-portable multi-user device. Concerns were expressed towards technologies that were difficult to use with aging-related changes, privacy, and perceptions of technology.

Conclusions: Participants felt generally positively towards a multifunctional wellness tool, and would be willing to use one if it were portable, intuitive, and had reliable health-related information on the device.

Introduction

A rapid growth in the population of older adults aged 65 or older is expected worldwide, rising from 524 million people in 2010 to 1.5 billion people in 2050[1]. These numbers are expected to continue to grow, leading to a large increase of older adults globally. As an individual ages, there is an increased probability of comorbidities and health problems. The increased probability of these issues result in an increased need for self-care management or health-related interventions[1,2]. Noncommunicable diseases already account for roughly 90% of the disease burden across low-, middle-, and high-income countries for those aged 60 or older[1]. Many older adults report impairments in vision, such as refractive errors, cataracts, and glaucoma (46.2 million worldwide), hearing (62.4 million worldwide), cognition and/or mobility, which may progress to a point where individuals are unable to carry out activities of daily life[3,4].

*Reprinted, with permission from *Informatics for Health and Social Care*. See Joe J, Chaudhuri S, Chung J, Thompson H, Demiris G. Older adults' attitudes and preferences regarding a multifunctional wellness tool: a pilot study. Inform Health Soc Care. 2014 Oct 17:1-16. doi:10.3109/17538157.2014.965305 for final article.

Healthy aging is not simply the absence of disease or illness. One definition suggests that healthy, successful aging involves 2 other components: engagement with life as well as high cognitive and physical function[5]. In a broader context, these components that together make up successful aging could be considered as factors in the overall wellness of an individual. Wellness encompasses other dimensions such as spiritual, cognitive, and social wellness, all of which contribute to an individual's overall well-being[6,7]. These wellness factors do not exist in isolation. For example, various studies support a link between social isolation and poor physical and mental health outcomes in older adults. Socially isolated older adults show worse cognition, a higher occurrence of depressive symptoms, and poor sleep[8,9]. For adults aged 65 or older, relationships with family and friends were ranked the second most important aspect of quality of life after their own health, indicating the value of communication to maintain these relationships[10]. However, social isolation is estimated to occur between 2 and 20 percent of older adults, suggesting that these needs are not being met in a substantive proportion of the population[11]. Additionally, active engagement in leisure activities has been correlated with slower cognitive decline in older adults, underscoring the importance of recreational activities in cognitive wellness[12]. Thus, there is a need for interventions to mitigate and deal with these issues in a rapidly growing older adult population.

A number of studies have looked at various technologic interventions for use in health and wellness. For example, in order to combat social isolation in older adults, internet

and computer technologies have been used successfully to ease loneliness[13]. Multiple studies show that targeted cognitive abilities of cognitively intact older adults can be improved by the use of cognitive training programs[14–16], including technology-based interventions. These improvements can be sustained over a number of years [17].

The rise in popularity of mobile phones among the population continues to trend upwards. Almost 70% of older adults in the US (2011), 60% of older adults in Hong Kong (2013), and 55% of older adults in the EU-27(2010), report use of a mobile phone[18–20]. This has led to increased interest in using mobile phones as a platform for health and wellness interventions. These mobile phone interventions have included studies that looked at symptom management for chemotherapy[21,22], management of diabetes via self-care advice[23,24] and detecting worsening symptoms earlier, reducing the length of hospital stays[25]. Further studies also aimed to track wandering dementia patients [26], supervise an exercise program among COPD patients[27], and use mobile phone images to diagnose skin lesions[28], among others[29]. Moreover, increased engagement during clinical visits and in health information by older adults has been associated with improved health outcomes, even through computer-based or internet-based programs[30,31].

The usability of mobile phone interventions and other technologies has been lagging for older adults, who have their own unique needs compared to other groups[32–35]. As older adults age, they experience a number of changes in learning and attention, in addition to decline in fine motor control, visual sharpness, and dexterity[32,36]. These

changes can affect how they interface with various technologies[32,36]. Older adults also experience reduced color and contrast sensitivity, as well as declines in the ability to judge depth correctly[37–39]. Many new technologies are often not designed specifically for older adults, and do not take into account their needs. Moreover, older adults are less willing to try new methods when older methods are still effective, and do not wish to be a burden on others by seeking help[40]. Thus, it is especially important to design intuitive interfaces and useful components for older adults to aid their use of new technologies.

Older adults are often seen as technology laggards, as evidenced by their adoption of various technologies. For example, as of 2013 in the United States, the penetration of mobile phones among older adults was 77% compared to 91% in the general population, and internet usage among older adults was 59% compared to 86% in the general population[41]. The lag in adoption has been attributed to several factors, including physical challenges, skepticism about the benefits of new technologies, and difficulties learning new technologies. However, older adults have shown a willingness to adopt new technologies in line with the technology acceptance model, as long as it meets their personal criteria for perceived usefulness, ease of use, and physical and psychosocial needs[42,43]. Mitzner et al found that older adults held positive attitudes towards technologies with the most important factors being convenience, features, and support for various activities. Negative attitudes were more varied and centered around factors such as security and reliability[44]. Once older adults adopt the internet as a

tool, 71% of this population go online daily while an additional 11% go online three to five times per week[41]. This trend suggests that once tools have been adopted and are perceived to be useful, they will see continued use.

Many of the aforementioned studies look at single potential software or hardware components of wellness tools for older adults, but there have been few studies that examine technologies that integrate several of these components[45–49]. While a single component is important, an integrated tool would be more attractive because it would reduce the need for additional training and integrate fragmented processes among the growing older adult population. Since older adults are often slow to adopt new technologies, care needs to be taken when creating new technologies or systems for their use[42]. Work needs to be done to explore the needs, attitudes, and preferences of older adult towards an integrated technology tool for health and wellness[50,51] prior to widespread deployment to create tools that older adults will find effective and useful.

The purpose of this paper is to examine older adults' attitudes towards multifunctional technology tools and specific preferences and expectations that would maximize their utility and usability.

Methods

In order to meet the study aims, this study used semi-structured focus groups as well as a questionnaire that aimed to ascertain what features would interest older adults in a multifunctional wellness tool.

Data Collection

We conducted a series of focus group sessions to explore older adults' preferences and attitudes towards multifunctional technology tools for health and wellness as well as barriers to possible use. The research team facilitated three separate sessions, following the guidelines outlined by Krueger et al.[52]. Focus groups were selected to allow integration of multiple perspectives, and to allow follow-up questioning on particularly interesting concepts or thoughts the participants may have brought up during discussion[52,53].

Recruitment occurred at several independent senior housing facilities that serve individuals across a wide range of socio-economic status in the greater Puget Sound area. These communities typically house older adults who are able to live independently with minimal help in maintaining their home or activities of daily living. Flyers were posted in common areas of these communities to recruit individuals for the sessions. In-person recruitment sessions also occurred consisting of a short presentation outlining the study with participants able to express their interest to participate in a session.

Participants were required to be 62 years of age or older (per the participating community's residential requirements), be a resident at a participating community, speak and read English, as well as not have any significant auditory impairment that would affect conversation.

Focus group sessions were facilitated by a trained researcher with prior experience facilitating and supporting similar studies of health technology design and assessment. A trained note taker also participated in data collection activities. The sessions lasted approximately an hour, and at the beginning of each session the facilitator introduced the purpose of the study. The focus group protocol included questions regarding what sorts of features they would or would not like to explore what features would make wellness tools agreeable to older adults and encourage their use. Additionally, the protocol included questions regarding their attitudes and concerns about such a system, best location(s) to use it in, and perceived usefulness. These questions were selected to gain a greater understanding of the facilitators and barriers to use.

About midway through the session, participants were also asked to fill out a short questionnaire with a list of possible features, indicating whether they would or would not like such a feature. These features were generated through discussions with the research team. The 27 features on the sheet were grouped into the following major categories: entertainment, learning, communication, and health management (See appendix). All participants were asked to mark each potential feature as interested, not

interested or unsure. Then, they selected 3 features that they decided they were the most interested in, followed by 3 features they were least interested in. The sheet was distributed to participants after asking what features the participants would prefer in a multifunctional wellness tool in an open-ended manner. The University of Washington institutional review board approved all procedures in this study.

Data Analysis

The sessions were audio recorded then transcribed while removing personally identifiable data. Qualitative descriptive analysis was performed to identify common themes across the various locations and focus group sessions[53]. Three researchers independently read through the transcripts and performed open coding to distinguish concepts related to the content. Codes were generated and assigned to utterances during the readings using an open coding format to allow discovery of themes without a preconception of what they would be. Codes were assigned to emerging themes and iteratively refined as more of the transcripts were coded. Once independently coded, the researchers met to reconcile the initially generated themes in order to develop a master codebook that covered all the emerging types of participant discussion. Afterwards, the master codebook was used to recode the transcripts separately, and the researchers met again to reconcile the codes. Once completed, these codes were used to generate cross-cutting themes that capture the sentiment across participants on their

preferences and barriers of a multifunctional wellness tool for older adults. Simple counts were used to analyze the questionnaire data.

Results

A total of 14 older adults over the age of 62 participated in focus group sessions across 3 independent retirement communities (n=6, n=3, n=5, respectively). These communities included a lower-income community (6 participants) and two middle to higher-income communities (8 participants). The groups had 6 male participants and 8 female participants.

Focus Group Discussion

Six crosscutting themes emerged across the 3 focus groups, and they touch on attitudes, facilitators, and barriers towards use of multifunctional wellness tools.

Participants foresee the value of using technologies for maintaining their health.

Many older adults explicitly expressed their desire to use technologies for various health purposes. For example, nine participants across these focus groups wanted some technologies to manage their medication adherence, exemplified by the quote, “well, I would want something that manages my medications” (FG 1). Another participant stated that technologies would be used for monitoring health-related indicators, “I'd like

for it to monitor me completely and everything I've scheduled it would let me know without having to perform some interaction like having in my room and not implanted and so that it could tell me like if my blood pressure's too high or what all that health stuff that is" (FG 1).

One participant cited a reminder feature of technologies as a possible contributor to reducing caregiver burden and thus maintaining independence among older adults. The participant commented: "You don't have to remember all this stuff...it could say 'You need to take your blood pressure today.' or 'Have you taken your heart pill today?' so that way a person would be reminded and it would eliminate for a lot of people having to have a caregiver come in or live in a facility where they have to be reminded of their medications because they are getting to be forgetful" (FG 1).

Participants appeared to feel dissatisfied with the current sources or the amount of health information they can get. "I'm sure it's her nursing staff that answers it, but there's no one to really answer those kinds of questions" (FG 3). Some participants wished to use technologies for finding health information necessary for managing their health, exemplified by the following quote, "I wanted to find out information about atypical heart rhythm" (FG 1). Another participant identified the way technologies can be used as an interactive tool for communicating remotely with their health care providers: "Communicate with your doctor or healthcare provider -- I would especially like that communication to be -- so you don't necessarily have to go there in person" (FG

1), most participants stated that they would prefer in-person communication with their primary physician instead of using an intermediary.

Aging-related changes seem to hinder older adults from active technology engagement.

Across the focus groups, participants clearly stated that physical disability due to aging is a definite barrier to the use of such technologies. Participants also expressed the need for the development of technologies that are designed specifically for older adults who are experiencing sensory changes or physical immobility related to aging. Two participants pointed out the importance of ergonomic issues that should enable older adults to accommodate changes in physical abilities while using information technologies. For example, participants with shoulder pain preferred using mouse and keyboard instead of touchscreen monitors, “because I've got two bad shoulders I kind of find that touchscreen kind of ... it's hard to do that (hold my arms up the whole time)” (FG 2). On the other hand, while a smaller and portable device was preferred by participants in most times, there was an instance in which older adults may need a bigger display in order to accommodate vision changes; “It's kind of a toss up. ...You know, when you get older, your eyes don't work like they should. So some days the iPhone is hard. It's kind of hard to deal with. Other days I'd like it bigger -- a bigger screen” (FG 2). Several participants expressed a desire for a voice recognition feature. The reasons for this varied from mobility issues to hand dexterity. These themes are illustrated by the following quotes: “seniors sometimes they are bedridden, sometimes

they are with walkers, sometimes they have devices that they can't actually -- you know, arthritis and that kind of thing" (FG 3); "the size of the keys are really hard for older people to even manipulate" (FG 3).

Preconceptions of technology are barriers to technology acceptance

Older adults in these focus groups appeared to have several preconceived barriers about technology and how it relates to them. Several participants suggested that "technology" is not something they'd be attracted to or intuitively find use for, "I'm honestly feeling that I'm in the wrong discussion because I don't have a computer either. And, technology is kind of not where I am. … I'm untechnological." (FG 1). Alternatively other members spoke of older adults in general not being technological, "I mentioned to you that this would be a problem that a lot of older people do not use computers." (FG 1).

A smaller, portable device, one can carry around with them at all times is preferable to a larger device that may sit in common areas.

Many older adults across the various focus groups expressed a preference for a smaller, portable device as opposed to a larger one that could be used in a community setting. Participants placed a premium on portability, such as wanting a device that is "small, and light and easy to take with me and easy to have with me all the time," (FG 2) due to

convenience. Many specifically voiced that they would want “a small mobile device as opposed to a large fixed box,“(FG 1) which they saw as unnecessary clutter. The portability and resulting convenience of the device was thus a more compelling vision for how they would want to use this tool. Consequently, there was a consensus that portability would allow them to have the tool near them at all times to maximize its usefulness.

Older adults have not found it easy to locate general health information that they can trust as reliable and accurate, and wish it were easy to do so.

One of the major themes that cut across the various focus groups was the idea that many older adults have questions about general health information that they are curious about but are unable to have answered easily. When they are able to locate an answer, they have a hard time discerning if the answer is accurate or reliable. Participants expressed their curiosity regarding several generalized health topics, where they were dissatisfied with their current understanding and options for discovery. For example, one participant wondered why “some medications say don’t eat grapefruit ... What is it that the grapefruit is doing?”(FG 3). The same participant noted that a centralized, reliable information source for general health questions would be helpful.

Another participant complained that when he tried to find health information online, he “came up with 3 different sources and they're done in an illogical way, an incomplete

way, they disagree. I wish that I could get something that is definitive that was like A-Z, instead of being totally random…if I was to score the people who did this work, I would say you have failed because I'm confused." (FG 3) This participant found that looking for more information about his health condition online as often contradictory and confusing, where several sources provide different information. These issues were exacerbated as search engines would provide many different potential sources of information, and it was unclear which source should be trusted. Similar to the other participant, he wished there was a centralized, trusted source where he could go and be confident in its information. Across the groups, perceived access to reliable and trusted health information was lacking, and participants would like a centralized resource where they can trust that the information they are getting is accurate.

While participants are willing to confer with technologies to get health and other information, they are concerned about the privacy & confidentiality of the tools.

While participants in focus groups were enthusiastic about having a device that could help them with various tasks, they expressed some concern with the privacy and confidentiality of that information with regards to the wellness tool. One participant voiced a concern that "the more personal [the information] is to me the less I would want the world to know"(FG 2), especially with respect to personal health information. Another participant voiced that "A medical record online; you're opening up all of that to everybody that has access." (FG 2). In order to mitigate some of the privacy

concerns, a third participant suggested that a filter could be implemented so that "[he] can see [the screen] but somebody behind me couldn't because the angle would be wrong for them" (FG 2). By having this screen available, he would feel more confident in using the tool for health purposes. While health information retrieval and management was seen very useful for their everyday lives, it was tempered by concerns about privacy and who would be able to access the data.

Questionnaire Results

Twelve of the thirteen participants completed the questionnaire. Participants noted that of the listed features, the most desired were: Learning via finding out information, communicating via phone, and managing health via tracking fitness (Table I). The least wanted feature was communicating via text chat (Table I).

[INSERT TABLE 2.1]

[INSERT TABLE 2.2]

[INSERT TABLE 2.3]

Discussion

The goals behind the sessions were to explore the preferences and attitudes of older adults towards a multifunctional wellness tool. During the discussions, it became clear that a major barrier to adoption of a wellness tool is the existing preconceptions of older adults towards what technology is and how it relates to them. While we were more interested in what in an ideal tool would have and were not discussing a specific, existing tool, some chose not to engage in the discussion, labeling themselves as "untechnological". Others in groups were wary, warning that encouraging people who do not engage with computers or technology to use new systems may be difficult, even if it is designed with them in mind. These sentiments suggest that greater education of what technology entails and what tools are available may be needed to change conceptions of what technology is and what it can do for older adults. As stated by Olphert et al., breaking down the barrier of an immediate negative reaction to technology itself, will improve its chances of acceptance[54]. Once the barrier has been crossed, if the new technology is difficult or frustrating to use, it will not appeal to them at all. Thus, a combination of an easy to use tool, combined with education or tutorials could create happier users.

Previous studies have suggested that many factors affect older adults' adoption of new technologies, including previous conceptions of what the technology is and entails. Many older adults may have negative perceptions towards technologies, such as having too many options, causing interruptions, inconvenience, and reliability issues[44]. On

the other hand, factors that generated a positive perception towards new technologies included supporting activities, convenience, and useful features[44]. There may be also some issues of access, lack of perceived utility, and financial worries[54–56]. The literature supports our findings of factors that generate positive or negative perceptions towards potential new technologies. We have found that similar issues would discourage adoption of wellness technologies of older adults, such as the inclusion of components that participants may consider useless. However, the participants felt strongly about adopting a wellness tool that could help them manage their health, where they could see that such a tool would fulfill an unmet need. Participants also described issues and unmet needs such as being able to find reliable health information online that would encourage their use of a wellness tool meeting these needs. The discussions suggest that older adults would be willing to use a multifunctional wellness tool if it met their specific preferences.

Another issue that consistently arose as a barrier to use is the dissatisfaction with currently available interfaces. Currently available interfaces were lacking with respect to aging-related changes that may hinder them from being actively engaged. Many complained about difficulties due to vision or physical changes like being unable to keep one's arm held up for touchscreens without discomfort, even for healthy older adults. These issues are exacerbated with individuals who have physical disabilities, such as those with walkers or are bedridden. For these reasons, voice recognition and commands were popular and suggest that future designs should make sure there are

multiple modalities of input so that users can comfortably use the tools across a wide range of physical states. More broadly, the interface between technology and user needs to be compatible with older adults and their unique needs [57], such as having the text be larger, being able to rest hands or arms with minimal stress, and making the tool ergonomically appropriate.

