8-2014

Designing for Understanding: Helping Older Adults Understand Over-the-Counter Medication Information

Aqueasha Martin

Clemson University, aqueasham@gmail.com

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DESIGNING FOR UNDERSTANDING: HELPING OLDER ADULTS
UNDERSTAND OVER-THE-COUNTER MEDICATION INFORMATION

A Dissertation
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy
Computer Science

by
Aqueasha Marie Martin
August 2014

Accepted by:
Dr. Juan E. Gilbert, Committee Chair
Dr. Damon Woodard, Committee Co-Chair
Dr. Larry F. Hodges, Committee Member
Dr. Tracy Fasolino, Committee Member
Dr. Sekou Remy, Committee Member

ABSTRACT

This research is motivated by some of the challenges faced by the healthcare community in communicating health information to the public and the potential for user-centered technology design to address some of these limitations. Each year, thousands die or are injured due to adverse-drug events due to both prescription and over-the-counter medications. The integration of technology has improved the incidence rate for adverse-drug events due to prescription medications. Similarly, personal health records and other consumer-based health applications have been shown to be beneficial for helping individuals manage their health. Despite this growing body of research, little to no research has been conducted to gauge the possible effectiveness of technology created through a user-centered design process to assist consumers in understanding similar events due to over-the-counter medications.

This research explores the implications for the design of interactive technology to help older adults understand the possible risk of an adverse drug events resulting from taking over-the-counter (OTC) medications. A user-centered design process was employed, leveraging various techniques to design technology to assist older adults with over-the-counter medication information. The three studies conducted for this research are part of an Exploratory Mixed-Methods Study, designed to identify current practices and challenges, identify opportunities for technology integration, and to examine the usability and effectiveness of the resultant technological artifacts for assisting older adults with over-the-counter medication information. Data collection included semi-structure interviews, surveys, questionnaires, and observations. Results from each study

suggest that the technologies evaluated are useful for assisting older adults with over-the-counter medication information. Design recommendations identified throughout each phase are presented to provide insight on the technology features found useful and not so useful by older adults throughout the process of this research.

DEDICATION

To my husband, parents, grandparents, brothers, aunts, uncles, cousins. Thank you for

your prayers, love, support, and encouragement.

In loving memory of …

My dad, Rev. Ukpaby Martin (1954 – 2012)

My grandmothers, Mrs. Vertille Greenwood (1932 – 2012)

and

Mrs. Ruth Martin (1921 - 2010)

ACKNOWLEDGMENTS

I would like to first thank God – for ordering my steps and blessing me with the strength, passion, and drive to begin and complete the Ph.D. process. Thank you for blessing me with the desire and curiosity to research topics that have the potential to touch the lives of people. To Mr. Demarelle Hammond, my husband and one of my closets friends, thank you for your love and continued support throughout this process. Thank you for continuing to encourage me to pursue my dreams while keeping things in perspective. Thank you for proofreading papers, listening to me talk about my research, and helping me find bugs in my code. To ma, Ms. Bettie A. Martin, and dada, the late Rev. Ukpaby Martin, thank you for your love and support. Thank you for raising me to seek God first in all I do, for with Him all things are possible. Thank you for encouraging me to pursue my dreams in spite of the challenges that I may need to overcome. Thank you for teaching me to enjoy learning and to ask questions. Ma, thank you for showing me that with prayer, hard work and persistence, you can reach your goals. Thanks for teaching me to be strong and resilient. Dada, I would like to thank you for teaching me to be assertive on matters that I am passionate about and to be vocal despite my quite nature. Thanks for teaching me to never give up. To my grandmothers, Vertille Greenwood and Ruth Martin, thank you for helping to raise me to be the woman I am today. Thank you for all your love, advice, long talks, and support throughout the years. Thank teaching me to be driven, but to remember that in the process I should try to help someone else. To my grandfather, Excel Greenwood, thank you for your love and support. Thank you for teaching me to embrace each experience as a chance to learn

something new and for teaching me about the importance of discipline and work practice. To my brothers, Olmec, Okeakia, and Deston Martin, thank you for your love and support. I appreciate our frank talks and the way we encourage each other. It is nice to know an honest opinion is always a phone call away. To my aunts and uncles, thank you for your love and support throughout this process. Everything you have done is well appreciated. To all my cousins, extended family, and friend, I truly appreciate each of you and the joy you have brought throughout the years.

To my advisor, Juan E. Gilbert, thank you for your support throughout this process. Thank you for writing letters, reading papers, signing forms and all the other things advisors do. Thank you for allowing me to pursue research that I am passionate about and your advice as I navigate the Ph.D. process. To my committee members, thank you for providing advice and feedback throughout this process. I appreciate all you have done and hope to continue to learn from you in the future.

To my mentors, I am always appreciative of your mentorship. Thank you for advice and opportunities that you have provided at various stages of this process. To my lab mates, thanks for reading papers, listening to talks, and helping with research ideas. I look forward to continue to collaborate with you in the future. To the Reading Recovery faculty and staff, thanks for providing me with an opportunity to work with you. It has been a joy. Thank you for supporting me in all the ways that you did. It was truly helpful in this process. To the organizations and participants with whom I worked, it was a joy to work with you and I appreciate everything you have done to make this research possible.

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LIST OF ABBREVIATIONS

ADE   Adverse Drug Event

CHI   Consumer Health Informatics

CHV   Consumer Health Vocabulary

FDA   Food and Drug Administration

HCI   Human-Computer Interaction

HIT   Health Information Technology

IR   Information Retrieval

OTC   Over-the-Counter

UCD   User-Centered Design

U.S.   United States

CHAPTER ONE

INTRODUCTION

Consumer-based Health Information Technology (HIT) design is a growing area of interest within the Human-Computer Interaction (HCI) community.   However, research within HCI, which focuses on helping consumers understand health information, is in its adolescence. Nonetheless, helping people understand health information is a fertile area where applying user-centered design techniques to consumer-based health information technology design has been immensely beneficial to better understanding the design needs of various populations. This has resulted in the design of Consumer Health Informatics (CHI) applications that helps patients and consumers become more knowledgeable, involved, and empowered about their personal health. However, because of the inherent complexity of health information and communicating health, several challenges still exist.

This research addresses some of the gaps in knowledge that exist related to communicating over-the-counter (OTC) medication information to older adults. Current methods for communicating OTC medication information are paper-based or consist of technologies that rely heavily on the same language used by their paper-based counterparts. Further, few studies currently exist that focus on how user-centered CHI applications can play a role in helping older adults better understand OTC medications, although this is still a major concern among older adults. The major goal of this research is to better understand and identify ways in which technology may assist older adults in the process of selecting appropriate OTC medications. Design considerations for a novel

technological artifact that could assist older adults in the OTC medication selection

process were identified. In addition, the feasibility, usefulness, usability, and short-term

effectiveness of the derived artifact and its components for improving understanding of

and delivering OTC medication risks and benefits for older adults was evaluated.

STUDY DESIGN

A three-phase Exploratory Sequential Mixed-Methods Study was conducted to

better understand how technology might assist older adults in the over-the-counter

selection process. The three phases of the study were conducted over a 2-year period and

each phase of the study informed the design of the next phase. The phases of the study

are outlined below.

Phase I: Understanding the Over-the-Counter Information Needs of Older Adults

The first study examined the current over-the-counter medication needs and

practices of older adults. This phase of research was conducted to better understand older

adults current OTC medication selection practices and any challenges they may have with

OTC medication information. Participants were required to take OTC medication,

purchase their own OTC medication and be 65 years of age or older. Semi-structured

interviews were conducted with 10 older adults that were recruited over the period of 4

months. Interviews were conducted until no new data emerged. Interviews were audio

recorded and later transcribed for analysis. A thematic analysis was conducted and 5

themes emerged related to the participants' current OTC medication practices. The

themes centered around participants 1) information seeking timeline, 2) barriers to

identifying OTC medication risks, 3) information needs and concerns, 4) information sources and 5) challenges with OTC medication information. The data was used to inform and develop a model of the participants OTC medication selection process.

Phase II: Identifying Design Considerations for Technology to Assist Older Adults with OTC Decision-Making

The second study identified design considerations for supporting older adults OTC consumer decision-making through technology. This phase was conducted to 1) conceptualize and design a novel prototype interface that could assist older adults in OTC consumer decision-making 2) examine the usability of the prototype for assisting older adults in the OTC consumer decision-making task and 3) identify aspects of design that might be useful to help older adults in the specific task of selecting OTC medication. Participants were required to take OTC medication, purchase their own OTC medication and be 65 years of age or older. Data collection included results of an expert review (brainstorming and walkthrough sessions), a round of semi-structured interviews that included a total of 7 participants, and hand-written notes of observed participant interactions with the paper-based prototype. Recruitment and data collected occurred over a period of 6 months. Data from expert review were collected through hand-written notes and email exchanges. Data was transcribed and content analysis was used to identify usability concerns. Interviews and participant observation notes were audio recorded and later transcribed for analysis. Thematic analysis was conducted to identify key aspects of the design that were found useful by the participants. Five major themes

emerged that centered various features and functionality of the system. These themes

included: 1) Guided Persuasion, 2) Personalization, Tailoring, and Decision Support, 3)

Trust and System Recommendation, 4) Consumer-Friendly Health Language and 5)

Support for Sharing.

