THE INFLUENCE OF CULTURE ON OLDER ADULTS'

ADOPTION OF SMART HOME MONITORING:

A QUALITATIVE DESCRIPTIVE STUDY

BY

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To the Faculty of Washington State University:

The members of the committee appointed to examine the dissertation of ROSCHELLE LYNNETTE FRITZ find it satisfactory and recommend that it be accepted.

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Abstract

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This qualitative descriptive interdisciplinary study, performed in the space between

nursing and engineering and within the field of gerontechnology, explored the influence of

culture on older adults' adoption of smart home monitoring. In-depth email interviews were used

with a purposive sample of older adults (n=21) age 65 and older from Washington, Idaho,

Alabama, Tennessee, and New York. Participants were asked to prospectively consider the

question of adoption of a smart home that is under development at Washington State

University's Center for Advanced Studies in Adaptive Systems (CASAS) that combines artificial

intelligence software with sensor monitoring for the purpose of maintaining safety and health.

This smart home learns the resident's motion patterns and can take an action on behalf of the

resident living in the home. Many participants indicated a prospective openness to smart home

monitoring. Openness depended on (a) the level and specificity of need and whether the smart

home would meet that need, (b) perceived loss of privacy compensated by a feeling of safety and

a receipt of health-assistance, (c) functionality, and (d) cost. Low inference themes emerging

from rich text and supported with multiple lines of participants' own words were *privacy, pride*

and dignity, family, trust, being watched, human touch, features and functionality, cost, and timing. Participants were asked to self-identify their own culture of socially constructed values, which were found to heavily inform perceptions of privacy, independence, and family. Findings from this study explicate and illuminate older adults' perceptions and descriptions of smart home monitoring, the relation to their own socially constructed values, and the influence on a decision to adopt or not adopt smart home monitoring. Findings may be used to inform future smart home design using machine learning, marketing, clinical nursing practice, nursing education, health policy, interdisciplinary collaboration, and research.

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Dedication

To God who granted my life, twice, when it seemed it might slip away.

This dissertation is first dedicated to Terry, my best friend, my husband. You are my rock and my heart's desire. Thank you for always believing in me and for granting me the time for this journey.

To Matthew and Michael, my beloved sons. You are my essence. Thank you for granting me this time to improve my mind and my spirit. Your generosity, open-mindedness, and understanding over the last few years have sustained me. Now let's have some fun!

To Mom and Dad, the greatest parents. Thank you for your support as I worked to become the first person on either side of our family to achieve a doctorate. Dad, I will never forget our walk and your wise words of encouragement the day I almost quit. Very effective!

Sally, this degree is part yours. I could not have achieved this goal without your daily help in our home. You gave of yourself so I could reach for a dream. Thank you! On the next path of your life's journey, may the blessings you have bestowed come full circle.

To the participants in this study, I dedicate this work to you. I honor you and thank you for sharing openly about potentially uncomfortable topics. You are truly representative of the greatest generation.

In Loving Memory of my grandmother Annie B. Jones, a writer and poet, born in 1906 on a farm in Winnipeg Manitoba, Canada. The oldest of 9 children, she was unable to attend school because of her family and farming duties, but at age 82 became an honorary student at a local community college where she enrolled in a computer class and learned to use an MS-DOS IBM PC.

CHAPTER ONE

INTRODUCTION

Everyday 10,000 Americans celebrate their 65th birthday! American seniors currently outnumber the entire population of Canada and their numbers continue to grow (Economic and Statistics Branch Newfoundland & Labrador Statistics Agency, 2013; United States Census Bureau, 2012). The 65 and over population is expected to increase from 41.1 million in 2013 to 92 million in 2060 (Administration on Aging, 2013). The Center for Disease Control reports that by 2050 the demand on healthcare workers, including nurses, is projected to more than double (Squillace, Remsburg, Bercovitz, Rosenoff, & Branden, 2007). The aging of America is a complex humanitarian issue that requires innovative solutions involving collaboration across disciplines. In this dissertation the innovative solution of smart home monitoring and the influence of culture on older adults' decisions to adopt such monitoring were explored. The research was interdisciplinary combining knowledge from the field of engineering and nursing.

Gerontechnology

Gerontechnology is a new multidisciplinary field focusing on the relationship between technology and older adults. An unlikely fusion of horizons, gerontechnology is a place where scholars, internationally, are working with technology to improve the quality of life for older adults. This is a unique time in history; there are large numbers of older adults who grew up without technology and yet may use complex assistive technologies as they age. Many of these older adults remember a time before jetliners, telephones, and personal computers; yet they may soon benefit from interactive smart home technologies such as biorobotics, personal assistive robots, intelligent ambient homes, wireless sensor networks, telerehabilitation, and perceptual

implants (Bouma, Fozard, Bouwhuis, & Taipale, 2007). Through imagination of innovative

solutions, research, design, and development of assistive technologies, gerontechnology scholars

are playing a significant role in helping older adults age in place (Rodeschini, 2011), maintain

quality of life, and sustain health.

Smart Homes

A primary focal area within the field of gerontechnology is smart home development, an

innovative solution to help older adults age in place. Smart homes contain in-home interactive

and assistive technologies to address health concerns, activities of daily living, and security. The

term *smart home technology* is used in a variety of ways and may refer to smart refrigerators or

stoves, medication reminder systems, and voice prompting, but may also include sensor

monitoring of position and motion (e.g., pressure sensors in the bed or hallway serial motion

sensors) and telemonitoring. Telemonitoring refers to audio-visual monitoring that involves

communication with a healthcare professional (Lorenz & Oppermann, 2009). In this study, the

term *smart home technology* includes *monitoring* and is referred to as *smart home monitoring*

and does not include telemonitoring. In this study, smart home monitoring is defined as an

intelligent agent that "perceives its environment through the use of sensors, and can act upon the

environment through the use of actuators" (Cook & Das, 2004). Sensors provide quantitative

information about the state of the environment and its residents. Common environment sensors

monitor motion, heat, light, and contact, and are unobtrusive. Unobtrusive monitoring refers to

ambient environmental monitoring, and uses monitors that are purposefully designed for subtlety

and do not draw the attention of the older adult. Sensors and monitors are not worn by the older

adult and do not require purposeful activation. Sensors detecting motion and ambient light levels

are placed on ceilings and walls, while sensors detecting door contact and ambient temperature

are placed on internal and external doors, as well as cabinets, refrigerator doors, and other surfaces. Sensor data is sent to a large server where software algorithms are applied for the purpose of identifying changes in activity and motion patterns, which may be indicators of changes in health conditions (Austin, Hayes, Kaye, Mattek, & Pavel, 2011).

Software designed to interpret data and take an action often utilizes machine learning and intelligent agent techniques because it is capable of learning the behavior patterns of the resident living within the home and can offer assistance by acting on the in-home environment. For example, if an older adult forgets to close the refrigerator door, the contact sensor will not be reactivated within the usual timeframe and the intelligent home-software program could send a signal to activate a mechanical door-closing device. Other forms of assistance may be given through auto-voice prompting or robots. This study specifically focuses on the use of artificially intelligent software, also known as machine learning, that can identify anomalies in patterns of daily activity and motion so potential changes in health status can be detected leading to health-sustaining interventions.

Problem Statement

By 2030 the population of adults 65 and over will double and the population of those 85 and over will triple (Administration on Aging, 2013; Pew Research Center, 2010; Squillace et al., 2007). There will not be enough healthcare workers to provide care for the older adult population and the associated cost of care is expected to rise significantly (Demiris et al., 2004; Mohammadi, Koppel, Beek, & Godfroij, 2012; Rashidi & Mihailidis, 2013; Squillace et al., 2007). "By 2030, health care spending will increase by 25%, largely because the population will be older. This estimate does not take into account inflation and higher costs associated with new diagnostic and assistive technologies. Medicare spending is projected to increase from $555

billion in 2011 to $903 billion in 2020" (Center for Disease Control and Prevention, 2013, p. 13). Society can no longer afford a status quo approach to care for the aging population and innovative solutions are needed to improve safety and positive outcomes while decreasing cost and demand on healthcare workers (Center for Disease Control and Prevention, 2013; Mohammadi et al., 2012; Schmitter-Edgecombe, Seelye, & Cook, 2013; Townsend, Knoefel, & Goubran, 2011).

Smart homes are an innovative solution, however, commercial desire for products supersedes explicit user needs (Courtney, Demiris, & Hensel, 2007; Haines, Mitchell, Cooper, & Maguire, 2007). Additionally, smart homes are designed by engineers, who are digital natives, for use by older adults, who are not digital natives and who are a vulnerable population (Lê, Nguyen, & Barnett, 2012). Clinical interventions used in vulnerable populations often do not consider complex cultural and contextual issues faced by these populations (Sullivan-Bolyai, Bova, & Harper, 2010). Exploring the influence of culture in relation to smart home adoption is important.

Purpose Statement

Through the lens of socially constructed values and beliefs, the purpose of this research is to explore older adults' perceptions and descriptions of smart home monitoring, discover factors that might influence adoption of smart home monitoring, and empower older adults by making their voices heard. Additionally, this research seeks to diffuse information to older adults about smart home features and how they may help with aging in place.

Research Questions

1. What is commonly known about smart home monitoring by older adults?

2. What are older adults' perceptions and descriptions of smart home monitoring?

3. What are the influencing factors in older adults' decisions to adopt smart home monitoring?

4. How do older adults' perceptions of their own socially constructed values and beliefs influence their decisions to adopt or not adopt smart home monitoring?

Specific Aims

1. To explicate and illuminate older adults' knowledge, perceptions and descriptions of smart home monitoring as these relate to self-identified culturally based expectations.

2. To understand the influence of socially constructed predictors and barriers to adoption of smart home monitoring.

The short-term goal is to inform culturally mindful design with a long-term goal of helping older adults age in place.

Significance and Rationale

The study of smart home monitoring adoption by the older adult population is significant because it focuses on innovative and potentially cost effective solutions for improving choice for residential living, safety, and quality of life in the growing aging population. It explores factors that may influence older adults' decisions regarding the adoption of smart home monitoring with a specific focus on the influence of one's culture on a decision to allow in-home monitoring, a question that has not previously been asked. This research answers the National Institute of Health (2013) and the National Science Foundation's (2014) call for interdisciplinary research and the Institute of Medicine's call for nurses to lead and collaborate to "advance research on models of care and innovative solutions, including technology, that will enable nurses to contribute to improved health and health care" (Institute of Medicine, 2010, p. 2) and to reform models of care to decrease cost (Institute of Medicine).

CHAPTER TWO

REVIEW OF LITERATURE

Six knowledge domains frame this study and the review of literature: aging and independence, health-assistive smart environments, adoption of in-home monitoring, Rogers' Diffusion of Innovation Theory, person-centered care, and culture. Chapter Two will discuss each knowledge domain and provide evidence of the need to study the influence of culture on older adults' adoption of smart home monitoring so the adoption process can be better understood, which may result in thoughtful application of this innovation in the older adult population.

Aging and Independence

Older adults with functional limitations continue to live at home despite decreased abilities to independently perform activities of daily living. Eighty percent of older adults receiving long-term care services and support live at home, while the other 20 percent live in residential care or nursing home facilities (Congress of the United States Congressional Budget Office, 2013). Recent projections indicate that over two-thirds of the 65 and over population will need long-term care services in their lifetime (National Center for Health Statistics, 2013), and as age increases, the likelihood of utilizing a nursing home facility increases (Congress of the United States Congressional Budget Office, 2013). Complications related to in-home falls is one reason older adults utilize nursing home facilities (Rosenberg, 2012). In 2011 emergency departments across the United States treated 2.4 million persons injured from non-fatal falls, and of these, 689,000 required hospitalization (Center for Disease Control and Prevention, 2014). Direct costs related to falls among older adults in 2010 was reportedly $30 billion and these costs

are projected to increase to $67.7 billion by 2020 (Center for Disease Control and Prevention, 2014). Health-assistive smart homes may improve quality of life for the large number of older adults who remain at home despite functional limitations and may decrease rising costs associated with injuries and declining health.

Safety and comfort is a growing concern for the community-dwelling older adult and housing environment needs change as people age (Abbott, Carman, Carman, & Scarfo, 2009). Over time the process of aging creates changes in older adults' abilities related to activities of daily living, self-management of health conditions, and socialization. When an acute change in health status, exacerbation of a chronic illness, or injury occurs requiring intervention by a healthcare provider, nurses are often called to evaluate the home environment to which the older adult will return. A role of gerontology nurses is to perform an assessment of the older adults' abilities to safely and autonomously perform activities of daily living when they return home. In-home evaluations include safety assessments related to falls, social isolation, and medication management (Marek, Popejoy, Petroski, & Rantz, 2006; Szanton et al., 2011). Older adults whose environments are deemed a safety risk are encouraged to make changes in their living arrangements. For many, this means moving near a child, entering an assisted living facility, or decidedly staying in place and living at risk (Pipher, 1999).

Unwanted changes to the living environment and the associated activities of daily living create relocation stress symptoms in older adults such as anxiety, confusion, fear, helplessness, hopelessness, indecisiveness, loneliness, suicidal thoughts, and suspicion (Walker, Cox-Curry, & Hogstel, 2007). Symptoms such as these can lead to a decline in health and ultimately shorten the lifespan. Health-assistive smart home technologies such as unobtrusive monitoring with interpretive software that can take an action on behalf of a resident are designed to improve

safety for those who wish to age in place. Although major decisions such as leaving the home for an assisted living facility or staying at home with health-assistive technology each carries a set of risks and benefits, expanding options from which older adults can choose is important. Health-assistive smart home environments are an evolving option. Nurses coordinating care, evaluating home environments, and educating older adults and their families regarding intervention options will increasingly be able to use health-assistive smart environments as a resource.

Literature Search and Language

A review of literature on smart homes and unobtrusive monitoring was undertaken to begin understanding health-assistive resource options for the community dwelling older adult. Prior to a comprehensive search, several exploratory preliminary searches were performed to begin discovering the language used in smart home literature. Preliminary searches were key to comprehending and integrating language that is not native to the discipline of nursing. During these preliminary searches, and before the defining of article inclusion and exclusion criteria, a few articles were discovered and set aside due to their probable relevance. These articles significantly informed beginning understandings of smart home adoption by older adults and the potential influence of culture and guided search terms. Demiris et al. (2004), Demiris, Hensel, Skubic, and Rantz (2008), and Courtney, Demiris, Hensel (2007) informed the comprehensive search by highlighting the concept of adoption and referring to it as acceptance and by featuring discussions of monitoring and the use of unobtrusive sensors in the home environment. Each of these articles focused on the older adult population. Hisham and Edwards (2007) and Steggell, Hooker, Bowman, Choun, and Kim (2010) lent support to the idea that culture informed older

adults' adoption of new technology. All articles that informed the exploratory phase of this research project were retained as references following the comprehensive search.

Language used for the comprehensive search was taken from language encountered during iterative exploratory preliminary searches in Google Scholar, CINAHL, PsychINFO, and IEEE Xplore. Words were determined to be congruent if they revealed significant overlap in article listings. Italicized words listed in the table below were added to iterative searches as it became apparent they were used extensively in the larger body of literature.

Table 1

Search Language Used in Preliminary Literature Review

Conceptual Word	Similar Words
Culture	Cultural, social values, beliefs, diversity
Older Adults	Elder, elderly, geriatric, gerontology
Smart	Intelligent, *ambient*, artificial, *environment*
Monitoring	Unobtrusive, *ambient*, passive, *ubiquitous*
Adoption	Acceptance, *perception*

A comprehensive search was completed in Google Scholar, CINAHL, PsychINFO, IEEE Xplore, PubMed, Cochrane, and Web of Science using the following search term

(older adult or elder* or geriatric or gerontology) and smart home or (ambient or

artificial or intelligent or environment) or (monitoring or unobtrusive or ambient

or passive or ubiquitous) and (adoption or perception or acceptance).

The comprehensive search revealed 119 titles whose abstracts were reviewed for relevancy. Articles were deemed relevant and kept for full review if the title and/or abstract included three key concepts (sensor monitoring, older adults, and adoption). Language from Table 1 guided the identification of these three key concepts. When more than 250 articles

presented using the comprehensive search term, adding "and the influence of culture" narrowed the search. Articles were excluded from full review if the primary focus was on home monitoring of a person with a specific illness (e.g., heart disease with dysrhythmia), or if the focus was on robotics, general technology for use by older adults, wearable sensors, commercial smart homes for use by the general population, business and marketing, disabled persons, dementia or Alzheimer's, younger adult user values, or ethics. In total, 44 articles were retained for full review. Of the 44 relevant articles only two specifically addressed the role of culture in older adults' adoption of a new *technology* (Hisham & Edwards, 2007; Steggell, Hooker, Bowman, Choun, & Kim, 2010). No articles discussed the influence of culture on older adults' adoption of smart home *monitoring.*

After the comprehensive search was completed, a separate search was performed in Gerontechnology Journal from the membership website of the International Society of Gerontechnology. This search revealed seven articles not encountered in the comprehensive search within the previously identified databases. Three of these articles were deemed relevant based on the inclusion criteria.

Across all literature reviewed in all six knowledge domains consistent themes were discovered regarding the rapid growth of the aging population, the inadequacy of status quo residential living for the declining older adult, and the increase in associated healthcare costs leading to a demand for innovative living arrangements. Smart home technologies are proposed in the literature as one such innovative solution. Conducting research to ascertain knowledge on how such technology could be implemented will be important to diffusion of this innovation, which may improve older adults' quality of life and potentially decrease healthcare costs associated with aging.

Theories on Adoption of Technology

Three main theories were encountered in the literatures that frame the discussion on acceptance of technology: Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and Rogers' Diffusion of Innovation Theory. A fourth theory, the Almere Model, is new and has not been used extensively.