Many features were discussed as potentially useful, but the most wanted features centered around issues of health and information. Through all groups, the lack of reliable, easy to locate health information was at the forefront of people's minds. The health information being sought was not necessarily specific to an individual user, however. Much of the information need surrounded general health information that could be applied to multiple people. As previously discussed, one participant wondered why she was not supposed to eat grapefruit with her medications and could not locate the information she wanted about it. She did not want to bother her personal physician with these questions, since she would rather ask specific questions about her situation in the short time allotted during the visit. Thus, a reliable, easily accessible resource for standard health questions would be well received by this population in a wellness tool. For example, one participant found WebMD and the Mayo Clinic website as trustworthy and reliable enough for her purposes.

Participants responded positively to the suggestion of a device that would give them health alerts, such as reminders to take medications or health monitoring to detect

early changes in health status, similar to other studies regarding older adult attitudes towards health monitoring in smart homes[58,59]. In fact, managing medications was the feature that was most frequently marked as “most wanted” by the participants, which includes reminders and information about what each medication does. While individualized health alerts and monitoring were desirable, there was some caution in storing this information, since they wanted to keep their privacy and confidentiality. If future work wishes to support health-related features, security issues should be addressed by those building the devices to ensure confidence by the eventual end users. Taken as a whole, this suggests that older adults would like a tool that could help them manage their health, with reminders to make sure they do the things they know they should be doing, and able to easily retrieve reliable information about health and health-related things.

Besides health information, there also seemed to be frustration about the level of difficulty on navigating and finding general information. Several participants suggested that it can be difficult to dig through the information out there to find what they want. Search engines seemed inadequate for their needs or did not match what they expected to find when searching. While they understood that search engine results are supposed to rank web pages by relevance to their query, they were not satisfied with this level of guidance and wanted a direct answer to their question immediately. They seemed to want information given to them rather than having to wade through several results of their searches, which would be a very useful feature on a wellness tool. Further

exploration of this area may lead to more satisfied users of wellness tools by alleviating frustration.

The groups placed an importance of the portability and convenience for this wellness tool, with all members wanting a device they could carry around with them at all times. Participants reacted negatively to the idea of a device that was large so it could be seen by several people. The participants were worried about the issue of privacy, especially with respect to their health data. The more personal or health-related the data were, the more likely the participants were to be worried about the privacy aspect when using a bigger screen. This is in line with the understanding of the tradeoff between usefulness and privacy in previous studies interested in health data with respect to smart homes, where it was recognized that in order to maximize usefulness, more private data may need to be used[59]. Thus, since participants expected more personal health data were to be used, they were not interested in having a large screen thus reducing the accessibility of their personal data. The large screen size was also at odds with the stated preference of a smaller, portable device that they could carry around with them everywhere for convenience purposes. By having a portable device, participants would not have a box that would sit at home and take up space. However, one individual suggested that being able to hook up the device to a larger screen might be useful. The actual wellness device would still be portable and easy to carry. Designs for a wellness tool should look into creating a small, easily portable device. However, how small differed somewhat, ranging from a preference of roughly 3.5” screen size to a

preference of a 6” screen size. Further research should look into what size screen would be ideal, and why individuals prefer each screen size.

Finally, although health was the biggest recurring issue, others also wanted to be entertained such as by watching movies or keeping up with the news. Previous studies have indicated that seniors’ online communities primarily act as entertainment and sources of casual leisure, suggesting that there is a need for play and entertainment that may not be fully satisfied elsewhere[60]. Entertainment, and games in particular, have the potential to increase older adults’ well-being by improving their affect and reducing loneliness[61]. Consequently, including play and entertainment features could increase the value of the wellness tool. One could consider integrating play features that positively affect social interaction and cognitive function.

Compared to the health management features, the entertainment features such as watching classic movies did not have a strong consensus across the participants. Participants were somewhat polarized in responses. For example, while several participants marked watching classic movies as one of their “most interested” features, others marked it as their “least interested.” It is currently unclear whether lack of interest may come from preferring newer movies, wanting no entertainment at all within a wellness tool or other reasons. Further investigation in the matter is needed before determining the reasons behind these differences. One may consider creating these features as a separate add-on feature for those who are interested. Finally,

others wished to have facile communication, such as by implementing a phone feature or easy access to health providers. However, these features had a wider range of responses, while health-related aspects were wanted by almost all of those present.

Conclusion & Future Work

Future research should expand on these themes. Researchers should investigate overcoming barriers of technology perception, how to ensure reliable health information is easily accessible, and examine more specifically how older adults wish to interface with a wellness tool during implementation. Further work is also needed to establish the effectiveness of these features together as a whole, and to seek further input by a larger number and variety of older adults.

In conclusion, a multifunctional wellness tool for older adults can be attractive for the population, if several key ideas are taken into account. First, the interface needs to be intuitive and interactions need to be able to be done without undue stress, pain or frustration and the device should be portable to facilitate convenience. Second, work needs to be done to better understand how to overcome preconceptions of technology that may lead people to dismiss new tools out of hand. Finally, health and health-related information tools should be at the forefront of new tools, so as to increase satisfaction and potential engagement.

Limitations

There are some limitations to this work that should be acknowledged. The first limitation is the ability to which this study can be generalized to a wider audience, due to a relatively small sample size. Although the sessions occurred at both lower and higher-income facilities, all participants were still from a single metro area. Furthermore, the level of computer comfort and skills was not assessed, and their perceptions may differ depending on the level of skill. Nonetheless, the results of this pilot study suggest directions for future inquiry.

Acknowledgements

This study was supported in part by the National Library of Medicine Biomedical and Health Informatics Training Grant T15 LM007442.

References for Chapter 2

[1] World Health Organization, National Institutes of Health. Global Health and Aging. Bethesda: 2011.

[2] Anderson G, Horvath J. The growing burden of chronic disease in America. Public Health Rep 2004;119:263–70. doi:10.1016/j.phr.2004.04.005.

[3] Verbrugge LM, Jette AM. The disablement process. Soc Sci Med 1994;38:1–14.

[4] World Health Organization. The Global Burden of Disease: 2004 Update. Geneva: 2008.

[5] Rowe JW, Kahn RL. Successful Aging. Gerontologist 1997;37:433–40. doi:10.1093/geront/37.4.433.

[6] Dunn HL. High-level wellness for man and society. Am J Public Health Nations Health 1959;49:786–92.

[7] Hoyman HS. Rethinking an ecologic-system model of man's health, disease, aging, death. J Sch Health 1975;45:509–18.

[8] Helve J, Krause U. Loneliness, health and depression in older males. Acta Ophthalmol 2009;50:896–900. doi:10.1080/1360786031000101193.

[9] Dickinson WJ, Potter GG, Hybels CF, McQuoid DR, Steffens DC. Change in stress and social support as predictors of cognitive decline in older adults with and without depression. Int J Geriatr Psychiatry 2011;26:1267–74. doi:10.1002/gps.2676.

[10] Bowling A. What things are important in people's lives? A survey of the public's judgements to inform scales of health related quality of life. Soc Sci Med 1995;41:1447–62. doi:10.1016/0277-9536(95)00113-L.

[11] Victor C, Scambler S. Being alone in later life: loneliness, social isolation and living alone. Rev Clin Gerontol 2000;10:407–17.

[12] Scarmeas N, Stern Y. Cognitive reserve and lifestyle. J Clin Exp Neuropsychol 2003;25:625–33. doi:10.1076/jcen.25.5.625.14576.

[13] Findlay R a. Interventions to reduce social isolation amongst older people: where is the evidence? Ageing Soc 2003;23:647–58. doi:10.1017/S0144686X03001296.

[14] Ball K, Berch DB, Helmers KF, Jobe JB, Leveck MD, Marsiske M, et al. Effects of cognitive training interventions with older adults: a randomized controlled trial. JAMA 2002;288:2271–81. doi:10.1001/jama.288.18.2271.

[15] Mahncke HW, Connor BB, Appelman J, Ahsanuddin ON, Hardy JL, Wood R a, et al. Memory enhancement in healthy older adults using a brain plasticity-based training program: a randomized, controlled study. Proc Natl Acad Sci U S A 2006;103:12523–8. doi:10.1073/pnas.0605194103.

[16] Kueider AM, Parisi JM, Gross AL, Rebok GW. Computerized cognitive training with older adults: a systematic review. PLoS One 2012;7:e40588. doi:10.1371/journal.pone.0040588.

[17] Willis SL, Tennstedt SL, Marsiske M, Ball K, Elias J, Koepke KM, et al. Long-term effects of cognitive training on everyday functional outcomes in older adults. JAMA 2006;296:2805–14. doi:10.1001/jama.296.23.2805.

[18] Smith A. Americans and Their Cell Phones. 2011.

[19] Lai CKY, Chung JCC, Leung NKL, Wong JCT, Mak DPS. A survey of older Hong Kong people's perceptions of telecommunication technologies and telecare devices. J Telemed Telecare 2010;16:441–6. doi:10.1258/jtt.2010.090905.

[20] Eurobarometer. E-communications household survey. 2010.

[21] Larsen ME, Rowntree J, Young AM, Pearson S, Smith J, Gibson OJ, et al. Chemotherapy side-effect management using mobile phones. Conf Proc IEEE Eng Med Biol Soc 2008;2008:5152–5. doi:10.1109/IEMBS.2008.4650374.

[22] Weaver A, Young AM, Rowntree J, Townsend N, Pearson S, Smith J, et al. Application of mobile phone technology for managing chemotherapy-associated side-effects. Ann Oncol 2007;18:1887–92. doi:10.1093/annonc/mdm354.

[23] Durso SC, Wendel I, Letzt AM, Lefkowitz J, Kaseman DF, Seifert RF. Older adults using cellular telephones for diabetes management: a pilot study. Medsurg Nurs 2003;12:313–7.

[24] Lim S, Kang SM, Shin H, Lee HJ, Won Yoon J, Yu SH, et al. Improved glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous healthcare service, a new medical information system. Diabetes Care 2011;34:308–13. doi:10.2337/dc10-1447.

[25] Scherr D, Kastner P, Kollmann A, Hallas A, Auer J, Krappinger H, et al. Effect of home-based telemonitoring using mobile phone technology on the outcome of heart failure patients after an episode of acute decompensation: randomized controlled trial. J Med Internet Res 2009;11:e34. doi:10.2196/jmir.1252.

[26] Aranguren ME, Bechhofer S, Lord P, Sattler U, Stevens R. Understanding and using the meaning of statements in a bio-ontology: recasting the Gene Ontology in OWL. BMC Bioinformatics 2007;8:57. doi:10.1186/1471-2105-8-57.

[27] Liu W-T, Wang C-H, Lin H-C, Lin S-M, Lee K-Y, Lo Y-L, et al. Efficacy of a cell phone-based exercise programme for COPD. Eur Respir J Off J Eur Soc Clin Respir Physiol 2008;32:651–9. doi:10.1183/09031936.00104407.

[28] Kroemer S, Frühauf J, Campbell TM, Massone C, Schwantzer G, Soyer HP, et al. Mobile teledermatology for skin tumour screening: diagnostic accuracy of clinical and dermoscopic image tele-evaluation using cellular phones. Br J Dermatol 2011;164:973–9. doi:10.1111/j.1365-2133.2011.10208.x.

[29] Joe J, Demiris G. Older adults and mobile phones for health: A review. J Biomed Inform 2013;46:6–13. doi:10.1016/j.jbi.2013.06.008.

[30] Gustafson DH, Hawkins RP, Boberg EW, McTavish F, Owens B, Wise M, et al. CHESS: 10 years of research and development in consumer health informatics for broad populations, including the underserved. Int J Med Inform 2002;65:169–77.

[31] Rost KM, Flavin KS, Cole K, McGill JB. Change in metabolic control and functional status after hospitalization. Impact of patient activation intervention in diabetic patients. Diabetes Care 1991;14:881–9. doi:10.2337/diacare.14.10.881.

[32] Hawthorn D. Possible implications of aging for interface designers. Interact Comput 2000;12:507–28. doi:10.1016/S0953-5438(99)00021-1.

[33] Nahm E-S, Preece J, Resnick B, Mills ME. Usability of Health Web Sites for Older Adults. CIN Comput Informatics, Nurs 2004;22:326–34. doi:10.1097/00024665-200411000-00007.

[34] National Institute on Aging, National Library of Medicine. Making Your Website Senior Friendly. 2009.

[35] Hudson R. Improving Web Accessibility for the Elderly. 26th Annu. Int. Technol. Pers. with Disabil. Conf., vol. 2, 2011, p. 1–12.

[36] Carmeli E, Patish H, Coleman R. The aging hand. J Gerontol A Biol Sci Med Sci 2003;58:146–52.

[37] Owsley C, Sekuler R, Siemsen D. Contrast sensitivity throughout adulthood. Vision Res 1983;23:689–99.

[38] Helve J, Krause U. The Influence of Age on Performance in the Panel D-15 Colour Vision Test. Acta Ophthalmol 2009;50:896–900.

[39] Bell B, Wolf E, Bernholz CD. Depth Perception as a Function of Age. Int J Aging Hum Dev 1972;3:77–81. doi:10.2190/0RQM-RRNK-A8GN-X99J.

[40] Akatsu H, Miki H. Usability research for the elderly people. Oki Tech Rev (Special Issue Hum … 2004;71:54–7.

[41] Smith A. Older Adults and Technology Use. Washington: 2014.

[42] Chen K, Chan a. HS. A review of technology acceptance by older adults. Gerontechnology 2011;10. doi:10.4017/gt.2011.10.01.006.00.

[43] Venkatesh V, Davis FD. A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Manage Sci 2000;46:186–204. doi:10.1287/mnsc.46.2.186.11926.

[44] Mitzner TL, Boron JB, Fausset CB, Adams AE, Charness N, Czaja SJ, et al. Older Adults Talk Technology: Technology Usage and Attitudes. Comput Human Behav 2010;26:1710–21. doi:10.1016/j.chb.2010.06.020.

[45] Murata A, Iwase H. Usability of Touch-Panel Interfaces for Older Adults. Hum Factors J Hum Factors Ergon Soc 2005;47:767–76. doi:10.1518/001872005775570952.

[46] Ellis RD, Kurniawan SH. Increasing the Usability of Online Information for Older Users: A Case Study in Participatory Design. Int J Hum Comput Interact 2000;12:263–76. doi:10.1207/S15327590IJHC1202_6.

[47] Doyle J, Skrba Z, McDonnell R, Arent B. Designing a touch screen communication device to support social interaction amongst older adults. 24th BCS Int. Conf. Human-Computer Interact., Dundee: 2010, p. 177–85.

[48] Villanueva K, Pereira G, Knuiman M, Bull F, Wood L, Christian H, et al. The impact of the built environment on health across the life course: design of a cross-sectional data linkage study. BMJ Open 2013;3. doi:10.1136/bmjopen-2012-002482.

[49] Lin C, Neafsey P, Strickler Z. Usability Testing by Older Adults of a Computer-Mediated Health Communication Program. J Health Commun 2009;14:1–16. doi:10.1080/10810730802659095.Usability.

[50] Selwyn N, Gorard S, Furlong J, Madden L. Older adults' use of information and communications technology in everyday life. Ageing Soc 2003;23:561–82. doi:10.1017/S0144686X03001302.

[51] McCreadie C, Tinker A. The acceptability of assistive technology to older people. Ageing Soc 2005;25:91–110. doi:10.1017/S0144686X0400248X.

[52] Krueger RA, Casey MA. Focus Groups: A Practical Guide for Applied Research. 3e ed. Thousand Oaks, CA: Sage Publications; 2000.

[53] Weiss RS. Learning from Strangers: The Art and Method of Qualitative Interview Studies. New York, NY: Simon & Schuster; 1994.

[54] Olphert C, Damodaran L, May A. Towards digital inclusion–engaging older people in the "digital world." Proc. 2005 Int. Conf. Access. Des. Digit. World, 2005, p. 7.

[55] Freedman V, Calkins M, Haitsma K Van. An exploratory study of barriers to implementing technology in U.S. residential long-term care settings. Gerontechnology 2005;4:86–100. doi:10.4017/gt.2005.04.02.004.00.

[56] Thielke S, Harniss M, Thompson H, Patel S, Demiris G, Johnson K. Maslow's Hierarchy of Human Needs and the Adoption of Health-Related Technologies for Older Adults. Ageing Int 2011;37:470–88. doi:10.1007/s12126-011-9121-4.

[57] Burns P, Jones SC, Iverson D, Caputi P. Usability testing of AsthmaWise with older adults. Comput Inform Nurs 2013;31:219–26; quiz 227–8. doi:10.1097/NXN.0b013e31828a0dc2.

[58] Demiris G, Rantz M, Aud M, Marek K, Tyrer H, Skubic M, et al. Older adults' attitudes towards and perceptions of "smart home" technologies: a pilot study. Med Inform Internet Med 2004;29:87–94. doi:10.1080/14639230410001684387.

[59] Wild K, Boise L, Lundell J, Foucek A. Unobtrusive In-Home Monitoring of Cognitive and Physical Health: Reactions and Perceptions of Older Adults. J Appl Gerontol 2008;27:181–200. doi:10.1177/0733464807311435.

[60] Nimrod G. The fun culture in seniors' online communities. Gerontologist 2011;51:226–37. doi:10.1093/geront/gnq084.

[61] Jung Y, Li KJ, Janissa NS, Gladys WLC, Lee KM. Games for a better life. Proc. Sixth Australas. Conf. Interact. Entertain. - IE '09, New York, New York, USA: ACM Press; 2009, p. 1–6. doi:10.1145/1746050.1746055.

Table 2.1. Features most frequently marked as "wanted" or "unwanted" by participants. (n=12) #=number of participants selecting.

Most Frequently Marked as Wanted		**Most Frequently Marked as Unwanted**	
#	**Feature**	**#**	**Feature**
12	Learn via Finding out information	6	Communicate via text chat
12	Communicate via phone	4	Entertained via watching classic movies
12	Manage health via tracking fitness	4	Entertained via playing games
11	Learn via Keeping up with the news	4	Entertained via listening to new music
11	Learn something new	4	Communicate with family
11	Manage health via finding health information	4	Communicate with friends
11	Manage health via communicating with doctor	4	Communicate with people nearby

Table 2.2. Features most frequently marked as "most interested" or "least interested" by participants. Each participant could select up to 3 features as "Most interested" or "least interested" in (n=12). #=number of participants selecting.

Most Frequently Marked as Most Interested		Most Frequently Marked as Least Interested	
#	**Feature**	**#**	**Feature**
5	Manage your health via managing your medications	4	Entertained via watching classic TV shows
4	Entertained via watching recently released movies	4	Entertained via playing games
3	Entertained via watching classic movies	4	Entertained via listening to new music
3	Learn via keeping up with the news	4	Entertained via solving puzzles
3	Learn via finding out information	4	Communicate via social network such as Facebook
3	Manage health via finding health information	3	Entertained via listening to older hit music
3	Manage health via communicating with doctor		

Table 2.3. Features most frequently marked as "unsure" by participants (n=12). #=number of participants selecting.