Phase III: Designing and Evaluating a Prototype Translator to Assist Older Adults

with OTC Decision Making

The final study examined the feasibility and effectiveness of a prototype translator

designed to assist older adults with OTC medication information. The translator was

designed through a human-centered process in which information needs were gathered

and later included in a prototype to elicit additional feedback from participants. The

results of prior studies were used to inform the design of the translator being examined in

the proposed study. Twenty-one older adults, 65 years of age or older, were recruited to

examine the effectiveness of the translator. Data for background information, health

literacy, control beliefs, perceived and actual difficulty of the information, and user

satisfaction were collected. Recruitment and data was collected over a period of 3

months. Data was collected through the use of 7-point Likert-Items, Questionnaires, and

observation. Data was analyzed by using descriptive and inferential statistics and

through thematic analysis of qualitative data.

RESEARCH CONTRIBUTIONS

Due to the limited research that focuses on designing technology to assist older adults with over-the-counter medication information and the novelty of the interface being design, the studies presented in this research are exploratory in nature. The research therefore focuses on understanding and identifying challenges, examing how technology might address the challenges, and conducting early stage evaluations of the technologies designed and implemented to address those challenges in order to direct future versions of the prototypes. The contributions of this research are therefore to:

1. Better understand older adults current over-the-counter medication selection practices and challenges, and identify opportunities for technology to assist older adults in the over-the-counter medication selection process. Limited to no research exists that focuses specifically on designing technology interventions to assist older adults with over-the-counter medication information. This research builds on prior literature in HCI that examines the design of health technologies that assists patients with medication related information. In a preliminary study, opportunities were identified for technology to assist older adults with the OTC medication selection process.

2. Conceptualize and design a novel interface for assisting older adults with OTC medication information and examine the usability of the novel interface for assisting older adults with OTC medication information. In the second phase of the study, a novel interface was designed and evaluated for its potential to address some of the challenges and barriers older adults face with OTC medication

information. The usability and usefulness of the features of the interface were examined and through this process, aspects of the design and technology features that are useful for assisting older adults with OTC medication information were identified.

3. Design a prototype translator that delivers simplified OTC medication information to older adults and examine the effectiveness of the prototype translator for affecting older adults control beliefs, comprehension, and satisfaction of OTC medication information and identify opportunities to improve the translator. In the final study presented in this dissertation, the feasibility and effectiveness of a prototype translator was evaluated. Results of the study provide insight on the feasibility of the technique for providing simplified information to older adults. In addition, recommendations are provided for improving future versions of the translator and similar techniques as well as suggestions for using such techniques in consumer-based technology that assist older adults with OTC medication.

CHAPTER TWO

UNDERSTANDING THE OVER-THE-COUNTER MEDICATION NEEDS AND

PRACTICES OF OLDER ADULTS

ABSTRACT

Understanding the needs of various stakeholders throughout the design process is key for creating consumer health applications that are usable, effective, and useful for the people that use them. This paper discusses the findings of an exploratory study aimed at understanding the current practices, information needs, and challenges of older adults (65 years and older) when selecting over-the-counter (OTC) medication. The context of this study lies in understanding older adults with the purpose of identifying opportunities for a tailored consumer health application to assist them with selecting appropriate OTC medications given their health history. This research contributes to the understanding of

the current practices of older adults as related to OTC medication selection. In addition, this paper provides a discussion of opportunities for future applications to help facilitate this task for older adults.

INTRODUCTION

Each year, thousands die or are injured due to adverse drug events (ADEs) resulting from taking medication [1, 2]. Medication interactions (ADEs resulting from a reaction to a medication) are considered to be the main cause of ADEs [3]. To this end, in recent years, several novel consumer health applications have emerged to support consumers in managing or understanding medication information.   In addition, these applications have encouraged consumers to become more informed about the medication they take.

This research builds on previous work by providing insight on the processes, information needs, and challenges of older adults (65 years and older) when using over-the-counter (OTC) medication information to make a purchasing decision. OTC medication use, compared to prescription, is heavily dependent on the consumer's ability to understand and correctly use the OTC medication given their knowledge of their own health. Emphasis is placed on older adults because certain factors (e.g. lower health literacy levels, risk of chronic illness) increase with age thereby increasing the risk of an ADE [4, 5].

Although recent work has focused on understanding users in order to design various consumer health applications for medication, little has been done to understand

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the specific needs of older adults in order to effectively communicate information for the purpose of assisting them in the selection of an appropriate OTC medication. The authors define an appropriate medication as one that does not conflict with a chronic illness or other medication. The goal therefore of this exploratory study is to better understand the current challenges and needs of older adults in an effort to identify opportunities for a consumer health application to help facilitate this task.

RELATED WORK

Over the years, several researchers in the healthcare field have conducted studies to understand users with the goal of improving user interactions with medication information. In 1999, the Food and Drug Administration published the OTC Drug Facts regulation as a guide for makers of OTC medication to follow [6]. That same year, researchers released the results of a study examining users' OTC Drug labeling format preferences [7]. Following this study, several studies were published that focused on different aspects of paper-based medication information design [7-10]. Similarly, researchers have used various techniques to better understand users with the goal of designing consumer-based applications to assist with different aspects of the medication regimen [11-19]. Seik and colleagues looked specifically at the needs of older adults to understand the requirements for a personal health application to help them manage medication [16]. Wilcox and colleagues examined the needs of cardiology patients to design an in-hospital application to provide them with information about their care (including medication and treatment) during their stay [17]. Neafsey and colleagues

explored the needs of older adults to understand how to design an interactive educational intervention to warn about OTC medication and alcohol interactions [18].

Although previous work in this area has provided insight on the needs of different groups of users for different tasks related to medication, to the knowledge of the researchers, no study has focused on understanding the needs of older adults when attempting to select (opposed to manage) an OTC medication. This work builds on previous literature by contributing to the understanding of older adults as related to selecting an OTC medication. In addition, this research provides a discussion of opportunities, based on the findings, for consumer health applications to assist in communicating information about OTC medication to help facilitate the decision-making process.

FIELD STUDY

The study was conducted on-site at two locations within the local community. A research team member met and conducted meetings with administrators at each location to explain the goals of the study, answer questions, obtain permission to recruit members, and to obtain research site letters for the institutional review board (IRB) application. Proper IRB approval was obtained before the study began.

Study Location and Participants

The study was performed at two locations: a senior life-long learning center and a local senior activity center. Participants of the study were members of one of the two

organizations. Participants were recruited by email or through a verbal announcement at

the center by one of the researchers. Participants in the study were required to be at least

65 years of age, purchase or select their own over-the-counter medication and have

purchased or selected for purchase at least one over-the-counter medication in the past

year.

A total of 10 participants were recruited for the study (female = 7, male = 3) with

ages ranging from 66 - 82 (mean = 74.2, S.D. = 4.685). Five participants were Caucasian

and five participants were African-American. One participant had a middle school

education, one earned a Master's degree, and one earned a Ph.D. Most participants had at

least some college education (n=7).

All 10 participants indicated that they took medication (prescription and over-the

counter). When asked how many medications they take on a daily or weekly basis,

participant responses ranged from 3 – 12 (mean ~ 7). In addition, all participants

indicated that they had taken at least one over-the-counter medication within the last year

(min = 2 daily, max = 5 daily). All participants reported that they primarily purchased

their own OTC medication, however participants with a significant other reported that

their spouse would sometimes purchase OTC medication for them.

METHODS

Semi-structured interviews were conducted with participants. All interviews were

audio recorded and later transcribed for analysis.   Data were analyzed for emerging

themes to create an initial coding guide. Two researchers met several times to discuss

emerging themes and make updates to the initial coding guide. Researchers later used the

coding guide to independently and thematically code participant responses. The percent

of agreement among researchers was greater that 80% for all categories indicating a high-

level of agreement among coders.

Interview questions were designed to better understand some of the current practices and

challenges of older adults when choosing an OTC medication. These questions fit

broadly into the two categories detailed below.

1) *Current OTC Selection Practices:* OTC medication, unlike prescription, does not

   require oversight from a healthcare provider and can be purchased at will by a

   consumer [20]. It was important to get a sense of older adults' attitudes towards

   OTC medication selection. Participants were therefore asked questions to

   understand their current selection process, the people involved, and the resources

   they consult.

2) *Challenges with OTC Medication Information:* Questions in this category focused

   on understanding some of the challenges older adults face when using OTC

   medication information to make a decision to select or purchase.   Participants

   were asked to describe any challenges they had with medication information in

   the past year. Participants were also given examples of OTC medication

   information (labels and page from WebMD) and asked to identify and discuss

   anything they found cumbersome or helpful about the information or the

   presentation of the information on the labels.