The Unified Theory of Acceptance and Use of Technology is informed by the Theory of Reasoned Action (TRA) (Davis, 1989). TRA is a model that predicts behavioral intention and incorporates perceptions of attitude in the prediction of behavioral intention. UTAUT regards end-user acceptance and combines eight different acceptance models (41 associated constructs) to explain 70 percent of variance in intention to use a technology (Chen & Chan, 2011). In this theory the language of acceptance regards actual use. UTAUT identifies direct influences on acceptance as: *performance expectancy, effort expectancy, social influence, intentions to use, and facilitating conditions*. Additionally, UTAUT utilizes four modifiers of intention: gender, age, experience, and voluntariness of use. UTAUT encompasses many factors, which are complex and comprehensive, however, the complexity may increase the difficulty of applying it as an organizational guide for study design and presentation of results. UTAUT is a Cartesian framework, which fits well with a multifactorial experimental study design, but is not a good fit for descriptive or interpretive methodologies. UTAUT was not used in this study because of its complexity and lack of previous use with descriptive methodologies.

The Technology Acceptance Model has two versions and is also informed by the Theory of Reasoned Action. The first version (TAM1), developed by Davis, Bagozzi, and Warshaw (1989), includes the constructs of *perceived ease of use, perceived usefulness,* and *intention to use.* The second version (TAM2), developed by Venkatesh and Davis (2000), incorporates the

additional constructs of *external variables, attitude toward use,* and *behavioral intention to use.* In this model, acceptance is defined as actual use. TAM has been used to explain acceptance in a variety of technologies (Heerink, Kröse, Evers, & Wielinga, 2010) in multiple countries: United States, Europe, Korea, China, Malaysia, Singapore, and South Africa (Chen & Chan, 2011). Both TAM1 and TAM2 predict end-use of the technology. Although TAM2 might be an acceptable model to guide this study because of its previous application to the older adult population, use in multiple countries representing various cultures, and inclusion of the constructs of behavior and attitude, it was not used because it lacked a direct language link to culture. Many factors may affect behavior and attitude that are not influenced by culture.

The Almere Model is relatively new and was adapted from UTAUT by Heerink et al. (2010). Heerink and colleagues adapted the UTAUT survey tool for use in their study on older adults' interactions with a social robot. A new model on the acceptance of technology with predictions for use emerged from this study, which included several new constructs: *anxiety, attitude towards technology, perceived adaptiveness, perceived enjoyment, perceived socialability, social influence, social presence, and trust*. Heerink et al. proposed good reliability of the model based on statistical analysis and a high Cronbach's Alpha (0.720 – 0.948) in each of the 12 constructs, with a sample size of 30 older adult participants. There is little cross application use of this model in the literature to date. This model has been primarily used in studies experimenting with human interaction and social robots. The Almere Model could be effectively used to study the influence of culture on older adults' adoption of smart home monitoring because it contains the constructs *perceived socialability, social influence, social presence*, which may be closely related to cultural values and beliefs. Nevertheless, there is no direct link in the language. The Almere model was not chosen to guide this study because there

is no link in the language between this model and culture and because of limited cross application outside of the study of robots.

Rogers' Diffusion of Innovation Theory was chosen to frame this study. It is a well honed and long standing theory developed in the 1950s by Everett M. Rogers. Rogers' theory has many cross applications and has been used to study a wide variety of populations, and has been used to study the uptake of technological innovations within populations defined by their culture (Sahin, 2006). Language within and around Rogers' theory specifically includes the word "culture."

In qualitative descriptive research, language is important to understanding and interpreting meaning (Creswell, 2009; Sandelowski, 2000). Language found in Rogers' theory matches the aim and purpose of this study because it addresses uptake of a technology by a "population," and "adoption" versus "acceptance" of a technology. Language used in the literatures of Rogers' theory includes extensive use of the word *population*. The emphasis on diffusion at the *population* level instead of the *individual* level makes Rogers' theory a good match for this study, which is designed to explore perceptions regarding smart home monitoring in a *population*.

The language of *adoption* is more aligned with a nursing perspective than use of the word *acceptance,* which is found in other theories. The word *adoption* is preferred because it infers a literal action without judgment; judgment may be inferred with use of the word *acceptance*. The word *acceptance* and its antonym *refusal* imply an action that may be in reference or deference to a professional recommendation. A*cceptance* and *refusals* are encountered regularly by nursing professionals, however, there is an underlying assumption regarding *refusals* (lack of *acceptance*) to professional recommendations: the patient made the wrong choice. This study

explores a technological intervention that may be recommended for patient health and safety in the future but which older adult patients may or may not feel comfortable allowing in their home. Discomfort with being monitored in one's own home is neither right nor wrong and it may be possible to adopt a technology based on need without fully "accepting" it. Therefore use of the word *adoption* is preferred.

Rogers' Diffusion of Innovation Theory

Diffusion of Innovation Theory guided all aspects of the proposed dissertation including research design, implementation, and analysis. Diffusion theory is useful for studying the proposed questions because it highlights the role of socially constructed predictors and barriers in the diffusion process and identifies adopter categories, which are based on socially constructed channels of communication. A pilot study was performed using Diffusion of Innovation Theory as an overtone and it demonstrated coherence of applied theory to proposed questions. The pilot study will be discussed further in Chapter 3.

Diffusion of Innovation Theory was a reapplication of Diffusion Theory, a theoretical model used in the field of agriculture in the 1950s. In 1962 Everett M. Rogers began reapplying Diffusion Theory to real world problems in the fields of public health, sociology, and mathematics (Rogers, 1976; Rogers, 2004). This reapplication experienced great success in discovering how populations take up innovations over time. Rogers helped move Diffusion Theory to Diffusion of Innovation Theory through two major studies: (a) diffusion of a new hybrid corn seed; and (b) an innovative campaign to stop HIV/AIDS (Rogers, 2004). Disciplines that have employed Rogers' theory to date include communication, marketing, public health, sociology, pharmacy, management, and nursing. Since 1962 over 6000 field studies in more than 6 disciplines using Diffusion of Innovation Theory have been published (Robinson, 2009;

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Rogers, 2004). Diffusion of Innovation Theory accurately explains uptake of innovations by populations, making it one of the most reliable theoretical frameworks used in all of social science research (Robinson; Rogers).

Diffusion is the process through which an innovation is spread through a social system. The diffusion process includes characteristics of the innovation, communication channels, time, and characteristics of the population (Robinson, 2009; Rogers, 2004; Sahin, 2006). An innovation is described by Rogers as an "idea, practice or project that is perceived as new by an individual or other unit of adoption" (Rogers, 2003, p. 12), which includes technologies that are new to a social system (Maarop, 2011; Rogers, 2004; Sahin, 2006). Communication channels are the process by which people share information and reach mutual understandings and a channel "is the means by which a message gets from the source to the receiver" (Rogers, 2003, p. 204). Channels are used to spread information about a new idea or innovation. Time is needed for the diffusion process and Rogers considered this aspect one of the strengths of his theory (Sahin, 2006). Rogers (2003) defined social systems as "a set of interrelated units engaged in joint problem solving to accomplish a common goal" (p. 23). Characteristics of the social system and the structure for communication influence diffusion within a given population (Sahin, 2006).

Diffusion of Innovation Theory offers three valuable insights into the process of social change. First, it identifies what qualities make an innovation spread through a social system. Second, it highlights the importance of communication channels among a social system. Third, it helps with understanding the needs of different segments of the potential users of a social system.

Qualities.

Rogers (2003) identifies several qualities that make an innovation spread through a social system. *Relative advantage* is the "degree to which an innovation is perceived as better than the idea it supersedes by a particular group of users" (Robinson, 2009, p. 2). Relative advantage is measured in terms of economic advantage, social prestige, convenience, and satisfaction. Greater perceived advantage leads to increased rates of adoption. *Compatibility* with existing values, practices, and needs of a social system affect the rate of adoption. Greater compatibility with social values, practices, and needs leads to higher rates of adoption. *Simplicity* and ease of use as perceived by the adopter will affect rates of adoption. Difficult to understand innovations will slow the rate of adoption. *Trialability* of the innovation addresses adopters' concerns related to difficulty of use, compatibility, and advantages and can lead to increased rates of adoption. *Observable* results allow the adopter to see the advantages and decreases feelings of uncertainty regarding the new innovation. Observable results can stimulate discussion among peers within the social system, leading to diffusion of the innovation through communication channels (Robinson).

Communication channels.

The importance of communication channels is highlighted by Rogers' theory. A key principle is that adoption of a new innovation involves the management of risk and uncertainty. Conversations with persons who are known and trusted and who were early adopters gives credible reassurances that an attempt to adopt the innovation will not result in embarrassment, financial loss, or wasted time (Robinson, 2009). Most people who make up a social system will see the risk in adoption and will require reassurances from trusted friends and/or family. Although mass media plays a role in diffusion of new innovations, Rogers' proposes that the

majority of diffusion happens via trusted communication channels within social systems (Robinson, 2009; Sahin, 2006).

Adopter categories.

Rogers (2003) proposed five adopter categories, which he stated were "classifications of a social system on the basis of innovativeness" (p. 22). Categories of adopters include innovators, early adopters, early majority, late majority, and laggards.
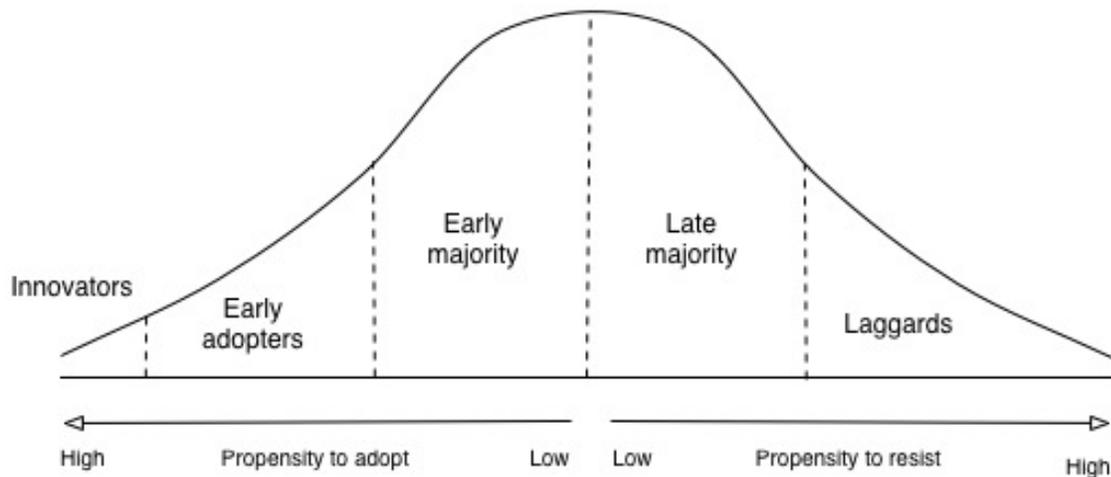
Figure 1. Rogers' Diffusion of Innovations Theory adopter categories represented by propensity to adopt. Adapted from "A Summary of Diffusion of Innovations," by Les Robinson, 2009, *Enabling Change,* p. 5. Reprinted with permission**.**

Innovators are the smallest percentage of the social system making up 2.5 percent of all members. Innovators are the gatekeepers for innovations from outside the social system (Sahin, 2006), and they tend to be visionary and creative. They often spend a great amount of time on new ideas or gadgets (Robinson, 2009). *Early adopters* represent 13.5 percent of the social system. They are often leaders who are slightly more guarded than innovators regarding new ideas. However, they are quick to notice when an innovation is compatible with social system

values and is demonstrating observable advantages. Attitudes toward the innovation by the early

adopting segment of the social system are important to diffusion of the innovation (Sahin, 2006).

Positive attitudes decrease uncertainty and result in increased rates of adoption. The *early*

majority segment makes up 34 percent of the social system. They do not have the leadership

qualities of the early adopting segment but are known to have moderately progressive ideas.

They are looking for better ways of doing what they already do, but are risk averse and are

deliberate decision makers. Early majority adopters base their decision to adopt on evidence that

the innovation has solid benefits (Robinson, 2009; Rogers, 2003; Sahin, 2006). The *latent*

majority makes up another 34 percent of the social system. These adopters dislike risk and

uncertainty and wait until most of their peers have already adopted an innovation before adopting

themselves. Pressure by peers or the fear of not fitting into new social norms is what obliges this

group to adopt (Sahin, 2006). *Laggards* make up 16 percent of all members of the social system

and are more skeptical about innovations and may have more to lose by adopting. They may

only associate with members of the same social system from the same category (Sahin, 2006).

Their "limited resources and lack of awareness" of new innovations increases uncertainty and

decreases willingness to trial the innovation (Sahin, 2006, p. 20). As the most latent group of

adopters, laggards observe the innovation longer, have lengthened periods of decision-making,

and may have more to lose.

Older Adults as First Adopters

Older adults participating in research on smart home monitoring fit the characteristics of

Rogers' innovators and early adopters of being gatekeepers, noticing potentially advantageous

technologies, being leaders within the social system, and understanding if the technology is

compatible with user values. Such characteristics are demonstrated when an older adult shows interest in the topic of smart home monitoring.

This research seeks to answer questions regarding older adults' adoption of health-assistive smart home monitoring by illuminating and explicating their perceptions and descriptions of smart home monitoring as these relate to self-identified culture. To answer these questions, given the newness of smart home monitoring, a sample was obtained that included older adults who currently use and understand basic technologies. Older adults who demonstrated proficiency and who would likely be interested in a conversation about an innovative technology were categorized as members of the innovator, early adopter, or early majority segment of their social system. According to Rogers (2003) those with a lack of resources, a criteria for vulnerable persons (Department of Health and Human Services, 2010), are not representative of innovators, early adopters, or early majority segments of the social system. Therefore, innovators, early adopters, and early majority adopters within the older adult social system were considered as those currently using technologies that late majority and laggard adopters may not be using yet, such as the Internet and email.

To demonstrate this further, consider that there are two main groups of older adults emerging with regard to use of technology. According to Smith (2014), Senior Researcher at the Pew Research Internet Project, the first group tends to be those younger than 74 and this group tends to have a higher education, be more affluent, and have relatively substantial technology assets. The second group tends to be 75 or older, less affluent, and suffer more health problems and disabilities (Smith, 2014). Although the rate of Internet use has increased rapidly since 2010 in the 65 and older category, from 38 percent to 59 percent, this group continues to lag behind their younger counterparts (Smith, 2014), and they tend to go online and "play in the shallow

end" (p. 1) of the technology pool, such as using email and performing searches. "A few pioneers have jumped into social media but these are the exception, not the rule" (Fox, 2010, p. 1). In the 75 and older population the use of the Internet drops off significantly (Fox; Smith; Zickuhr & Madden, 2012), making Internet users in this category statistically innovators or early adopters. Rogers indicates that 50 percent of adopters will be categorized as innovators, early adopters, or early majority adopters and Smith (2014) indicates that 59 percent of adults 65 and over are using the Internet. It can, therefore, be assumed that most older adults using the Internet and email are part the innovator, early adopter, or early majority group.

Because the state of the science of smart home sensor monitoring is still in the research and design phase, participant sampling sought innovators and early or majority adopters, who were unlikely to be of vulnerable socioeconomic status based on knowledge regarding early adoption. However, *any* older adult with an Internet connection who met all other inclusion criteria was invited to participate and diverse participants were actively sought in recruitment efforts.

Older Adults as Vulnerable

Older adults are considered a vulnerable population due to the high prevalence of chronic illness, a higher incidence of hospitalization, and a higher prevalence of health risk factors (Lê, Nguyen, & Barnett, 2012; Neill, Mccutcheon, & Angel, 2013; Sponselee, Schouten, Bouwhuis, & Willems, 2008). *Healthy People 2020* identified older adults as a focus population due to the vulnerability and rapid growth of this population (Department of Health and Human Services, 2010).

Vulnerability and risk.

Rogers (2003) proposes that risk is a concept managed by those considering adoption of a new technology. Today, older adults must manage safety and vulnerability risks brought on by the aging process and the introduction of new technology. There is a broad spectrum of technology users within the older adult population who are navigating risks associated with reliance on technology. Smart homes are a risk to be managed and because older adults are most likely to adopt *proven* technologies (Wang, Redington, Steinmetz, & Lindeman, 2011) and smart homes are not yet a proven technology, the adoption of this technology may appear to involve greater risk. Nevertheless, navigation of health-assistive technologies such as smart home monitoring may seem less threatening to older adults than navigating a move into a health-assistive facility.

Managing Risk

Older adults will tend to adopt a new technology if it is easy to use and serves a purpose such as helping with independent living and connecting with family (Lee, 2012; Steggell et al., 2010). Literature on adoption of smart home technologies reveals a variety of novel innovations, which are designed to assist older adults with independent living. These innovations include, but are not limited to, assistive robots, touch screen computers, social media and gaming, telemedicine, and monitoring. Adoption of such technological innovations vary by innovation, however, older adults consistently report that usability and functionality are key to adoption and management of risk (Crombag, 2009; Demiris et al., 2004; Jacelon & Hanson, 2012; Sixsmith & Johnson, 2004; Sponselee et al., 2008).

There are risks and benefits with use or non-use of any technology. Management of the risks with aging, as well as health assistive technologies, is necessary (Demiris et al., 2004) and

is part of the societal conversation on management of aging. Older adults seeking to manage

health risks such as stroke or falls may adopt in-home monitoring that directly reports risks and

events to family or providers (Rashidi & Mihailidis, 2013; Townsend et al., 2011).

In studies exploring the use of health-assistive technology, older adults highlighted three

concepts as important: (a) maintaining independence; (b) maintaining health; and (c) reliability

of technology. In seeking to remain independent, older adults stated they are often willing to

take risks that may end in a fall or other unsafe situations (Johnson, Otr, Davenport, & Mann,

2007; Londei et al., 2009), however the importance of remaining independent is perceived as

greater than the risk (Demiris, 2009).

In seeking to maintain health the idea of in-home monitoring was new and concerns with

reliability were raised (Courtney et al., 2007; Demiris, Hensel, et al., 2008). Managing risk also

included older adults' desire for technology that will directly address their health needs and the

need to know who had access to monitored data. Family members of older adults had similar

concerns related to privacy of data and reliability of technology. Families needed assurance that

data would be secured, at low risk for identity theft, and that the technology would work as

expected. They realized the existence of an innate risk with dependence on technology to assist

with safety and health (Maarop, 2011; Rodeschini, 2011).