Most Frequently Marked as Unsure	
#	**Feature**
3	Manage health via managing medications
2	Communicate via Social networking like Facebook
2	Entertained via solving puzzles
2	Entertained via watching classic TV
2	Entertained via watching new TV

Appendix 2.1: Feature Sheet

UNIVERSITY OF WASHINGTON

FEATURE SHEET

Understanding Attitudes towards a Multi-Purpose Technology Tool for Community Engagement Among Older Adults

Are you interested in a technology that lets you…

Be Entertained in the following ways:	Yes	No	Unsure	
Watch recently released movies	☐	☐	☐	____
Watch classic movies	☐	☐	☐	____
Watch new television shows	☐	☐	☐	____
Watch classic television shows	☐	☐	☐	____
Play Games	☐	☐	☐	____
Listen to recently released/new music	☐	☐	☐	____
Listen to older hit music or classics from specific eras	☐	☐	☐	____
Solve Puzzles	☐	☐	☐	____
Look at old pictures of family and friends	☐	☐	☐	____
Look at new pictures of family and friends	☐	☐	☐	____

Are you interested in a technology that lets you…

Learn in the following ways:	Yes	No	Unsure	
Keep up with the news	☐	☐	☐	____
Find out information	☐	☐	☐	____
Learn something new	☐	☐	☐	____

Are you interested in a technology that lets you…

Communicate in the following ways:	Yes	No	Unsure	
Through video	☐	☐	☐	___
Through phone	☐	☐	☐	___
Through email	☐	☐	☐	___
Through text chat feature	☐	☐	☐	___
With family	☐	☐	☐	___
With friends	☐	☐	☐	___
With people nearby	☐	☐	☐	___
With people far away	☐	☐	☐	___
By using a social network such as Facebook	☐	☐	☐	___

Are you interested in a technology that lets you…

Manage your Health in the following ways:	Yes	No	Unsure	
Manage your medications	☐	☐	☐	___
Find health information	☐	☐	☐	___
Track your fitness	☐	☐	☐	___
Stay fit (with exercise games or videos)	☐	☐	☐	___
Communicate with your doctor/health care provider	☐	☐	☐	___

Chapter 3: The Use of Think-Aloud and Instant Data Analysis in Evaluation Research: Exemplar and Lessons Learned*

Abstract

While health information technologies have become increasingly popular, many have not been formally tested to ascertain their usability. Traditional rigorous methods take significant amounts of time and manpower to evaluate the usability of a system. In this paper, we evaluate the use of instant data analysis (IDA) as developed by Kjeldskov et al. to perform usability testing tool designed for older adults and caregivers. The IDA method is attractive because it takes significantly less time and manpower than the traditional usability testing methods. In this paper we demonstrate how IDA was used to evaluate usability of a multifunctional wellness tool, discuss study results and lessons learned while using this method. We also present findings from an extension of the method which allows the grouping of similar usability problems in an efficient manner. We found that the IDA method is a quick, relatively easy approach to identifying and ranking usability issues among health information technologies.

Highlights

1. We present the use of a quick method for usability testing with a case exemplar.
2. The method presented in this study gives good insight into usability issues.
3. Others can benefit from this method as it's faster and requires less commitment.

**This manuscript has been submitted for review in the Journal of Biomedical Informatics and has been written to meet publication guidelines.*

1 Introduction

Usability testing is an important component of design, as it aims to assess ease of use and identify learnability issues of a specific tool. Performing usability testing typically involves users from the target user group. These "real" users may think or act differently than expected by the designers or developers[1]. Often, usability issues are only identified when testing with real users, reinforcing the importance of doing "real world" usability testing. Furthermore, this testing can be done during early stages of development, leading to easier and cheaper fixes compared to finding issues after the product has been built and released. However, the usability testing process can be time consuming and labor intensive. This may lead designers to omit testing, as the upfront cost is perceived to be too high even though the process could be useful. Instant data analysis may be one solution to address this challenge providing real world testing while reducing the time and labor involved.

1.1 Usability Testing

Traditional usability testing involves a think-aloud protocol combined with a video recording of a user from the target group as they interact directly with the device or tool in question to complete specified tasks[2–4]. This recorded video allows for observation of the user to identify points of frustration, confusion or other issues. The video is transcribed and often analyzed qualitatively or referenced for issues. These issues are then reconciled between researchers, and scored by severity, depending on the

frequency of the issue and how much it delayed or frustrated the user on completing the tasks. While such observational analysis identifies what causes the user to be frustrated or delayed, the reason or *why* this causes frustration may not be clear. In order to better understand the users' thought process, observation is often combined with a think-aloud protocol. The think-aloud protocol asks the user to verbalize their thoughts as they perform the tasks required in a usability test thus providing insight into their mental model with its roots in Ericsson and Simon's work[1,5]. With these data, researchers can then examine the differences between the participants' mental model and the system's interaction model to identify errors and changes that need to be made. The users' thoughts can address what users like, what they dislike or how to improve the interface and tool from their perspective. Combining these two techniques with qualitative analysis of a transcript comprises the traditional method for usability testing. At the end of the analysis, researchers or designers are able to generate a list of usability issues and a related a score/severity ranking for each issue. Such usability tests have been used successfully to assess the usability of home-based telemedicine systems[6], medical diagnostic and research tools[7], and online self management tools[8], among others[9–12].

Traditional usability testing however, is not without its own challenges. While such an approach is very thorough, it can require significant amounts of manpower and time. Transcription of user comments and verbalizations, along with specifying user actions in relation to the interface can require a significant amount of researchers' time, which is

then followed up by qualitative coding and analysis. Thus, the time between when the actual usability tests occur and when the final results are generated can span several weeks. For example, Jeffries et al.'s empirical usability study, with 6 users each participating in a 2 hour usability session took 199 man-hours to analyze[13]. This may delay or discourage system improvements.

Other methods, such as heuristic evaluation, rely on usability experts to compare a system against usability principles, in order to hopefully avoid major usability issues[14–17]. Once a device or application has been through a heuristic evaluation, various aspects of the tool will have been judged to be either in or out of compliance with recognized usability heuristics[18]. From this analysis, changes can be made to bring the device or application into compliance, and hopefully avoid user frustration. While this method can save time compared to conducting the usability tests and can form an important component of the design lifecycle for tools, it lacks interaction between the system and real users. Additionally, heuristic evaluation is based on the expert's assumptions about user needs and preferences, rather than the users' perspective. Users may interact differently with the system than expected by the usability expert, with the result being many unidentified usability problems. Furthermore, the fact that multiple expert evaluators are needed to do a heuristic evaluation can be challenging within a single organization [19]. Heuristic evaluation can therefore be a useful complement to traditional usability testing, but is not a direct replacement.

1.2 Instant Data Analysis

Instant data analysis (IDA) aims to reduce the labor and time commitment required to perform and analyze a usability test[20]. In IDA, multiple individual sessions are held on a single day. After sessions are completed, those participating in the evaluation meet to discuss the usability issues that were identified. Meeting directly after the sessions allows a better recall of the events, and allows thoughts and ideas that may not be at the forefront of one's memory to be prompted. The idea behind this initial brainstorming session is to document as many usability issues remembered or seen down as possible. These issues are then ranked based on severity and frequency with which the issue arose. This method is designed to make usability testing more accessible while retaining the advantages of "real" user testing by cutting down on the amount of time needed for analysis [20]. The majority of time involved in usability testing goes into understanding what issues were identified during the tests. IDA significantly reduces the amount of time needed for analysis, potentially allowing results to be seen on the day of the usability testing sessions. Previous studies have shown that using IDA can reduce the amount of time needed for analysis by 90%, while achieving 85% overlap in critical usability issues compared to the traditional standard video analysis. A second study found 76% overlap between the two methods [20,21]. However, IDA is relatively novel. To date, it has been used successfully to improve the design of medication lists to reduce adverse drug events, personal health applications, and electronic meeting support systems[9,22–25].

This paper details our experiences using the novel IDA method together with analysis mapping methods. We use an exemplar of this method in the evaluation of a multifunctional wellness tool designed for older adults. We provide insight into the feasibility of the IDA method and discuss our experiences and insights of this method to inform future researchers, designers and other stakeholders who evaluate the usability of technology tools.

2 Case Exemplar

The number of adults aged 65 or older in the United States is projected to grow quickly over the next few decades, climbing from 40 million in 2010 to 72 million by 2030[26]. As people age, they are more likely to have health issues and multiple comorbidities, leading to an increased need for health interventions[27] while the healthcare workforce is not increasing at a similar rate. Information technology is emerging for the delivery of health related interventions targeting both health maintenance and disease management, While the use of technologies has generally grown, the usability of these technologies have lagged for older adults, who have their own unique needs[28,29]. Usability concerns will play a larger role, potentially leading to greater user dissatisfaction and reduced effectiveness.

This paper is based on a pilot study for testing the usability of a multifunctional, commercially available wellness tool for older adults, hereafter referred to as “Device A”

using IDA as the usability testing approach. The purpose of the pilot was to evaluate and assess usability issues with the device in an older adult population. Older adult participants (N=5) were recruited at an independent retirement community via information sessions. Participants could not have had prior exposure to the device to be evaluated. All participants conducted usability sessions individually and were given 3 tasks to complete using the device.

2.1 Design

Usability testing was accomplished with a think-aloud protocol that asks users to verbalize their thoughts as they complete various tasks, allowing investigators to gain insight on participants' thought processes in relation to the interface and task[1]. Sessions included a single participant and a facilitator and a designated note-taker, who observed and took notes as the participant worked through the various tasks. Testing involved a short questionnaire with questions about demographics, eHealth literacy (eHEALS) [30] and other technology use questions, followed by 3 tasks for the participants to complete. A brief post-session interview was then conducted to solicit further feedback regarding their overall impressions of the system, suggestions for improvement, and any particular frustrations they wanted to emphasize. The University of Washington institutional review board approved all procedures in this study.

2.2 Device

This study focuses on usability testing a commercially available multifunctional wellness tool, Device A. Device A is a multifunctional, touchscreen wellness tool installed in over a thousand communities across the US. It has features that were selected to address many different dimensions of wellness, including social wellness (email, video chat, reminiscence features), cognitive wellness (brain exercises, puzzles), spiritual wellness (videos, relaxation), and physical wellness (exercise videos, aerobics).

Physically, the device consists of a touchscreen computer, with a keyboard, mouse and speakers on a movable stand. The entire device is mounted to allow user-adjustable height. The main navigation consists of a 3x3 grid, where each point is a button that specifies a category or folder, with a hierarchy that is several levels deep. There is persistent navigation along the top to allow users to go back to the previous page and change the volume. The device was developed for senior communities with the activities targeted towards older adults. This particular device was selected for this study due to the popularity of the device; however there was sparse published information regarding usability available.

2.3 Procedures

Since we were interested in first-time use and learnability[31], participants were not to have used or seen the device before as assessed verbally by the researcher. Following informed consent, participants were asked to complete a questionnaire which asked general demographic questions such as age and education, questions about eHealth literacy (via the eHEALS instrument), and other technology usage questions such as how often they used a mobile phone or computer[32].

Participants were introduced to the system and walked through some brief example tasks to understand how the system worked and familiarize themselves with the think-aloud protocol. Participants were guided through the evaluation by a facilitator, who was responsible for prompting thoughts from the participants if they stopped thinking aloud. The facilitator was responsible for keeping the sessions on track and intervening when needed if the participant was excessively frustrated[33]. The next task was presented when participants indicated that they thought they had completed the task or if they did not feel that they could complete the task. A second researcher served as the note-taker, recording issues, frustrations, and comments made by the participants during the session. The note-taker observed the participant and participants' actions and thoughts without directly interacting with them.

Participants were given 3 representative tasks depicting a range of difficulties and applications within the interface and were to: 1) play music, 2) read their home newspaper, and 3) play tic-tac-toe and then watch a relaxing waterfall video and aquarium application. These tasks were selected to be a spectrum of difficulties, from easy to hard to complete. Since leisure activities have been associated with slower cognitive decline, these activities fit well within the context of a wellness tool[34,35]. Participants were asked to complete these tasks navigating through the device's interface while thinking aloud to give insight into their thought processes. Participants gave their thoughts on what they liked, what was confusing, and where they thought they needed to go within the interface to accomplish the task at hand along with other feedback. Throughout the process, participants gave their thoughts on the difficulties they were experiencing, where things did not match their mental model and suggestions for improvement. To encourage honest feedback and thoughts on the system as it was being used, researchers assured the participants that the device was being tested, not them. The session concluded with an exit- interview asking for additional comments from participants that they did not already verbalize during the sessions. This included what aspects of the system they found particularly frustrating, the utility of the system from their perspective as well as any suggestions for improvement.

2.4 Instant Data Analysis

Sessions were analyzed via IDA. To complete the IDA, initial brainstorming occurred at the end of each day to identify observed usability issues. Each issue was ranked as *critical* (unable to complete task), *severe* (significant delay or frustration in task completion), or *cosmetic* (minor issues). Each of these issues was then annotated with specific, clear references to the interface and other notes giving additional detail on the problem and participants' reactions.

2.5 Affinity Mapping

While the ranked list generated by IDA serves the purpose of identifying individual issues, we sought to gain a broader understanding on the major types of issues that were causing problems. In order to do this, we separated out all the issues and aggregated them into larger themes using affinity mapping once all sessions were completed[36]. The inductive process looks at all the issues as a whole, by aggregating like issues together until all of the issues have been sorted into groups. By keeping all of the issues on separate pieces of paper, it is feasible to re-categorize and regroup issues as needed as themes emerge. Once all the groups had been sorted, they were then labeled to create larger themes or categories. Thus, at the end of this process, we had identified major themes of usability issues as well as the specific issues associated with each one. This process is a bottom-up, inductive exercise, with categories emerging

from the data at large. Using the process with five older adult participants, we identified 48 usability issues, which aggregated into eight major themes. The IDA process worked well for our population, and did not need a significant revision.

3 Lessons Learned Using IDA

3.1 Think Aloud/Usability Session

The think-aloud process asked participants to verbalize their thoughts, feelings, and frustrations with the facilitator as they worked their way through the tasks. A good facilitator must make sure not to cut off or intervene the participant too early, as this may cause them to give up earlier in the subsequent tasks, or encourage them to look to the facilitator for help in completing the tasks early[1]. Ideally, the participant should act as if they were encountering the device in question within context in real life, where there would be no expert user nearby to offer immediate aid. Thus, it is important for the facilitator to be able to resist helping the user immediately after running into a problem so as to more accurately portray how a new user may act. The facilitator must also decide how much deviation from the task is acceptable, as participants may take a non-direct path to reach their goal, in line with their mental model. In order to better standardize the process, we would recommend using the same facilitator through the sessions. As for the think-aloud process, some participants found it easier than others. An initial explanation of the think-aloud process with an example seemed to help. Reminding participants when they became silent also seemed to help keep them on

track, and some participants made suggestions for improvement as they made their way through the tasks. The resulting insights that users provided via think aloud were useful to identify frustrations that may have not been obvious to designers when building the tool. Finally, emphasizing that the device was being tested and not the participant seemed to relax the participants before the tasks were given to them.

3.2 Brainstorming & Scoring

The goal behind brainstorming was to allow the facilitator and notetaker to elicit as many usability issues as could be remembered. We found great utility in conducting this together as it enabled prompting of remembered issues. The researchers generated issues quickly in the beginning but tended to slow down as time went on. Prompting was useful for identifying additional issues. Furthermore, brainstorming by both team members enabled researchers to add in detail or fill in gaps in the issues identified by the other member.

The actual brainstorming took no more than an hour, followed up by another hour of writing out all the details of the usability issues and references to the interface per day. Compared to the standard of transcription and coding (or video annotation), the IDA method of analysis was much less labor and time-intensive. Our findings were in line with those reported by Kjeldskov's 10-fold reduction in analysis time when comparing the traditional method to instant data analysis methods[20]. Consequently, while the

IDA method was likely not as exhaustive as the traditional method, we were satisfied with the number and quality of issues that were identified, as well as the immediacy of the results and cost-benefit ratio compared to the traditional method. The same day analysis is easier and more immediate, allowing for quick identification and potential system changes to be generated in the same day. By ranking severity in the same process, it was also easier to identify which issues should be tackled first.

There were some tradeoffs to IDA that should be kept in mind when selecting a usability testing technique. First, the resulting usability issues list is generally not as exhaustive as the traditional method. If searching for the maximum number of issues out of a given number of usability sessions, researchers may want to consider using the traditional method, although the tradeoff would be greater analysis time. Furthermore, since IDA involves several sessions taking place in a single day followed immediately by initial analysis, the logistics of scheduling both participants and researchers can be problematic. Depending on the length of each session, the session and analysis could take up a whole or several day(s), which may be difficult to accomplish given competing priorities. In some contexts, the availability of representative users may be limited. In these cases, the benefits gained from using representative users should be weighed against the difficulty of scheduling users to test the technology system.

Overall, the use of the IDA method may be a good place to start for organizations wanting to do user testing, but do not have or want to commit the time and resources

to traditional user testing. IDA can be used as a component in an organization's implementation of the human-centered design framework, and can complement other design techniques and processes to more fully understand the user[37].

3.3 Affinity Mapping

Affinity mapping/diagramming was used to extend the IDA method and generate larger themes to categorize the issues identified in an inductive manner, rather than have a collection of disparate issues. The process of laying out all the issues to group them together allowed an overview of the bigger issues that could suggest what needs to be done as a focus for future development. It also highlights the fact that similar issues came up multiple times, and were not isolated issues. The affinity mapping process added to the results by allowing us able to easily see the number and severity of issues for each theme. Creating an uncategorized section for yet to be sorted issues or issues that did not fit into other larger categories was also effective, so as to not force an issue to be placed in a poorly matching category or with only a tenuous similarity to other issues in that category.

It was useful to have the researchers involved in data collection together in the same room to carry out the exercise. The researchers could discuss the reasons of aggregating issues together, and easily make changes when another researcher brought up a better congregation or match. This allowed agreement across all the researchers involved, and

relatively quick completion. Initially sorting the ideas in silence helped the process along so that each researcher was not disproportionately influenced by the other researchers. Once the initial sort was nearly complete, discussion occurred to identify the shared meanings of each group, and if any changes should be made to create a better aggregation between issues. This process of silence followed by discussion allowed natural sorting without undue influence from the other researchers, while at the same time allowing consensus to be reached at the end.