FINDINGS

Participants' responses to interview questions were categorized into high-level themes based on the thematic coding of the interview data. In interviews, at a conceptual level, participants described their current OTC medication selection processes. In this process, older adults enter one or more states on their journey to selecting an OTC medication (See Fig. 2-1). These states provide a basis for the information seeking timeline. When searching for an OTC medication the older is either presented with barriers that prevent them from identifying the benefits and risks of the OTC medication or is faced with information needs or concerns that trigger a cycle in which the older adult seeks information from information sources. In this cycle, if the older adult finds the information presented challenging he or she may consult additional information sources until an OTC medication is selected. Additionally, once the older adult has selected an OTC medication to take, he or she may seek information regarding a medication they have already selected. Each state in this process maps to one of the key-themes and is detailed below.
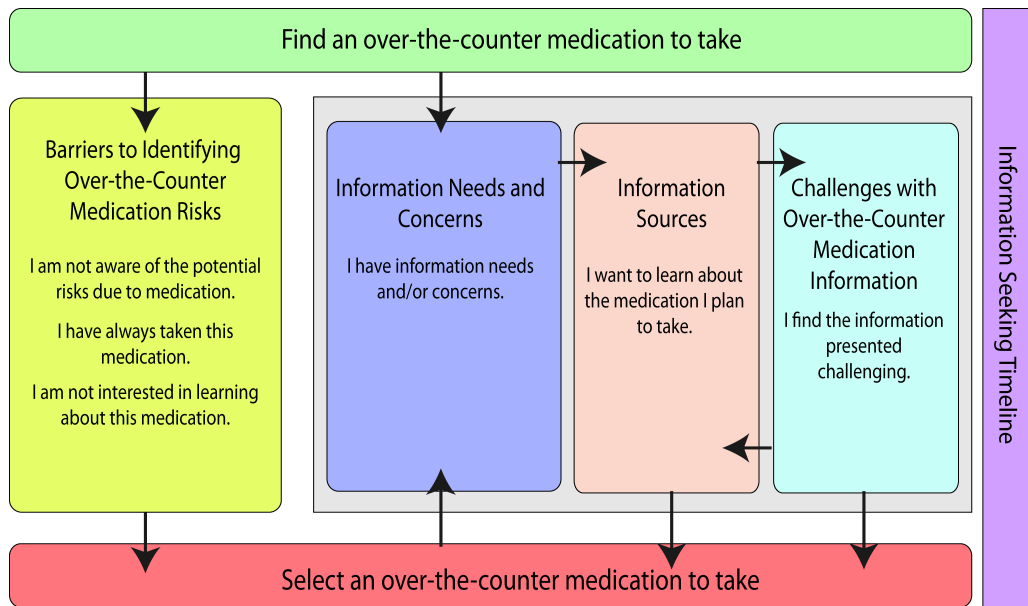
Figure 2-1. Older adults' over-the-counter medication selection process.

Information Seeking Timeline

Of the participants that mentioned that they sought information about their OTC medications, some indicated that they would seek this information after first taking the OTC medication. This was due to various factors including timing of scheduled visits with their doctors or having taken the medication before. For example, four participants mentioned that they felt comfortable asking their doctor about medications during regular visits. P8 stated, "If I have any questions [about an OTC medication], I ask the pharmacist and then at my next appointment with the doctor, I will ask the doctor."

Barriers to Identifying OTC Medication Risks

The interviews revealed several potential barriers that may prevent older adults from identifying OTC medication risks. One participant expressed his perception that

OTC medications generally could not do much harm. He stated, "You have a feeling, if you buy something over-the-counter, it's probably not going to kill you. Right?" Three participants mentioned that history or familiarity with a medication might influence whether or not someone seeks advice about an OTC medication before selecting. P1 stated, "The other thing is, if it's a person who's been around for decades, and decades, and decades … and they've taken Advil their whole life, they're just going to grab a jar of Advil. You know, you sometimes develop an affinity for a certain pill that's over-the-counter".

Finally, six participants indicated they were generally not interested or ignored OTC medication information for various reasons. P6 stated, "I look at risks, but I sadly have grown to the point of almost ignoring it because they list so many risk and it seems though it's mostly just for liability reasons".

Information Needs and Concerns

Participants discussed several pieces of information they found important when making a decision about taking an OTC medication. The top information need discussed was medication use mentioned by eight of the ten participants. Medication use was followed by interactions, mentioned by seven of the ten participants. At least two participants discussed brand of medication, side-effects/risks, dosage information/directions, ingredients, and price/cost each as important pieces of information for making a decision to purchase a medication. One participant discussed

expiration date and another the route (how the medication is administered) as an information need.

Information Sources

Participants indicated a variety of information sources for learning about OTC medications. Several participants expressed that they would consult a doctor or pharmacist about an OTC medication. For example, when asked about the OTC medication selection process, Participant 2 (P2) stated, "Well, if I am not sure, I just ask the druggist [pharmacist]". Additionally, P1 expressed concerns about asking the doctor or pharmacist about an OTC medication. She stated, "They [the doctors] are so busy now… The pharmacist is a little bit more available. I tend not to bother them if the store is busy or something." Several participants also mentioned consulting friends or family (word-of-mouth) or using the OTC medication label.

Other participants mentioned using some type of technology to help them learn about an OTC medication. For example, P5 stated, "Speaking for myself, I do have an app on my pad that will give me the generic and the … What is it when it's not generic, when there's a patented name?" However, when mentioned, the Internet was the primary source for searching for medication information. Most participants however, did not cite a technological source for learning about OTC medications. P1 provided an example of how she searched for medication information on the Internet, but later stated, "When I'm buying something over-the-counter, I usually don't go into this great detail."

Challenges with OTC Medication Information

One of the most common challenges discussed with OTC medication information was the layout and formatting of the OTC packaging labels. Eight of the ten participants discussed challenges they had with either the size of the text or the organization of the information. P4 expressed frustration when searching for the dosage on the OTC medication packaging. He stated, "Where [is the] dosage? It's not here. Okay, you got to go on the other side and the dosage is buried in the middle of other things. 'Stop and ask your doctor if you vomit or something'. Well, I would like the directions [and] the dosage to be right up front at the beginning."

Another common complaint was with the language. Participants expressed that often times they did not understand the information on the label which made it difficult to use. P1 stated, "The other thing I see is a problem … I think they said, Don't take this if you are taking other drugs containing prescription or non-prescription NSAIDs… I wouldn't know what an NSAID is unless I Googled it".

Participants also discussed challenges with the amount and kind of information presented. P6 stated, "I think too that it's so complex. There's so much to try and read and absorb off that label…". He later suggested that some types of information were not there or not apparent.

DISCUSSION AND CONCLUSIONS

The findings of this study provide a better understanding of the current practices of older adults related to OTC medication selection and reveal several opportunities for

technology to assist in this task. Although some participants in this study did not cite a technological source for learning about their OTC medication, their non-use or non-adoption of current technology may be tied to the perceived benefit (i.e. usefulness) or effectiveness of current technology for completing the targeted task [21].

For example, consistent with other studies, participants in this study expressed challenges with the formatting and layout of OTC medication information [7-10]. Although prior research has produced guidelines for label formatting and layout, understanding that font size is still a concern among older adults, presents the opportunity for designers to provide technology that can address this concern (e.g. tools that provide the same information with larger font) and highlight a benefit that is currently not address through labeling.

Given that older adults are at greater risk for adverse drug events due to medication, it is imperative that they are aware that there are potential benefits and risk and upon this realization, that they can clearly see, find, and understand the information provided to make an informed decision [4, 5]. A consumer health application therefore has the opportunity to address some of the limitations of labeling, which may help better support older adults in the process of selecting appropriate OTC medications. Furthermore, careful technology design may also increase awareness of OTC medication risks, which can incentivize the use of such technology among the older adult population [21]. A discussion of opportunities is provided below.

Technology to Support Language Simplification

Understanding health information is a challenge that is faced by many in the population regardless of education level or expertise [4]. Participants of this study also expressed challenges with understanding some of the medical terminology used on the label. Technology may therefore be useful to bridge the gap between the required medical terminology used on the label for accuracy and the layperson terminology desired by the consumers for making a decision. Using plain language guides in the design or automated techniques (e.g. text simplification) for simplifying language in the application may greatly improve the usability of the information for any user, not just older adults.

Technology to Support Awareness

The findings of this study also imply that some older adults may not be aware of the potential risks of OTC medication. Depending on the type of application being developed, designers may also consider integrating elements of persuasion into their applications. Persuasive technology design aims to change the attitudes and/or behaviors of users through one of seven persuasion techniques: reduction, tunneling, tailoring, suggestion, self-monitoring, surveillance, or conditioning [22]. Older adults in this study mentioned challenges that can potentially be addressed by one or more of these techniques. For example, reduction persuades by simplifying the steps a user takes to complete a task. If the task of finding relevant information can be simplified through technology design, older adults may change their attitudes toward seeking OTC information in the future.

LIMITATIONS AND FUTURE WORK

Though interviews were conducted until no new data emerged, the study is limited by number of people interviewed. Further work is needed to determine if the findings can be generalized to the larger population of older adults. Future studies will be conducted to confirm the usefulness of the opportunities described and to further examine ways of addressing the concerns through technology.

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CHAPTER THREE

DESIGNING AN OVER-THE-COUNTER CONSUMER DECISION MAKING TOOL
FOR OLDER ADULTS

ABSTRACT

Older adults are at increased risk of adverse drug events (ADEs) due to

medication and generally have more difficulty understanding health information. Health

information technology coupled with effective communication is thought to be beneficial

to improving many health related tasks. This paper describes the iterative design process

of a novel OTC consumer decision-making tool for older adults. Through expert review

and brainstorming, researchers designed a concept for a novel prototype system to help

older adults with OTC medication selection. In addition, older adults users were engaged

in user sessions to identify usability issues in the prototype system and to identify

features and functionality that might be useful in system designed to assist with over-the-

counter medications. Nine usability issues were identified by 7 older adults in the current

design representing a probability of detection of .917. This study focuses on identifying

usability concerns in the initial design and features that older adults find beneficial for

selecting appropriate OTC medication. Finally, this paper presents a discussion of how

early stage usability evaluation helped to refine the design of the resultant technology.