Monitoring Perceptions and Preferences

Older adults participating in individual interviews or focus groups across several

qualitative studies, which focused on perceptions of smart home monitoring, indicated they had a

strong desire to remain in their home (Demiris et al., 2004; International Federation on Ageing,

2011; Jacelon & Hanson, 2012; Zejda, 2010). There was an openness to the idea of in-home

unobtrusive monitoring as a way to remain in their homes longer (Demiris, Oliver, Dickey, Skubic, & Rantz, 2008; Demiris et al., 2004; Johnson et al., 2007).

Acceptance of monitoring by the smart home raised concerns among older adults regarding privacy, use of captured data, and ability for the technology to improve independence and quality of life. Nevertheless, most older adults indicated a willingness to trade perceived loss of privacy for independence, improved quality of life, and the ability to remain in their own home longer (Demiris et al., 2004; Townsend et al., 2011). There was greater interest in unobtrusive monitoring, which is subtle and does not stand out in the home environment.

Older adults indicated they did not care which type of monitoring was used, with the exclusion of cameras, but that the performance of the technology was important (Johnson et al., 2007). When comparing direct distributed monitoring, a type of sensor that perceives presence through motion, and infrastructure mediated monitoring, which perceives activities through measurements of activation of in-home structures such as plumbing and electrical systems, Demiris (2009) found no preference by older adults. He also reported that older adults were amenable to monitoring via cameras and microphones but that these were less preferential to monitoring that included only sensors. Similarly, Jacelon and Hanson (2012) reported that older adults were open to video monitoring but preferred cameras capable of silhouetting to preserve privacy and that they preferred sensor monitoring over use of cameras. Johnson and colleagues' (2007) findings indicated that older adults were most likely to accept the smart home component that best addressed their particular need such as a smart door for the visually impaired that announces there is a visitor at the door and projects a picture of the visitor on a screen inside the home.

Person-Centered Care

Person-centered care is a philosophy of nursing practice created for nurses by nurses (Webster & Cowart, 1999). It encompasses a value-driven focus on person-centered care in a healthcare delivery system of managed care, which is influenced by external marketplace and economic forces (Webster & Cowart). There is solid evidence that person-centered care improves the quality of care and reduces cost (Powers, 2013), and that nurses are interested in client perceptions and preferences such as those associated with smart home monitoring.

A person-centered model of care focuses on *the person* not just their healthcare needs or available delivery systems. In this practice model, clinical reasoning becomes necessary to safely apply evidence-based practice guidelines, a form of aggregate knowledge, so the patient receives individualized yet safely guided evidence-based care. Achieving person-centered care requires specific knowledge of the client and extensive of knowledge of evidence-based guidelines. Difficulties with combining these knowledge domains exists such as considering the client's own health values and beliefs, which may not align with evidence-based knowledge. Nurses, however, with their vast knowledge of pathophysiology, healthcare interventions, evidence-based practice guidelines, and delivery systems, are well positioned to accomplish safe delivery of person-centered care, which improves quality of life, quality of healthcare delivery, and customer satisfaction (Manley, 2011).

A person-centered model of care frames the following discussion on culture as it relates to future delivery of healthcare through health-assistive smart home monitoring. Application of this model allows for conceptualization of culture as *self-identified* despite culture being a shared set of beliefs and practices by a *group* of people. A person-centered framework removes the assumption that *culture* references groups of people by generally accepted categories such as

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race, ethnicity, religion and so forth. It highlights personhood and allows one to identify his or her culture in words or ideas that may be neoteric, such as the culture of *engineering* or *small town American girl*. Such descriptions of one's culture may allow a better understanding of the *influence of culture* on the older adult's adoption of smart home monitoring.

Culture

Culture is a broad term and the discussion of its meaning uniquely complex. It is an abstract concept, a perspective of *one* and of *many*. Culture is an expression of an ensemble of socially constructed values that are shared in the space between humans (Geertz, 1973), and which inform behaviors, actions, and activities.

Culture is referenced in a variety of literature as a norming of beliefs and behaviors across a specific group of people, which can be identified by race, ethnicity, geographic location, language spoken, or country of origin. Examples of normed beliefs and behaviors are Hispanic machismo (Abein, B. & Russell-Kibble, 2014) and Asian collectivism or group think (Lê et al., 2012; Lockett, 1988). Business and management literature discusses culture as group norms (Lockett, 1988; Straub, Loch, & Hill, 2001) and similarly nursing and health sciences literature refers to culture as normed beliefs and behaviors. Wilkinson and Treas (2011), authors of an introductory nursing textbook, refer to the culture of particular races and ethnic groups as well as religious groups when discussing cultural competence. The American Association of Colleges of Nursing (2010), which offers a toolkit on cultural competency, highlights sociocultural group norms.

Smart home literature also refers to culture in the context of socially constructed values, which are normed based on group characteristics. Hisham and Edwards (2007) proposed that cultural norms learned during childhood remained in the consciousness of older adult Malaysian

women and that these norms had significant influence on users' perceptions and adoption of computer technologies. Haines et al. (2007) discovered that user needs included cultural values, which often did not fit stereotype beliefs held by design engineers. Additionally, Haines et al. proposed that mindful design was necessary to diffuse smart home innovations in the future. In 2010, Steggell et al. discovered that cultural influences such as family time, played a role in Hispanic and Korean older adults' interest in adopting new gerontechnologies and that "culture and personal biography shape the course of technology acceptance at the individual level" (p. 434). Furthermore, Lê et al. (2012) proposed that integration of smart home technologies into the home environment of older adults should consider sociocultural mores and their impact of on views of aging and caring. According to Lê et al., Vietnamese older adult immigrants to Australia valued concepts of collectivism and co-existence and, therefore, the concept of independence, a goal of smart home technologies, was not a good fit.

Culture "self-defined."

The culture of a person must be defined by the person. A first-person account of culture is the most authentic and is the only one that should be applied to conversations regarding decision-making about adoption of a technology as personal as in-home monitoring. To create a person-centered exploration of the smart home adoption process, a neoteric definition of culture is needed. The neoteric term s*elf-identified culture* will be used in this research and will be operationalized as *defining of one's own culture based on important personal values that are socially constructed throughout the life experience that may impact one's decisions and cannot be identified by checking a categorical box.* Examples of neoteric self-identified cultures that might be expressed by participants are "engineering" or "small town American girl" or "Cablinasian," a term coined by Tiger Woods to describe himself (Davis, 2009). The above

examples are not typical predetermined categories such as Black or Asian or Pacific Islander or Jewish or female, instead *self-identified culture* is based on socially constructed values formed by life experiences that influence beliefs, decisions, and other core aspects of a person's life. A definition of culture as *self-identified* returns power to individuals and allows them to identify, describe, or explore their own culture. Such a definition allows for exploration that may improve knowledge about how culture influences smart home monitoring adoption decision-making processes.

An important distinction between culture and self-identity then comes to the forefront. Because culture is a concept related to more than one person, a group rather than an individual, how then can *self-identified culture* regard culture? The neoteric definition proposed above may not be appropriate for use in studies where the purpose is to identify *commonalities of cultural influences* across or between groups of people, however it is appropriate for a study that explores the *influence of culture* on one's decision to adopt or not adopt smart home monitoring. A decision to adopt monitoring within one's home is personal and exploration of group values would not answer the personal nature of the question of how the influence of culture impacts one's decision. Therefore, the neoteric definition described above is the best application of the term culture for this study. The neoteric definition of culture will help the researcher discover the influence of socially constructed values that come from an authentic conversation where thoughts of culture are not imposed but, instead, where dasein culture (inextricability of a person and the world they live in and regard) can be conversationally explored with the older adult.

Summary

A post-positivist, interdisciplinary, and openly inquisitive qualitative discovery process is needed to explore the influence of culture on older adults' adoption decisions regarding smart

home monitoring. Rogers' Diffusion of Innovation Theory, person-centered care, and a neoteric definition of culture as self-identified guided the discovery process and served as overtones to the qualitative descriptive methodology. A study regarding the influence of culture on adoption of smart home monitoring was performed to discover older adults' knowledge, perceptions, and descriptions, and to identify predictors and barriers to adoption, so future engineers, nurses, and other professionals can integrate culturally mindful design in the development and implementation of health-assistive smart environments for those wishing to age in place.

CHAPTER THREE

RESEARCH DESIGN AND METHOD

Qualitative Descriptive Methodology

      Historical and philosophical underpinnings.

      Qualitative Descriptive (QD) is one of several qualitative research methodologies used to understand a lived human experience relating to a particular event or phenomenon. QD became a leading methodology in qualitative research in the 1980s, evolving out of Husserl's line of philosophy, which highlighted the need for scientific research to focus on understanding human experiences (Lopez & Willis, 2004). In the 1990s QD received some criticism for lacking "epistemological credibility" (Thorne, Kirkham, & Macdonald-emes, 1997, p. 170), which resulted in posturing about which qualitative methodology was best (Sandelowski, 2000). Interestingly, early QD supporters do not appear to have postured as effectively as those aligned with the five main methodologies currently found in most qualitative research textbooks: ethnography, grounded theory, discourse analysis, phenomenology, narrative study. Nevertheless, QD is found extensively in social sciences research literature and Sandelowski (2000) argued for a renewed respect for QD as a methodology stating it is "precisely" what is needed due to the "increasing complexities" of qualitative methods (p. 334). QD is a post-positivist leaning qualitative methodology with distinct and unique traditions (Kahlke, 2014; Sandelowski, 2010).

      The uniqueness of the post-positivist qualitative descriptive methodology lies in the philosophical approach and design. The aim is a rich description that remains close to participants' own words and phrases (Kahlke, 2014; Neergaard, Oleson, Andersen, &

Sondergaard, 2009; Sullivan-Bolyai et al., 2010). It is not the "thick" (Neergaard et al.) inquiry

of ethnography, nor a means for theory development as in grounded theory. Unlike other

methodologies where open-ended questions are the only acceptable lines of inquiry, the QD

process includes a more prescriptive interview and may include some discrete questions with

'yes/no' answers. Additionally, the researcher may use bracketing, a method of consciously

removing self bias and "holding in abeyance ideas [and] preconceptions" (Lopez & Willis, 2004;

p. 728), whereas in other methodologies like phenomenology, the researcher is encouraged to

submerse self in the conversation. Finally, the end product is unique as the report reflects the

simple naturalistic inquiry with low inference interpretation and original phrases of participants

(Kahlke; Magilvy & Thomas, 2009; Neergaard, et al.) that culminate in rich descriptions using

multiple lines of participants' own words to support identified themes.

Basic assumptions associated with QD involve key ideas about human consciousness and

purposive research. One assumption is that there are "lived experiences that are common to all

persons who have the experience" (Lopez & Willis, 2004, p. 728). Another assumption is that

interpretation is not necessary to share a rich description of an experience but neither is it

discouraged (Dicicco-Bloom & Crabtree, 2006; Sandelowski, 2000; J. Smith et al., 2008;

Sullivan-Bolyai et al., 2010; Thorne et al., 1997). Furthermore, it is assumed that the researcher

wants to know the *who*, *what*, *where,* and *how* of events or phenomena and that a form of content

analysis will be the primary method of organizing data (Dicicco-Bloom & Crabtree;

Sandelowski). Lastly, it is assumed that overtones from other forms of inquiry may or may not

be used when organizing and analyzing data and that this is acceptable if clearly stated and

defined.

The components of QD, such as seeking to understand *what* and *how*, were congruent

with this study's research questions and Rogers' Diffusion of Innovation Theory was a

compatible overtone. A dynamic relationship existed between sampling, data collection,

analysis, and thinking theoretically (Morse et al., 2002) and congruency and fluidity of these

components led to reliable and valid research.

Situated Philosophy

A post-positivist stance through a qualitative methodological lens values exploratory

breadth and depth of the human experience (Creswell, 2009). In this dissertation, breadth was

found in the researcher's interdisciplinary scholarship as an Integrative Graduate Education and

Research Training (IGERT) Fellow, membership in the International Society of

Gerontechnology Scholars, and experience as a Registered Nurse for more than 20 years.

Dissertation depth was found in the chosen methodology, which answered the research question

using qualitative descriptive methods. Qualitative descriptive methods are informed by

traditions handed down from the Husserl line of philosophers, who highlighted the value of in-

depth interviews and the description of human experiences by discovering the how, who, what,

where, and when (Creswell, 2009; Lopez & Willis, 2004). This nursing research was as an

interdisciplinary and post positivist work situated between the disciplines of nursing and

engineering. It was openly inquisitive and guided by traditions within the profession of "nursing

as caring" (Parker, 2006, p. 335).

Method

Sample.

Sampling was purposive and voluntary and included 21 English speaking older adults

living in the United States age 65 and over and of any gender. Participants had to have Internet

access, a personal email address, and actively use an email account. Participants using email as a technology were considered representative of Rogers' categories of first adopters or early majority.

Maximum variation of sampling was sought to provide "broad insight" (Neergaard, et al., 2009, p. 2) into understanding the influence of culture on smart home monitoring adoption decisions. To obtain maximum variation, participants were sought from a variety of geographic locations throughout the United States. Participants were sought from urban, suburban, and rural areas. Diversity was sought by seeking variation of race, ethnicity, religion, or gender. Although purposive sampling through a circle of influence may naturally limit variation of the sample, a focus on desired variation during the recruiting process improved sample variation. Data collection via email interviews also improved variation and diversity; this form of contact was not limited by geography. Participants were excluded if they were non-English speaking, lived outside the United States, or did not use email. Participants with a reported history or suspicion of cognitive impairment were excluded. Information regarding such a diagnosis was sought in the form of a discrete question about illness during opening rounds of email exchanges. The participant was asked, "Have you been diagnosed with a chronic (long lasting) illness? If so, what illness? Are you currently seeing a doctor or nurse for this illness? Has a doctor or nurse told you that suffer from cognitive or mental impairment?" The participant's answer was accepted. No participants answered, "yes" to the question of cognitive or mental impairment and therefore there were no exclusions.

Participant recruitment.

Recruiting was done through the researcher's circle of influence of known or recommended contacts. A snowball effect was anticipated and accepted and did occur. If

needed, participants would have been sought from senior centers in the United States. The plan

for recruiting from senior centers, which included posters, flyers, and in-person announcements,

was not needed. The snowball effect was overwhelmingly successful.

Participants were contacted by phone or email after the researcher received their name as

an interested party. A brief introduction of self was given along with a brief description of the

study and statement of purpose. The operational definition of smart home technology used

during the introductory phase was the Washington State University Center for Advanced Studies

in Adaptive Systems (CASAS) definition discussed in Chapter One. When permission to make

contact had been received from a potential participant verbally or by email, the first email was

sent, which formally reiterated in writing an introduction of self, purpose of the study,

description of the study, estimated time commitment by participant, and identification of risk and

benefits. See Appendix A for introductory email.

Data collection.

Data collection was attained by in-depth asynchronous email interview and included both

discrete and non-discrete unstructured text based data; all data was text. Discrete data was

collected in opening rounds of email exchanges. See Appendix B for discrete data questions.

Non-discrete data were collected through multiple rounds of in-depth exchanges allowing

concepts to evolve as the researcher adapted further questions (within set concepts) to the email

conversation. Concepts of focus were culture, aging, smart home adoption, and monitoring.

Interviewing and analysis were done integrally as accommodations were made for new

insights throughout the collection and analysis process (Sandelowski, 2000). Responsiveness,

flexibility, creativity, and sensitivity were characteristics employed to improve validity and

reliability of content (Morse et al., 2002). Theoretical thinking was employed on both macro and

micro levels and was iterative and responsive to the analytics' team suggestions to assure that large cognitive leaps were not made and a solid foundation of data was collected for analysis (Morse et al.).

A naturalistic approach to drawing the conversation to an end was sought by the researcher when saturation of data had been reached. Discrete structured data was collected in first and last email exchanges and unstructured data was collected in all other email exchanges.

Analysis.

Chronological email text-based data was transferred from the email system to a Word® document to create a transcript that was sent to the analysis team. Data included email data-time stamps and salutations. All transcripts were de-identified at the time data was transferred and line numbering was enabled. The ability to reference text by numbered line allowed the analysis team to easily refer back to text within the transcript to confirm proposed themes and facilitated any necessary audits. Each interview transcript was emailed to the analysis team, which consisted of three members representing expertise in qualitative methodology, gerontology, technology, and critical judgment. One member of the analysis team held a Doctorate of Philosophy in Nursing, another a Master's in Public Health, and another a Master's of Science in Nursing. Members holding a Master's degree were concurrently enrolled in the Doctorate of Philosophy in College of Nursing at Washington State University.

Content analysis was the primary method of organizing data into themes. Content was analyzed for individual transcripts and then compared with other participants' transcripts, looking for shared themes across participants. Transcripts were iteratively and reflexively reviewed, both individually and comparatively. Themes of low inference were sought and supported by references to rich text. After reviewing the text data, each team member wrote a

simple summary with initial thoughts on possible themes. The summary document referenced supportive text, which was identified by line number to allow for future confirmation of supportive data. Summaries were returned to the researcher. After receipt of five summaries a comparison was made looking for common themes across summaries and across identified text from original transcripts. Original text was re-reviewed to verify the validity of proposed themes. A separate and lengthier summary of developing common themes across participants' transcripts, supported with rich text and referenced by line, was written and returned to the team. After every set of five transcripts, the process repeated and included comparison of discovered themes from all previous summaries. Confirmation, an action that enhances validity (Morse et al., 2002), of developing themes was obtained from the team and reflexive changes were made to thematic summaries until all team members reached a consensus. Researcher triangulation and peer review was used to iteratively validate proposed themes and findings (Neergaard, et al., 2009).