It is important to not allow a single individual to dominate the affinity mapping process, which would not lead to a satisfactory consensual grouping as others involved may feel left out and their opinions not being taken into account. The silence in mapping can dissuade this somewhat, but care must be taken into not having a single person dominate the process. Finally, the affinity mapping process may not be necessary if only a small number of issues are identified (i.e., less than 10 or 15). In this case, it may be possible to skip this step.

4 Case Exemplar Results & Discussion

4.1 Demographics

A convenience sample of five older adults was recruited for this usability testing study, which is in line with the recommended number of users for usability sessions[38]. The mean age of the participants was 72.4 years (Range: 64-86), with the majority being

women (60%). Four participants (80%) identified as white, and one participant identified as mixed racial background (White/American Indian). For their highest completed degree, two participants had completed four years of college or higher (40%), two participants had completed two years of college (40%), and 1 participant had completed a high school degree (20%).

4.2 eHealth Literacy Scale (eHEALS) and Technology Use

The mean eHEALS score (Possible range: 8-40, higher score indicates higher electronic self-sufficiency) for participants was 32.8 (range: 21-37). Three participants had high electronic self-sufficiency (60%, Score: 30-40) and the other two participants had moderate electronic self-sufficiency in eHealth (40%: Score: 19-29). The majority of participants (3, 60%) indicated they used a mobile phone, while two participants reported they did not own a mobile phone. Of the three mobile phone users, one each reported use across each of the following categories: use rarely, use moderately, and use frequently. All participants indicated they owned a computer, and most of these participants (4, 80%) used their computer "Frequently" while one participant (20%) indicated he used it "rarely."

4.3 Usability Issues

Among the participants, 48 usability issues were identified. Of these issues, 19 issues were ranked as critical (40%), 21 issues as severe (44%) and eight issues as cosmetic (16%). “Critical issues” were defined as those issues that prevented task completion, “severe issues” were defined as those issues that caused significant slowdown or frustration, and “cosmetic issues” were the ones that were left and caused minimal issues. These issues were then grouped into themes using affinity mapping into eight major categories.

4.3.1 Unintuitive Categorization & Nomenclature

The layout of the device homepage consists of large icons and labels that act as folders for the content lower in the hierarchy. Many participants found the categorization of various applications within the system to be unintuitive. The system uses a multi-level categorization method to separate out the various applications. For example, participants had issues with categories or applications that appeared in multiple places, asking “have I been here before?” They may have recognized some of the icons, but not others. This led to confusion and frustration of users and was categorized as a critical error. Furthermore, the categories were perceived as having an unclear naming scheme. The various category names did not intuitively describe the applications and objects stored inside the folder. Frequently, the applications within a category were not

consistent with user expectations. The categorization was challenging for participants to deal with and it “takes [them] awhile to find what [they are] looking for.”

Participants did not think that the pictures attached to the categorical label matched the content, leaving some participants to wonder which one more accurately reflected the content hidden underneath. Some participants were unaware of what “Skype” was, while Device A seemed to assume that users would know what it is, and left the Skype name as an option without any further explanation. Participants felt that the categories were not mutually exclusive, and were confused about where to move forward to find what they were looking for. Terminology was also unclear. For example, one participant typed “E-S-C” in response to a prompt to push “ESC” to escape.

4.3.2 Unclear Iconography

A common issue was unclear or confusing iconography. Critical issues included those where the icons could be interpreted as symbols for something else. For example, an icon with a globe intended to represent “internet needed for this feature” was taken by participants to represent various things, including that it had to do with the environment or something global. Other icons intended to help distinguish between various features, such as a film icon to indicate it was a playable movie had unintended consequences. Some participants thought that every video had that icon, so non-movie videos were not seen as playable. Other icons were reused for different purposes,

causing confusion about whether the icon represented an actual application or a folder. In addition, zoom icons (plus or minus icons) were unclear to a participant on whether a plus or minus made the text bigger or smaller. Finally, participants found the images for categories useful, but often found the images didn't match what they would expect. This caused confusion and interefered with completing tasks.

4.3.3 Unclear Place in Navigation Tree

Many critical issues were related to participants being unclear about where they were in the navigation tree. Device A is set up so that it has several folders that a user can click on and subfolders to organize the applications. Several participants were unclear where they were in the hierarchy, and were unable to successfully navigate between folders to complete the tasks. For example, a participant was stuck in the "entertainment" folder and did not realize he could move up another directory to the home screen, to reach the correct folder. This was related to the confusion of category labels. Participants did not remember which category they selected, and were liable to select the same category again when backing out and trying to complete a task. This caused participants significant frustration. Finally, multiple participants were unclear on the concept of a "homepage". When directed to go to the homepage, these participants were unclear on the meaning and why they needed to be there. As a result, participants were unable to complete the task, which is classified as a critical error.

4.3.4 Misuse of Conventions and Misleading Perceived Affordances

Several of the issues identified were caused by misuse of conventions and misleading perceived affordances. The term “affordance” was originally coined by Gibson, to refer to what an object offers to an organism to perform an action[39]. Norman later coined “perceived affordance” which refers to the perception of properties of an object that suggest what actions can be done to the object or how it could be used[40]. Conventions are a learned way to understand or interact with an object established by usage [40]. Breaking conventions or having misleading perceived affordances could greatly increase the frustration and make tasks more difficult to complete.

Severe issues included graying out the back button even when it could still be pressed, leading a participant to assume they were on the home page since they associated greyed out with unable to be pushed. This can lead to great delay and frustration in task completion. Another severe issue observed was the lack of clarity when a keyboard input was required versus when a touchscreen input was allowed. A participant switched to a mode of input once from the touchscreen interface to the keyboard, and didn’t switch back to the touchscreen even when the new input method was not allowing her to be successful in her intended task. Moreover, a participant was unable to complete a task since the box to input text was not selected, and it was not clear to the participant that it needed to be. This confusion could potentially have been avoided if designers had stuck to using standard conventions from the web or computing areas.

Other conventions were misleading, such as a participant thinking that a white box that looked like a text entry box was actually a progress bar, leading to her trying to click and type in a search entry unsuccessfully, and thus leading to task failure.

4.3.5 Accessibility Issues

Participants indicated having a touchscreen mounted vertically, such as a computer monitor or television, could lead to fatigue. The constant upward moving motion and placing one's hand back down could become tiring, and those adults with shoulder issues would not be able to use the touch interface comfortably at all. Furthermore, while Device A was able to raise and lower to different heights, one participant wished the device could move even lower. Since the device was unable to accommodate her request, she had to strain to look at the screen and had trouble reading the screen, causing some frustration. The same participant was also left handed, and while Device A allowed the mouse to be moved to the other side of the computer for left-handed access, the participant didn't see an easy way to switch the orientation of the mouse buttons, so that the primary mouse click was on the right side of the mouse. She said that she wished it would switch automatically, and pressed the incorrect button for her intended action multiple times.

4.3.6 Physical Responsiveness of the Touchscreen Problematic

The touchscreen on Device A allowed easier menu selection, since users could directly touch what they wanted to select. However, the physical responsiveness of the touchscreen was problematic, creating severe issues such as how the delay of touching the screen to selecting on the device was enough that participants ended up pushing multiple times to achieve their intended action. Delays in system feedback due to this caused consternation on the part of the users. Also, participants occasionally used a tap and hold gesture rather that a single tap on the screen, with unintended consequences. Other times, the system failed to pick up the touch at all. This caused confusion and increased retouching to make sure the selections were picked up by the system.

There were critical issues with the touchscreen. For example, one participant used three fingers to touch the screen, which caused a failure to select the intended object properly. Since she would always touch with 3 fingers, the system often forced her to touch again to select the intended action.

4.3.7 Inability to Exit Consistently

Participants had a difficult time exiting the page or application consistently. Even when there was a labeled “close” button, one participant was unable to close the window because the finger’s touch target was off by a few pixels, which led to selection of the

wrong portion of the screen. This participant had to try closing many times before clicking the “close” button successfully after a significant delay. Another participant was unable to close the same window successfully, and missed the button labeled “close.” Only after a delay did the participant recognize the button, even saying that it “wasn’t there before.” Other severe issues included the lack of clarity on what the “exit” button did on the always present navigation bar, such as whether the button exited the current application, the entire system, or something else. Also, because the navigation bar disappeared in the full-screen scenario, participants were unable to exit full-screen applications, leading to both severe (only exited after frustration or long delay) and critical (unable to exit) issues.

4.3.8 Sound Volume Issues

Participants indicated that they wished to change the sound volume but were unable to do so without significant frustration or delay. Participants did not discover the volume option initially, even when they complained that they couldn’t hear anything because the system was too quiet. The navigation bar had a volume button to increase and decrease the volume, but it did not seem to be obvious to participants unless prompted by the facilitator. Furthermore, Device A uses hardware speakers with a hardware dial for volume control, but this was not discovered or used by any of the participants.

4.4 Discussion of Case Exemplar

The usability testing study was performed to better understand issues that exist within a multifunctional wellness tool. These findings can inform the development of future wellness tools. Even popular, commercially available multifunctional wellness tools have many usability issues that should be addressed. This study has identified many usability issues that were categorized into eight major categories. This suggests that designers should carefully consider how the content and organization of their multifunctional wellness tools are presented to older adult users. These themes should be used to inform future development of tools that cause less frustration and potentially happier users. This study also highlights the importance of testing devices with representative users. Even this popular commercial device has many issues that could be remedied to create a better experience.

Cognitive changes related to aging, such as a decline in working memory should be fully considered when designing wellness tools for older adults[41]. Taxing working memory should be minimized when possible. Many participants found issues with navigation, and especially with keeping track of where they were within the navigation tree. Thus, it was unclear how often they could move up a level, and difficult to remember what category they had clicked on to reach the page they were currently on. Difficulties in navigation are in line with previous studies that suggested that reduced working memory made it more difficult for older adults to navigate and use the web[42,43].

Designers could alleviate these issues by creating obvious titles on each page, and creating breadcrumbs (navigation trail) to show what level of the hierarchy they are on, as well as how they reached that page. Previous studies have suggested the use of breadcrumbs for positive effects in performance and user satisfaction[44,45].

In addition, a designer should think deeply about what needs to be included in the system and remove unnecessary features to simplify the number of levels and options. Simplifying the navigation hierarchy will reduce the load of navigation on working memory, which is in line with previous research that suggests the use of shallow hierarchies[46]. Designers may also want to consider the external cognition framework, which describes how cognition does not solely occur in the individual, but also relies on external representations in the environment[47,48]. Increasing computational offloading could help a user experiencing cognitive decline continue to successfully use the system.

Related to navigation were categorization and nomenclature issues, many participants found that the categories in which applications were sorted were not memorable and did not match their mental model of how applications should be sorted. When using icons or pictures, designers should validate that the icons are intuitive and represent to users what they represent to designers and wellness tool to minimize confusion. This is underscored by previous studies that indicate that older adult reluctance to use some technological systems was the result of not being able to understand the terminology

and symbols used [49,50]. While certain terminology and symbols may be understood by more technologically adept or younger people, if the intended user group is older adults, the use of these terms would not be satisfactory. Our experiences within the study reinforce the importance of user testing with the intended user group of older adults. Furthermore, seeking broad older adult input on categorization and labels to match their mental models would alleviate much of the frustration of the users and could make them more inclined to learn and use a wellness tool.

Another area that spurred frustration among participants pertained to conventions that led them astray or perceived affordances that misled them. If designers are going to use conventions, such as greying out a button to indicate that it can no longer be pressed, it should be consistent with norms that exist. Designers should be aware of what the conventions are, such as a white box usually representing a text box or a greyed button usually meaning it can no longer be pressed. Interface designers should avoid breaking these conventions to minimize frustration of users.

Accessibility issues, such as physical changes related to aging including chronic conditions such as shoulder pain, should be considered when designing wellness tools for older adults. Participants worried about shoulder pain and fatigue when using touchscreens set vertically, such as in computer monitors, especially for those adults who have chronic shoulder pain. Work should be done to observe users using the device to get a better idea of what range of motion is needed to satisfy them, as well as the

positioning and type of input to reduce physical stress and fatigue on users. Participants appreciated the touchscreen, as it was more intuitive as they could touch what they wanted to select. However, the delay in processing their touch caused them to press again with unintended consequences. Touch points of where participants intended to touch compared to where the system registered touch were not always in sync. Future designers should test the touch interface with real users, and make changes as necessary to reduce the burden on the user. Other input methods, such as voice recognition could be used for input. The use of voice input as an alternative to mitigate some of the issues older adults have with using technologies has been suggested by previous studies, although voice input comes with its own issues[51–53].

Other issues that arose, such as the inability to exit consistently or change volume as needed suggest that designers should test these features extensively with users early in the design process. Repeated, iterative testing could identify interface problems and facilitate the creation of potential solutions.

Our results are consistent with existing user interface and information architecture design guidelines[14–16]. These guidelines recommend facilitating users to recognize what they're looking for rather than recalling from memory. This aligns with our suggestion of reducing memory load to help navigation. Furthermore, systems should speak the user's language and match the user's nomenclature. The match between user language and system language did not occur in our tested device but should be

incoporated into future designs. Finally, these guidelines suggest that wellness systems should work in a way that is consistent with user expectations. This also reinforces the need to test with actual users in order to see their mental model of understanding with regard to navigation, nomenclature, categorization, and object function. While ideally all future wellness tools should employ a designer with extensive usability and information architecture experience, we hope that this study's guidelines will be useful for designers without this experience.

5 Conclusion

Minimizing usability issues of tools before releasing to a wide audience can increase user satisfaction and reduce user frustration with these tools. This paper presents the feasibility of and lessons learned while using the IDA method as a quick and less labor-intensive way of performing usability testing.

IDA would be most useful to those organizations and designers who are interested in usability testing from real users, but do not want to commit the time or resources to perform the traditional usability testing methods. The speed at which results are generated and issues identified with lower resource commitment can be useful for relatively quick feedback on the design of tools as they currently stand. Organizations that currently perform traditional usability testing may want to consider the cost-benefit ratio of the additional and more thorough results from the traditional testing compared to IDA and determine whether the additional commitment of resources and time is

worth it. Additionally, it is important to recruit individuals who are similar in nature to the intended users of a tool to get the best results. Finally, when considering the use of instant data analysis, researchers and designers should remember that IDA aims to identify the most critical issues, not all of them.

The IDA method is quicker and less labor-intensive than traditional usability testing methods and leads to results that has many of the benefits of traditional usability testing with end users. Furthermore, the addition of affinity mapping was highly beneficial in the identification of themes and areas for further investigation. When combined with the severity rankings, these methods can lead future designers to correct and/or avoid previous mistakes. Future studies may want to compare the use of IDA with other usability testing and inspection methods to more clearly understand the cost-benefit of each method relative to the other. Our study shows the feasibility of the IDA method for usability testing in analysis in a pilot study with older adults, and the use of the addition of affinity mapping to identify themes as feasible and pragmatic. This study has detailed the use of IDA in a clearly defined methodology with affinity mapping that could be beneficial for researchers who are interested in identifying usability issues with users and wish to attenuate these issues before the next iteration of the application.

5 Acknowledgements

This study was supported, in part, by the National Library of Medicine Biomedical and Health Informatics Training Grant T15 LM007442.

Bibliography for Chapter 3

[1] Rubin J. Handbook of usability testing: how to plan, design, and conduct effective tests. John WIley & Sons; 1994.

[2] Nayak N, Mrazek D, Smith D. Analyzing and communicating usability data: now that you have the data what do you do? a CHI'94 workshop. ACM SIGCHI Bull 1995;27.

[3] Kushniruk AW, Patel VL. Cognitive computer-based video analysis: its application in assessing the usability of medical systems. Medinfo 1995;8 Pt 2:1566–9.

[4] Mack RL, Lewis CH, Carroll JM. Learning to use word processors: problems and prospects. ACM Trans Inf Syst 1983;1:254–71. doi:10.1145/357436.357440.

[5] Ericsson KA, Simon HA. Verbal reports as data. Psychol Rev 1980;87:215–51. doi:10.1037/0033-295X.87.3.215.

[6] Kaufman DR, Patel VL, Hilliman C, Morin PC, Pevzner J, Weinstock RS, et al. Usability in the real world: assessing medical information technologies in patients' homes. J Biomed Inform 2003;36:45–60. doi:10.1016/S1532-0464(03)00056-X.

[7] Bond RR, Finlay DD, Nugent CD, Moore G, Guldenring D. A usability evaluation of medical software at an expert conference setting. Comput Methods Programs Biomed 2014;113:383–95. doi:10.1016/j.cmpb.2013.10.006.

[8] Simon ACR, Holleman F, Gude WT, Hoekstra JBL, Peute LW, Jaspers MWM, et al. Safety and usability evaluation of a web-based insulin self-titration system for patients with type 2 diabetes mellitus. Artif Intell Med 2013;59:23–31. doi:10.1016/j.artmed.2013.04.009.

[9] Siek K a, Khan DU, Ross SE, Haverhals LM, Meyers J, Cali SR. Designing a personal health application for older adults to manage medications: a comprehensive case study. J Med Syst 2011;35:1099–121. doi:10.1007/s10916-011-9719-9.

[10] Harris LT, Tufano J, Le T, Rees C, Lewis G a, Evert AB, et al. Designing mobile support for glycemic control in patients with diabetes. J Biomed Inform 2010;43:S37–40. doi:10.1016/j.jbi.2010.05.004.

[11] Luckmann R, Vidal A. Design of a handheld electronic pain, treatment and activity diary. J Biomed Inform 2010;43:S32–6. doi:10.1016/j.jbi.2010.05.005.

[12] Neri PM, Pollard SE, Volk L a., Newmark LP, Varugheese M, Baxter S, et al. Usability of a novel clinician interface for genetic results. J Biomed Inform 2012;45:950–7. doi:10.1016/j.jbi.2012.03.007.

[13] Jeffries R, Miller JR, Wharton C, Uyeda K. User interface evaluation in the real world: a comparison of four techniques. Proc. SIGCHI Conf. Hum. factors Comput. Syst. Reach. through Technol. - CHI '91, 1991, p. 119–24. doi:10.1145/108844.108862.

[14] Nielsen J. 10 Usability Heuristics for User Interface Design 1995. http://www.nngroup.com/articles/ten-usability-heuristics/ (accessed April 8, 2014).

[15] Tognazzini B. First Principles of Interaction Design (Revised & Expanded). AskTog 2014:1–38. asktog.com/atc/principles-of-interaction-design/.

[16] Brown D. Eight principles of information architecture. Bull Am Soc Inf … 2010;36:30–4. doi:10.1002/bult.2010.1720360609.

[17] Nielsen J. Finding usability problems through heuristic evaluation. Proc SIGCHI Conf Hum Factors Comput Syst - CHI '92 1992:373–80. doi:10.1145/142750.142834.