Additionally, a discussion is presented of how early stage evaluation helped to revise the

model of how technology support mechanisms may be useful in the OTC decision-

making process for older adults.

INTRODUCTION

Communicating different types of health information to patients and consumers is a huge concern in the public health community (Nielsen-Bohlm, 2004). Some health-related tasks, such as choosing an appropriate over-the-counter (OTC) medication, do not require direct oversight from a health care provider, which increases the risk of potential adverse events for the consumer (Covington, 2006; DeWalt, 2010). Therefore, it is important for consumers to have sufficient health-related knowledge to lessen potentially fatal events.

Thousands of hospitalizations and fatalities occur each year due to adverse drug events (ADEs) caused by medication (DeWalt, 2010; Institutes of Medicine, 1999). Unlike prescription medication, safe OTC medication use is heavily dependent on the consumer's ability to understand and use the OTC medication appropriately. In addition, consumers view OTC medications differently than prescriptions and generally perceive them as harmless (DeWalt, 2010). Although considerable research has been dedicated to better understanding how to design "easy-to-read" labeling for medication, ADEs still occur and older adults are at higher risk (United States Food and Drug Administration, 2009).

One approach to addressing challenges with communicating health information is through health information technology (Healthy People2020, 2020). The design of consumer-based health information technology to assist users with health related tasks is a growing area within Human-Computer Interaction. Included in these health related tasks are issues that surround the design of medication-related applications for varying

groups of users. This research builds on prior work in this area by focusing specifically on the design of technology to facilitate the consumer decision-making process when selecting over-the-counter medication.

BACKGROUND

Consumers often misunderstand OTC or non-prescription medication information, which contributes to the large number of adverse drug events occurring each year (DeWalt, 2010; Institutes of Medicine, 1999). There are nearly one hundred thousand medications available over-the-counter (Rolita & Freedman, 2008). Older adults account for nearly 40% of all over-the-counter medication use and use twice as many over-the-counter medications than prescription medications (Conn, 1992). On average, older adults take 6-9 medications concurrently placing them at a higher risk for ADEs. In addition to taking more medication, older adults also tend to have lower health literacy levels and are at increased risk for chronic illness, which also contributes to a higher risk of adverse drug events (Nielsen-Bohlm, 2004). Health literacy or the "degree to which an individual has the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" is noted throughout literature as a contributing factor to the success of health communication efforts (Nielsen-Bohlm, 2004; Warner, Menachemi, & Brooks, 2006). Adequate health literacy is also central to favorable health outcomes (Nielsen-Bohlm, 2004; Warner, Menachemi, & Brooks, 2006). Adults 65 years of age and older tend to have on average lower health literacy levels than adults younger than 65 (Nielsen-Bohlm, 2004).

Many factors affect a person's ability to understand health information (Nielsen-Bohlm, 2004). Among these factors is the way health information is presented to the consumers. For older adults, one of the primary challenges with OTC medication is the size of the font used on the labels (Martin, Jones, & Gilbert, 2013; Watanabe, Gilbreath, & Sakamoto, 1994; William & Wogalter, 1999). However, formatting, information order, external tag placement, and language used may also influence how well OTC medication labels communicate information to consumers (Klein & Issacson, 2003; Morrow, Weiner, Young, Steinley, & Murray, 2003; Rolita & Freedman, 2008; Watanabe, Gilbreath, & Sakamoto, 1994; William & Wogalter, 1999).

RELATED WORK

In the area of Human Computer Interaction (HCI), research that focuses on the design of consumer-based Health Information Technology (HIT) is a growing area of concentration. The main emphasis of HCI is to design technologies from a user-centered standpoint to improve the usability of those technologies. The goals of usability are to ensure that technologies are effective, efficient, safe, have good utility, are easy to learn, and easy to remember (Preece, Rogers, & Sharp, 2007). One tenant of HCI is to approach the design process with the user's needs in mind (user-centered design) in order to develop technologies that meet the goals of usability. This tenet is well situated for consumer health applications where the consumer's information needs are important to the success of the application.

Consumer-Based Technologies for Communicating Medication Information

Within the area of HCI, approaches to designing consumer-based technologies are wide ranging and address a wide range of issues in healthcare, including helping consumers with medications. These technologies can be roughly divided into two groups: Health Interfaces and Applications and Physical Devices. However, the groups often overlap. Prior research on consumer-based technologies involving medication provides a foundation for this research and therefore an overview of current trends is provided.

Health Interfaces and Applications

The popularity of the Internet, mobile devices, and other technologies have prompted research within HCI that focuses on designing personal health applications and interfaces to aid consumers in managing their prescription and OTC medications. Making use of mobile devices, personal computers, and other forms of technology, prior research has tackled several of the healthcare concerns surrounding patient or consumer-based medication practices.

One growing body of research focuses on designing medication compliance and management systems to remind patients to take medications and of dosage (Bickmore & Jack, 2009; Bickmore, Mauer, Francisco, & Brown, 2008; Hoogendoorn, Klein, & Mosch, 2008; Khan, Siek, Meyers & Haverhals, 2010; Qudah, Leidekkers, & Gay, 2010; Rodrigo, Cherubini, & Oliver, 2010; Seik et al, 2011; Seik et al, 2010; Silva, Moutthan, & Saddik, 2009). These applications are designed from a patient's perspective with the

goal of improving usability and thereby promoting usage. Each of these applications

have varying designs, but they provide the ability for patients to set reminders, enter

dosage, create medication lists, and/or check potential interactions. Another body of

work focuses on helping patients or consumers better understand medications and

treatments.

Wilcox and colleagues through participatory efforts, designed personal health

applications and in-hospital displays to provide hospital patients with information

regarding their hospital care during their stay (Wilcox, Morris, Tan, Gatewood, &

Horvitz, 2011). Interviews with physicians, nurses, and patients were conducted to

determine the medication information that was important to share with patients

throughout their stay. One aspect of this work focuses on providing patients with "micro-

explanations" of the medications they are prescribed and treatments administered while

in the hospital (Wilcox, Morris, Tan, Gatewood, & Horvitz, 2011).

Another area of research focuses on designing instructional training systems for

patients and consumers regarding medication practices. The goal of these applications is

to teach users about a particular medication, medication regimen, or medication risks.

Neafsey and colleagues designed an interactive educational intervention to help active

older users understand OTC medications and alcohol interactions (Neafsey, Strickler,

Shellman, & Padula, 2001; Neafsey, Strickler, Shellman, & Chartier, 2002). Using

touchscreen notebook computers, the goal of this research was to increase older adults'

knowledge of the potential drug interactions between prescription medications; and OTC

drugs and alcohol (Neafsey, Strickler, Shellman, & Padula, 2001; Neafsey, Strickler,

Shellman, & Chartier, 2002). To address this goal, the researchers created the Personal Education Program (PEP), an interactive multimedia computer software program that nurse practitioners provided for patients on visits. Results of this study suggest that users of PEP demonstrated a greater self-efficacy or confidence to avoid the adverse interactions presented by PEP. In addition, both users of the control group and of PEP were highly satisfied with PEP and indicated that they planned to make changes in self-medication behavior after using PEP (Neafsey, Strickler, Shellman, & Padula, 2001; Neafsey, Strickler, Shellman, & Chartier, 2002).

Health dialog systems are another form of interface for communicating medication information. A health dialog system is roughly defined as any computational system that facilitates communication between a computer and a user (Bickmore & Giorgino, 2006). A simple example of a dialog system is a wizard that guides a user through the task of installing some software. This communication generally involves input from the users (e.g. voice, gestures, text, touch) and output from the computer system (e.g. spoken language, text). Timothy Bickmore describes one example of how dialog systems can be used to facilitate medical information to patients. Bickmore and colleagues designed a virtual nurse agent to help instruct low health literacy hospital patients about their post-hospital care regimen including their medication regimen (Bickmore & Giorgino, 2006; Bickmore & Jack, 2009). The virtual agent and system design was informed by the results of UCD process through ethnographic studies, interviews with nurses and patients, and usability testing. As a result the overall satisfaction level of the virtual nurse was high (94%) (Bickmore & Giorgino, 2006).

Physical Devices

Research aimed at helping consumers understand medication information is not limited to interface design. Physical devices designed to help patients comply and manage medication regimes are growing in the area of ubiquitous computing. Researchers at the Center for Strategic Technology Research presented a concept of a Magic Medicine Cabinet that communicates allergy information and potential interactions to users by examining RFID smart labels (Wan, 1999). Similar devices including a "Smart Drawer" and a portable medicine dispenser were created using user-centered design principles to aid individuals in medication management and compliance (Becker et al, 2009; Beer, Keijers, Shahid, Abdullah, & Mubin, 2010).