Team members communicated via email exchanges and by group conference call as needed throughout the process. Planned conference calls were anticipated but were ultimately not needed because all members of the analytic team deemed email communication sufficient. To improve rigor, each team member's thoughts were equally valued. During each interaction with text data, summaries, and team communication, consensus was sought and obtained. Consideration of stability of the data guided iterations and consensus. Agreed upon themes that held over time were indicators that data was stable and these themes were included in future interviews with participants. For example, if a theme such as reliability of technology was identified as common across the first five participants' transcripts, it was actively sought as a theme in the second set of five participants' transcripts. If this theme was identified in 10 or

more transcripts it was considered stable and questions regarding the concept of reliability of technology were introduced into conversations with all future participants, or until there was saturation of data for that theme. Themes that emerged in the first 5-10 interviews but may not have surfaced in interviews 10-15, were briefly re-checked in later interviews. For example, aloneness as loneliness emerged as a theme early on and was re-checked with participants 15-20. No themes that emerged early on were dropped, but several were subsumed by more prominent themes that later emerged. Consensus among the analysis team was sought and obtained for all themes identified as stable. There were no plans to use a computer software program for storing text-based data that is unstructured such as NVivo® and none were used. Words and phraseology that were commonly used in the transcript were identified through iterative reviews of the data completed manually or by using the find option in Word®. Periodically, with mindfulness to low inference interpretation, synonyms and antonyms were sought in the text and referenced in the formulation of interpretation.

Findings are presented in Chapter Four using multiple lines of rich text of participant's own words to support low inference themes in keeping with QD tradition. Simple summaries provide a rich description that remains close to the original source. Presentation of findings includes a description of the data collection and analytic processes for the purpose of transparency. Such a record allows the reader to assess validity and reliability of the findings and evaluate the rigor of the research.

Human subjects protection.

An addendum to the IRB pilot study application, which received exempt status, was submitted to increase the sample size from two to 20-25 participants. The modification to increase the sample size was approved under exempt status.

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Risks to participants included the discussion of a time when the aging process has disabled the older adult and they are no longer able to remain in their home without assistance. The discussion of such a time could cause distress, even anxiety or depression. No participants exhibited distress or anxiety and, therefore, no interventions were necessary. There was also risk in introducing them to a technology that is not currently commercially available and activating the hope of remaining at home with the assistance of a smart home. The future commercial availability of this health-assistive technology was, and remains, unknown. There was risk to individuals and society with diffusing information on a technology that was not fully developed and commercially available because a future product sought by participants, based on their participation in this study, may or may not resemble the smart home monitoring product discussed in the interview. A blind assumption that smart home monitoring *is a good thing* could be a risk to society. Adoption of any technology would include both risk and benefit related to reliability and functionality of the product.

The amount of time spent by the participant on the email interview process may have posed a burden. Mindfulness of participant time was regarded through observing the length of participants' email responses and watching for cues indicating onset of a feeling of burden or fatigue. Periodically, the participant was asked, "How are you doing for time?" and was reminded that the conversation could be drawn to a close at any time. Two participants requested to end the interview early and one participant requested to withdraw (due to an unplanned and impending back surgery). All three participant requests were obliged. A maximum of eight hours of participant time was anticipated. Participants indicated they spent between one and seven hours of time in thinking and responding.

Potential risks and benefits were anticipated. Alertness to cues in email text that indicated the participant was stressed or anxious minimized risk. Should anxiety have occurred, the research would have referred the participant to their healthcare provider or a counselor in their local area. This was not necessary; no participants used language in the text that suggested anxiety or stress. With two participants, cues were noted regarding time and fatigue of the interview and those interviews were drawn to a naturalistic end. Additionally, it was not assumed that smart home technology *is a good thing* for everyone and mindfulness to nuances in the email conversation that might imply such a philosophy were avoided and this helped mitigate the risk of an overtone that smart home technology *is a good thing*. Presentation of potential risks to participants were embedded in the introductory email and acknowledgement by the participant of such risk was sought and obtained in their email response. See Appendix A. A potential benefit to participants and society was the introduction of smart home technology as a potential future option for aging in place, if one so desires. Choices improve autonomy and dignity and are *a good thing*.

Security measures were taken for email exchanges. The Washington State University (WSU; wsu.edu) email account was the only email account used by the researcher for conversing with the participant and collecting data. The WSU email system was secured with firewalls that met industry standards. Email from the WSU account was not be forwarded to an outside or home email account. Rules were set so each participant response was sent directly to a folder, which was labeled with the participant's pseudonym. This prevented the researcher from causally seeing the participant's response while taking care of other business, which normally occurs on the WSU email account. To view each participant's response a folder had to be purposefully opened. Before opening the respondent's email folder, a quiet and private place

was sought, such as the home office, so participant confidentiality was maintained and mindfulness of *being in an interview* was enhanced. The interview environment was purposefully created just as with a face-to-face interview. This process removed any tendency toward casualness with the email interview.

Pilot Study

Preparation for dissertation research was done by implementing a pilot study and through methodical movement from the pilot study to full dissertation design. Rogers' Diffusion of Innovation Theory served as an overtone for the pilot study. Rogers' theory specifically informed identification of the target population and sample. It also framed discussion of culture, creating a focus on the qualities that impact diffusion within a population such as relative advantage, compatibility with existing values, and diffusion via trusted communication channels within social systems (Robinson, 2009; Sahin, 2006). It guided interview questions, which were designed to elicit information about how smart home adoption rates may diffuse in the older adult population over time.

In October 2013, a pilot study, which received Institutional Review Board (IRB) exempt status, was performed to determine whether the methodology and methods proposed would adequately answer the research questions. The pilot study also provided information regarding theoretical and methodological coherence, meaning the research question matched the methods which matched the data and the analytic procedures (Morse et al., 2002). The analysis team determined methodological coherence existed because the data answered the research question and theoretical overtones (Rogers' theory and qualitative descriptive) supported the analytic process.

Research questions for the pilot study were:

1. Who will adopt smart home monitoring?; and

2. How does culture play a role in the decision to adopt?

Three participants were recruited and two were interviewed. One participant did not respond to the email after agreeing to participant during the initial phone call. Both participants that engaged in the email interview were over 65 years of age, spoke English, were cognitively alert and oriented, and were actively using email as a communication method. The sample was purposive and voluntary and was representative of the target population of first adopters or early majority.

Using a qualitative descriptive design, a fundamental method of inquiry according to Sandelowski (Sandelowski, 2000), in-depth interviews were conducted via email using discrete and non-discrete text based questions. Participants demonstrated their ability to comprehend smart home monitoring as defined for the study and to apply this idea to possible use in their own home. They shared perceptions and potential barriers to use, and discussed how these related to self-identified culturally based expectations. They also demonstrated capability and ease of use with email exchanges and the email interview method of inquiry. Both participants responded to an asynchronous format of multiple email queries. One participant naturally followed a continuous email reply format where data was placed directly in the email response field. The other participant preferred to attach Word® documents to email replies. Both formats were determined effective, although replies within the email response field were later noted as much easier to analyze. Participants spent 2-6 hours total time on the interview, which fell within the estimated time of 8 hours presented to the IRB. Content analysis of email transcripts was performed and various themes were identified. Low inference was primarily used to

identify themes, although one member of the analysis team was innately and by training a phenomenological interpretive researcher. This team member performed some interpretation of the data that was not low inference. Variance of the level of acceptable interpretation was purposefully discussed among the team members and variance of analysis was allowed based on qualitative description traditions (Sandelowski, 2000).

Rogers' Diffusion of Innovation Theory was used to frame findings, which were formulated with the acknowledgement that participants were likely first adopters or early majority. Discussion commenced among the analysis team regarding a subtle, but noticeable, assumption within Rogers' theory of diffusion that adoption is *a good thing*. Applying this concept to adoption of smart home monitoring carries a connoted assumption. This assumption, which is not addressed in the literature, was considered and monitored and it did *not* become a strong overtone during the interview process. Awareness of ethical considerations helped with mindfulness regarding this concern and tenets from Rogers' theory regarding compatibility with users' existing values served as a guide to decrease any impact from this assumption.

Five initial themes were identified from the pilot study and validated meaningfulness of the proposed research. The themes were: (a) a strong desire to remain in their own home as long as possible; (b) a willingness, even excitement, to try smart home monitoring; (c) performance of the technology is important; (d) privacy expectations differ; and (e) loneliness is a phenomenon experienced by older adults, which smart homes may help address. Each participant had a strong sense of self-identified culture, which they were able to relate to socially constructed values formed by life experiences. Unawareness of smart homes and the broadness of the concept of culture required abstract thought by participants to address the question "How does culture play a role in the decision to adopt?" Conversation inter-relating these topics

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required careful cultivation during the data collection discourse, but resulted in preliminary themes that supported the direction and importance of the larger study.

The experience of this pilot study validated the choice of methodology and methods in the discovery of older adults' perceptions and descriptions of smart home monitoring as they relate to self-identified culturally based expectations. The pilot study experience informed the design of full research procedures and processes, including recruitment, data collection, and analysis. A purposive and voluntary sample recruited from the researcher's circle of influence of known or recommended contacts worked well for the pilot study. Variation was noted in that one participant was rural and female and the other was suburban, male, and an immigrant with English as his second language. He spoke English fluently. Throughout the recruiting process several potentially interested participants requested to be placed on a list for future contact. The use of email interviews was successful and provided a rich description of participants' perceptions, a tenet of qualitative descriptive methodology (Sandelowski, 2000). Additionally, transcripts were clean and concise and had the added benefit of already being in text form. Participants demonstrated depth of thought throughout the pilot study and engaged beyond expectations. The method of data collection lent itself to inclusion of participants who would likely be first adopters of smart home monitoring, which is the target population. Based on these findings similar methods were used for the dissertation study.

Modifications.

A few modifications were needed for the dissertation study. A significant modification was a purposeful focus on the "influence of culture" on one's decision to adopt smart home monitoring and NOT "cultural influences" on adoption of monitoring. There was a subtle yet distinct difference in the use of language. Although the "influence of culture" was an intended

thread through the pilot study, it was not well defined and as such led to confusion and assumptions that themes would be drawn across cultures as populations or normed groups. This was rectified in the language and in the final dissertation design.

New questions were needed based on post hoc discussion regarding the ability to answer the question "Who will adopt smart home monitoring?" with a qualitative descriptive methodology and a focus on the influence of culture in the decision-making process. New questions became:

1. What is commonly known about smart home monitoring by older adults?;

2. What are older adults' perceptions and descriptions of smart home monitoring?;

3. What factors influence older adults' decisions about adoption of smart home monitoring?; and

4. How do older adults' perceptions of their own socially constructed values and beliefs influence their decisions to adopt or not adopt smart home monitoring?

A second modification was that participants were encouraged to place email responses directly in the email response field instead of using a word processor such as Word®, although one participant requested and was allowed to use Word® documents in responding. This made analysis of text-based transcripts easier to organize and analyze.

A third modification was the addition of more information to the opening email about smart home monitoring. It became apparent in the pilot study that one or two additional email exchanges designed to explain smart home monitoring were needed because both participants denied encountering information about this technology prior to the study. After completing the additional exchanges and based on responses, participants appeared to understand the meaning of the words *smart home monitoring*. An estimate of one additional hour of participant time was

added to the dissertation study; however, the total estimated time presented to participants remained less than 8 hours.

Finally, person-centered care replaced Cultural Safety Theory, originally considered as an informing philosophical overtone. Person-centered care was closely aligned with the concept of self-identified culture presented in Chapter 2 and did not carry with it critical social theory tenets, which were not compatible with a post-positivist research stance. Language of culture in email exchanges with participants was not modified because participants demonstrated comprehension of questions about self-identified culture and were able to express its influence on their decision-making process regarding adoption of smart home monitoring.

Strengths

Through this study, an abundance of evidence that can add to the extant knowledge on adoption of smart home monitoring has been accrued. Using in-depth interviews to ask older adults their personal and in-depth thoughts regarding potential adoption of smart home monitoring and exploring what is "normal" for a person via in-depth interviewing is a first for Washington State University's smart home research program. Findings may inform design features related to machine learning, norming, and private behaviors.

Performing data collection by in-depth email interview created an environment whereby participants could take the time to deeply ponder and then formulate well thought-out responses. The nature of the line of questioning (on privacy) and the use of email may have offered older adults an environment where they felt more comfortable sharing intimate details and concerns related to the private nature of their lives at home. Additionally, analytic team members indicated the researcher's email interview style was an asset to eliciting intricate and authentic thinking by older adults.

The discovery that the epoch experience of culture influences adoption by informing thoughts on privacy, independence, and family, is a first in the literature. This finding supports the need for future research regarding culture and smart home adoption. The use of a neoteric definition for culture was both a strength and a limitation. Framing the questions of the influence of culture with a "self-identified culture" perspective elicited rich descriptions regarding participants' perceived culture that resulted in clear contextual linkages to prospective adoption decisions.

The study sample was relatively heterogeneous across gender and age groups and this lends credibility by minimizing the chance for heavily weighted perceptions that may be consistent only within one group. Additionally, the large number of distinctly variant voices lends to the authenticity of findings.

Limitations

This study was limited by the prospective nature of the interview questions. A discussion regarding a technology that is not currently on the market, and which older adults may not have heard about prior to the interview, may not evoke "true" responses from participants. Asking older adults to examine their prospective perceptions on being monitored in their own home by an intelligent and interactive monitoring system that they cannot see or touch and must imagine, is limiting.

Another limitation is the lack of racial/ethnic diversity. Diverse sampling is recommended in qualitative descriptive methodologies. Although non-white voices were sought, only two were recruited and both of these were Asian American. The geographical location of the participants may be a limitation. Most participants resided in Washington State. One other participant was from the Pacific Northwest and was a resident of Idaho. Regional propensity

toward adoption of smart home monitoring cannot be ascertained due to the few number of participants residing outside the state of Washington and because the line of questioning did not address regional cultures within the United States.

The line of questioning regarding "self-defined" culture was a limitation because participants initially found these questions confusing. However, after further coaching from the researcher, participants were able to richly express their self-identified cultures and the influence of their cultural values on adoption of smart home monitoring, which greatly informed the themes of privacy, independence, and family.

Summary

A qualitative descriptive study using content analysis of in-depth email interviews was used to answer research questions about the influence of culture on older adults' adoption of smart home monitoring. Qualitative descriptive methods traditionally seek to answer questions of *who, what, when, where*, and *how* in regards to the human experience. Research questions in this study were designed to elicit older adults' thoughts about smart home monitoring and *how* the influence of culture may impact potential adoption decisions. A pilot study indicated there was methodological and theoretical coherence prior to the start of the dissertation study and pilot study data supported the direction and importance of the larger dissertation study.

CHAPTER FOUR

FORMATIVE FINDINGS

Sample Description

The study sample consisted of 21 community-dwelling participants age 65 and older who

denied a history or diagnosis of cognitive decline or dementia. Because of the exploratory nature

of the research questions and chosen methodology, a diverse sample was sought and obtained.

Variant voices represented a colorful tapestry of the older adult population in the United States

and included representation by gender, religion, race and ethnicity, sexual orientation,

socioeconomic status, level of education, disability status, immigrant status, region of residency

within the United States, and urban versus rural residency.

The youngest participant was 65 years of age and the oldest was 96, providing an overall

participant age span of 31 years. The sample consisted of 11 females and 10 males. Female age

span was from 65 to 96 with a mean of 74 years of age. Male age span was from 65 to 91 with a

mean of 75.2 years of age.

Table 2

Age Demographics

	Age 65-70	Age 71-80	Age 81-90	Age 90+
Males	3	4	2	1
Females	4	5	0	2
Total	7	9	2	3

Participants were primarily from Washington State. Other states represented were Idaho,

Alabama, Tennessee, and New York. Many participants stated they lived outside of Washington

State for much of their lives, making their voices representative of more diversity than overt

interpretation of discrete data might appear. Suburban-dwelling participants made up the majority of the sample, 13 of 21 participants. The seven rural-dwelling participants were the next most represented group, and there were three urban-dwelling participants. One participant qualified as both urban and rural and homeless, a gentleman who traveled between the urban streets of Portland, Oregon and Seattle, Washington and rural Western Washington; this gentleman likely does not view himself as homeless because he currently has a pick-up and camper.

The sample consisted primarily of persons of Caucasian descent. Two participants were of Asian descent. Persons of African-American, Hispanic, First Nation, and Arab descent were actively sought to increase the diversity within the sample, however none were identified that met all inclusion criteria and were willing to participate. These are considered missing voices. Five participants were immigrants, which included the two Asian Americans. Of the five immigrant participants, four indicated that English was an additional language, however, all immigrants indicated English was their "main" language.

A majority of participants were highly educated (college level and higher) and were of middle or upper socioeconomic status. Four participants were educated at a level no higher than high school and/or less than one year of community college. Only one participant qualified as having both a lower level of education *and* a low income. One participant was highly educated and low income. He self-identified as an "anarchist."

Participants with disabilities that were not cognitive in nature were included in the sample. Three participants self-identified as being permanently disabled; their collective diagnoses included amyotrophic lateral sclerosis (ALS), macular degeneration, rheumatoid arthritis, and depression.

Information regarding religion surfaced from the discussion on culture. Although religion was not a direct line of questioning in the study, three participants mentioned their religion as part of the description of their self-identified culture. Religions represented in this sample were Christian (both Protestant and Catholic) and Buddhist. It is assumed that non-religious perspectives are represented based on cultural discussions where participants mentioned former religions or where there was a noted absence of the topic of religion (9 participants).

The sample included older adults who are retired, partially retired, or who continue to be employed full-time. Careers were diverse. Careers represented in the sample were professors (engineering, chemistry, psychology), bookkeeping, store clerk, banker, corporate project manager, nurse, pharmacist, social worker, physical education teacher, librarian, Navy corpsman, and architect.

Eight participants admitted to suffering a chronic illness and 13 denied any diagnosis of a chronic illness.

Table 3

Sample Descriptive Statistics

Descriptor	Number of
Caucasian	19
Asian	2
Immigrant	5
Retired (Fully)	14
Retired (Part-time)	1
Not Retired	6
Disability	3
Have a Chronic Illness	8
No Chronic Illness	13

Organization of Qualitative Findings

Qualitative findings were organized by major themes that emerged from the texts and were directly identified as standing out and connected by language. Major themes subsumed multiple minor themes that were connected to major themes by word association and context within the text. Common themes were discovered across transcripts during iterative and reflexive content analysis that was ongoing throughout the interview process and thereafter. Final themes were identified after completion of all interviews and after holistic comparison of interpretative and original text-based data across all participants. Subsumed themes were organized under final themes based on context and language association found within original rich text of participants' own words.