[18] Nielsen J, Molich R. Heuristic evaluation of user interfaces. Proc. SIGCHI Conf. Hum. factors Comput. Syst. Empower. people - CHI '90, New York, New York, USA: ACM Press; 1990, p. 249–56. doi:10.1145/97243.97281.

[19] Jeffries R, Desurvire H. Usability testing vs. heuristic evaluation. ACM SIGCHI Bull 1992;24:39–41. doi:10.1145/142167.142179.

[20] Kjeldskov J, Skov MB, Stage J. Instant data analysis. Proc. third Nord. Conf. Human-computer Interact. - Nord. '04, New York, New York, USA: ACM Press; 2004, p. 233–40. doi:10.1145/1028014.1028050.

[21] Best MA De, Deurzen K Van, Geels M, van Oostrom F, Pries J, Scheele B. Quick and clean, fast and efficient usability testing for software redesign. Proc. CHI Ned. 2009, 2009, p. 149–52.

[22] Khan DU, Siek K a., Meyers J, Haverhals LM, Cali S, Ross SE. Designing a personal health application for older adults to manage medications. Proc ACM Int Conf Heal Informatics - IHI '10 2010:849. doi:10.1145/1882992.1883124.

[23] Lawton K, Skjoet P. Assessment of three systems to empower the patient and decrease the risk of adverse drug events. Stud Heal Technol Inf 2011.

[24] Zurita G, Baloian N, Baytelman F, Morales M. A Gestures and Freehand Writing Interaction Based Electronic Meeting Support System with Handhelds. In: Meersman R, Tari Z, editors. Move to Meaningful Internet Syst. 2006 CoopIS, DOA, GADA, ODBASE, Berlin: Springer; 2006, p. 679–96. doi:10.1007/11914853_40.

[25] Siek K a, Ross SE, Khan DU, Haverhals LM, Cali SR, Meyers J. Colorado Care Tablet: the design of an interoperable Personal Health Application to help older adults with multimorbidity manage their medications. J Biomed Inform 2010;43:S22–6. doi:10.1016/j.jbi.2010.05.007.

[26] US Census Bureau. The Next Four Decades: The Older Population in the United States: 2010 to 2050. 2010.

[27] Anderson G, Horvath J. The growing burden of chronic disease in America. Public Health Rep 2004;119:263–70. doi:10.1016/j.phr.2004.04.005.

[28] Nahm E-S, Preece J, Resnick B, Mills ME. Usability of Health Web Sites for Older Adults. CIN Comput Informatics, Nurs 2004;22:326–34. doi:10.1097/00024665-200411000-00007.

[29] Hawthorn D. Possible implications of aging for interface designers. Interact Comput 2000;12:507–28. doi:10.1016/S0953-5438(99)00021-1.

[30] Norman CD, Skinner HA. eHEALS: The eHealth Literacy Scale. J Med Internet Res 2006;8:e27. doi:10.2196/jmir.8.4.e27.

[31] Grossman T, Fitzmaurice G, Attar R. A survey of software learnability: Metrics Methodologies, and Guidelines. Proc. 27th Int. Conf. Hum. factors Comput. Syst. - CHI 09, New York, New York, USA: ACM Press; 2009, p. 649. doi:10.1145/1518701.1518803.

[32] Norman CD, Skinner H a. eHEALS: The eHealth Literacy Scale. J Med Internet Res 2006;8:e27. doi:10.2196/jmir.8.4.e27.

[33] Barnum C. Usability Testing Essentials: Ready, Set .. Test! Burlington, MA: Elsevier, Inc; 2011.

[34] Scarmeas N, Stern Y. Cognitive reserve and lifestyle. J Clin Exp Neuropsychol 2003;25:625–33. doi:10.1076/jcen.25.5.625.14576.

[35] Scarmeas N, Levy G, Tang MX, Manly J, Stern Y. Influence of leisure activity on the incidence of Alzheimer's disease. Neurology 2001;57:2236–42. doi:10.1212/WNL.57.12.2236.

[36] Martin B, Hanington B. Universal Methods of Design. 2nd ed. Beverly: Rockport Publishers; 2012.

[37] ISO FDIS 9241-210. Ergonomics of human system interaction - Part 210: Human-centered design for interactive systems (formerly known as 13407). 2010.

[38] Nielson J. Why You Only Need to Test with 5 Users. Neilson Norman Gr Alertbox 2000. http://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/.

[39] Gibson JJ. The Theory of Affordances. Perceiving, Acting, and Knowing, vol. Perceiving, 1977, p. 127–42 (332). doi:citeulike-article-id:3508530.

[40] Norman D. The Design of Everyday Things. New York: Doubleday; 1990.

[41] Dobbs AR, Rule BG. Adult age differences in working memory. Psychol Aging 1989;4:500–3. doi:10.1037//0882-7974.4.4.500.

[42] Mead SE, Spaulding VA, Sit RA, Meyer B, Walker N. Effects of Age and Training on World Wide Web Navigation Strategies. Proc Hum Factors Ergon Soc Annu Meet 1997;41:152–6. doi:10.1177/107118139704100135.

[43] Becker SA. A study of web usability for older adults seeking online health resources. ACM Trans Comput Interact 2004;11:387–406. doi:10.1145/1035575.1035578.

[44] Kurniawan SH, King a., Evans DG, Blenkhorn PL. Personalising web page presentation for older people. Interact Comput 2006;18:457–77. doi:10.1016/j.intcom.2005.11.006.

[45] Maldonado C a., Jlesnick ML. Do Common User Interface Design Patterns Improve Navigation? Proc Hum Factors Ergon Soc Annu Meet 2002;46:1315–9. doi:10.1177/154193120204601416.

[46] Gappa H, Nordbrock G. Applying Web accessibility to Internet portals. Univers Access Inf Soc 2004;3:80–7. doi:10.1007/s10209-003-0070-x.

[47] Scaife M, Rogers Y. External cognition: how do graphical representations work? Int J Hum Comput Stud 1996;45:185–213. doi:10.1006/ijhc.1996.0048.

[48] Rogers Y. New theoretical approaches for HCI. Annu Rev Inf Sci Technol 2004;38:87–143. doi:10.1002/aris.1440380103.

[49] Holzinger A, Searle G, Auinger A, Ziefle M. Informatics as semiotics engineering: Lessons learned from design, development and evaluation of ambient assisted living applications for elderly people. In: Stephanidis C, editor. Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics), vol. 6767 LNCS, Berlin: Springer Berlin Heidelberg; 2011, p. 183–92. doi:10.1007/978-3-642-21666-4_21.

[50] Aula A. User study on older adults' use of the Web and search engines. Univers Access Inf Soc 2005;4:67–81. doi:10.1007/s10209-004-0097-7.

[51] Dias MS, Pires CG, Pinto FM, Teixeira VD, Freitas J. Multimodal user interfaces to improve social integration of elderly and mobility impaired. Stud. Health Technol. Inform., vol. 177, 2012, p. 14–25. doi:10.3233/978-1-61499-069-7-14.

[52] Smith MW, Sharit J, Czaja SJ. Aging, motor control, and the performance of computer mouse tasks. Hum Factors 1999;41:389–96. doi:10.1518/001872099779611102.

[53] Maguire M, Osman Z. Designing for Older Inexperienced Mobile Phone Users. In: Stephaniedis C, editor. Proc. HCI Int. 2003, Mahwah, New Jersey: Lawrence Erlbaum Associates; 2003, p. 22–7.

Chapter 4: IT-based Wellness Tools for Older Adults: Design Concepts and Feedback

Abstract

Objective: To explore older adults' preferences regarding e-health applications through use of generated concepts that inform the design of wellness tools.

Methods: An iterative approach was used to generate design ideas and elicit feedback on older adults' preferences for e-health applications. The 6-8-5 method and affinity mapping were used to create five e-health design ideas rooted in themes from previous studies that were translated into wellness tool storyboards and scenarios by health technology researchers. Six focus groups were conducted onsite to obtain feedback on the final wellness tool storyboard and scenario ideas and participants were additionally asked to sketch their ideal wellness tool. A qualitative analysis of the focus groups using a constant comparative approach for emerging themes was conducted. Sketches were analyzed using a "quick & dirty" analysis.

Results: Forty-three older adults participated in six focus group sessions. The majority of participants found the storyboard wellness tools useful. Preferred tools included features that supported participants in areas of unmet needs, such as the need to find reliable health information, cognitive training, medication reminders, or maintaining social ties. Participants favored features that allowed them to remotely and conveniently access information and support through use of voice navigation. However,

the most frequently voiced concerns were cost and the need for technology skills, access, and technical support. Sketches reinforced wants of participants, including portability, convenience and simplicity.

Conclusions: In general, the majority of participants found the presented wellness tools attractive and useful. Several factors were found to increase the desirability of such devices including but not limited to: convenient access to their health and health information, a simple, accessible interface, and support for memory issues. Researchers and designers should work to better understand the needs of older adults regarding wellness tools, so that future designs meet the needs of older adults.

1 Introduction

Life expectancy in the United States (US) has increased with older adults (those 65 years of age or older) representing the fastest-growing segment of the population. The number of older adults over the age of 65 in the US is projected to increase from 40 million in 2010 to 72 million in 2030(1). As people age they are more likely to have health problems or multiple comorbidities, prompting a heightened need for health interventions. The vast majority of older adults report living with one or more chronic conditions (92%) and most older adults (53%) report impairments in hearing, cognition, mobility or vision, which may progress to the point where they cannot carry out activities of daily living(2,3). As a greater number of people live longer, there will be a parallel increased interest in meeting their unique needs(4).

While physical health is important, it is only one part of the concept of wellness. This broader concept includes cognitive, spiritual, social, and the aforementioned physical aspects of wellness(5,6). For example, relationships with family or friends were rated as the second most important thing in life after their own health for adults aged 65 or older(7). In fact, social isolation in older adults has been linked with poor health outcomes, including higher blood pressure, higher incidence of depressive symptoms, and worse cognition(8–10). Therefore, there is a need for interventions to deal with these broader concerns that influence wellness and health.

1.1 New technologies have emerged

As personal technologies have become more accessible, new technologies for health and wellness have been created. In the US, the number of adults owning a mobile phone has trended upward, rising from 65% in 2004 to 91% in 2013(11). While older adults are often seen as laggards in technology adoption(12), they have adopted mobile phones at high rates. Seventy-six percent of adults aged 65 or older report owning a mobile phone in 2013(11). Accordingly, there is interest in using new technologies in novel ways, especially with regards to health and wellness for older adults. The ubiquity of mobile phones within the population have led to interest in using them for health and wellness interventions, including management of diabetes(13,14), symptom management (15), and fall detection(16). Other novel technology interventions in health

and wellness have also been successfully studied with older adults. For example, cognitive training programs have been shown to enhance the cognitive abilities of older adults(17,18). The success of cognitive training interventions have led to using computerized cognitive training to allow wider dissemination at lower cost(19).

1.2 Technologies are Often Not Designed with Older Adults in Mind

While older adults are often seen as slow to uptake new technologies, studies have shown that they are willing to adopt new technologies if they perceive the technology as being beneficial or useful to them(20–22). In contrast, new technologies are proliferating, but they are often not designed with older adults in mind(23). Consequently, technologies designed for older adults should meet the wants and needs of older adults, to increase the chances of uptake.

Normal aging changes need to be considered in technology design and implementation. As people age, they may experience a decline in their vision, such as reduced visual acuity, contrast and color sensitivity(23–25). Further deterioration of vision is seen in depth perception and peripheral vision as people age(26,27). In addition to visual declines, changes in hand movement, such as reduced dexterity and fine motor control may affect how older adults interface with current technologies. Older adults may also experience changes in attention and memory, including working memory, which can make it difficult to learn to use new complicated interfaces(23,28). These physical

declines, along with declines in memory and learning can make it difficult to use tools that were not designed with older adults in mind. Moreover, older adults tend to be more risk averse, and slow down more after making an error compared to younger adults. Therefore, they are less likely to try new methods when familiar methods continue to work for them, and they do not wish to be a burden by asking others for help(29).

Before considering the implementation of a system, it is important to understand how a system can be useful to older adults. Without perceived usefulness, they will not see a reason to learn and adopt new technologies for their health and wellness. By taking into account what older adults would like and dislike when designing wellness tools, there is a higher chance of satisfaction and use, and thus the final product can potentially have a greater impact. Therefore, the purpose of this study is to understand what older adults prefer regarding technology-based wellness tools, using generated design concepts.

2 Methods

2.1 Design Concept Generation

Previous work examined older adults' preferences towards a multifunctional wellness tool, such as their perceived value for using technology for health and difficulties in finding reliable health information(30). Additional work has examined the usability of a currently available multifunctional wellness tool for older adults, and suggested

problems that should be fixed to reduce frustration. We reviewed the facilitators and barriers to wellness tools from these previous studies and performed brainstorming activities to generate ideas on how we might improve the wellness of older adults using technology tools and concepts. In order to facilitate idea generation, we used the 6-8-5 method(31). The 6-8-5 method first involves a group of two or more people getting together to each individually generate 6 to 8 ideas in 5 minutes silently. After the 5 minutes, each of the ideas were shared with each member in the group. Next, the method shifted back to the individual phase for a second round. These iterations of silent brainstorming followed by group sharing were repeated several times, in order to rapidly generate ideas in succession. After the completion of the method, we broke out into a larger brainstorming session, which allowed for more interaction between researchers and their ideas(32). This method allowed the team to create as many ideas as possible, while deferring judgment and using previous ideas to jump off to new ideas and expand.

After ideas and concepts were generated, we used affinity mapping to group together like ideas and concepts(33). Affinity mapping is an inductive, bottom-up process that aggregates concepts together until all are sorted into groups that emerge from the data. In this study, all ideas were written on separate pieces of paper, to facilitate movement of ideas and to enable identification of groups until all ideas were agglomerated. These groups were then labeled to give a better idea of the larger ideas and similarities that ran between concepts. Ideas were then filtered via voting, where each researcher was

given a number of votes to indicate which ideas the researcher felt were the most compelling and in line with what older adults indicated they would like in a wellness tool(30). The most compelling ideas were then converted into scenarios and storyboards, and integrated into a story that suggested how each idea could be used in the future. Ideas were integrated together to more closely match the findings indicated in previous research(30), and selected to capture a broad spectrum of functionalities and scenarios of use.

2.2 Focus Groups

Participants were recruited from Puget Sound independent living retirement communities and community centers, via in-person information sessions and flyers posted around the facilities. Participants were eligible to participate if they were 60 years of age or older, resident or member of the participating facility or community center, able to read and speak English, and willing to sketch with a pen or pencil on paper. The institutional review board of the University of Washington approved all procedures of this study.

Each focus group session started took place onsite at the participating at the participating independent living retirement community or community center. Every session started with a short demographics form, and then up to 5 design concepts were presented to each group as either a storyboard or scenario in written form (See

Appendix 4.1). Following the storyboard, an explanation was provided to answer any questions participants may have about the scenario. Participants were then asked to discuss their likes, dislikes, and other feedback regarding how they perceived the presented design idea. Solicited feedback also included why or why not participants found it attractive, if they could see it fitting into their everyday lives, and any suggested improvements. Finally, at the end of the session, participants were asked to provide a rough sketch of what their ideal system would look like.

2.2.1 Design Concepts

Design Concept 1. The first design concept consisted of a watch that tracked blood pressure, and alerts the wearer if it has detected any spikes or unusual activity, so that the wearer can take action if needed. Furthermore, the watch would send alerts to the wearer's daughter if the participant wearer fainted so the daughter could check up on her to see if she was okay.

Design Concept 2. The second concept was a touchscreen health tool that could also be queried via voice. When asking health related questions, the health tool shows a trustworthiness score for sites, and can check for any foods that a user should avoid based on their medications list. The scenario takes place after a doctor's appointment when the user is out and about, and has questions that were generated by instructions

during the appointment. The questions were general in nature, rather than specific to their particular situation.

Design Concept 3. The third design concept was a device (e.g. a mobile device) that reminded the user of their schedule, such as to take their medications. The device also asked if the participant wanted any additional information such as side effects to should watch out for. In addition, the device also contained cognitive training games, to help out the user's memory, and responded to voice commands such as showing what was on the device's screen onto a larger television. Finally, the device also had a command to immediately connect the device to a technology support person who could walk through the user in solving any problems they had in using the device.

Design Concept 4. The setting for the fourth design concept was a facility for rehabilitation after a fall. The device for this concept looked similar to a television on wheels, where the main feature was to facilitate communication via video calling to friends, family, and to attend religious services. Since this device was intended to be used by multiple people at the rehabilitation facility, a user would login with a fingerprint to protect their personal information. It was also self-propelled, in that it could move to the next user when the current user was done using it for the day.

Design Concept 5. The fifth design concept consisted of an application on a tablet that has voice navigation for accessibility, as well as the ability to share health and patient

information with designated stakeholders. In this scenario, the stakeholder helps the user to manage medications and track lab results.

2.3 Analysis

Demographic data were analyzed using descriptive statistics via Microsoft Excel. Focus groups were audio recorded and transcribed to facilitate analysis. Qualitative descriptive methods were used to identify common themes in the discussions across focus groups(34). Three researchers were involved in the coding. Each researcher independently went through each transcript using open coding to distinguish concepts of interest from the transcripts. Codes were then created and assigned to utterances of participants based on emerging themes within the data. After each transcript, the codes were reconciled through consensus, and any additions were added to the master codebook. The master codebook was then used as the basis for the next transcripts' coding. This process was used to capture sentiment and identify cross-cutting themes across various people and locations in response to our scenarios and storyboards.

The sketches were analyzed using a "quick & dirty analysis", which involved spreading out all the sketches on a table. Patterns emerged and sketches were arranged to aggregate sketches based on their similarity. Similarities and differences were then explored by rearranging sketches based on various aspects of the sketched ideal system(35).

3 Results

A total of 43 older adults participated in six focus group sessions. Each session lasted up to 90 minutes. The average age across participants who answered the demographic survey was 77(R:61-92, No Response(NR)=3) with 32 participants identifying as female, and 9 participants identifying as male (See Table 1).

Multiple themes were identified, which are summarized below, and grouped by design concept. Following each design concept explanation are themes that emerged across focus group participants.

3.1 Design Concept 1. Blood Pressure Tracking Watch

The majority of participants found the idea of tracking health a useful idea, and thought this watch would be a "really good idea" (FG 2). Furthermore, participants indicated it would be particularly useful for those who live alone or those who have worries about their health. For example, participants suggested that the watch would be useful for "people who have high blood pressure who may not be taking good care of themselves" (FG 6), so that they can "take immediate measures to bring down your blood pressure" (FG 4). Living alone was also a big factor mentioned when participants talked about usefulness, as the automated alerts reassured them that they would have access to help when they were unable to directly ask for it themselves. However, participants also

indicated that they wished that the individuals who are alerted or called by the device would be selected by the users, allowing them to indicate primary and secondary contact numbers (or a backup person).