Researchers at the University of Baja California designed three ubiquitous computing devices (Remind-Me, Guide-Me, and Care-Me) to assist elderly individuals with medication management and compliance. Remind-Me was designed to prompt elderly users to take their medications. Guide-Me provides elderly users with dosage information. Care-Me was designed to make elderly individuals aware of the importance of completing medication regimes despite how they may feel (Vazquez, Rodrigues, & Andrade, 2010). Similarly, research concentrating on health monitoring sensor networks aims to improve upon existing reminder systems tracking to detect the time, amount, and manner in which a medication was taken and alert a patient to stop the regimen when adverse events occur (Evers, Wildvuur, & Krose, 2010; Lee & Dey, 2011).

Building on prior literature, this research proposes that technology designed to assist older adults during the process of selecting an OTC medication may also be

beneficial to improving understanding and awareness of OTC medication information for older adults. Currently, there is limited research that focuses on how technology can be designed to help older adults navigate the decision-making processes of selecting OTC medication.

Management, Compliance, and Consumer Decision-Making

Much of the literature dedicated to the design of medication related technology, has focused on medication management or compliance, which although related somewhat, is different from the task of consumer decision-making. Managing a medication regimen can be a complex task especially for older adults (Marek & Antle, 2008; Seik. Khan, Ross, Haverhals, & Meyers, 2011). At a high-level medication management can include any tasks related to buying, taking, and understanding various medications (Marek & Antle, 2008). However, each task presents its own set of challenges. Oftentimes medication management applications are designed to meet one or all of the tasks related to medication management. For example, the design of a compliance application or devices typically focus on monitoring whether or not a patient has taken his or her medication and whether or not that medication was taken on schedule. Other applications focus on helping patients to schedule medications and/or prescription refills by providing users with the ability to create lists to document medications, pharmacist, physicians, and alarms/alerts to help them comply with a particular regimen. However, little guidance is available on how to design medication applications that focus on helping consumers to make a decision about a medication.

Consumer decision-making is concerned with "how consumers develop and use strategies for making decisions, how different amounts of prior knowledge influence consumer choice processes, how consumers adapt to different decision strategies, and how consumers categorize products"(Bettman, Johnson & Payne, 1991). Further, Bettman and colleagues describe a consumer decision-making task as an intricate set of factors that requires a consumer to consider the number of alternatives available, attributes of value, uncertainty, availability of information in terms of environment and content, and a variety of other factors (e.g. importance of the task- what are the consequences of making the wrong decision). In the case of OTC decision-making, there are thousands of OTC medications available on the market (hundreds of alternatives) with different attributes of values (risks, warnings, dosages, ingredients, etc.) that present tradeoffs. In the pharmacy (environment) the label provides one source of in-environment information. The pharmacist is also a good in-environment information source. The content provided by the label and pharmacist can also provide consumers with additional information about tradeoffs of attribute values (e.g. risks, warnings). However, oftentimes these sources are underutilized due to other factors. For example, the small print on the label has found to be a challenge for consumers especially the older adult population (Klein & Issacson, 2003; Martin, Jones & Gilbert, 2013; Warner, Menachemi & Brooks, 2006). Similarly, understanding health terminology can be challenging and may impact how consumers are able to comprehend the OTC medication label (Nielson-Bohlm, 2004; Martin, Jones & Gilbert, 2013). Therefore, the OTC consumer-decision making task can become complex. This research therefore extends, previous research on the design of consumer-

focused or patient-focused medication applications by exploring the design of a novel consumer-decision making tool to assist older adults in this task. To the author's knowledge, no such technology currently exists that focuses specifically on supporting older adults' OTC decision-making. This research describes the iterative design process employed to conceptualize, design, and evaluate a novel interface to assist older adults in the task of selecting appropriate over-the-counter medication.

STUDY OVERVIEW

An exploratory study was conducted to conceptualize and design technology that could assist older adults in OTC consumer decision-making. A combination of expert review and user sessions with older adults were used to identify tasks, information needs, features, functionality, and aspects of the look-and-feel that were important and useful to the task of OTC consumer decision making. The preliminary design of the prototype was informed by previous literature on design for older adults and the results of a previous study. The preliminary prototype was then evaluated through rounds of expert review. Following, older adults evaluated the prototype for usability flaws and discussed features and functionality that they feel would be helpful in the task of selecting appropriate OTC medications.

METHODS

An iterative design process was used to conceptualize and design a preliminary prototype (See Figure 3-1). This study is part of a larger Exploratory-Sequential Mixed

Method study (Creswell, 2013) and each phase of the study was used to inform the next

phase. The results of a preliminary study, and literature on design for older adults and

design of medication related applications were used to develop preliminary prototypes.

Expert reviewers met to discuss preliminary prototype designs, evaluate the designs

based on their knowledge of design principles and design for older adults, and examine

how well the prototype might facilitate the task of OTC consumer decision-making. In

addition, older adults were engaged in participatory user sessions to better understand

features and functionality that might be useful in the task OTC consumer decision-

making. Participants also provided feedback on any concerns with usability or ease of

use.

Figure 3-1. Iterative Design Process

Preliminary Prototype Design

Two researchers met over the period of 2.5 months to brainstorm preliminary

prototype ideas and evaluate the potential for the prototype to facilitate the task of OTC

consumer decision-making for older adults. For the initial prototypes, the researchers

goals were to explore different ways to address the challenges identified in literature and

in the preliminary study (See Table 3-1). Nielsen's Usability Heuristics were used to

guide reviews of the system (Nielsen, 1994). Prototypes ranged from low-fidelity (paper-

based mock-ups) to high-fidelity (PowerPoint decks that included simulated interactions).

Overall, the researchers aimed to design a persuasive interface. Prior research indicates

that many times consumers are unaware of OTC medication risks and may need support

when navigating OTC medication information (DeWalt, 2010; Martin, Jones & Gilbert,

2013). This implies that a persuasive design may be able to address some of the

challenges and barriers faced by older adults. The preliminary design therefore included

aspects of persuasive technology design that could potentially address those challenges.

Initial Design Goal	Description/Reasoning
Support for Medical Terminology	Prior research indicates that consumers, in particular older adults, may have trouble understanding and acting upon health information (Hanchate, Ash, Garmararia & Paasche-Orlow; Nielsen-Bohlm, 2004; Warner, Menachemi & Brooks, 2006). In addition, in interviews with older adults, participants identified that they found some terms included on the OTC medication label challenging.
Tailored Design for Older Adults	Research on the design of medication packaging indicates that formatting and layout are important factors in how consumers use medication information (Klein & Issacson, 2003; Morrow, Weiner, Young, Steinley, & Murray, 2003; William & Wogalter, 1999). Older adults also indicated that formatting such as font-size might hinder them from using OTC

	medication information to make decisions (Martin, Jones & Gilbert, 2013). Therefore, the design was tailored by focusing on formatting, layout, and information needs that may be useful to older adults.
Access to Technology	Another design goal was to look at technologies that could be accessed by older adults who may or may not currently have access to a computer at home or a mobile smart device. The rationale for this is to provide access to technology for a group of older adults who may be curious or could be persuaded to use technology even though they may not have personal access for searching for information about medication at home or otherwise.

Table 3-1. Initial Design Goals

Persuasive Technology Design

Fogg presents two approaches to designing persuasive systems: Macrosuasion and

Microsuasion (Fogg, 2002). Macrosuasion is used to describe systems in which

persuasion and/or motivation are the singular intent of the product. For example, if a

system is designed with the sole intent of promoting or motivating a certain behavior. On

the other hand, products that are designed with microsuasion in mind do not have an

overall intent to persuade but instead incorporate persuasive elements to achieve some

other goal. Because the overall intent of the system being designed is to assist older

adults with OTC decision-making, the microsuasion approach was taken by integrating

varying persuasive technology tools into the design of the system. Fogg defines

persuasive tools as an "interactive product designed to change attitudes or behaviors".

Seven types of tools have been identified including: Reduction, Tunneling, Tailoring,

Suggestion, Self-monitoring, Surveillance, and Conditioning. Three of those tools were applied to the design of this system and are described below.

Reduction

Reduction (persuasion through simplifying) focuses on making complex tasks simpler (Fogg, 2002). The premise behind reduction technology is that by making target behaviors easier, one can increase the benefit/cost ration of performing the behavior because humans seek to minimize costs and maximize gains. Reduction can be implemented by minimizing the number of steps it takes to complete a task. One example provided by Fogg is Amazon "one-click" shopping. The argument is that because the number of steps to purchase "thing A" is reduced, consumers will be more motivated to buy "thing A". For the purposes of this research, simplifying was integrated into the prototype by providing support for medication terminology. Prior research in healthcare has identified health literacy as a potential barrier to understanding health information. In addition, in a formative study, older adults identified "complex medical terms" as a potential barrier to using OTC medication information. By providing support for simplified information in the system, the goal was to reduce the number of steps and time needed to understand the information.

Tunneling

Tunneling (guided persuasion) motivates by leading users through a set of steps to some goal (Fogg, 2002). The premise behind tunneling is that it makes it easier to go

through the process because the designer controls what the user experiences and also supports them through the process. Similarly, tunneling provides consistency, and it is believed that once a person commits to something, he or she will most likely follow through. In the prototype, the system guides the user through the process of determining whether or not an OTC medication was appropriate. The initial interface was designed to guide a consumer through the information, highlighting information that should be considered in OTC decision-making process, and supporting the user through the process by providing access to streamlined and simplified information.