Many themes surfaced in literal fashion, which were common across transcripts, during the interview and the analysis process. The appearance of themes that clearly stood out allowed the employment of a low inference approach to content analysis and the re-presentation of findings, which were supported by multiple lines of rich text in participants' own words. Some themes were discovered after employing a low interference form of interpretation, which is acceptable in qualitative descriptive methods (Sandelowski & Barroso, 2003). One member of the analytic team was known to be primarily a phenomenological researcher. Her themes, although more interpretative, were not heavily phenomenological and were classified as qualitative descriptive interpretative findings. These interpretations did inform both major and minor low inference themes. Themes expressed as phrases or sentences during the iterative process were subsumed under simple themes of low inference, which were sought during final analytic iterations.

Low inference themes that stood out as major concepts were *privacy, family, trust, being watched, features and functionality, human touch, cost, and timing.* Each of these major themes subsumed several other themes, which were common across transcripts and were linked via participants' language to the major themes. For example, generally participants who spoke about privacy also referred to independence within the same line or paragraph as seen in this response:

> *Since we are private it is a new concept to think of someone/something*
>
> *monitoring our habits and taking care of us. On the other side of this, the idea of*
>
> *being independent also helps with the acceptance of the new technology.*
>
> *(Belfaire, 500-502)*

All subsumed themes followed a similar pattern. A summary presentation of organized themes can be found in Appendix C.

Privacy

The concept of privacy surfaced in every interview (except one) almost immediately after the introduction of motion sensor monitors and computer-engineered algorithms that allow machine learning. Three views on privacy that emerged, and which frame the discussion, were *privacy as modesty, private by nature,* and *privacy normed.*

Privacy as modesty was portrayed across transcripts as statements that regarded being watched while in the bathroom or during times when participants were not fully clothed. For example,

> *Monitoring would be OK if there was some way to provide for privacy. I would*
>
> *not want monitoring of me bathing or going to the bathroom. Is there a way*
>
> *around this barrier?" (Social, 294-301)*

Furthermore, female participants in this study had a higher rate of indicating concern regarding privacy as modesty than male participants. Three women specifically stated they had an aversion to being monitored in the bathroom, while two men specifically stated they had no problem with monitoring and/or use of cameras in the bathroom. Social's statement above regarding "bathing or going to the bathroom" is an exemplary female statement regarding concerns with modesty. Male statements may be represented in statements made by Emeritus and Howie:

> *For me, if your HAL would watch me taking a shower, I would be happy; for I*
> *might fall down in my doddering old age and need help. If someone or something*
> *is watching over me, it would make me feel safe. (Emeritus, 2109-2911)*

Howie indicated: "*Video is OK. No point in sand.*" (293)

> *Private by nature* was seen as a form of privacy that involved a general way of life in which one maintains a significant part of personal life that is considered private, a side of life that is not shared with others, but where others may be called upon in time of need. For example Belfaire and Friday indicated:

> *Since we are private it is a new concept to think of someone/something*
> *monitoring our habits and taking care of us. (Belfaire, 500-501)*

And

> *...I have a large private self that is hard to share. I do understand learning*
> *general routines, but some portions of routines are extremely private. (Friday,*
> *483-485)*

Privacy normed refers to the idea that a group view (societal or cultural; socially constructed) exists regarding what individuals do, or not do, in private. Some participants

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expressed concern that the smart home would misinterpret their actions or motions because they perceived that they personally engaged in activities, in private, that might be outside of what is considered normal "private" behavior in society. The perception that there may be a normal way to behave in the privacy of one's own home appeared several times across many transcripts. The Professor wrote:

> *Another problem with technology that learns your habits is that I really like novelty and change my habits every few months. For instance, I live in a three bedroom house and change bedrooms with the seasons. I also use all of my bathrooms so the showers, sinks and toilets get regular use. I sleep on the floor, not on the bed and carry my bedroll from room to room depending on whether I want to read, watch television, or listen to an audiobook. I'm sure there is some pattern to my behavior but I really like to change it up. I can imagine that pattern recognizing technology would work well for people who have more predictable habits. I wouldn't want the technology to influence my behavior to the point where I feel I have to perform routinely for the sake of the monitoring system rather than just behaving normally because "normal" includes frequent changes in routine. (The Professor, 400-411)*

Another example is seen in the conversation with Friday.

> *...again for privacy concerns. In general areas of the house ok, not the bathroom, bedroom, or closet (nobody watches me brush my teeth or dress, for example). Possibly if there was a way to "pull the shade" for a short time to allow for private moments it would make me feel more comfortable... (Friday, 488-491)*

Friday later indicated: *I could actually clean my closet (7x12') and put a chair in there to escape (764).* Friday's statement regarding time spent in her closet for the purpose of "escape" instead of dressing or undressing, which might be considered a more "normal" closet related behavior by society, and which certainly involves more motion and less time, is a recurring example of her concern that she partakes in private behaviors that may be misinterpreted by the smart home.

Independence.

Older adults in this study considered independence a desirable trait, which directly related to aging in place. For example Friendly stated,

> *If I had the smart home technologies mentioned in your summary above my mind would be put at ease. It would be very comforting to know that if I fell or passed out these actions would be monitored and help would be on the way! I would like to remain in my apartment and live independently as long as possible. (349-52)*

Independence (also referred to as self-reliance) was a theme that was closely connected to the language of privacy. A synergy existed between these concepts; the loss of one seemed to indicate a potential loss of the other, and vice versa. Chewie's statement represents contextual and synergistic linking of independence and privacy.

> *As more people in our society are aging and becoming less self-reliant I think the concept and application of modern technologies certainly have their place in the home particularly of those who are living alone. However, these employed high technologies should be specific to the needs of the individual without over scarifying their privacy. (Chewie, 262-265)*

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Perceived levels of independence were juxtaposed with perceived levels of need. There was a perception that smart home monitoring would need to be designed to meet the various intersecting levels of independence and need. One participant indicated:

> *Right now, being (still!) of right mind and able to move, the independent Dutch streak in me would say "Get lost, don't bother me, don't need you!" But of course, a time may come when we will need you and your smart home technology! What form that it needs to take, or may take, is still happily, for us, shrouded in the future, but worthy of our thoughts! (Emeritus, 1315-1321)*

A perception also existed, and in some cases an acknowledgment, that more invasive monitoring may be needed over time to maintain desired levels of independence. Friday stated,

> *It is my understanding that they would "observe" the person(s) in the home and notify a designated individual if there is a significant change in the routine of the person. I would hope they could evolve as the person in the home "devolves"— needs more monitoring. (222-225)*

The increasing invasion of privacy or *evolving* was expected and accepted by a majority of participants, however, two participants did *not* find this acceptable.

Connected to the idea of levels of need versus levels of monitoring, a concept surfaced regarding late stage disability, aging, and end of life care. There was an acknowledgement of a point where physical care of the body would be needed and it was perceived that the smart home would not be ideal for care during this stage. This concept will be discussed further under the theme *Human Touch*.

The idea of individualized technology was also connected to privacy and independence. Older adults perceived that a one-size-fits-all monitoring system would not provide maximal

protection with minimal invasion of privacy. There was a perception that a system designed for the general population might have monitoring features and functional interventions that were not necessary for a particular individual and therefore would expose or even exploit that individual in ways that were not necessary. An example of this perception is seen in Chewie's statement, "*these employed high technologies should be specific to the needs of the individual without over scarifying their privacy" (264-265).* Chewie further reinforced his point by stating, "a*s I mentioned in my earlier response, technologies should be individualized to one's need and want" (468-469).*

Older adult participants overwhelmingly were interested in maintaining their independence as long as possible, although two felt they could fulfill their desire to remain independent by living near family, or even in a nursing facility. Navy's preference not to be monitored in his own home with smart technology but instead to live with or near family, or in an assistive facility, may exemplify the preferences of other older adults who do not want in-home monitoring. Navy stated,

> *Your smart houses may be a good thing for a lot of people, but there may be some that will think it an invasion of their privacy …as long as we are close to our daughter, I know she would provide any assistance she could even if it meant putting me in an assistant living facility. (235-237)*

Pride and Dignity

Pride and dignity were associated with privacy and independence in the context of individualized technology. The language of pride was expressed in the texts as dignity, and was contextually connected to privacy. For example, "*personal dignity and privacy must be taken into account" (Chewie, 92).*

Concepts of pride and dignity as a combined concept were induced from the transcripts, meaning they were not found directly in-text, but instead were found across all analytic team members' interpretations of individual transcripts. Across several transcripts, removal of independence was closely related to language indicating a perception of decreasing dignity, something that negatively impacted one's pride. Independence was a source of pride and the opposite was true too.

One participant clearly expressed a concern with being judged by the smart home and stated,

> *I imagine a group of strangers looking over my shoulder. For example, if I've been sitting in a chair reading for two hours, will they think I'm lazy? If I put ice cream in my freezer, will I feel uncomfortable eating it? As they collect this data, will I get intrusive messages about my diet and physical activity level? Reminders to spend more time on the treadmill? (The Professor, 379-383)*

Incorrect or inappropriate judgment may break down pride and dignity and is, therefore, something to be avoided.

Cameras.

Use of cameras for monitoring was explored with participants. Perceptions on privacy with the use of a camera varied greatly. Most participants preferred monitoring via ambient sensors only. Several participants indicated: *"No camera" (Chip, 302),* while others indicated: *"No, I am not afraid of a video camera" (Bangkok, 436).* Some participants indicated they would agree to cameras in the main areas of the home but not in private areas. Main areas of the home were considered the kitchen, living room, entry, and hallway. Private areas were mentioned as the bathroom and bedroom closet. Some participants considered the bedroom as

private while others did not. Differentiating locations within the home where monitoring would

be acceptable or not may indicate a perception that levels of privacy exist. For example Chewie

stated,

> *If the camera is used in some locations such as living room, kitchen and hallways*
>
> *it is not a concern to me. But, there again, each situation would have to be*
>
> *evaluated and the occupant should be the one to make a decision on how and*
>
> *where to monitor. Monitoring in silhouette definitely desensitizes some stigma of*
>
> *losing personal identity for some people. I personally would prefer that as long it*
>
> *can accomplish the same objective. (397-401)*

Friendly's statement also indicates there may be perceived levels of privacy.

> *I would like to have others respect my modesty and at this point in my life I would*
>
> *like to have control over when the video camera is active. If I am dressed I*
>
> *wouldn't mind talking to someone (such as a doctor or my family members) using*
>
> *a video camera. However, I would be uncomfortable if a video camera was on*
>
> *filming me running … nude from the bathroom after showering to my bedroom!*
>
> *(683-689)*

Several participants indicated they would like to have monitoring outside of the home to

improve safety. These participants recognized the need for monitoring in and around the garage,

patios, sidewalks, and the barn. Language regarding privacy and cameras outside the home was

not as strong as language regarding privacy inside the home, and language was strongest

regarding private areas within the home. Regarding the use of cameras versus sensor monitoring

inside or around the house one participant indicated: "*I spend very little time in the house so I*

would think a motion sensor would be all I need [inside]" *(71young, 430),* while another

participant indicated that *"cameras in my private spaces would result in refusals" (Friday, 517).*

Silhouettes. If a camera were used as a component of smart home monitoring, images containing only a silhouette were overall preferable to non-silhouetted images. For example, participants indicated: "i*f a video camera shows only an outline I wouldn't care" (71young, 254)* and *"I would probably be more comfortable with just an outline" (Friendly, 693).*

Trade-offs.

Several participants perceived there were trade-offs to adoption of smart home monitoring. In exchange for safety, convenience, and health monitoring one may be exposed to technology that could go awry, technology that is not individualized enough, and security breaches such as identity theft or selling of personal data for marketing purposes.

Some participants brought up concerns over whom had access to the data and how it would be used. For example Belfaire indicated: "*my trust factor is lacking and I am wondering how this information will be used in the future by companies" (570-571)* and "*I would feel better if restrictions on data collection could be somewhat restricted in how it is used" (578-579).*

Decisions regarding adoption would involve weighing the pros and cons, which would include considerations regarding desired product functions and dignified lifestyle, and personal views on privacy (modesty, nature, normed expectations), levels of privacy (location of camera, silhouette, individualization of product features), and security (safety and identity).

Family

References to family included language about living alone or not, physical location and distance from the nearest family member, decision-making, and the idea of being a burden.

Overwhelmingly, participants indicated that family opinions were an important influencing factor of adoption.

Several participants felt that living alone would increase one's motivation to adopt a smart home and this sentiment was irrelevant to whether they were currently living alone or not. Friendly and Elle both lived alone at the time of their interviews. Friendly stated, "*Because I have ALS and syncope and I live alone I find myself more motivated to learn about smart homes and assistive devices in general*" (458-459). Elle indicated living alone was a motivation for her as well stating, "*I do consider myself as living alone, and I'm sure that the motivation to use technology is because of this*" (442-443). Romaine, who did not live alone (lives with his wife), also indicated that aloneness would impact an adoption decision stating, "*If I were not living alone I would think that I would not need such technology since my wife would be there to respond in an emergency*" (Romaine, 375-376).

Many references to family specifically regarded the relationship between the older adult and their children. Two subthemes were identified as related to the parent-child relationship: not being a burden and decision-making. A consistent theme across transcripts regarded the aging adult and their desire to not be a burden on their children. All participants were asked whether they had children and how often they visited with their children in person. Consistently, these questions evolved into a conversation about not wanting to burden them and how the smart home may help in this regard. There was a perception that a smart home capable of helping the older adult remain in their home longer while decreasing the naturally increasing burden on their children, was *a good thing*.

Trust was a related concept noted in the context of conversations about family. Participants who were interested in the opinion of their children regarding adoption expressed

more trust for the opinion of family than non-family, which may include healthcare professionals such as nurses and certainly includes data management companies. The Professor indicated:

> *Further, who are these strangers monitoring my home? If I leave to visit family*
>
> *for a week, will they rob my house because they know I'm gone? I'm not really*
>
> *paranoid, but I do know that these things happen. I would be more comfortable if*
>
> *the person collecting data and monitoring me was -- me! Or, one of my daughters.*
>
> *(383-387)*

Role expectations were identified by certain participants as important to the question of adoption and the idea of being a burden. Role expectations regarding a child caring for the aged parent surfaced. Role expectations regarded differences in generational expectations, and culture and ethnicity. One participant highlighted differences in generational expectations while another regarded cultural expectations. Friday highlighted the existence of generational expectations.

> *My husband and I lost all 4 parents in the last 16 years and remember the*
>
> *concerns we had about aging parents and would like to spare the kids that stress*
>
> *as much as possible. (499-500)*

Chewie highlighted the existence of cultural expectations.

> *In the traditional Chinese culture, one is to revere and take care of your elder*
>
> *parents until they are gone. I took care of my parents in my home with three*
>
> *generations under the same roof for years against all prevailing social norms that*
>
> *some times questioned and ostracized such practice.   However, personal*
>
> *situations change over time, these values have long been diluted and diminished*
>
> *and I do not expect my next generations will ever embrace them. (458-464)*

Trust

Older adults in this study generally lacked trust regarding smart home monitoring and management of associated data. Most participants had little or no knowledge of smart homes, monitoring, or actions that could be taken by the home, before receiving information from the researcher as a part of this study. Both knowledge and trust levels were low across multiple participants and there were no participants where knowledge and trust were both high or where knowledge was low and trust high. Twenty of 21 participants admitted knowing very little, if anything, about health-assistive smart homes for older adults. There were no participants who knew about smart home monitoring and machines that learn motion patterns and that can determine potential health and safety problems and take a purposeful action on behalf of the older adult. Rogers' (2003) proposes that innovations diffuse slowly in the beginning due to lack of knowledge and lack of trust for the innovation. Rogers (2003) also indicated that trust develops after the majority has evidence that the innovation will not create social and financial failures. Therefore, in-text observance of lack of trust was not surprising because of the newness of a technology.

Trust and the newness of smart home monitoring included language about the dangers associated with a technology designed to monitor health and safety, but that may not work correctly. Language found in analytic team members' interpretative documents included terms such as *tech gone awry, safety and safety's antonym danger,* and *tech failure.* Participants expressed concern with trusting the technology:

> *Sometimes my computer will not let me go on unless I do something it wants me to*
> *do, but I do not want to do. So I reboot! Now suppose I were supposed to take*
> *my meds at a certain time, but I got off schedule. I would not want my home to be*

so intelligent that it would, for example, refuse to open the refrigerator door, until

it "saw" me take my meds. Or, set off an alarm that I could not override." (Ray-

of-Light, 323-329)

And

The two astronauts in 2001 were quite happy to talk and play chess with HAL

during their long and lonely journey to Jupiter. But… When HAL screwed up and

took control, things fouled up fast! (Emeritus, 2760-2763)

Concerns with possible misinterpretation of data may have informed perceptions on trust.

Participants were generally quick to imagine the potential impact on their daily activities or

quality of life, should the smart home take an incorrect action based on misinterpreted data. An

underlying assumption existed that a human would not misinterpret as easily, which may indicate

a preference for care by humans.   One participant who stood squarely against smart home

monitoring indicated:

…as long as we are close to our daughter, I know she would provide any

assistance she could even if it meant putting me in an assistant living facility.

(Navy, 235-237)

A lack of trust in big companies that collect and mine personal data surfaced as well.