	Number	%
Total Participants	43	
Gender		
Male	9	20.9
Female	32	74.4
No Response	2	04.6
Ethnicity		
Hispanic	0	0
Not Hispanic	28	65.1
No Response	15	34.9
Race		
American Indian/Alaska Native	1	2.3
Asian	2	4.7
Black	6	14
Native Hawaiian	1	2.3
White	30	69.8
No Response	3	7.0
Average Age	77.0	

Table 4.1. Demographics of Participants

While calling the wearer's daughter was useful, they also hoped that it would call the retirement facility nurse, a physician, or emergency services in case the daughter was unavailable.

Importantly, participants saw this design concept as a way to increase self-management and improve engagement in their own health and health care. One participant noted that the watch concept was "good ... It's form of control" (FG 6). By being alerted, they could have the warning to take action, and the confidence that if something goes wrong, there is a backup individual who will be alerted to help them out.

Participants responded positively to the watch form factor (the physical size and shape of the device), especially when compared to another device they would have to carry with them. This was especially attractive for those who already wore a watch, since it would not require them to remember an additional device. Participants generally seemed to agree that the watch was "small and easy to carry around and it's always on you." (FG 2), and that it would not require them to dig around in their bag or purse, which would reduce its convenience. Furthermore, the watch form factor allowed the watch to be "close to [the participant's] body and it's instant [continuous monitoring]", unlike something that would sit in their pocket or purse.

Participants suggested improvements that would make the device more attractive to them, such as if the watch could also have fall alerts, track heart rate or track blood

sugar. For example one participant suggested “something that would alert you ... a thing [that] emits a signal when you collapse ... a wrist watch would be a good idea” (FG 2) would be desirable in addition to the heart rate alerts. Consequently, participants saw the continuous tracking watch to be a great idea and were excited about the possibilities of various types of health measures that this watch could theoretically track.

All aspects of the design concept were not universally praised. Enthusiasm for the design concept was tempered by the concern regarding price, with willingness to pay a higher price depending on need (health status, living situation). Participants also indicated that they hoped that the cost could be lessened by Medicare or insurance, so as to reduce the financial burden on individuals. Furthermore, a subset of participants were wary of continuous tracking, worrying that continuous tracking could cause unnecessary stress on the wearer. This subset of participants worried that “[this device] will make your blood pressure go higher if you're obsessing with [your blood pressure]” (FG 5), and that “when you have an obsession with [tracking your blood pressure], it's just going to go higher because it would make you nervous” (FG 3).

3.2 Design Concept 2. Touchscreen HealthTool with Graded Online Information

The majority of participants felt they could relate to the scenario presented, as they often have health or medical questions outside the clinic and may resort to unreliable

information. One participant felt that “most of us in desperation, if anything, go searching out information wherever we can find it” (FG 1). They often like asking their medical provider when they have questions, but once outside the appointment they are unsatisfied with the reliability and validity of the health information that they can find. Even those that go search for information online feel that “there's so much information in our internet and you don't have any way of figuring out what you should really believe” (FG 3).

Focus group participants also felt they were lacking in information in areas they found to be of importance, and mused they could have avoided issues if they had that information. One participant had an issue where she had a “recent incident where she was taking a certain medication and they changed it to something else and I had complications and if I had access to this I could have avoided that” (FG 1). Medication changes and other issues resulting from new medications often came up, with participants agreeing that the health tool that was presented was very attractive for avoiding these issues. Many of them had personally experienced or knew someone else who had experienced a similar problem.

While the graded trustworthiness of health sites online was very attractive to participants, there was some concern on who would be responsible for doing the grading of the sites. Since they would be relying on these scores for their health, they hoped that the grader would be “the most competent person” (FG 2). While some

suggested their pharmacist or physician should be the grader, those entities trusted to grade these sites tended to be large, well-known medical centers such as Johns Hopkins, the Mayo Clinic, and the University of Washington.

Participants also enjoyed the convenience of getting health information from sources they trust that were not necessarily their personal physician. Some participants indicated that they didn't fully trust their own doctor as the only reliable source of information, seeking second opinions from other physicians or family/friends. As such, having a tool that had scored health sites would be another useful source of information. One participant indicated that although she usually uses alternative medicine, she would still use it for general health questions as shown in the scenario. "I would use it for general health questions, absolutely. I still do. I'm always - I'm on the Internet and I find things on a regular basis" (FG 2).

3.3 Design Concept 3. Device with scheduling reminders, including medication reminders and medication information, instant technology support, and cognitive training games

Some participants reported that they did receive medication information when picking up their medications, but noted that the provided information was "too much fine print " (FG 1), and that because of that "[she doesn't] read it" (FG 2). They suggested that instead of listing "every blasted side effect" (FG2), to "condense it down to one page– Just like when to take it, and the side effects" (FG 1) in a "little larger font" (FG 1).

Consequently, if the device could meet these requirements when they are taking it, they would find such a device to be useful.

Interestingly, some participants suggested that the ability to share medication information with others would be helpful. For example, if a friend got a new medication prescribed, “you could go to that particular tool and you can show them for you can talk to them or something. So, it's not only for the individual but you can share with somebody else” (FG 1).

The idea of cognitive training resonated with many participants. A participant noted that she really “like[s] the training aspect of it for somebody who has memory kind of moderate memory loss and if there are some games or training that you can take that will improve your memory then that’s a really good idea.” Participants currently performed activities with the intent to help keep their mind sharp, including computer games, Sudoku, crosswords, language classes, and reading. The scheduling feature in the design concept was also attractive, since participants found that their current methods did not always work and they may forget to take their medications or forget to attend other scheduled events.

A concern voiced among some participants was that people with severe cognitive impairment or memory issues may be unable to successfully use the device, since they wouldn’t be able to remember when or how to use it. One participant noted that

teaching something new to someone with memory loss is “frustrating”, and “once you have memory loss, it’s gone” (FG 1). Consequently, participants were concerned that while people with severe cognitive impairment could benefit the most from cognitive training applications, they would not be able to effectively and easily the applications due to their memory loss.

The idea of being able to instantly get technology support in order to guide older adults to perform their wanted tasks was seen positively by many participants, including several who indicated that this feature was their favorite. In fact, over 80% of participants who made specific comments on the feature felt positive about it Participants indicated that they thought instant technical support would be “pretty handy” (FG 1), and that they liked it because “it’s instant” and a “safety thing that [they] like” (FG 4).

3.4 Design Concept 4. A self-propelled device (robot like) that allows video calling to talk to friends/family, as well as attend religious services via video. It also involves a fingerprint to protect personal information in a community or clinical setting.

Participants valued social connections, and could see use of such a device for both people who are living alone on a regular basis as well as people who became more socially isolated due to an incident such as hospitalization. One participant indicated that she thought “it must be very comforting to [the user] to be able to see family

members on a screen. I mean, it doesn't replace them being there physically but to me it would just be so comforting and for the daughter and other family members to view her wherever she is" (FG 5). This participant found that such a device would be comforting to someone who was taken out of their home and was more socially isolated because they were in a rehabilitation facility. The idea of using the device to maintain social ties was seen as something that would be a "lifesaver", notably when family and friends are far away or unable to visit in person (FG 2). This was especially true for people who are active, because the change from being active to being relatively isolated due to an incident leading to hospitalization or rehabilitation could be "traumatic" (FG 2). One participant mentioned that this device could encourage her grandchildren to stay in touch with her because a "high-tech thing like this that would excite them" (FG 3).

While the majority of participants responded positively to the device and scenario outlined, others were more hesitant. One participant insisted on visitations in person only, so she could talk to a "real person" (FG 2), while another participant mentioned that she would be satisfied with a simple phone call or currently available video calling applications (e.g., Skype). One participant even suggested that if such tools were needed due to the difficulties of distance, one should just move closer to family.

Participants liked the idea of using fingerprints instead of forgetting passwords, with participants proclaiming that using fingerprints to login were "better than trying to remember a bunch of passwords" (FG 3). From a more practical perspective, other

participants suggested that the fingerprint system would be superior to other methods, such as keycard access because “you’re not going to lose your hand”, but that “you can lose your cards and things” (FG 3). Consequently, they saw using a fingerprint to access their personal profiles as increasing the convenience of not having to remember yet another password, but without the danger of losing other physical objects.

One participant expressed concerns over how remote verification would work on the phone, since a fingerprint could not be verbally transmitted. Finally, one individual found the use of fingerprints “intrusive” and was “against giving my fingerprints over to – because I want to go to church on Sunday” (FG 5). Of those who made specific comments about the fingerprint sensor, 80% were favorable.

Some participants expressed concerns about other issues related to the device, such as the physical form factor (too large), cost (too expensive or too much investment), privacy (too invasive) and lack of real human interaction.

3.5 Design Concept 5. Tablet application that has voice-navigation, with the ability to share health information with her daughter.

Sharing data with various stakeholders was seen as attractive, especially if they already rely on others for managing their health information, and could perhaps even make up for their lack of technological expertise. One participant mentioned that a sharing

feature would be helpful, because his "son does all that and I'd be lost without him" and his daughter "really want[s] to know more [about] what was going on than she did" (FG 3). Another participant said sharing health information "would be very useful because [her] children are scattered all over the country" and that her children like to be able to "check into a system like this and know exactly what was happening … because it's difficult to convey over email or the phone and you forget" (FG 3). Consequently, participants felt that being able to share health information conveniently supported their current health information practices.

Importantly, being able to select whom to share with and have access to their data was seen as a good way to manage their health information. Participants appreciated being aware of and in control of who to share or communicate their health information. In a sense, they appreciated being in control and sharing on their own terms. One participant suggested that while they do not have their children heavily involved in their health, being able to share is "good idea so that they know too. Particularly, as one gets more disabled" (FG 2). Another participant suggested one scenario where "[the kids] want to check in on their mother or their father, but maybe their mother and father don't [want to be checked in on]" (FG 3), emphasizing the importance of being able to control the sharing of health information.

3.6 Themes that cut across multiple design concepts

While many comments were device or concept specific, several cross-cutting themes emerged that were seen across multiple focus groups and design concepts.

3.6.1 Conveniently-sized or located devices

Some participants preferred to have a device similar in size to a tablet or a smartphone, as they saw it was a convenient way to access the proposed devices. However, some participants were concerned that this would be "giving [them] more things to carry … there's not enough pockets to go around" (FG 4), and that this would lead to "fumbling around all the time with your pockets and your purse and your bag."

A proposed solution was in the form of a wearable device, such as the watch concept, because "it's always on you" (FG 2). This would circumvent the need and frustration of not being able to locate the device to obtain the information wanted, while at the same time increasing the convenience of the device for information access. Another participant suggested that instead of having a separate device to carry around at all times, if the need was for medical information, to have "at the pharmacy having a kiosk or something ... at every place that a senior might pick up their medicines" (FG 6). In this case, this would avoid the participant having to keep up with another device, while still having increased convenience to medical information than they have now.

3.6.2 Simplicity

Participants repeatedly mentioned the need for simplicity in any new technologies or devices to encourage use. When discussing applications, participants mentioned that “it would be important to have the access to this application as simple as possible” (FG 3), and complained that “every time you go and look at some sort of device there's fifty thousand things on it. We don't need fifty thousand things” (FG 2). The complexity of devices would be a major point of contention and dissuade participants from using or fully engaging with any new device aimed at wellness and health. One participant mentioned that a design concept is something that was useful and that a user could “still manage because it’s simple” (FG 4), underscoring the point that simplicity was not a bonus, but rather an important component in the design of the wellness tool.

3.6.3 Cost

While many of the design concepts and features were attractive to participants, this excitement was tempered by concerns about the cost to the individual user. Participants mused that they “[thought] cost would be the big thing” (FG 1), and that “it would be very nice [to use such devices] from time to time but I'm sure that the cost is prohibitive” (FG 5).

Other participants, in addition to being worried about the absolute cost, were "concerned about the cost-effectiveness – How expensive this is... and how to pay for that" (FG 1). While such devices seemed useful and attractive in a vacuum, this participant wondered if the cost would be worth it for the value he got out of it. Finally, some participants hoped that the cost to the end-user could be minimized by having part of or all the cost being covered by their insurance program, therefore reducing the financial burden.

3.6.4 Voice navigation and activation

Participants were enthused about being able to talk to a device to get it to do what they wanted. One participant was attracted to the idea because "voice activat[ion] and information readily there, it's easy [to] access" (FG 4), while another participant found that "Voice-activat[ion], because I talk a lot, would be very nice. This is very appealing for me" (FG 3). For these participants, the voice navigation was a way to conveniently access the device via natural speech.

For other participants, the voice navigation represented a way to navigate a device and bypass accessibility concerns. A participant indicated that "putting fingers on those little keys would be very stressful but voice activation is perfect" (FG 6). This particular participant found typing on small touchscreens to be difficult and disagreeable, and thus found voice navigation to be a convenient workaround. Others with declining vision

would find “voice activation [as] something that does work. … The blind have been using voice activation for years. Where would they be without it? It’s a great feature” (FG 2). One participant indicated that they have been undergoing declines in their vision and “it’s been really hard to adapt… being able to have another way of using your [device] would be through the voice, once again would be very helpful” (FG 2). Consequently, participants found the idea of voice activation and navigation as a great feature, whether viewed as a convenience or necessity.

3.6.5 Hesitance to Change

A subset of participants (9/43) had systems that they had refined over many years or decades, and were not convinced that there was a compelling reason to switch to a new device or method to achieve the same ends. One participant relayed that he “I just use[s] the plain old basics is what I do. I've run a business for 28 years… and I was under a lot of stress all the time and I've never had any problems because of it” (FG 1). This participant had been using the same methods for many years, and didn’t feel like that his current methods was lacking in any way. Another participant mentioned that she was “sure [her] computer has all that technology and [she was] not willing to learn” (FG 6). This participant acknowledged that she was not fully utilizing her computer, but was unwilling to learn new features as she did not feel there was anything that she was not satisfied with in her current methods.

3.7 Sketch Results

After the full discussion, participants were asked to sketch what their ideal system would look like, in a single sketch (Figure 1). Form factors of the sketched systems fit into 3 major categories: wearable, smartphone/tablet-sized, and home-based technologies. The sketches within the wearable categories took the form of a watch or pendant worn around the neck, which participants had mentioned was for the convenience and always having it on hand. The smartphone and tablet-sized devices were of the shape and size of currently available smartphones and tablets, and generally consisted of a large touchscreen with all available options front and center. Finally, the home-based category consisted of a smart-lamp, which could be queried for medical questions, and a self-propelled robot that could answer questions and move to where the user was located. Importantly, the form factors of these devices were all done in such a way that it would not be obvious that the user was in poor health or needed medical information or help. The wearables looked like bracelets, necklaces, or watches, and the phone/tablet-based devices all looked like something someone who may not have medical issues would potentially carry around. In the home, the smart-lamp was intended to blend in with the surroundings, and only activate its smart features if the user knew the way to do so already. Otherwise, it was a generic lamp (Figure 1).

Many features were seen across the sketched designs, with the major categories of features being: alerts/reminders, monitoring, access to medical information, and access

to emergency services. Many participants indicated that their ideal device would have reminders, such as medication reminders, appointment reminders, and general scheduling. Participants also sketched health monitoring as a feature in their ideal device, whether it was to monitor blood pressure, blood sugar, heart rates, or other things such as cholesterol levels. The need for medical information was also seen across multiple sketches, both to have access to personal health information, such as from the doctor's office, as well as having access to a service that could answer their questions about health and wellness outside of the clinic.

Some sketches also emphasized the importance of being able to integrate various sources of information and stakeholders, such as providing involved family members with access to medical information about the older adult user, and having direct access to medical records and scheduling at the doctor's office. Finally, participants also sketched having quick access to emergency service on their ideal system, with single button access on the homepage of their devices.

Several larger themes emerge from the sketches of participants' ideal systems. First, most participants value portability, as their sketches indicated that they would like their devices to either be a wearable (such as a watch or pendant), or in a similar form factor to a tablet or smartphone. Secondly, participants indicated that they appreciated convenience, whether in the form of having access to all the information they need, being able to easily connect with people about their health, or the immediacy of access

to health information (or health measures) as well as to their provider. Next, participants emphasized the simplicity and ease of use in their sketches, with sketches having a straightforward interface without complicated menus. Often, this showed as direct access to all buttons or icons in a single screen. In addition, many devices showed integration, in both all-in-one devices which combined many health features in one device, as well as integration between the user and family members and medical providers. These devices provided easy access and kept other stakeholders involved with the user's health and wellness. All the devices sketched were designed in order to avoid stigma. The sketches showed devices that upon first glance would not suggest that the user had medical issues in their daily life, even if these devices facilitated easier access to health and wellness information.

Finally, the devices sketched showed how participants wanted to be able to be helped – both on how to use technology and devices as well as getting help understanding medical and health issues and information. Overall, the sketches pointed in the direction that participants valued connections with loved ones, their health, as well as simplicity and the immediacy of getting their needs met.