Tailoring

A tailoring (persuasion through customization) technology provides users with relevant individualized information to users to change their attitudes and/or behaviors (Fogg, 2002). The premise behind tailoring is to make the task simpler by highlighting information that is relevant to the individual. Tailored information has been found to be more effective than generic information at changing attitudes and behaviors. The initial prototype was designed to provide tailoring through a custom interface designed for older adults and through custom information and/or recommendation to the consumer based on the input he or she provided to the system.

Brainstorming and Review: Round I

The first two mockups were designed as search interfaces that augmented the information provided on the OTC medication label. In Mockup A, after typing in a

medication name and searching for a medication the user would be presented with a
tabbed interface that provided information about the medication (See Figure 3-2).
Mockup B took and more informed approach where users could enter information about
any chronic illnesses or prescription medication they may have. The system would
customize information based on their input. Users would also be presented with a code
on their first use so that they could bypass some steps in subsequent interactions with the
system (See Figure 3-3). By including information on illnesses and prescription
medication, users, in addition to the augmented information, would be provided with
alerts that notify them of a potential adverse interaction.
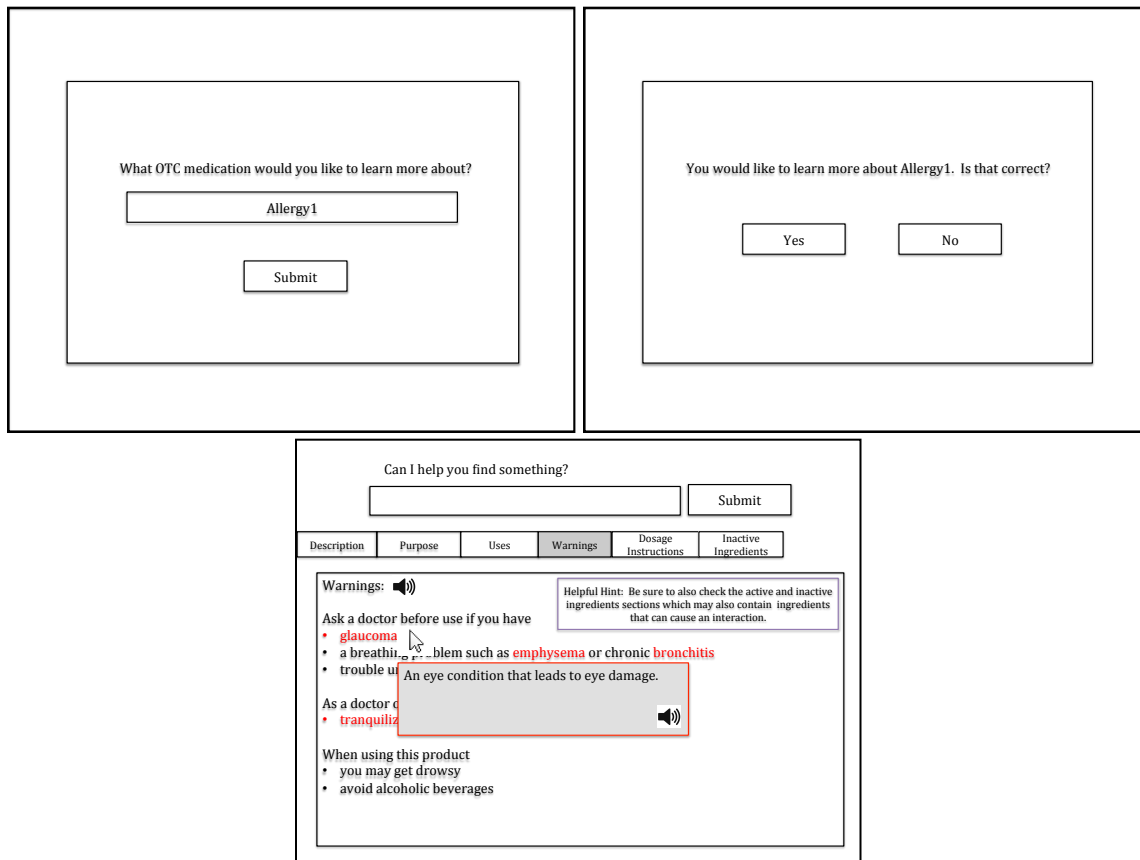
Figure 3-2. Mockup A – Search Interface with Augmented Information
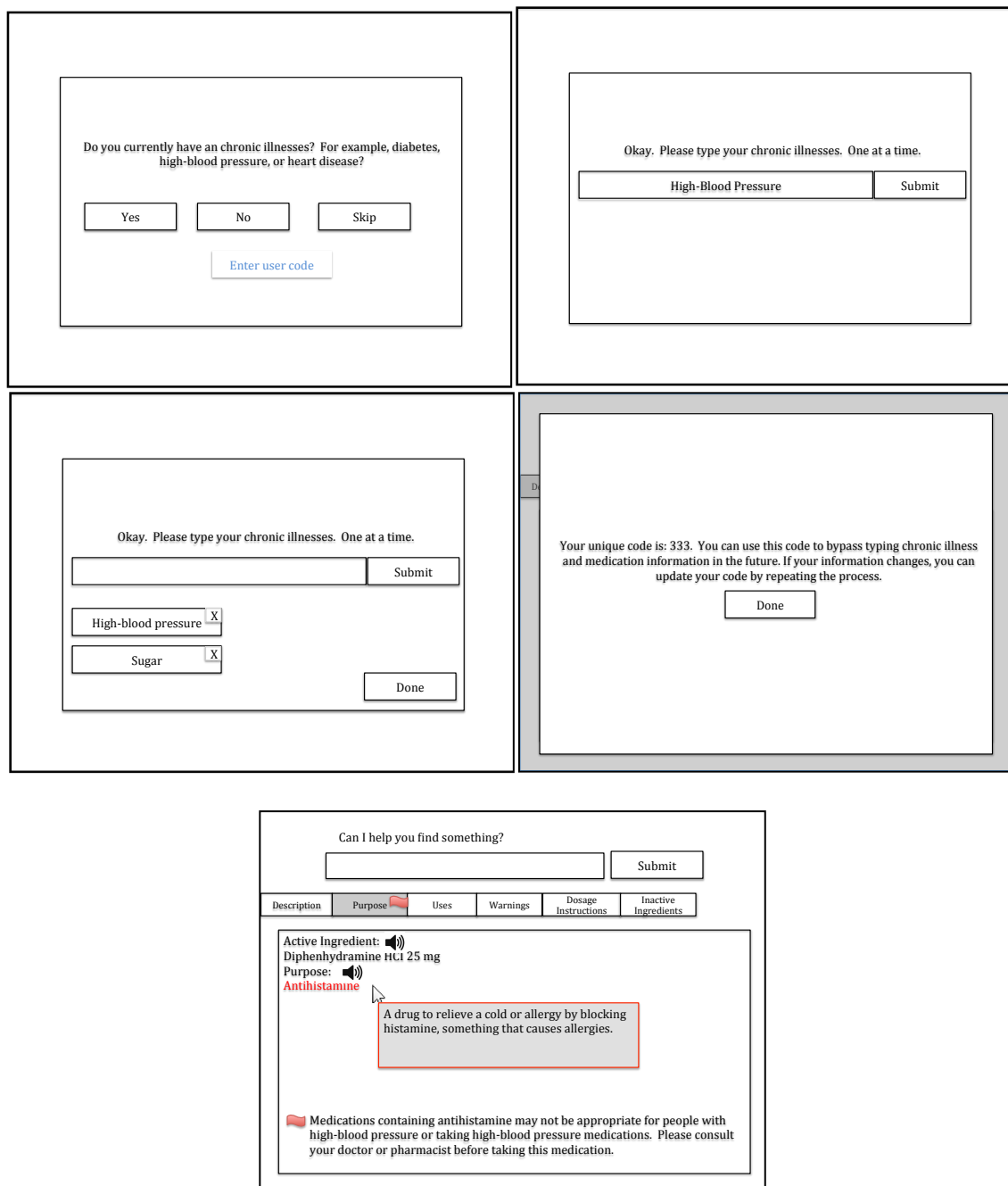
Figure 3-3. Mockup B –Search Interface with Customized Augmented Information

Protocol

Evaluation: Round I

Both mockups were designed to be presented on a multimodal kiosk and provide touch input and visual and audio output. Two HCI researchers evaluated mockups for their potential for assisting older adults with OTC consumer decision-making. Although the prototypes addressed several of the initial design goals, researchers identified several usability concerns.

- Input method – Typing (Flexibility and Efficiency of Use)

  Although typing allows users to freely search for any OTC medication, reviewers agreed that there might be issues with knowing how to spell certain medications. In addition, because the device was being designed for in-pharmacy use, there were concerns with the amount of additional time typing would add to the task at hand.

- Amount of Information Presented & Not Enough Guidance (Aesthetic and Minimalist Design)

  Tabs were added to provide formatting and to delineate the OTC medication information presented by the mockup. Although, this reduced the amount of information presented to the user by some degree, the results of the review revealed that additional guidance might be beneficial for older adults. The mockup presented the medication information with settle alerts about things to consider. However, because oftentimes consumers are not aware of the risk of OTC medication (DeWalt, 2010), it was decided that the mockups needed more

guidance and support to make consumers more aware of things they should consider in their decision-making process. Additionally, it was decided that the alerting mechanism was not pronounced enough considering the purpose of the technology is to alert older adult of potential risks.