Several participants ask questions such as, "Who will see my data?" and "Where will it go?" and

"Will they steal my identity or rob me at home?" Participants with whom this theme evolved

extensively were asked which types of companies they would trust. A timely article in TIME

Magazine about future smart homes, which was seen by multiple participants, informed the

discussion of trusted (versus not trusted) companies. Four participants embarked on a discussion

about smart homes and the companies mentioned in the TIME article. This discussion led a line

of questioning that regarded trust, data mining, and large data warehousing companies. Responses to this line of questioning varied greatly and were without pattern, but every response gave rationale that included descriptions of previous experience, either good or bad, with a stated company category. Categories presented in this line of questioning were taken directly from the TIME article and were presented to participants in email text as

1. Big Tech companies (like Google, Microsoft, Apple, GE, etc.)

2. Telecom companies (like AT&T, Verizon, Comcast, etc.)

3. Retailers (like Lowes, Home Depot, Costco, etc.)

4. Home security companies (like ADT, LifeShield, Protection 1, etc.)

5. Medical alert companies (like Life Alert, LifeFone, Alert 1, etc… the "I've fallen and I can't get up companies already in existence)

6. Start-up tech companies (with unfamiliar names but who do exist like SmartThings and Revolve)

7. Companies connected with university research teams

In the context of this conversation, two participants brought up the recent media coverage regarding hacking. It should be noted that two newsworthy hacking events occurred during this study, which may impact study findings: (a) hacking of Target ® credit cards and (b) hacking of Sony pictures. Two other major newsworthy events that occurred within one year prior to this study and which may have impacted this conversation were: the case of Edward Snowden and the stealing of personal healthcare data from the Veteran's Administration by an employee.

Power and powerlessness. Power differentials were identified as a theme subsumed by the theme of trust but worthy of particular acknowledgement due to the sensitive nature of the topic, the pervasiveness noted in the text, and the known existence of a power differential

between nurses and patients (Powers, 2013). According to Pipher (1999), a feeling of powerlessness is not an unusual finding among older adults, especially those who are concurrently experiencing a chronic illness.

All members of the analytic team observed powerlessness in the texts. This theme appeared in both overt and subtle ways. It was first noted with participant responses to initial email exchanges when the participant response was accompanied with statements such as "*will do the best I can" (Sister, 50)* or "*I will try to keep up" (Apple96, 180).* It was also observed in one participant who needed verbal reassurance that she was doing fine responding to questions in email format.

The concept of powerlessness also appeared within the text regarding potential adoption specifically of "monitoring" and the smart home "taking an action" on behalf of the resident living within the home. First, several participants indicated they would need to discuss this option with their children before they would make a decision to adopt such a technology. The need to include children in the conversation may indicate that the older adult does not feel powerful enough (e.g. knowledgeable enough to wield the power of information) and make an independent decision or that the older adult does not feel powerful *alone* in answering to healthcare professionals. The lack of knowledge, and therefore lack of power, may also relate to the technology literacy gap between many older adults and younger adults, and between gerontechnology literacy and the technology older adults may encounter, such as smart home monitoring. Second, several participants indicated a concern with the functionality of the smart home and whether it would work as declared or whether it would take over their home and begin demanding unreasonable actions of the resident based on misinterpretation of private behavior patterns. Participants declared a need to be able to trust the technology before adopting, and this

trust was tightly linked to advice from their children.

Being Watched

Being watched is a theme nuanced with the idea of *being seen*. The language around the word "watched" in the text differs depending on the context. For example Emeritus refers to being "watched" as a comfortable action:

> *But Lo! What if I become senile or invalid in my coming old age? There is no telling how needy I may end up being! If then there could be a technology that could help me to continue to be independent longer, <u>yet watched over,</u> I would certainly be open to that. (685-689)* (Underlined emphasis by participant.)

Further interpretation across transcripts, which alludes to Emeritus' desire to be *watched over,* uncovers a thread regarding older adults desire to been seen.

> *"If I had the smart home technologies mentioned in your summary above my mind would be put at ease. It would be very comforting to know that if I fell or passed out these actions would be monitored and help would be on the way! I would like to remain in my apartment and live independently as long as possible." (Friendly, 349-352)*

The Professor uses the word "watched" and likely means "watched" as opposed to being seen.

> *As a generation, I think we all have strong resistance to being watched in our homes. Baby-boomers are also more resistant to being dependent on our children, so finding a compromise that allowed us to stay at home without being watched by strangers or a burden on our children would be very positive. (588-592) The people I talk to are getting weary of being watched and having their personal information accessed. (606-607)*

66

Bikler adds:

> *A little disturbing at the thought of someone or something watching me at all*
>
> *times but great ideas for keeping people alive. (346)*

If safety is to be the result of smart home use, monitoring is required. Monitoring may be perceived as being watched. Consider The Professor who states, "*It honestly sounds 'creepy" (333)*. However, monitoring may also allow the older adult to be seen in a way that "*would be very comforting" (Friendly, 350)*. Belfaire offers a different perspective, which includes elements of forward thinking and is neither for nor against monitoring. This philosophy may best represent Rogers' population of majority adopters.

> *I think everyone is getting used to our loss of privacy. We now have so many TV*
>
> *shows such as big brother, survivor and many more which I have not watched but*
>
> *my kids do. This I think makes it more acceptable for the generations coming up*
>
> *behind us to embrace the smart homes. (506-9)* and *I do feel that if I thought I*
>
> *needed the help or if another family member thought I needed help I would be*
>
> *receptive to the smart home learning my habits." (426-432)* and *I would definitely*
>
> *take a close look at the smart home (without cameras) as a long term solution.*
>
> *(Belfaire, 436-7*)

Other participants brought up the idea of big brother, creepiness, and feeling like you might be on a reality television show too:

> *In the 1950s there were "aliens from outer space," flying saucers, and Big*
>
> *Brother watching you. Today we have hackers that can get into your smart*
>
> *devices. They can find out you live alone and come and rob you! (Friendly, 819-*
>
> *821)*

And

"Yes, I think that big brother already knows enough about me." (Navy, 235)

And

The idea that my movements might be monitored with sensors and cameras

would make me feel like I was on a reality television show. Even if I adapted to

them, the thought that someone might be watching my every move would make

home seem like prison. Further, I find it very hard to trust that this information

would be kept private and not available over the internet, making older people

are targets for those who could use information about habits and activities to

take advantage of them. It honestly sounds "creepy." (The Professor, 327-333)

A hesitancy to adopt a solution for aging safely that feels like being watched exists. This

hesitancy is observed in-text with the language of "if." Several participants indicated they would

be willing to try smart home monitoring *if* their children recommended it or *if* it would relieve

the burden on children, *if* there were no cameras, *if* there was a need, *if* it was financially

feasible, *if* data was secured, and *if* the smart home functioned as promised.

Human Touch

Part of *being seen* and not *watched* involved the idea of human touch. Some participants

directly questioned whether the smart home would eventually "replace" humans or whether it

would be used "in addition" to human caregivers. Concerns regarded the extent to which the

smart home would provide care and whether smart home care was suitable only in the early

stages of decline (like the need for reminders), or whether advanced care needs involving the

physical body would be featured as well. Participants stated they would like a home that would

"*detect when something is boiling over on the stove or smell when a frying pan is too hot and*

turn of the burner or turn off the toaster before it starts to burn" (Romaine, 142-144), or help

them *"not to have to repeat my medical history with each appointment" (Belfaire, 298).* Other

participants indicated they would like the smart home to provide:

> *...a way to warn one that there were objects in the path that one did not see to*
>
> *prevent falls from tripping over things, or injuries from bumping into things. But*
>
> *I cannot think how that could be done. (Ray-of-Light, 174-176),*

or provide *"security, heat, health monitoring and many other systems in place at my home if I*

needed it" (Social, 182-184). However, even those who admitted they would be willing to try a

smart home made statements of concern regarding the potential lack of human touch when using

a smart home.

> *As portrayed in the movie "Robot and Frank" which takes place in the future I*
>
> *could have a robot helper to cook, clean, and keep me company. But I shudder at*
>
> *the thought! Hopefully there will be enough human caregivers to provide us with*
>
> *care in a loving, caring way. (Friendly, 516-520)*

No participants indicated an interest in having a robot provide care for the physical body such as

helping with dressing, bathing, feeding, or getting up from the floor after a fall.

Also included within the context of human touch were the concepts of comfort (physical

and emotional), trust, and accuracy of smart home interpretations of observed motion patterns.

Appropriate care actions and personalization of care were associated with human touch more

than smart home interventions. Comfort was contextualized as human (not robot) and was a

recurring thought for The Professor who began the interview by saying, *"Smart home*

technologies are able to adapt to a person's lifestyle and create a home environment that is safe,

comfortable, and seamless (213-215), but later expressed her concerns with being

uncomfortable, which included a feeling of distrust about being misinterpreted and misguided by the home. Her final exclamation reflects her preference for human care and comfort, especially if the human were her child.

> *I imagine a group of strangers looking over my shoulder. For example, if I've been sitting in a chair reading for two hours, will they think I'm lazy? If I put ice cream in my freezer, will I feel uncomfortable eating it? As they collect this data, will I get intrusive messages about my diet and physical activity level? Reminders to spend more time on the treadmill? Further, who are these strangers monitoring my home? If I leave to visit family for a week, will they rob my house because they know I'm gone? I'm not really paranoid, but I do know that these things happen. I would be more comfortable if the person collecting data and monitoring me was -- me! Or, one of my daughters. (The Professor, 379-387)*

Features and Functionality

Older adults in this study expressed a great interest in the features and functionality of the smart home. A main reason given for willingness to participate in the study was a desire to know more about smart homes and the opportunities for aging in place provided by this technology. Interviews included a somewhat lengthy discussion of the many features under development at Washington State University College of Computer Science and Engineering. Participants were willing to prospectively consider the smart home and ambient monitoring. Desired features were stated in practical terms, such as medication reminders and turning the stove off.   A literacy gap existed between older adult participants in this study and the technology they were asked to prospectively discuss. Participants reported some features they perceived they might like or need, should they ever use a smart home. A complete list of

desirable features mentioned by participants across all transcripts can be found in Appendix D.

The only concerning feature mentioned throughout the study was the potential use of video cameras, especially in private areas of the home. Concerns were otherwise directed at functionality and regarded whether the technology would work as expected and could be relied upon to provide safety and security and to not exploit.

Safety.

Safety was a concern for all participants without exception and the desire for safety was a main factor influencing prospective adoption decision-making. The desire to remain safe during the aging process was presented as a reason to adopt a smart home. Safety was the primary concern stated by participants, which often included descriptions of injuries related to falls such as "*I think that falling and breaking a bone would be a blow to your confidence which you would never overcome" (Elle, 583-584).*

When asked how he felt about being monitored and having a smart home learn his daily habits, Romaine also brought up safety stating, "*If I were living alone I can see that for my safety this would be a good thing. I think that those who live alone are often concerned about this issue" (331-332).* The desire for safety while aging in place could supersede concerns with invasion of privacy. FarmerG expressed this when she said:

> *I'm still not interested in a camera as I feel like its a violation of my person. I could be persuaded to use smart home monitoring if I could stay in my home [but] at this point no monitoring would be acceptable. [However], as a last straw I would accept some monitoring to remain in the home. (198-201)*

Social's statement supports FarmerG's, which alludes to prioritization of safety over privacy:

> *Some of my patients might be willing to do the monitoring and smart technology if*

there was no other safe way for them to continue living at home. (305-306)

Quality of life.

Comfort home features were seen as directly related to quality of life. Although convenience considerations surfaced in some discussions, convenience was not highlighted in the text as more important than comfort and safety. Quality of life was expressed in terms of the comfort and safety a smart home could provide. Should the smart home function as designed, quality of life was seen to likely improve, especially if this meant one could remain at home. However, if the smart home malfunctioned, there was a perception that one's quality of life would deteriorate quickly and may even deteriorate to a point below the pre-smart home quality of life level. This insight was observed on two levels during the study. Level one was observed in statements regarding the use of computers, Internet, and email for the interview. More than one participant suffered technology failures while attempting to respond to interview questions and their statements regarding such failures were telling.

> *Last week on Tuesday our phone went out, the TVs stopped and my computer*
>
> *fried totally. Comcast came out, fixed it fast but could not explain. Some weird*
>
> *surge, maybe lightning? Just yesterday I got my computer back out of the shop*
>
> *and I spend all day to restore and salvage what I could. (Emeritus, 443-448)*

And one week later Emeritus sent the message, *"Well, I am still struggling out of my bewildering computer crash last week, but I do the best I can! (747-748)*

The second level regarded perceptions that the smart home, as a technology, could go awry. Concerns specifically regarded potential breaches in safety, residential onsite security breaches, data breaches or identity theft, and misinterpretations of motion patterns that would lead to the smart home to take inappropriate action on behalf of the resident living within. For

example, there was a mention of the garage door opening in the night unbeknownst to the resident, or a complex failure that would make the resident want to *reboot (Ray-of-Light, 326),* or the home not opening the refrigerator because the resident had not yet exercised for the day. One participant, who spent his career in engineering and computer science, expressed specific concerns regarding the potential for an artificially intelligent home to spin out of control, such as the intelligent computer character HAL in a 2001 movie that became paranoid (based on collected data) and attempted to kill the human astronauts on board the spaceship.

> *...the main reason why I brought these two movies to your attention is that we are discussing Smart Homes. Amazing, how Arthur Clarke, already in the seventies, had the insight to create HAL! You will see how HAL, in 2001, interacted with the crew on a personal basis, and then screws up royally!*
>
> *I have mentioned before to you that passive and active computers are a very different breed!*
>
> *This laptop I am typing on right now is still totally passive. It does what I tell it to! (At least most of the time) but it never takes independent action!*
>
> *HAL does, and so will and must your eventual Smart Home computer. (Emeritus, 2567-2576)*

Participants expressed concern that a manmade object would fail at some point and shared that engineers and computer scientists developing such systems needed to embed safety features whereby breaches would be minimized or omitted.

Cost

Cost of the smart home was seen as a potential barrier to adoption, including the initial purchase price and costs associated with ongoing monitoring. Several participants indicated that

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they were on a fixed income and that paying for such a technology would likely be above their

financial capabilities. For example:

> *The cost of home monitoring might also be prohibitive to many people. This*
>
> *would be used to postpone taking advantage of the technology, even if there were*
>
> *other reasons, including fear. (The population you would be targeting are often*
>
> *on a limited income, and if they are, it would be a good excuse to not take*
>
> *advantage of the help, when the real reason might be fear or pride….) (Elle, 477-*
>
> *482)*

And

> *The only point I can add as far as not using the concept is price. I will go it alone*
>
> *if it is too expensive. It may not have been mentioned yet but I am also a*
>
> *cheapskate. (Bikler, 417-419)*

Elle ventured to share her thoughts on what such a technology might be worth financially. She

was the only participant to do so and therefore the following thoughts cannot be supported with

other text. Nevertheless her "guess" is enlightening.

> *The advertised home monitors sell for about $30 a month. There is probably a set*
>
> *up charge. I don't think this is expensive, but if the person was on a fixed income,*
>
> *that might be a lot. Many times this cost is paid by a son or daughter, when they*
>
> *can't be near the older relative. The set up charge for smart home monitoring*
>
> *would include cameras, which the advertised ones do not have, and some*
>
> *automatic devices for switching off heat sources and possibly water sources. In*
>
> *addition, there would be record keeping, probably by computer, but I would take*
>
> *a wild guess and say that the set up charges would be at least $2000 and record*

keeping and notification would have to cost $100 a month, and in all probability

much more. I have no experience in home security systems' cost, but the home

monitoring would be more, I'm sure. (Elle, 515-526)

Finally, a few of participants shared a concern that this type of care (smart home

monitoring) would only be available to the rich and that equality of care for *all* older adults was

an important consideration. Payment by Medicare was seen as a criterion that would imply equal

access.

Timing

The timing of the introduction of smart home monitoring surfaced as important to

adoption. Introduction of smart home monitoring at a younger age (early older adulthood) was

seen as better than waiting until there was an actual need, which was perceived as a less ideal

time to introduce a complex and potentially invasive technology. This position was juxtaposed

with an expression across transcripts of "*if I thought I needed help… I would be receptive….*"

(Belfaire, 431) Multiple participants indicated they were not currently in need of such a

technology and would therefore not be receptive at this time. For example:

I suppose at this point in my life I am under the impression that I am way too

healthy to have an expensive system installed in my house. (Bikler, 410-411)

And

Of course I do not want any of that wimpy stuff right now! I stand erect and proud

and I can take care of all I need to take care of! Lucky me!

But……. Then there is that Leviathan, looming! (366-368)

Influence of Culture on Adoption

Answering the question "How do older adults' perceptions of their own socially constructed values and beliefs influence their decisions to adopt or not adopt smart home monitoring?" remains somewhat elusive. Many participants had difficulty with the line of questioning that regarded "self-identified" culture as seen in the statement by Emeritus "*Frankly I have no idea!" (909)*. Additional coaching (further explanation of what the researcher meant by self-identified culture and rewording of the question) was necessary to help several participants understand what was being asked. Some confusion ensued because the question of culture regarded the neoteric conceptualization of culture as self-identified. The "self-identified" reference to culture proved quite different from the commonly used and accepted reference to culture as race/ethnicity or country of origin, which may have been how the participants usually conceptualized the topic. The additional coaching, however, resulted in rich responses in which participants' described perceptions of their own socially constructed values and related these to a potential decision to use smart home monitoring or not. Nevertheless, two potential participants declined answering this question and one participant declared culture irrelevant to adoption of smart home monitoring stating,

> *I do not think one's cultural value has any impact on either the acceptance or the use of smart home technology in the US. It is simply a fact of using proven and available technology to enhance a senior to continue on with his/her independent living preference as well as to age in the familiarity of one's home. The only objection to this technology could only be from someone who would rather be "taken care of" by others, be that family members or hired hands. (Chip, 374-379)*

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Most participants simply partook in the conversation about culture without making statements that regarded culture was an influencing factor or not. Five participants declared that culture definitely would influence older adults' decisions on whether or not to adopt. One such participant indicated: *"Culture definitely has a role in a person's decision to use or not use smart home technology" (Social, 418-419).*

One participant, after initially declaring, "*I am not really sure how my 'Cultural Values' enter into this picture!" (Emeritus, 1328-1329)* later decided culture would influence some aspects of adoption. Emeritus went on to richly describe the influence of culture on privacy (see below), a major theme of this study.

Privacy and Culture

Emeritus on privacy and culture:

These are indeed important concepts worthy of consideration in this Smart Home study. Yet, as I see it, these are not simple cut and dried issues. I am giving this a lot of thought.

In my view, what things constitute 'PRIVACY', are definitely both cultural and very personal things. Privacy is definitely tied up with intangible personal values, such as decency, properness, shyness, embarrassment, but also with the local culturally acceptable standards which may vary from culture to culture, and even within one culture. These standards also vary from time to time and are subject to the 'Zeitgeist'.