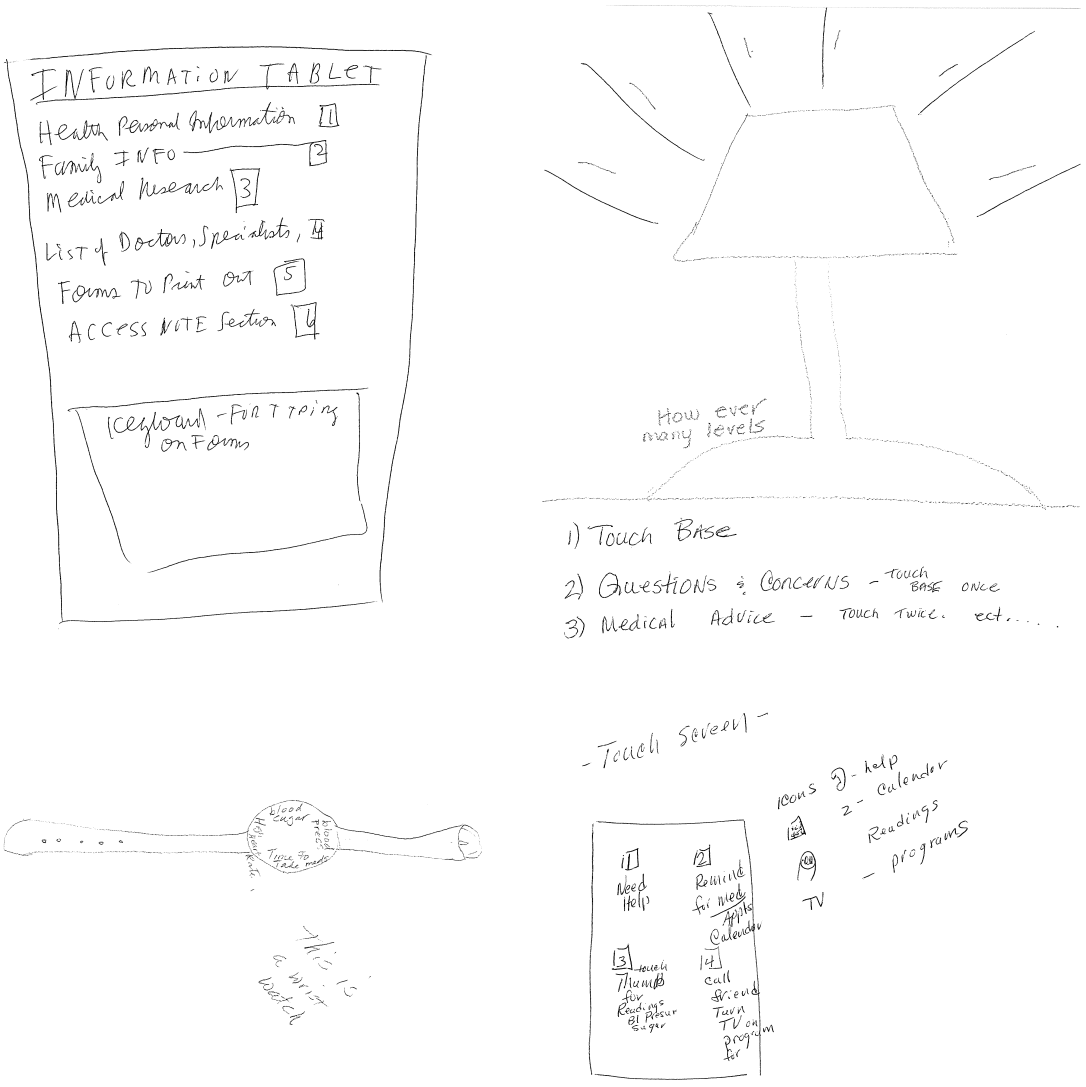

Figure 4.1. Examples of Participant Sketches

4 Discussion

The purpose of the study was to understand what older adults would prefer regarding wellness tools, with the design concepts as a starting point of discussion. Over the course of the sessions, it became clear that several attributes of the design concepts

resonated with participants. Participants enjoyed being able to be in control of their health, having convenient access to other sources of information, maintaining social ties, and supporting their memory.

Previous studies have suggested that supporting these needs in wellness tools are attractive(30). While most older adults have positive attitudes towards technology, other studies have suggested barriers to adoption, including high cost, inadequate skills, lack of perceived usefulness and perceived reduction in independence(20,36–38). Facilitators and positive attitudes towards new technologies were related to convenience, useful features, perceived ease of use, and psychosocial characteristics(20,39). Consequently, themes identified from our study reinforce prior work. The importance of autonomy, control, convenience and usefulness all came out during the study. The subset of participants who were hesitant to change their current methods is in line with previous literature showing that perceived usefulness is a big factor in technology acceptance by older adults. Consequently, organizations seeking to design tools for older adults should take these factors into account when designing wellness tools for older adults.

Across all focus groups, convenience was seen as valuable in any new tool for their wellness. This manifested itself in many forms, including those who enjoyed the convenience of the wearable watch form factor. The convenience of not having to dig through a purse or bag, combined with the idea that they wouldn't have to remember

another object to carry was very attractive to participants. Similar to previous studies, convenience played a role in the positive attitudes towards new technologies(39). The form factor, combined with the continuous tracking and immediacy of alerts increased the usefulness of the concept. Others may not have been as enthused about the watch form factor, but still valued convenience. They desired a size that they would be easy to carry around with them day to day, or a kiosk in areas where they would seek help such as a pharmacy. Finally, the convenience of having immediate access to reliable health information, whether through the internet or other service was preferred across the focus group sessions. Importantly, this information must be vetted and trusted by the individual, since their current health practices indicated that they lacked reliable, easy to access trusted health resources.

While participants were enthusiastic about the potential in the new tool design concepts presented, they emphasized the need for simplicity, similar to other studies with older adults and technologies(40,41). While this was discussed during the sessions, the sketches also reflected this emphasis on simplicity. Participants often sketched out a straightforward interface without complicated menus. Rather than hiding features under menus or other navigation features, many participants sketched out the main screen having direct access to all features, buttons, or icons so as to facilitate access. Between the sketches and what was said during the discussions, the emphasis on simplicity is something that should be taken in to account when designing wellness tools

for older adults. The participant feedback and sketches suggest that simplicity is an important factor in the acceptance of new technology tools.

Even though several features were self-contained, participants responded positively to the idea of having device integration of a wellness tool. This idea precipitated in two main camps: all-in-one integration and external integration. Many participants supported all-in-one integration, where they wanted features from each of the design concepts integrated into a single device that would meet their needs well. Others supported connections with external stakeholders and resources, including family members stakeholders or their healthcare provider's systems to facilitate ease of use. While increasing the potential utility of devices by adding more features could be attractive to older adults, this desire must be balanced with the need for simplicity and ease-of-use, which were important factors for facilitating use of a new wellness tool. Participants valued the larger need of staying connected with their health and loved ones, which supports previous studies that indicate that relationships with family or friends as the second most important thing In their lives(7). While participants may have disagreed on the exact form it should take, they strongly agreed that they wanted ways to keep connections to others and their health strong. They often wished that they could keep in touch with their family, especially if they were unable to see them in person as often as they would like, whether due to geography, distance, health status, or living conditions.

Interestingly, the designs sketched by participants avoided the stigma of needing help with tracking or needing help with their health and wellness by appearing to be something that could be for non-health purposes. For example, the wearables were sketched in watch form, or as a pendent on a necklace. Others were sketched as either tablet or smartphone sized, none of which would label the participant as needing help with their health or wellness. One participant even drew a smart lamp, which was intended to sit in her home. The smart lamp wouldn't activate its smart features unless the user already knew how to use it. The lamp would blend into her home without the stigma of having an obtrusive device marking the participant as needing help. All of these devices thus allow easy access to needed information or features without being known to others. Our results support previous research that indicate that stigma is a challenge in getting older adults to adopt health technologies(42).

Finally, participants valued being able to get help when they needed it, both for technical support and health information. Having immediate technical support allayed many of their fears of being unable to use a new device. Access to reliable health information, both in health measures and answers to health related questions, was seen as a desirable feature. Although immediate help was seen as valuable, participants also indicated that they valued their own autonomy and control over themselves and their information. Designers hoping to meet these needs should also be sure to give users an appropriate level of autonomy so they still feel as if they are in control of the situation.

Previous work suggested that older adults found the idea of technology-based wellness tools attractive, and that currently available tools were lacking(30). Furthermore, the inability to access reliable health information in a facile manner and aging-related changes that may hinder technology engagement(30) constitute major problems, while factors such as simplicity(43) and convenience(39) are desirable . Previous studies also found that perceived need, perceived usefulness, as well as biophysical and psychosocial characteristics were also factors in technology acceptance for older adults(20). However, more insight was needed into the preferences withholder adults when presented with design concepts, as speaking about an idea abstractly in isolation may engender different attitudes than when integrated into a wellness device, especially with regard to their needs. Our study confirms the potential that older adults see in using technologies for health, as well as the value that older adults place on simplicity and convenience of new technology tools for wellness. Participants also reiterated the potential barriers to use due to biophysical characteristics, such as reduced visual acuity and dexterity, and appreciated designs that provided alternative means to use these wellness tools.

In addition, within the context of wellness tools, several new insights were generated. First, increasing a wellness tool's convenience increased its utility and usefulness. While convenience can be increased by making a device smaller to increase its portability, it can also be increased by being available in areas where they would be needed (such as a kiosk at a grocery store or pharmacy), being always available without digging through a

purse or bag, and not having to remember yet another device (such as a watch). Second, voice navigation and activation was attractive for convenience (those who liked to talk), and those who had impairments (to make a device more accessible). Third, participants enjoyed the feeling of being independent and in control. For example, one of the reasons participants liked the blood pressure tracking watch concept is that it allowed for increased self-management and engagement in their health rather than relying on others more heavily. In addition, they liked the idea of sharing health information with other stakeholders, but only if they could pick and choose who got to see what information. Fourth, participants valued instant help, both with technology issues (therefore reducing worry about not being able to use a device), and health information. Finally, the sketched drawings of participants' ideal wellness tool suggest the importance of having a device that was not stigmatizing, and thus looked like everyday objects. Designers should consider these factors when creating wellness tools for older adults, in order to create attractive, useful tools.

5 Conclusions and Future Work

Future work should focus on validating these findings in a wider geographic sample, and in seeking input from older adults with low and higher fidelity prototypes. As participants may have different opinions in abstract versus the concrete, this would be a useful research direction. Moreover, future work should observe how older adults currently manage their wellness and health, so as to better inform the design of wellness tools.

Therefore, the utility of wellness tools for older adults seem promising, with older adult participants expressing enthusiasm in several ideas and features. Designers and researchers should take into account several ideas when designing wellness tools for older adults, including, but not limited to: convenience, simplicity, connections to others, living situation, and health status. By taking these factors into account, future designs can be attractive to older adults, and thus increase its probability of acceptance.

6 Limitations

There are some limitations in this work that should be acknowledged. Since all participants were from a single metro area, the generalizability of the study may not be strong. Furthermore, since the level of computer and technical skills were not assessed, older adults' perceptions may differ depending on their level of comfort and skill. However, this study still provides useful direction for designers and future research.

7 Acknowledgements

This study was supported, in part, by the National Library of Medicine Biomedical and Health Informatics Training Grant T15 LM007442

References for Chapter 4

1. US Census Bureau. The Next Four Decades: The Older Population in the United States: 2010 to 2050. 2010.

2. Hung WW, Ross JS, Boockvar KS, Siu AL. Recent trends in chronic disease, impairment and disability among older adults in the United States. BMC Geriatr [Internet]. BioMed Central Ltd; 2011 Jan [cited 2013 Feb 22];11(1):47. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3170191&tool=pmcentrez&rendertype=abstract

3. Verbrugge LM, Jette AM. The disablement process. Soc Sci Med [Internet]. 1994 Jan [cited 2013 Feb 22];38(1):1–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8146699

4. Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. Lancet [Internet]. Elsevier Ltd; 2009;374(9696):1196–208. Available from: http://dx.doi.org/10.1016/S0140-6736(09)61460-4

5. Dunn HL. High-level wellness for man and society. Am J Public Health Nations Health [Internet]. 1959 Jun [cited 2013 Feb 22];49(6):786–92. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1372807&tool=pmcentrez&rendertype=abstract

6. Hoyman HS. Rethinking an ecologic-system model of man's health, disease, aging, death. J Sch Health [Internet]. 1975 Nov [cited 2013 Feb 25];45(9):509–18. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1042431

7. Farquhar M. Elderly people's definitions of quality of life. Soc Sci Med [Internet]. 1995 Nov [cited 2013 Apr 23];41(10):1439–46. Available from: http://linkinghub.elsevier.com/retrieve/pii/027795369500117P

8. Dickinson WJ, Potter GG, Hybels CF, McQuoid DR, Steffens DC. Change in stress and social support as predictors of cognitive decline in older adults with and without depression. Int J Geriatr Psychiatry [Internet]. 2011 Dec [cited 2012 Nov 19];26(12):1267–74. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21370277

9. Luanaigh CO, Lawlor BA. Loneliness and the health of older people. Int J Geriatr Psychiatry [Internet]. 2008 Dec [cited 2012 Nov 19];23(12):1213–21. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18537197

10. Helve J, Krause U. Loneliness, health and depression in older males. Acta Ophthalmol [Internet]. 2009 May 27 [cited 2013 May 10];50(6):896–900. Available from: http://doi.wiley.com/10.1111/j.1755-3768.1972.tb06628.x

11. Rainie L. Cell phone ownership hits 91% of adults [Internet]. Pew Research Center Internet & American Life Project. 2013. Available from: http://www.pewresearch.org/fact-tank/2013/06/06/cell-phone-ownership-hits-91-of-adults/

12. Smith A. Older Adults and Technology Use [Internet]. 2014. Available from: http://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/

13. Rollo ME, Ash S, Lyons-Wall P, Russell A. Trial of a mobile phone method for recording dietary intake in adults with type 2 diabetes: evaluation and implications for future applications. J Telemed Telecare [Internet]. 2011 Jan [cited 2012 Aug 15];17(6):318–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21844173

14. Lim S, Kang SM, Shin H, Lee HJ, Won Yoon J, Yu SH, et al. Improved glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous healthcare service, a new medical information system. Diabetes Care [Internet]. 2011 Feb [cited 2012 Oct 4];34(2):308–13. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3024339&tool=pmcentrez&rendertype=abstract

15. Larsen ME, Rowntree J, Young AM, Pearson S, Smith J, Gibson OJ, et al. Chemotherapy side-effect management using mobile phones. Conf Proc IEEE Eng Med Biol Soc [Internet]. 2008 Jan;2008:5152–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19163877

16. Lee RYW, Carlisle AJ. Detection of falls using accelerometers and mobile phone technology. Age Ageing [Internet]. 2011 Nov [cited 2012 Oct 4];40(6):690–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21596711

17. Ball K, Berch DB, Helmers KF, Jobe JB, Leveck MD, Marsiske M, et al. Effects of cognitive training interventions with older adults: a randomized controlled trial. JAMA [Internet]. 2002 Nov 13 [cited 2013 Mar 8];288(18):2271–81. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2916176&tool=pmcentrez&rendertype=abstract

18. Mahncke HW, Connor BB, Appelman J, Ahsanuddin ON, Hardy JL, Wood R a, et al. Memory enhancement in healthy older adults using a brain plasticity-based training program: a randomized, controlled study. Proc Natl Acad Sci U S A [Internet]. 2006 Aug 15;103(33):12523–8. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1526649&tool=pmcentrez&rendertype=abstract

19. Rebok GW, Carlson MC, Langbaum JBS. Training and maintaining memory abilities in healthy older adults: traditional and novel approaches. J Gerontol B Psychol Sci Soc Sci [Internet]. 2007 Jun;62 Spec No(I):53–61. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17565165

20. Chen K, Chan a. HS. A review of technology acceptance by older adults. Gerontechnology [Internet]. 2011 Jan 1 [cited 2013 Sep 9];10(1). Available from: http://gerontechnology.info/index.php/journal/article/view/1464

21. McCreadie C, Tinker A. The acceptability of assistive technology to older people. Ageing Soc [Internet]. 2005 Jan [cited 2013 Sep 9];25(1):91–110. Available from: http://www.journals.cambridge.org/abstract_S0144686X0400248X

22. Selwyn N. The information aged: A qualitative study of older adults' use of information and communications technology. J Aging Stud [Internet]. 2004 Nov [cited 2013 Aug 27];18(4):369–84. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0890406504000477

23. Hawthorn D. Possible implications of aging for interface designers. Interact Comput [Internet]. 2000 Apr;12(5):507–28. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0953543899000211

24. Helve J, Krause U. The Influence of Age on Performance in the Panel D-15 Colour Vision Test. Acta Ophthalmol [Internet]. 2009 May 27 [cited 2013 May 10];50(6):896–900. Available from: http://doi.wiley.com/10.1111/j.1755-3768.1972.tb06628.x

25. Owsley C, Sekuler R, Siemsen D. Contrast sensitivity throughout adulthood. Vision Res [Internet]. 1983 Jan;23(7):689–99. Available from: http://www.ncbi.nlm.nih.gov/pubmed/6613011

26. Bell B, Wolf E, Bernholz CD. Depth Perception as a Function of Age. Int J Aging Hum Dev [Internet]. 1972 Jan 1;3(1):77–81. Available from: http://baywood.metapress.com/openurl.asp?genre=article&id=doi:10.2190/0RQM-RRNK-A8GN-X99J

27. Cerella J. Age-related decline in extrafoveal letter perception. J Gerontol [Internet]. 1985 Nov [cited 2013 May 10];40(6):727–36. Available from: http://www.ncbi.nlm.nih.gov/pubmed/4056329

28. Dobbs AR, Rule BG. Adult age differences in working memory. Psychol Aging. 1989;4(4):500–3.

29. Akatsu H, Miki H. Usability research for the elderly people. Oki Tech Rev (Special Issue Hum … [Internet]. 2004 [cited 2012 Nov 2];71(199):54–7. Available from: https://oki.com/en/otr/2004/n199/pdf/otr-199-R15.pdf

30. Joe J, Chaudhuri S, Chung J, Thompson H, Demiris G. Older adults' attitudes and preferences regarding a multifunctional wellness tool: a pilot study. Informatics Heal Soc Care [Internet]. 2014 Oct 17 [cited 2014 Oct 28];(1):1–16. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25325513

31. Gray D, Brown S, Macanufo J. Gamestorming: A Playbook for Innovators, Rulebreakers, and Changemakers. O'Reilly Media; 2010. 288 p.

32. Hasso-Plattner Institute of Design. Bootcamp Bootleg [Internet]. 2010. Available from: http://dschool.stanford.edu/wp-content/uploads/2011/03/BootcampBootleg2010v2SLIM.pdf

33. Martin B, Hanington B. Universal Methods of Design [Internet]. 2nd ed. Beverly: Rockport Publishers; 2012. Available from: http://www.trilemon.com/wp-content/uploads/2013/12/Universal-Methods-of-Design.pdf

34. Weiss RS. Learning from Strangers: The Art and Method of Qualitative Interview Studies. New York, NY: Simon & Schuster; 1994. 9-14 p.