- Privacy vs. Intelligence (Special Considerations)

  The trade-off between privacy and intelligence was key concern in the conceptualization of the initial mockup. Because the idea was that the technology could be accessed in the pharmacy, the researchers were concerned with asking users to input information in a public place and also the potential storage of that data. Mockup A approached the challenge by not asking users for any personal information. It was designed to only provide information about a selected medication and "hints" about potential risks. Mockup B was designed to allow users to type in their current medications and illnesses and the user was then provided with a code they could use to bypass these questions in subsequent visits to the system. The mockup would then provide personalized alerts of potential risks a user might have. After reviewing the two mockups, it was decided that neither approach A nor B was ideal. Therefore, the researchers agreed that a more seamless approach to providing customization while considering privacy was needed. This concern was revisited in successive designs.

Brainstorming and Review: Round 2

Following the first round of brainstorming and review, a second set of prototypes was designed to address the concerns identified in the first review (See Figures 3-4 & 3-5). Two prototype versions were designed. Both were designed as multimodal systems that allow touch input and provided both visual and audio output. The first version was designed as a recommender system. Users could choose conditions they had and/or medication they were taking and the system would provide a recommendation of whether the medication was appropriate. Additionally, alternative designs were created that included recommendation of other medications that may be appropriate. The second version of the prototype was designed to provide the user with information only. In this version, the system would alert users of any medical conditions and/or medications that might interact with the medication. The following changes were implemented to address the concerns identified in the previous review:

- Input Method – Barcode Scanner

  First, informed by prior work (Seik et al, 2011), a barcode scanner was included in the design as an input method to eliminate the need for typing. By including a barcode, users were not required to remember the spelling of medications and the amount of time it takes a user to complete a task may be reduced.

- Guidance and Amount of Information

  To reduce the amount of information presented to the user, information on the medication was limited to benefits and potential interactions with medical

44

conditions and medications. The interface was re-designed to be more persuasive and to guide users through the process while highlighting important information.

- Privacy vs. Intelligence

  To address the trade-off between privacy and intelligence, the new design included a degree of customization that did not require users to input information about illness and medications directly. Instead of asking users to directly enter information on conditions and medication, the system would suggest potential illness and medication interactions with the medication. Users could then select any options that apply to their case and the system would use this information to provide recommendation about whether or not the medication may be safe to take.

Main Navigation Sequence

Alternative Recommendation Screen

Figure 3-4. Recommender System Prototype
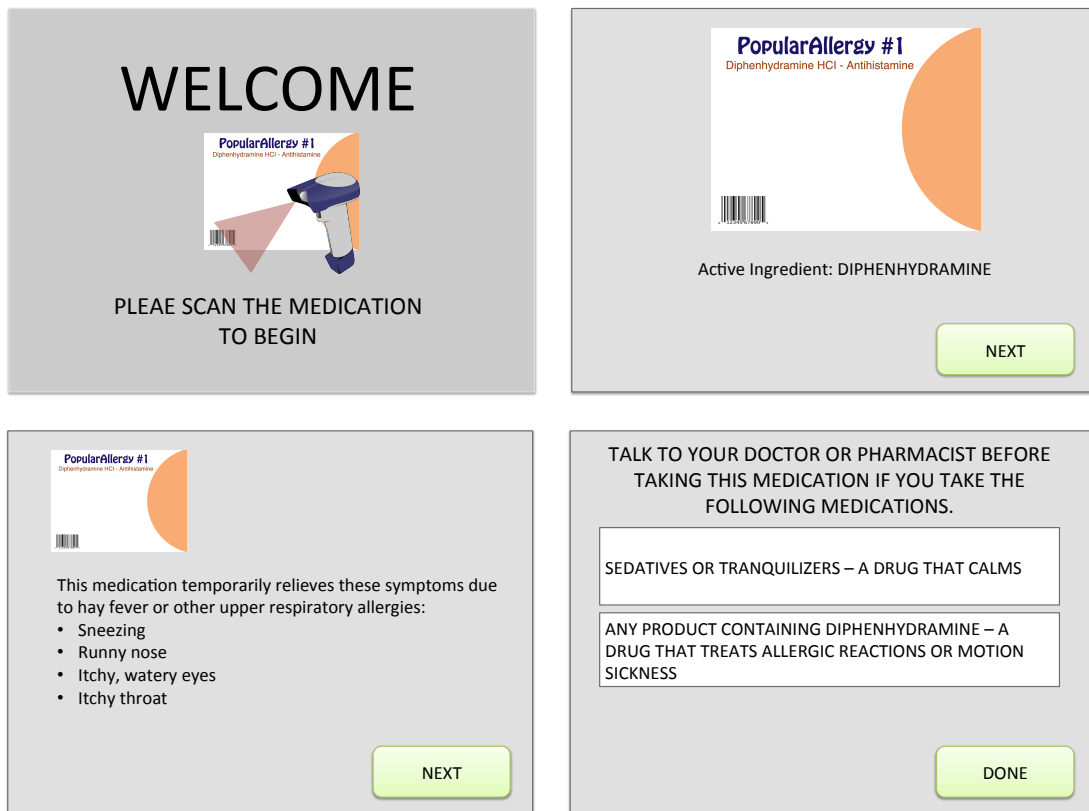
Figure 3-5. Information System Prototype

Evaluation: Round II

A review of the updated prototypes yielded several additional usability concerns. First, one reviewer mentioned based on his experience designing touch-based interfaces that include checkboxes, that the design of the checkboxes may be a problem (Consistency and Standards). The design was therefore updated to remove obvious checkboxes (See Figure 3-6). Second, there was concern for how the consumer-friendly information was presented (Match Between System and the Real World). The prototype was updated to include links to consumer-friendly language. This approach allowed us to

provide the option without altering the original information. It was also decided that a "I AM NOT SURE" option should be included in the list of medications and conditions presented to the user to minimize the risk that the user may get stuck if none apply (Error Prevention). Similarly, a "Back" and "Cancel" button was added to each screen to allow the users to go back without restarting the process and to provide an exit if needed (User Control and Freedom). Finally, coloring was added to the final screen to provide additional notification of the system's recommendation (Visibility of System Status). There was some also concern with links being displayed on a button. However, it was decided to test the concept with users to get feedback.
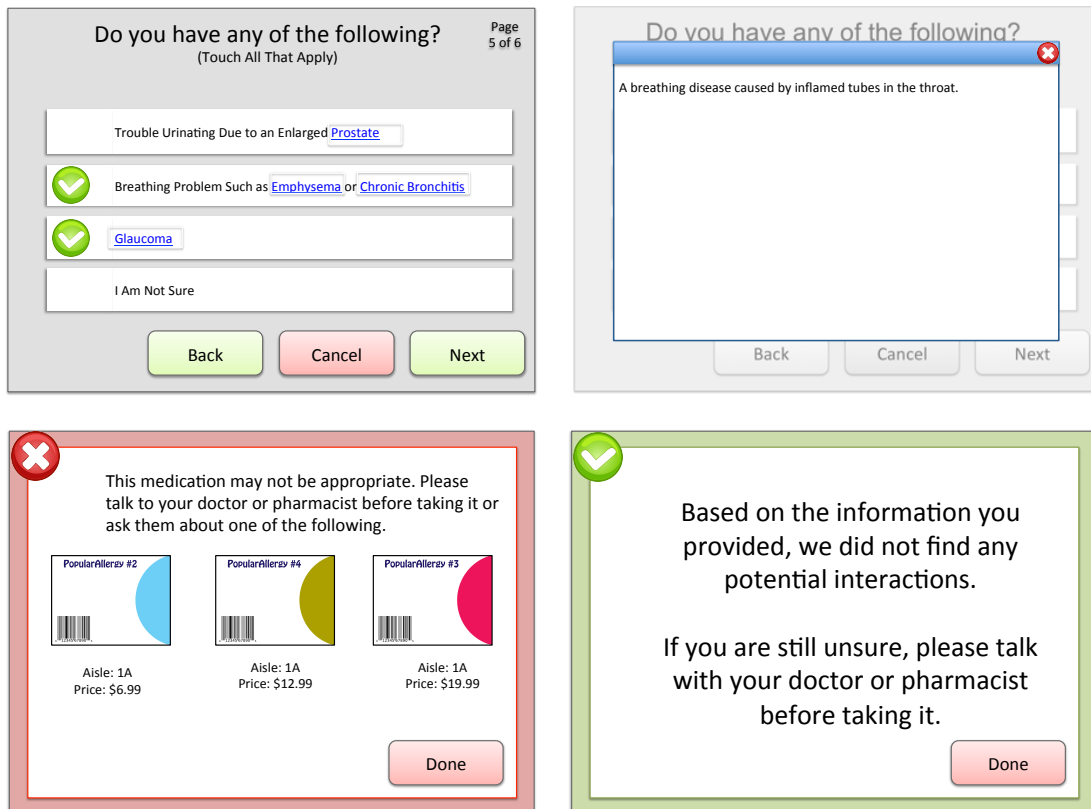
Figure 3-6. Prototype Updates

In addition to the minor usability concerns, there was still concern about the amount of medication information included in the prototype (Aesthetic and Minimalist Design). Therefore, based on a prior study, the prototype was updated to include all information included on OTC medication level, but to be presented to the user in chucks based on topic (i.e. Inactive Ingredients, Purpose) instead of all at once.