When I grew up in Holland it was deeply embarrassing to be seen in your underwear, now the Dutch (and the European tourists) all walk totally nude on the beach, even inside restaurants, and think nothing of it.

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Don't do that in the U.S.A. or you get thrown in jail!

A totally different aspect of 'PRIVACY' comes from the need of some people to be on their own and not be bothered. Remember the famous quote from Greta Garbo, the famous movie star, "I want to be alone".

My Dad was the same way! When he got older, he simply did not want to be bothered. Too proud to be monitored, too proud to be told what to do, what to eat, when to take his pills or his vitamins.

His favorite saying was "Dat zoek ik zelf wel uit", which is Dutch for "Leave it to me, I'll figure it out".

But then, thank heaven, not all of us are stubborn Dutchmen.

Other cultures may well have very different attitudes.

So: how to account for such personal differences on privacy, I do not know, but it must be a consideration in your Smart Home design.

For this whole study, just today, working on this PRIVACY issue, I came across a Time magazine of a few months ago which I picked up randomly at the Gym we go to.

It fell open right at a major three page article titled

PRIVACY IS MOSTLY AN ILLUSION

Time Magazine August 2, 2013

How is that for serendipity. (2408-2447)

Privacy normed.

The concept of misinterpretation of motion patterns observed through ambient in-home monitoring was a concern expressed by multiple participants. Concerns with misinterpretation

may regard the ideas that a correct interpretation exists. Analysis of examples like *"As to my*

personal habits. I could actually clean my closet (7x12') and put a chair in there to

escape" (Friday, 764) found that such statements were often accompanied with questions of how

the smart home would interpret such an action. The context revealed an underlying assumption

that normal private behavior exists. Concerns with misinterpretation may then be grounded in

the assumption that the smart home would take action based on information that is assumed by

society as normal private behavior, but that indeed is not true for an individual. For example,

Friday's smart home might think she lost consciousness in the closet when in reality she is just

sitting in there to escape the difficulties of daily life!

Another example of the underlying assumption of a normed privacy is seen in the

following discussion about smart homes learning the daily motion patterns of a resident. The

statement, *I sleep on the floor, not on the bed (The Professor, 403),* reveals that people engage in

behaviors in the privacy of their own homes that they perceive as potentially outside of a normed

set of behaviors. The Professor is hinting at a recognition that people typically sleep on a bed.

> *I really like novelty and change my habits every few months. For instance, I live*
>
> *in a three bedroom house and change bedrooms with the seasons. I also use all of*
>
> *my bathrooms so the showers, sinks and toilets get regular use. I sleep on the*
>
> *floor, not on the bed and carry my bedroll from room to room depending on*
>
> *whether I want to read, watch television, or listen to an audiobook. I'm sure there*
>
> *is some pattern to my behavior but I really like to change it up. (The Professor,*
>
> *401-407)*

Recognition that perceptions exist regarding a group-normed set of private behaviors that

are socially constructed (e.g., it is normal to sleep on a bed roll in some cultures of the world) has

implications for the use of artificial intelligence technology, which norms behavior of the monitored person to that person and not across persons with assumed patterns based on group norms. Implications for use of artificial intelligence will be discussed further in Chapter Five.

Privacy in the United States.

Historically, across many venues, United States' citizens have been described as independent and private and the nationalistic idea that persons have a right to privacy may have informed the discussion on privacy and culture. Many older adult participants in this study revealed themselves as private. References to privacy were contextualized on the surface as *privacy as modesty* and/or as part of one's *nature*. However, an underlying thread emerged about culture and privacy that regarded the right to privacy of United States' citizens and valuing the right to privacy of personal data, personal communications, and privacy within the walls of one's own home. This thread was noted primarily in the texts of participants who stood flatly opposed to smart home monitoring but was also alluded to by participants who indicated they would be willing to try a smart home. The term "Big Brother" was offered across multiple transcripts in support of this concern. For example Navy indicted: "*Yes, I think that big brother already knows enough about me" (Navy, 235)* and Friendly indicated:

> *I can understand some older people who may not want to use the smart home*
>
> *monitoring. Perhaps some are mentally ill or paranoid about using devices that*
>
> *would be "spying" on them. In the 1950s there were "aliens from outer space,"*
>
> *flying saucers, and Big Brother watching you.*
>
> *(862-865)*

The opinions on privacy of individual citizens of the United States may be as vast as the number of individuals asked. However, various cultural and ethnic groups do exist

within the borders of the United States. Although Emeritus was not directly referring to

ethnicity within the United States in the following statement, the text highlights the

importance of considering how different ethnic groups might perceive privacy, even here

in the United States.

> *Of course, the concept of privacy, and acceptance of degrees of visual intrusion is*
>
> *a very sensitive issue that not only varies from person to person, from generation*
>
> *to generation, but also strongly from culture to culture.*
>
> *Me? They can watch me take a shower anytime, I would feel protected.*
>
> *But don't do that to my dad, he would whop you!*
>
> *Even more so, consider Middle East cultures, where the women have to walk*
>
> *around in burqas and veils: how would in-home and in-private observation go*
>
> *over in such cultures? (Emeritus, 2464-2472)*

Self-identified Culture

Although many older adults in this study shared their own self-identified cultures, several

participants referred to culture from a traditional "boxed" perspective (race/ethnicity, religion, or

socioeconomic status). Whether perspectives on culture were boxed or not, each identified

culture represented an epochal human experience that included socially constructed values

collected on the journey through life and aging. See Table 4.

The epochal experience emerged in the texts as a composition of a lifetime of social

encounters, which were constructed like a puzzle. The pieces were representative of previous

social encounters that prompted collection of a social value as one's own. Pieces were identified

as race/ethnicity, socioeconomic status, political leanings, psychology, family, level of

education, where one was born and raised, and where one currently lives (rural, suburban, urban).

Influencing the journey through the aging process were human experiences encountered along the way that involved interaction with technology; for example Emeritus' experience with passive versus active computers, Social's experience with smart homes in her work as a medical social worker, or Elle's experience as the first person in her family to use a computer.

Table 4

Participants' Self-identified Culture in Their Own Words

Participant	Identified Culture
1	*Small town American girl*
2	*Engineer, educated*
3	*WASP, female, educated*
4	*Farmer, female, socialite, busy*
5	*Midwest farmer, neighborly, liking change*
6	*Los Angeles, Spokane; Urban, modern liberal, generational mature silent, Boomer*
7	*Navy*
8	*Hard-working, church-going, self-supporting, independent*
9	*Anarchist, former eschatological protestant religion (Seventh-day Adventist)*
10	*Fitness, parents with children*
11	*Middle class*
12	*Chinese American*
13	*Educated, corporate class, Vietnamese American*
14	*Romanian American*
15	Not answered
16	*Seeking the unselfish path (as opposed to selfish)*
17	*De-cultured world traveler (part of so many world cultures, no longer cultured to one)*
18	*Midwest, Methodist, multi-cultured (U.S. coast-to- coast)*
19	*Christian, Caucasian, educated, middle class, financially stable*
20	*Boomer, tech savvy, independent*
21	Not answered

Educated.

Many participants perceived education as informing their culture and their journey. Four participants specifically used the word "educated" to describe (in part) their self-identified culture, while multiple others brought up their level of education in the context of factors that may influence their decision to adopt or not adopt smart home monitoring. The concept of "being educated" was associated with socioeconomic status by some, and the combination of "being educated" and a part of "middle class" America further informed perceptions on adoption. Emerging from the text was the concept that if one was of middle-income status and educated, one may be able to financially afford a smart home that would help with remaining independent at home longer. Education was therefore identified as an influencing factor of adoption.

Gender.

Female participants expressed perspectives on culture and adoption as regarding gender. An underlying thread emerged from the texts across multiple transcripts where female participants drew attention to their own perspectives as female and pointed out the existence of a difference in perceptions between men and women. The following are examples of female perspectives:

Somehow, in this area, I think that women would be more receptive to the

technology than men would. But statistically, women would need it more than

men. (Elle, 353-355)

And

From what I have learned in my life, I think that a lot of men have the 'manly'

feeling about themselves and that it is not just a regional culture. They often do

not want to ask for help, whether they are refusing to ask for directions, as the

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adage goes, or just want to take the lead in family things. In my opinion, few men

want to show their so-called feminine side. I believe that education plays into

this, but it is something I have observed everywhere I have interacted with

people. And asking for help at home would be an extension of that feeling. They

don't want to be seen as 'weak' and needing help. Again, this is my opinion. My

granddaughter is a theater major and has many gay friends. They are really

great in that they don't feel the need to push their masculinity. (Elle, 408-419)

And

I do believe there are differences in men vs women regarding both needs and

acceptances. I have no real idea where this feeling comes from, probably

observing my family (extended and extended generational). I may have a

different family, but in my parents, in-laws, and maternal grandparents, it was the

woman who needed the care and the husband who extended it. In all cases, the

husband tried (until failing) to do it all themselves; they did not ask for nor

gracefully accept offered assistance ... I suspect 71young may be more open to

technology as he has been introduced thru this study. (Friday, 1017-1025)

A male voice refers the influence of gender on adoption as well:

I would accept this home system readily because I would like the challenge. I can

see where a lot of men not liking it because of their background of independence

and not wanting help. (71young, 498-500)

Independent spirit.

Two participants explicitly stated that independence was part of their self-identified

culture, however, the independent spirit of older adults in the United States and their desire for

independence, surfaced in the texts across the majority of transcripts. The context of the discussion of the independent spirit was the "learning your habits of daily motion patterns" by the smart home. Consistently, older adults described their prospective journey as one of maximal independence for as long as possible. For example, Belfaire stated, "*It is my hope that as I age I can remain independent with a high quality of life for many years" (Belfaire, 295-296).*

The Epochal Experience of Culture Globally

Epochal experiences expressed as culture and containing cultural values are likely different for first and third world nations and may influence global adoption of smart home monitoring. Although participants in this study were all living in communities in the United States, and their description of culture sounded like individual expressions of their unique lives, there was a common feature across all transcripts involving the human experience of NEED. The unavoidable human experience of NEEDing assistance at some point in the aging process was acknowledged by *all* participants, which has global implications. Two participants shared that they did not have a desire to remain in their own homes as they moved along the journey of aging toward NEED. They indicated that living with family, in assisted-living, or in a nursing home seemed like a fine option. However, the majority of participants indicated that aging in place was a priority; a perspective represented by this exemplar:

> *My personal preference to remain independent, self-sufficient, not living in a*
> *community setting, and amidst the familiar objects (e.g. books, movies, photos…)*
> *that reflect a life-time of accomplishments and memories is absolute. If would be*
> *greatly beneficial if smart home technology could assist me to accomplish this.*
> *(Chip, 308-312)*

For those seeking ways and means to age in place, smart home monitoring was an option worth exploring. Some participants shared a willingness to accept assistance from a technology that was non-human if their safety and rights would not be violated, while others shared a willingness to accept non-human assistance only if it included a human too. The overarching aspect is the global human experience and the need for assistance, which includes the need for human contact throughout the journey. Most older adults will be discerning about whether or not to plan ahead for assistance from a smart home.

Summary

Twenty-one participants were interviewed. Ten indicated they would be open to smart home monitoring, three were absolutely against it, and eight were categorized as maybe. Participants categorized as a "maybe" might be better described as a "hesitant yes … if."

Culture was cited by some as a significant influencing factor in potential decisions regarding adoption, while others indicated it had no bearing on a decision to adopt. Themes of privacy, independence, and family, were heavily informed by participants' perceptions of their own socially constructed values.

The thought of an intelligent home that uses ambient monitoring to discover and/or predict changes in safety and health *and* can take an action on behalf of an older adult is a new concept for older adults. The majority of participants in this study expressed they had little or no knowledge about smart homes that are designed to help with aging in place safely. Perceptions and descriptions of smart home monitoring used simple language and regarded specific features like detecting a fall. Factors influencing adoption were perceptions of invasion of privacy that are greater than the level of perceived need, the opinions of family (especially children of the older adult), trust (working and functional technology, processing and hosting data without

breach), being seen but not watched, having access to human touch, having the option of

personalized features, cost, and introduction of smart home monitoring "at the right time."

CHAPTER FIVE

IMPLICATIONS AND CONCLUSION

Implications

The current qualitative descriptive study resulted in explicating the nature of what is currently known by older adults about smart home monitoring. Older adult participants shared their perceptions and descriptions of smart home monitoring and explored influencing factors on adoption, including the influence of older adults' socially constructed values and beliefs. Factors influencing potential adoption were thoughts about privacy, family (not causing worry or being a burden), features and functionality, readiness to adopt based on need, and cost. The primary socially constructed value influencing adoption was independence, which may be representative of the independent American spirit. Older adults' in this study desired to remain independent and self-reliant as long as possible throughout the journey of aging. Older adults' desire to remain independent will likely inform adoption rates in the United States. Most older adults will entertain the option of smart home monitoring as a way to age in place, even if hesitatingly or as a last resort.

Adoption.

There are intersecting levels of need (for help) and acceptable levels of loss of privacy; as needs increase, privacy decreases. A desire for independence heavily influences older adults' willingness to entertain a solution that involves a perceived loss of privacy in trade for greater independence. Independence, for many older adults, is more important than privacy and recognition of the need for assistance to remain safe and independent at home informed older adults' statements regarding prospective willingness to adopt smart home monitoring. Smart home monitoring was perceived as a solution that would increase independence and the ability to

age in place, but which may require sacrificing privacy in the home. Recognition by older adults that smart home monitoring is a potentially viable solution has implications for public readiness and diffusion of smart home innovations. The sooner this innovation is highly functional and on the market, the sooner there will be more potentially effective options for older adults who desire to age in place with improved health and safety. Market availability will lead to some older adults adopting this technology, which may lead to decreasing healthcare costs related to falls and preventable sudden changes in health status and improved quality of life for older adults.

Despite a prospective willingness to adopt smart home monitoring, older adults in this study expressed their desire for the smart home to be individualized to decrease exposure, thereby maintaining higher levels of privacy. They also expressed a desire for the smart home to only address specifically identified needs and for the smart home not to take unnecessary, undesirable, or unrequested action. The smart home taking unwanted action was perceived as an invasion of privacy and a removal of independence, and thereby an undesirable outcome which would negatively impact adoption. A one-size-fits-all smart home was not desirable and may make older adults feel exposed and/or exploited. Smart homes of the future will need to include design features that address the individualization requirements of older adults. An inaccessibility to adopt a product with individualized features will likely slow adoption rates.

Machine learning.

Superficially speaking, it would not be practical to produce a smart home with features that are completely individualized for every older adult, however, smart homes that use machine learning, a form of artificial intelligence, may be a practical solution to address the request for an individualized product. The smart home that uses machines (computers with software algorithms) to learn the motion patterns of the older adult living within the home and to take an

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action on behalf of that individual, is a technology that specifically performs individualized monitoring and interventions. If a continuum existed where a one-size-fits all product was on one end, the smart home that uses machine learning would be on the opposite end, because it is the most individualized technological invention currently in existence.

Individualization

One-size-fits-all   Machine Learning
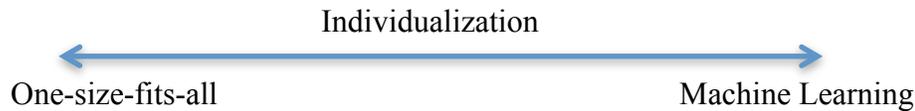
Figure 2. Continuum of smart home features related to specificity and individualization of smart home monitoring.

The smart home using machine learning becomes more and more specifically individualized the longer it is employed with the same person. This level of specificity (offered only by machine learning) has the potential to increase the older adult's feeling of comfort with adoption by decreasing the perception of a prospective loss of privacy that would accompany the purchase of a one-size-fits-all product. It may be considered that in compensation for the perceived loss of privacy the older adult would receive a fully individualized system that would not expose or exploit. Should this perception hold true among older adults, it would potentially increase adoption rates. Smart homes of the future should include machine learning features to best serve the safety and health needs of older adults.

On the other hand, the perceived existence of a normed privacy has implications for the use of machine learning and the idea of an individualized product. The perception by older adults in this study that some kind of normalcy exists that is associated with private behavior across the human population and the knowledge that smart homes monitor these private

behaviors, impacts personal perceptions of prospective use. Older adults who believe they enact behaviors that might be interpreted as outside of the norm may wonder whether the smart home is capable of accurately interpreting their behavior and therefore may struggle with distrust of the product. The resulting decision may be to *not* adopt smart home monitoring. Such concerns will need to be addressed through education and marketing. Another way to address this concern may be through participatory research, which would intimately include the older adult.

Marketing.

Companies that will perform health-assistive monitoring, house and process data, and manage actions taken by "the machine," will need to be mindful of older adults' perceptions that they are allowing themselves to be monitored only for the purpose of safely maintaining their independence and that older adults do not want their data used for *any* other purposes. Marketing of the smart home product should address this concern.

The communication channels used by older adults will affect trust in the product. According to Rogers' (2003), trust is improved when an individual hears about a product from a trusted friend and/or can observe someone else use the product first. The observation that the product is simple (ease of use) and compatible with existing values will lead to trust of the product and a willingness to try it. A decision to trust or not to trust is a risk management behavior.

The literacy rate among older adults regarding the health-assistive smart home is low and it would be unethical to introduce this product to an older adult, install it in their home, and monitor them, without properly educating them on the product, allowing them to make an informed decision (for or against), and providing them around-the-clock *human* customer support should they choose to use the product. The education component should be provided for

the older adult *and* their children. Many older adults will rely on their children for support when making a decision to use such a product. Older adults in this study indicated they trusted family above all others. Trust is an important influencing factor of adoption; a lack of trust in the company or the product will negatively affect adoption rates.