35. Tohidi M, Buxton W, Baecker R, Sellen A. User Sketches: A Quick, Inexpensive, and Effective way to Elicit More Reflective User Feedback. NordiCHI '06: Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles [Internet]. 2006 [cited 2013 Jul 5]. p. 105–14. Available from: http://dl.acm.org/citation.cfm?id=1182487

36. Thielke S, Harniss M, Thompson H, Patel S, Demiris G, Johnson K. Maslow's Hierarchy of Human Needs and the Adoption of Health-Related Technologies for Older Adults. Ageing Int [Internet]. 2011 Jun 23 [cited 2013 Nov 18];37(4):470–88. Available from: http://link.springer.com/10.1007/s12126-011-9121-4

37. Freedman V, Calkins M, Haitsma K Van. An exploratory study of barriers to implementing technology in U.S. residential long-term care settings. Gerontechnology [Internet]. 2005 Apr 1 [cited 2014 Sep 18];4(2):86–100. Available from: http://gerontechnology.info/index.php/journal/article/view/542

38. Olphert C, Damodaran L, May A. Towards digital inclusion–engaging older people in the "digital world." Proceedings of the 2005 international conference on Accessible Design in the Digital World [Internet]. 2005 [cited 2013 Dec 3]. p. 7. Available from: http://www.researchgate.net/publication/228623727_Towards_digital_inclusionengaging_older_people_in_the_'digital_world'/file/32bfe510fd7fd7166b.pdf

39. Mitzner TL, Boron JB, Fausset CB, Adams AE, Charness N, Czaja SJ, et al. Older Adults Talk Technology: Technology Usage and Attitudes. Comput Human Behav [Internet]. Elsevier Ltd; 2010 Nov 1 [cited 2013 Nov 12];26(6):1710–21. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2956433&tool=pmcentrez&rendertype=abstract

40. Rice M, Alm N. Designing new interfaces for digital interactive television usable by older adults. Comput Entertain. 2008;6(1):1.

41. Nahm E-S, Preece J, Resnick B, Mills ME. Usability of health Web sites for older adults: a preliminary study. Comput Inform Nurs [Internet]. 2004 [cited 2012 Nov 18];22(6):326–34; quiz 335–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15602301

42. Kang HG, Mahoney DF, Hoenig H, Hirth V a., Bonato P, Hajjar I, et al. In situ monitoring of health in older adults: Technologies and issues. J Am Geriatr Soc. 2010;58(8):1579–86.

43. Nahm E-S, Preece J, Resnick B, Mills ME. Usability of Health Web Sites for Older Adults. CIN Comput Informatics, Nurs [Internet]. 2004 Nov [cited 2012 Nov 18];22(6):326–34. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15602301

Appendix 4.1 Design Session Procedures

UNIVERSITY OF WASHINGTON

DESIGN SESSION PROCEDURES

Designing a multi-purpose technology tool for community engagement among older adults

Welcome

Thank you for making time to attend our focus group today.

1. This will be a group discussion. We are going to discuss a multi-purpose technology system. We hope this process will also help you understand what others think as well. We do not want to discuss anything that would concern you in any way. However, if any time you would like to leave the group and not participate, that will be fine.
2. How the participants can help us to achieve our goal(s): relax, share, listen to others, follow format.
3. Why the participants are suitable for the task- your unique perspectives and opinions will help us better understand how to design multipurpose wellness tools for older adults.
4. Restrooms/snacks/drinks location

Explain the means to record the session.

Explain that the participants have the right to withdraw from the session at any time.

Introduce and ask the participants to sign the consent form

1. Make sure all participants have access and understand the consent form (e.g. should we have participants with impaired vision, you must read out the consent form)
2. Ask the participants to sign and return the consent form.

Introduce and ask the participants to fill out demographics questionnaire

1. Make sure participants understand and fill out demographics questionnaire
2. Answers to questionnaire will not be linked back to them or their future answers

Introduce yourself and the co-facilitators, if used.

1. Your name and role: Amanda Lazar, graduate student in BHI and/or Jonathan Joe, graduate student in BHI
2. Introduce other members of the research team, if present.

Rules

We would like this to be a non-judgmental, relaxed environment for you to feel safe to discuss your thoughts about your preferences for technology use. Please don't hesitate to ask questions or if you need any clarification please ask for it.

Please be considerate of one another and let everyone participate and share their ideas. There is no right or wrong answer, but just different experiences and opinions. Your thoughts and opinions will also be important to help guide further study work in the development of technology tools for older adults.

START AUDIORECORDING

Participants introduce themselves

- Ask all participants to introduce themselves in a few sentences. Ask them to share their favorite movie or television show. (This is to break the ice and get participants to start thinking about the topic)

Discussion

- Carefully word each question before that question is addressed by the group. The facilitate discussion around the answers to each question, one at a time.

Explain Storyboards/Lo-Fi Prototypes Origins

1. "Over the past few years, there has been increased interest in creating wellness tools for adults aged 60 and older so that they can live independently at home happier."
2. "Consequently, there has been a lot of work into looking at what older adults want in a wellness tool, how they want to use it, and what they don't want."
3. "We have gotten feedback and solicited ideas from previous groups of older adults, and have generated some ideas on how a wellness tool would work."
4. "So, I'm going to introduce each idea we have to you with a brief explanation. After each idea, I would like you to tell me what you think about the idea, ask any questions you may have, and any ideas for improvement."

Show each Storyboard/Lo-Fi prototype

1. Give a brief explanation of what themes from previous older adults that the design would cover.
    a. E.g. "Previous groups have told us they wanted a small, portable device they can carry."
2. Show each storyboard/prototype one at a time.
    a. Explain what the prototype/storyboard shows, and go through each of the parts.
        i. If storyboard: Explain the story, and what is happening in each section
        ii. If Prototype: Go through the various sections of prototype and what it's supposed to do
    b. Clear up any questions people may have about the story or prototype.
3. Solicit feedback and thoughts on each storyboard/prototype.
    a. Discuss likes, dislikes, ideas for improvement and any other feedback.
    b. If needed, prompt:
        i. Do you have comments on any of the features?

ii. Is this attractive to you? Why or why not?
iii. Could you see this system fitting into your everyday lives?
iv. How would you improve such a system?

Ask Participants to Sketch Ideal System design

1. Hand subjects a blank piece of paper
2. Ask them to sketch ideal system design or changes they would integrate into proposed?
    a. Quick drawing showing core features of main interface fine

Near end of session

1. Thank the participants for their time and adjourn the meeting

Chapter 5: Conclusion

Summary

As the population of older adults grows, technologies for maintaining wellness in older adults will become increasingly crucial. Even though many technologies are being used for health and wellness, they are often not designed with older adults in mind and thus do not meet their unique wants and needs. The aim of the studies presented is to explore how older adults want to use wellness tools, including factors that would increase or decrease the attractiveness and utility of these tools. The work presented here is a starting point to better understand how to design wellness tools for older adults and encourage their use.

The first study explored older adults' attitudes and preferences towards multifunctional wellness tools. Important factors of consideration and attractive features were identified through focus groups conducted with 14 individuals. The primary contribution of this study was to provide a better understanding of the preferences and attitudes of older adults towards multifunctional wellness tools. This study provided recommendations for designers to increase the desirability of new wellness tools for older adults. Previous studies support the need to overcome immediate negative reactions to technologies to improve the probability of acceptance(1), as well as older adults' wants for health alerts and notification of changes in health status in the context of smart homes(2,3).

The second study examined usability issues and barriers to use of a community-based, commercially available multifunctional wellness tool for older adults. These

issues were elicited via a task-based usability test with a think aloud protocol, followed by instant data analysis and affinity mapping. There were two main outcomes to this study. First, the usability issues of a widely used, commercially available multifunctional wellness tool were identified and these issues should be avoided in any new wellness tool designs. Second, the successful use of Instant Data Analysis (IDA) as a novel method for usability testing analysis lends credence to the method. The researchers were satisfied with the number and quality of issues identified for the labor invested. This study reinforces the need to design for older adults unique wants and needs, as well as particular areas in which to avoid to minimize user frustration, to increase the attractiveness of new designs for wellness tools. This study is in line with previous research that suggested that older adults have more difficulty navigating the web due to reduced working memory(4,5), and that designers should take into account the unique needs of older adults so that they can interact with technological interfaces(6).

The third study explored the wants and needs of older adults regarding wellness tools by using design scenarios and storyboards as an initial point of discussion. These scenarios and storyboards were generated after taking into account the themes for the first and second studies to create design concepts and ideas that would be attractive to older adults. The main contribution of this study was providing design concepts and refined recommendations for wellness tools based on user feedback. The secondary contribution was the successful use of various methods with older adults regarding wellness tools. Participants' sketches and the "quick and dirty analysis" method provided additional insight into the wants and needs of older adults regarding novel

wellness tools. Six focus group sessions were held with 43 participants to seek feedback on five design concepts and ideas in the form of scenarios and storyboards and were then asked to sketch their ideal system. This paper provides insight into the factors that designers should take into account when creating wellness tools to increase the appeal to older adults. Our findings are supported by previous research that suggests that older adults see value in technology for health(7), and view technology positively that supports activities and enhances convenience(8).

Together, these studies provide several design recommendations for the design of wellness tools for older adults. Furthermore, this dissertation gives insight on the attitudes and other factors that may affect the attractiveness of wellness tools for older adults. Within these studies, older adults' opinions and attitudes regarding wellness tools are well represented, and are the first step into appropriately designing such tools to maximize their appeal.

Design Recommendations

The results from these studies will help improve the design of wellness tools for older adults so that they better align with their wants and needs.

One of the biggest unmet needs seen across the studies was the lack of an accessible, reliable source of health information. While some participants came up with their own alternatives to the problem, others were still dissatisfied with their currently available options, using them even though they know they it may not be the most reliable. Another need that came up across the studies was the need for social

connections and communication. While not always possible, participants wanted more quality time maintaining social relationships, whether in person, over video or phone. Finally, participants wanted to be autonomous and independent, by engaging in monitoring and maintaining their health as they saw fit. By incorporating these aspects, newly designed wellness tools can meet this need. By meeting these needs, along with the other recommendations from the studies in this dissertation, newly design wellness tools will have a higher chance of adoption.

Cost remains a concern among participants even without an explicit number. Previous studies have found that cost is an important determinant to adoption in technologies(9,10). Participants suggested that a low out-of-pocket cost for the user would be more important than total cost, assuming that the device is cost-effective even if another entity such as an insurance company picked up the rest of the cost. Although many features and new technologies integrated together in a single tool can be very useful, users may be turned off by what they consider a high price. Designers should strive to minimize costs where possible to the consumer.

Privacy concerns were echoed across studies, with multiple participants indicating that they were worried about the confidentiality of their information. Although it may be possible to collect more information in order to potentially help users more with new features, this must be balanced with users' autonomy and privacy worries. Previous research found that stakeholders in long-term care settings, including older adults and their families, are open to the idea of new technologies to improve quality of life and that the design of these technologies needs to fully address concerns

stakeholders have with privacy, autonomy, and dignity(11). Older adults also report a willingness for adopting new technologies and give up more privacy if it allows them to continue to be independent(12).

The issues identified on a popular, commercially available multifunctional wellness tool highlight the importance of user testing with users from the target user group. Many issues could have been avoided before committing to manufacturing. Implementing changes in the earlier stages of the design would save costs. Perceived ease-of-use, biophysical characteristics and abilities are important factors for older adult technology acceptance. Identifying issues related to these areas and implementing changes to combat them can increase the desirability and acceptance of new wellness tools(13). With the instant data analysis method, organizations can identify these key problems without a high time and personnel resource commitment, yielding significant improvements to the product in a short time frame.

Simplicity and ease of use was a recurring theme reflected across the studies. Ease of use is one of the major factors of the technology acceptance model, meaning that it is a key component of the decision-making process on whether to adopt a new technology(13). The need for interface simplicity was a point that was iterated across several groups, indicating that while participants would like many features, simplicity should be emphasized. For example, during the usability test of the commercially available wellness tool, the great number of features led to a navigation structure that many participants found difficult to navigate. While there may be some tradeoffs for

number of features versus simplicity, designers should make sure to not err too far in the direction of adding many features at the expense of simplicity.

Finally, the unique needs of older adults resulting from biophysical changes should be carefully considered when designing new wellness tools. The usability study of a commercially available wellness tool revealed many problems that could have been avoided if these changes were taken into account. For example, chronic conditions leading to shoulder pain may limit the range of motion and make it difficult to use vertical touchscreens. Cognitive changes, such as declines in working memory made it more difficult for participants to navigate the device, since they often lost track where they were within the navigation structure or what they had previously selected. During the group discussions, worries about various impairments and the effect they would have in making it difficult for people to use a device as intended were discussed. Problems such as vision or auditory impairment can be worked around as long as the designers of the device in question consider and implement alternative methods of input. The attractiveness of features such as voice navigation was the ability to make it easier for people with dexterity or vision issues full access to the design concept's features. Careful consideration of the target user group's abilities is needed when designing tools to achieve the widest potential penetrance of the device.

While these studies represent the needs and attitudes of older adult participants, there are limitations that should be acknowledged. First, the studies were geographically limited to the Pacific Northwest with a relatively small sample size. Secondly, we did not formally assess the level of technology or a computer familiarity

and expertise of the participants. Consequently, the attitudes and opinions of the participants may limit generalizability.

Implications for Future Research

Improvements in the design of wellness tools to better match the unique wants and needs of older adults will encourage greater adoption and use of such tools by older adults. With the projected growth of the population of older adults, the need for technology-based wellness tools to help older adults stay autonomous and engaged in their health and wellness is becoming ever greater.

While these studies pose a good starting point for improving the design of wellness tools for older adults, further research into various issues is needed before the recommendations can be fully implemented. During the research sessions, it was clear that a major need was for a convenient, reliable and trustworthy source for health information. There is a wealth of information online and in other sources, but it can be difficult to know what is trustworthy and what is not. Future research is needed to figure out who can write or rate health information online in an accessible manner that would be trusted by older adults. Research is also needed to identify the level of sophistication of medical information that could be understand by older adults, as well as policy issues such as potential liability before a health information system could be implemented.

Another issue that could derail successful adoption of technology-based wellness tools by older adults are preconceptions of technology. This set of participants seemed

to be against the idea of 'technology', in that the word had a negative connotation for them. Often, these participants felt that since they did not see anything lacking or anything bothersome enough to motivate them to change their current methods. More research is needed to better understand the root of preconceptions against technology. By understanding the root of the problem, work could be done to change their attitudes to be open to adoption of new technologies. Previous research has indicated that a modified technology acceptance model for older adults would more accurately capture the factors that determine technology acceptance(13). Besides the standard factors of perceived ease of use and perceived usefulness, this research has suggested that other factors also contribute, including but not limited to: abilities, psychosocial characteristics, and biophysical characteristics. Further research is needed to determine which of these factors loom largest in preventing wellness technology adoption by older adults and whether it can be overcome in new designs.

There is still a need for further research on wellness tools for older adults to assure their advancement. Larger studies should be performed across a broader geographic area to ensure a larger variety of older adults and to more accurately assess the opinion of older adults on future devices and tools. Additional testing with older adult participants, and publication on the problems they had would help the community at large work towards the goal of raising the overall quality of wellness tools for older adults. Future work should include more diverse sample (addressing not only racial and ethnic diversity but also diversity in professional background, experience with technology and socio-economic and marital status as well as levels of health literacy).

Finally, further research is needed to understand how older adults manage their wellness information currently. By understanding current practices, including what works well and frustrations for older adults, new wellness tool designs can better fit into their daily lives and meet their needs. Further work can then be done to advance design concepts into concrete prototypes that will fit into older adults' daily lives and meet their needs for health and wellness.

The studies contained within this dissertation gives the attitudes and preferences of older adults regarding technology-based wellness tools, as well as feedback and potential issues that would detract from the desirability of such devices. These studies give actionable insights for future designs of technology-based wellness tools, and improvements to these devices can help users stay more engaged in their health and wellness as they age.

References for Chapter 5

1. Olphert C, Damodaran L, May A. Towards digital inclusion–engaging older people in the "digital world." Proceedings of the 2005 international conference on Accessible Design in the Digital World [Internet]. 2005 [cited 2013 Dec 3]. p. 7. Available from: http://www.researchgate.net/publication/228623727_Towards_digital_inclusionengaging_older_people_in_the_'digital_world'/file/32bfe510fd7fd7166b.pdf

2. Demiris G, Rantz M, Aud M, Marek K, Tyrer H, Skubic M, et al. Older adults' attitudes towards and perceptions of "smart home" technologies: a pilot study. Med Inform Internet Med [Internet]. 2004 Jun [cited 2013 Nov 11];29(2):87–94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15370989

3. Wild K, Boise L, Lundell J, Foucek A. Unobtrusive In-Home Monitoring of Cognitive and Physical Health: Reactions and Perceptions of Older Adults. J Appl Gerontol [Internet]. 2008 Jan [cited 2013 Nov 16];27(2):181–200. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2629437&tool=pmcentrez&rendertype=abstract

4. Mead SE, Spaulding VA, Sit RA, Meyer B, Walker N. Effects of Age and Training on World Wide Web Navigation Strategies. Proc Hum Factors Ergon Soc Annu Meet. 1997;41(1):152–6.

5. Becker SA. A study of web usability for older adults seeking online health resources. ACM Trans Comput Interact [Internet]. 2004;11(4):387–406. Available from: http://doi.acm.org/10.1145/1035575.1035578\nhttp://dl.acm.org/ft_gateway.cfm?id=1035578&type=pdf

6. Hawthorn D. Possible implications of aging for interface designers. Interact Comput [Internet]. 2000 Apr;12(5):507–28. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0953543899000211

7. Joe J, Chaudhuri S, Chung J, Thompson H, Demiris G. Older adults' attitudes and preferences regarding a multifunctional wellness tool: a pilot study. Informatics Heal Soc Care [Internet]. 2014 Oct 17 [cited 2014 Oct 28];(1):1–16. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25325513

8. Mitzner TL, Boron JB, Fausset CB, Adams AE, Charness N, Czaja SJ, et al. Older Adults Talk Technology: Technology Usage and Attitudes. Comput Human Behav [Internet]. 2010 Nov 1 [cited 2014 May 6];26(6):1710–21. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2956433&tool=pmcentrez&rendertype=abstract

9. Steele R, Lo A, Secombe C, Wong YK. Elderly persons' perception and acceptance of using wireless sensor networks to assist healthcare. Int J Med Inform. 2009;78(12):788–801.

10. Mallenius S, Rossi M, Tuunainen V. Factors affecting the adoption and use of mobile devices and services by elderly people–results from a pilot study. 6th Annu Glob Mobil …. 2007;

11. Dorsten A-M, Sifford KS, Bharucha A, Mecca LP, Wactlar H. Ethical perspectives on emerging assistive technologies: insights from focus groups with stakeholders in long-term care facilities. J Empir Res Hum Res Ethics. 2009;4(1):25–36.

12. Kang HG, Mahoney DF, Hoenig H, Hirth V a., Bonato P, Hajjar I, et al. In situ monitoring of health in older adults: Technologies and issues. J Am Geriatr Soc. 2010;58(8):1579–86.

13. Chen K, Chan a. HS. A review of technology acceptance by older adults. Gerontechnology [Internet]. 2011 Jan 1 [cited 2013 Sep 9];10(1). Available from: http://gerontechnology.info/index.php/journal/article/view/1464