Increasing knowledge increases power. Power is a personal form of strength that declines with advancing age, especially when accompanied by chronic illness (Pipher, 1999) and can result in a feeling of powerlessness. Opportunities for older adults to gain more knowledge on smart home monitoring will be an important part of the diffusion of this innovation in the United States' older adult population. Opportunities for learning about this technology should be available through nurses (and other members of the geriatric healthcare team), smart home companies, and organizations like American Association of Retired Persons (AARP). Older adults who display knowledge regarding available choices for maintaining independence and who understand the desirable and undesirable aspects of smart home monitoring will personally be in a more powerful position than older adults who lack similar knowledge. The coming age of smart homes is inevitable and therefore education is needed; however, education should be factual, not persuasive. Knowledge should be shared to empower older adults and not wielded from a position or place of power. Older adults with knowledge of the product will make an informed decision regarding use from a position of power and this may increase adoption rates. However, an older adult who lacks understanding of the product may *at best* feel powerless, which may lead to an acceptance of the status quo and a refusal to adopt smart home monitoring, or *at worst* lead to an older adult being monitored against their will.

Clinical practice.

Implications for clinical practice include the nurse, patient, technology triad. As smart home monitoring becomes a viable solution for helping older adults age in the place of their choosing, nurses will need to develop the knowledge and skills to integrate this technology into patient care. A patient-centered approach to integration of this technology may enhance patient health and quality care outcomes. However, safe application of this product will require the nurse to use his/her clinical reasoning skills. An imbalanced focus by the nurse on making the technology functional on a daily basis in the home would not serve the patient well. Functionality concerns should be brought to the attention of those with technical expertise and an interdisciplinary approach to problem solving will be necessary. The nurse's focus must remain patient-centered and should prioritize safety.

Nurses will need to become effective advocates for patients who adopt smart home monitoring. Effective advocacy will only be possible if the nurse understands the patient's motivation for adopting monitoring and the perceived sacrifices they "risk managed" regarding privacy. Nurses will also need to be familiar with older adults' perceptions of a normed privacy and the knowledge that smart homes that use machine learning attribute actions to personally learned patterns and not patterns occurring across a population. Effective advocacy also requires the nurse to know herself (Wilkinson & Treas, 2011) and, therefore, reflecting on personal beliefs regarding privacy and monitoring of people in their own homes may need to be explored by the nurse. Prospective reflection may help nurses hold at bay their own biases when helping the older adult client to understand his/her options for aging in place. Reflection is a common clinical practice used by nurses to improve quality of care, ethical understandings, and critical

thinking and will be helpful when applied to caring for the older adult and the use of new technology.

Safety will be a major concern for nurses who are introducing or maintaining smart home monitoring. Implementation of processes to identify unsafe conditions will be a responsibility of the nurse because nurses are frontline caregivers. Unsafe conditions may be due to technical functionality failures or may be related to a lack of prospective design features for detection of safety. Either way, nurses will need to proactively (and prospectively whenever possible) identify unsafe conditions on behalf of the patient. A moderate depth of understanding of the technology and the ability to communicate with developers will be a requirement to perform this duty. It will be important for nurses to engage in conversations and "have a seat at the table" with computer scientists and engineers who are developing and managing this product.

The timing for introduction of such a technology will impact clinical practice. Introduction of smart home monitoring late in the aging process may be a source of anxiety for both the patient and the nurse. Early introduction is preferred to improve older adults' comprehension of the technology and its role in helping with safety and health-assistance.

Ethical discussions regarding in-home monitoring, invasion of privacy, costs related to care of the aging population, and human-patient versus human-robot interactions should be followed by clinical nurses who are working with community-dwelling older adults. Nurses must remain vigilant and faithful to the Nursing Code of Ethics© (American Nurses Association, 2011). Provisions three, eight, and nine specifically apply to the nurse-patient-smart home monitoring scenario. Provision 3 requires the nurse to advocate for and strive to protect the health, safety, and rights of the patient. Health and safety are both functional goals of smart home monitoring. Invasion of privacy is related to patients' rights to privacy. Provision 8

requires the nurse to collaborate with other health professionals and the public to promote efforts to meet patients' health needs. Working collaboratively with engineers (and other disciplines) to bring smart home monitoring to older adults promotes innovative efforts to meet the safety and health needs of older adults. Provision 9 requires the nurse to maintain the integrity of the profession and practice and to shape social policy. To maintain personal and professional integrity, nurses will need to rely on their training regarding advocacy and self-reflection. To shape social policy regarding smart home adoption the nurse will need to continue to advocate for patients' rights on a local and national level, specifically regarding privacy and in-home monitoring, and management of private data.

Nursing education.

Nursing education will need to focus on increasing technology literacy levels among future and current nurses regarding smart home monitoring. Additionally, it will be important to facilitate a mindset that engages in forward thinking. Training nurses on current and future technologies for use in direct patient care is crucial to successful diffusion of any new health-related technology. Nurses who care for community-dwelling older adults are most likely to encounter smart home monitoring in their patient population in the near future and should therefore become familiar with its features, functionality, and the ethical considerations of in-home monitoring.

Student nurses should be introduced to the role of technology in patient care, including its use with community-dwelling patients. Student nurses should also be given the opportunity to prospectively think about the role of new technologies and their impact patient care and the future-working environment of professional nurses. Discussion of how technology will change the future of nursing practice is essential to producing nurses capable of adapting, and who can

implement and manage highly interactive technologies (e.g. those with artificial intelligence capabilities) employed in patient care. Forward thinking will be necessary to maximize patient safety, advocacy, and adaptation to change.

Health policy.

Health policy will need to address the costs related to care of the aging population, removal of barriers to adoption, and patient rights regarding access to and management of their own health data. Smart home monitoring may be less expensive than care in an assisted living or hired in-home help, and may alleviate some of the worsening pressure felt from the impending shortage of caregivers and nurses (Squillace et al., 2007).

Barriers. Removal of barriers to smart home access will be necessary to address safety with *all* older adults, not just those who are part of middle and upper socioeconomic status. Barriers that need removed are: low levels of health-assistive gerontechnology literacy, Medicare reimbursement for smart home monitoring, and Internet connectivity.

A gap exists between older adults' exposure to advanced technology, specifically health-assistive technologies designed for older adults, and current levels of technology. The gerontechnology literacy gap exists in part due to the rapidly changing technology environment. Although the current generation of older adults may not have had exposure to technology at the same level expected of future generations, it is quite likely that technology will continue to increase faster than diffusion of these technologies, leading to an eternal gerontechnology gap. To optimize gerontechnology literacy levels of older adult United States' citizens, policy makers may need to consider ways to reach them with education on health-assistive technology. The current design for educating patients with diabetes has worked well for older adults and consideration may need to be given to employing a similar education design for older adults who

require education on health-assistive technologies that are employed in their care. It may be that the Nurse Informatics position may soon extend beyond the acute care setting and into the community and home health settings.

Innovative solutions are needed to address costs related to the growing aging population (Administration on Aging, 2013) and smart home monitoring is one such solution. Costs associated with new technologies are often slowly approved by the Center for Medicare and Medicaid Services for use with patients. Policy makers may need to seek consultation from experts in the field of gerontechnology to better understand the projected cost/risk benefit ratios associated with high-functioning technologies that will be available for use with older adult patients in the near future.

Rural health policy leaders need to specifically address current suboptimal levels of Internet connectivity in rural and remote areas. Rural and remote citizens may have a greater need of smart home monitoring than citizens living in more populated areas where neighbors are nearby.

Patient rights and health data.

Health policies regarding a patient's right to privacy are strong and employed effectively. However, patients' rights related to management of their own health data and control over who accesses this data is much more obscure. Health policy makers need to better define "health data" and pass laws that explicitly protect the private data of patients using health-assistive technologies. Restrictions placed on corporations or government entities' sharing of health data should be guided by legal and indemnified patient rights and wishes, and should never place the older adult in a position of exposure or exploitation.

Future Research

Interdisciplinary collaboration in research and development is necessary for producing an effective and acceptable smart home that uses machine learning to assist older adults with aging in place safely and with improved health. Aging is a complex process that holistically regards mind, body, and spirit. No single discipline can holistically address the journey through aging. Key interdisciplinary team members currently include computer science and engineering, psychology, neuroscience, social work, and nurses. Future interdisciplinary teams should consider the inclusion of physical therapy, speech therapy, physicians, and health information technology experts. Understanding what information is needed and/or wanted by the physician and integration of this information into the electronic medical record will be important as personal health data becomes integrated at a national level on the new healthcare information cyber highway.

End user involvement in research and design may improve older adults' overall perceptions and understandings regarding smart home technology and would likely influence adoption rates because of exposure and because product design would closely reflect what older adults feel they need and want. Participant involvement in this research study represents successful involvement of older adults in research and design. Due to the private nature of in-home monitoring, transparency in research and development are needed. Beyond transparency, accountability is needed for the creation of a trusting relationship between developers, commercial companies, and older adults.

Future research should consider use of a psychometric email survey to reach a larger number of older adult participants. Consideration should be given to the categorical ages of older adults and the potential for differences in their perceptions across the age continuum.

Adults less than 75 years of age are more likely to be early or majority adopters and may have a higher level of gerontechnology literacy and, therefore, may be more informative in future research in gerontechnology. Additionally, use of a participatory research design methodology may be a way to discover older adults' authentic perceptions while empowering them through involvement in research and concurrently improving the rate of health-assistive technology literacy levels.

Further exploration is needed regarding (a) the concept of trust as it regards adoption of a new technology, (b) views of family and caregivers, (c) specific features that are desired by older adults, (d) interaction between the human and the health-assistive technology as it relates to human emotion, (e) cost analysis, (f) marketing,
(g) health-assistive technology literacy levels of older adults and their children, and
(h) implementation and receipt of the smart home by older adults. Collaboration across computer and engineering sciences and the social sciences will remain important in the exploration of these areas.

One final consideration for future smart home research is conceptualizing the "Internet of things" (I.O.T) and the role I.O.T will play as technology advances. I.O.T refers to the inclusion of hardware and software in any device that is otherwise not typically considered computerized to enhance its value by giving it the ability to communicate with other devices via the Internet. Each device is uniquely identifiable and can network with other devices or machines to increase personalization of device activities (which may be automated) including smart monitoring. I.O.T may be the next step in smart home development and forward thinking in research regarding adoption will be important.

Conclusion

Older adults are concerned with safety, health, and independence as they journey through the aging process. When introduced to the health-assistive smart home under development at Washington State University College of Computer Science and Engineering Center for Advanced Studies in Adaptive Systems (CASAS), which uses artificial intelligence software to monitor and take actions on behalf of the resident, the majority of older adult participants in this study indicated a prospective openness to the idea of adopting such a technology. Openness depended on (a) the level and specificity of need and whether the smart home would meet that need, (b) perceived loss of privacy and compensation for this perceived loss with a feeling safety and knowledge of receipt of health-assistance, (c) functionality, and (d) cost. There are implications from this study for smart home design and machine learning, marketing, clinical nursing practice, nursing education, health policy, interdisciplinary collaboration, and future research.

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Appendix A

Introductory Email Letter

Hello (Participant Name),

Welcome to my research study on smart home technologies and *Thank You* for your time and willingness to participate.

My name is Shelly, sometimes people call me Roschelle and we spoke on the phone recently about my research with smart homes. I am a Ph.D. student in the College of Nursing at Washington State University.

This is a pilot study, which is a small study that will help guide a larger dissertation study on the same topic. This study is about older adults and a specific smart home technology that involves monitoring. (We will talk more about smart homes and what they are later.) The intention is to explore how your cultural values might influence a decision to use smart home monitoring within your own home as a way to help you age safely, in the place of your choosing.

As a participant in this study you will be asked to spend approximately 6 hours between now and the middle of October (2013) answering questions and discussing *by email* your thoughts about the use of smart home technologies. Please be assured that you can withdraw from participation at any time. You may also answer questions according to your level of comfort. You may answer fully, partially, or decline to answer altogether. Your comfort with this process is important to me! If you feel uncomfortable at any point in the conversation, please do not hesitate to let me know and we can move on to another question or end our conversation at any time. Also, please know that your information and our conversations will be kept confidential. Your thoughts and ideas are important and will contribute to the findings of this study may be included in the write-up of the study and reported in professional meetings, however, your identity will remain confidential and will not be reported. There are no costs or benefits for participation in this study. However, you may find joy in knowing that smart home design engineers will hear your input and will likely use it to guide the design of future smart homes.

If you have questions regarding this study please feel free to call me anytime at the number listed below, or contact my supervising Professor.

Again, thank you for graciously offering your time. Please reply to this email if you are willing to voluntarily continue our email conversation. I will then send you a set of questions.

Sincerely,

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Appendix B

Opening Line of Questioning: Discrete and Non-discrete

1. Tell me about your understanding of smart home technologies... what they are, what they do?
2. Tell me about any expectations you have related to smart home technologies?

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3. How old are you?
4. What is your gender?
      a. Male   b. Female
5. Where do you live right now?
      City _____
      State_____
      Country _____
6. Where you were born?
      State _____
      Country _____
7. Is English the main language you use?
      a. Yes   b. No
    If not, what language do you prefer to use?
8. What is the highest grade level you completed? _____ (example: 10th grade)
9. Do you hold any degrees or certifications? If so, what are those?
10. What was your main job before you retired?
11. How many years have you been retired?
12. Do you have children?
13. If so, approximately how often do you see one of your children in-person?
      a. Daily
      b. Weekly
      c. Yearly
14. Where do you primarily get your news?
      a. TV
      b. Newspaper
      c. Radio
      d. Internet
15. Have you been diagnosed with a chronic (long lasting) illness?
    If so, what illness?
    Are you currently seeing a doctor or nurse for this illness?

*Has a doctor or nurse told you that suffer from cognitive or mental impairment? *(Added after pilot study.)*

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16. Do you see yourself as a part of a specific culture(s)? If so, which one(s)?
17. Describe your relationship with that culture and the impact on your daily life?

18. Describe how your cultural values might impact your acceptance of smart home monitoring?
19. How might your cultural values encourage your use of smart home monitoring? How might they discourage your use of it? Tell me more...
20. Share anything you feel smart home developers should know about your needs and wants.

Appendix C

Organization of Themes

    I.   Privacy
           a. Independence
           b. Pride and Dignity
           c. Cameras
                 i. Silhouettes
   II.   Family
  III.   Trust
           a. Power and Powerlessness
  IV.   Being Watched
   V.   Human Touch
  VI.   Features and Functionality
           a. Safety
           b. Quality of Life
 VII.   Cost
VIII.   Timing

Appendix D

Comprehensive of List of Older Adults' Desired Smart Home Features

This is comprehensive list of features across all transcripts in participants' own words.

Older adults' statements regarding "functionality" are not included here. It is assumed that older

adults want each feature to be functional.

1. *Alert someone if I couldn't get out of the bathtub*
2. *Alert someone if I … didn't get out of bed at a reasonable time*
3. *Some kind of device to open my door, even if it was bolted, to allow emergency crews to enter without destroying the door*
4. *Convenience duties with lights and heat*
5. *Reminders to take medicines*
6. *Watch over me*
7. *Turn off the stove when I forget*
8. *Cover my oversights and forgetfulness*
9. *Help with mobility loss, memory loss, hearing and sight loss*
10. *There must be smoke alarms with very bright flashing red lights or something like that*
11. *A direct connection to the local Fire House*
12. *No stairs to climb and already wheelchair accessible! No steps, no bumps, level all the way through! … the Smart Home of the future must be a one level Rancher!*
13. *Smart fridges should have an auto closing devise!*
14. *A Smart garage door that knows when I am indoors, the cars are inside, and closes the garage doors when I forget*
15. *When my smart monitors notice that we have gone to bed, it would be nice to know that the doors will be locked and the lights are turned off, should we forget*
16. *Some way must be provided to help them to be supplied with basic shopping essentials*
17. *Place a touch sensitive monitor on, let's say, the fridge door! Fill it with graphic pictures of commonly needed food items, for instance,*
18. *Payments can be tied in by linking the order to a suitable banking link*
19. *Ordering pharmaceuticals from home refrigerator computer*
20. *It would be helpful to be monitored and I am alone*
21. *I would like it [smart monitor] in the bathroom where I could fall in the tub*
22. *A built in B/P set to monitor B/P and pulse rate. Sometimes my heart gets going fast.*
23. *Walk in bathtub*
24. *Phone apps*
25. *Video conferencing with my nurse or doctor*
26. *When I go to the doctor not to have to repeat my medical history with each appointment*
27. *A female voice would be more soothing to seniors and I would hate to be commanded so a reminder would be more palatable.*
28. *Evolve as the person in the home "devolves"*

29. *Notice if the person were walking and stopped walking at a place other than normal i.e. bottom of stairs after a fall*
30. *Outside monitoring*
31. *Monitor the pathways outside the home, for instance between the doors and where the cars are parked, again to detect falls*
32. *The system would be able to function with allowances for the animals*
33. *Monitor my health status*
34. *Call for help in an emergency*
35. *Stroke and heart attack detection*
36. *"Pull the shade" for a short time to allow for private moments*
37. *If I fell or passed out these actions would be monitored and help would be on the way*
38. *Control the thermostat, lighting, opening and closing blinds, opening and closing door from my recliner instead of getting up*
39. *A fresh cup of coffee could be brought to the table by my chair so I don't have to get up and spill it as I walk back to my chair*
40. *There would need to be recognition of the disposition or character of the person's thoughts and feelings.*
41. *Alert someone that I have fallen and I can't get up. Also if I break glass or other harmful material and I can't get up or can't clean it up*
42. *An intercom would allow us to talk without the caregiver having to come to the room*
43. *A way to warn one that there were objects in the path that one did not see*
44. *Being able to do things by remote control, like raise and lower window shade*
45. *Turn things on and off by remote, or speaking*
46. *A way to detect when something is boiling over on the stove or smell when a frying pan is to hot and turn of the burner or turn off the toaster before it starts to burn*
47. *It would be nice if in the system there were a simple way to have two way communication with remote family (i.e. voice command and instant internet contact)*
48. *It would be very good for them to be able to communicate with the smart technology in the own language (Romanian)… most of the old people revert back to there mother tongue*
49. *Computer/smart phone controlled alert systems, thermostats, door locks, cooking systems*
50. *Computer terminals for monitoring and contacting [family, doctors]*
51. *Security*
52. *Heart health monitoring*
53. *Control everything in the house from just a few locations and set and maintain a water temperature in the shower*