User Sessions with Older Adults

Following the expert review, the preliminary prototype was evaluated with older adults to obtain additional feedback on the usability of the prototype and learn about features they find useful to assist with the OTC consumer decision-making task. Because the focus of the technology is a consumer-decision making tool that can be used independently by an older adult consumer, participants were purposefully recruited to meet several criteria. Participants were required to be 65 years of age, purchase or select their own OTC medication, and have purchased or selected at least one OTC medication within the past year.

Seven older adults volunteered to participate (female = 3, male = 4). Participants' ages ranged from 65 – 75 (mean = 70, S.D. = 3.1). Three participants were Caucasian and four participants were African-American. All but two participants had at least some college education and all but one participant was retired. Most participants reported taking at least one over-the-counter medication per week. One participant took OTC medication every 3 – 4 months. IRB approval was obtained before the study began.

Individual sessions with older adults were conducted on-site at two locations that serve older adults populations. During a session, the participant was presented with a mixture or low-fidelity and high-fidelity paper-based prototypes of an OTC consumer decision-making technology. Participants were then provided with a verbal scenario and were asked to interact with the prototype and walk through an OTC decision-making task. The scenario involved a fictional adult that was 65 years old and with a list conditions/diseases and medications. The prototype was presented to participants on an iPad device. The design was informed by previous literature on design for older adults and expert review. It mimicked a partially functioning touch-based interface and simulated text-to-speech by speaking the words presented on the screen. It guided participants through the task of navigating the OTC medication information (See Figures 4-6).

Once the participants finished interacting with the prototype, they were asked a series of questions in the form of a semi-structured interview. Interview questions centered on several broad categories including: overall like or dislike of the prototype; motivations for use; ease of use; language; guidance; trust; and amount of information provided. The primary role of the prototype was to act as a technology probe (Hutchinson et al, 2003) and discussion point to elicit conversation on the usefulness of the features during the interview session. In addition, several alternative paper-based mock-ups were used in the interview to encourage discussion of features that were not included in the simulated prototype, but were being considered for inclusion by the researchers. The purpose of the alternative mock-ups were to elicit discussion on what additional features

participants felt were needed but not included in the current design or features that could be removed. Therefore, the design sessions were not iterative and each participant viewed the same prototype throughout the duration of the study. In addition to responses to interview questions, feedback was also collected through observation and direct response from participants on any usability and design concerns.

FINDINGS: USABILITY AND DESIGN CONCERNS

A total of 9 usability issues were identified during the study (See Table 3-2). Of the 9 usability issues that were identified 3 were identified by over half of the participants in the study. A usability issue was defined as anything that prevented the user from finishing the task at hand (Tullis and Albert, 2008). This included anything that caused confusion, not seeing something that should be noticed, not understanding the navigation, and/or misinterpreting content. During the study, participants were observed and potential usability issues were recorded on printouts of the system's interface. The researcher considered both verbal and non-verbal expressions made by the participant when interacting with the system that might point to usability issues. In addition, usability issues described in the interview transcripts were analyzed and coded.

Each of the 9 usability issues were rated based on severity to the overall design of the system. A high severity task is any issue that leads to task failure (Tullis and Albert, 2008). Two issues were rated as high severity 1) It was not clear how to move to the next step in the system and 2) It was not clear how to begin using the system. Although the tasks rated with high severity may not lead to task failure, they may deter use of the

system or prevent users from completing task. Two tasks were rated as medium severity.

Medium severity tasks contribute to task failure but do not directly prevent task failure

(Tullis and Albert, 2008). All other tasks were rated as low severity due to the small

percentage of participants that identified the issue and/or its overall impact on the system

design.

Usability Issue	Description	Number of Unique Instances	Number of Participants that Experienced Issue	Severity Rating
Issue 1	Participant mentioned that inactive ingredients are not necessary and viewing them should be optional.	4	2	Low
Issue 2	It was not clear how to move to the next step in the system.	9	4	High
Issue 3	Once the system has found one possible interaction, there is no exit and the user must finish all steps before getting to the final screen.	2	2	Low
Issue 4	It was not clear how to begin using the system.	6	6	High
Issue 5	Participant had trouble selecting buttons that listed conditions or medications that might interact with the medication.	6	3	Medium
Issue 6	Participant did not notice links to additional information about medical terms.	6	5	Low
Issue 7	Participant could not turn off speech completely.	2	2	Low
Issue 8	Participant could not hear voice user interface even at the highest volume setting.	5	5	Medium
Issue 9	Participant attempted to navigate the system using his or her voice, although speech recognition was provided.	2	1	Low

Table 3-2. Usability Concerns

Typically, five participants is recommended for usability testing as nearly 80% of

usability issues are thought to be observed with the first five participants (Lewis, 1994;

Nielsen & Landauer, 1993). Because, this is an early stage usability test on a novel

system design, seven participants were recruited to help to refine the design. Data

gathered from the seven participants reveal that the overall average proportion is 0.49,

which is the overall probability rate for the test (See Table 3-3). The probability of

detection is therefore 0.991. This suggests that ~99.1% of the usability issues found

would be identified with a sample of seven users (See Figure 3-7).

Participant	Issue 1	Issue 2	Issue 3	Issue 4	Issue 5	Issue 6	Issue 7	Issue 8	Issue 9	Proportion
P1				X		X		X		0.33
P2	X	X		X		X		X	X	0.67
P3				X						0.11
P4			X	X	X					0.33
P5	X	X		X	X	X		X		0.67
P6	X	X	X			X	X	X		0.67
P7	X	X		X		X	X	X		0.67
Proportion	0.57	0.57	0.29	0.86	0.29	0.72	0.29	0.72	0.14	0.49

Table 3-3. Average proportion of usability issues found

Probability of Detection $= 1 - (1 - p)^n$
identifies the number of users needed to identify a certain percentage of
usability issues
where p is the average proportion for a test and n is the number of users
- $1 - (1 - p)^n$
- $1 - (1 - 0.49)^7$
- $1 - (0.51)^7$
- $1 - 0.0089741$
- $\sim.991$ or 99.1% of usability issues

Figure 3-7. Probability of Detection

DESIGN CONSIDERATIONS

Interviews with older adults continued until no new insights were gained. Participants' interview responses were transcribed, coded, and analyzed for recurring themes. One researcher analyzed data initially to create a coding guide. Afterward, two researchers met several times to discuss the guide and update it based on their independent views of the data. The researchers then used the guideline to code the interview transcripts. NVivo 10 was used for final coding and analysis and a coding comparison of all themes yielded an average percent agreement of 99.176% and an average Kappa of .851746 indicating excellent agreement. Five design considerations were identified that participants found useful to help with the tasks of selecting appropriate over-the-counter medication.

Tunneling - Guided Persuasion

The prototype was designed to guide participants through the process of selecting an OTC medication (See Figure 3-3). Varying information about the medication was highlighted at each step of the process, participants provided input about conditions and medications and at the end a decision of whether or not the medication was appropriate was provided. The information highlighted in the prototype was based on the Federal Drug Administration Drug Facts guidelines and was presented in chunks based on the grouping presented in the guidelines. As mentioned earlier, the interface was designed purposefully to provide tunneling or guided persuasion in order to motivate consumers to use OTC medication information in the OTC decision-making task. When asked to

discuss the wizard-like interface, all participants in the study (n=7) expressed a favorable impression of the wizard concept. For example, Participant 1 commented on the usefulness of the approach:

"I like the wizard approach, stepping people through and going down different paths depending on the response" (P1)

In short, participants discussed that having the system guide them through the process of selecting a medication was something they viewed as beneficial for the prototype and useful for helping with an OTC decision-making task.

Personalization, Tailoring, and Decision Support

Although the prototype was tailored to the design needs of older adults, the original prototype provided a limited degree of personalization. Participants were presented with conditions and medications that might potentially conflict with the OTC medication that they were considering and were asked to check any that apply. While most participants liked this approach, it only acted as a data gathering step to provide data to the prototype's decision support algorithm. However, some participants suggested that the system should have an option for providing a higher degree of customization at the individual level. Participant 4 stated:

"My wife has a thing called Sweet's syndrome. She can't take any steroids. I believe one of the things in here was some sort of steroid, as an inactive ingredient. One

of the things … you need to have a person maybe list the conditions that they have at the

beginning so that they can weed out the medications that they definitely can't take." (P4)

Similarly, when asked if she felt the prototype provided enough information, another participant stated:

"It didn't say this medicine may affect people who have diabetes … It should be

listed if it's going to interfere with people with diabetes I think it should be listed." (P3)

The condition mentioned by Participant 4 was not included in the warnings section of the medication box and therefore was not included in the prototype. However, some participants discussed in the interview that they wanted more individualized information. Participants discussed having the ability to input information about medications or conditions before using the system. Others mentioned going beyond the information on the label to include other information such as potential condition/ingredient interactions that may not be specifically stated on the label, which suggests another degree of reasoning of the data that was not provided by the prototype at the time of this study.

Trust and System Recommendation

To spark discussion in the interview sessions, alternative screen mock-ups were included that only provided participants with information about an OTC medication they were considering. In comparison with the high-fidelity prototype in which the participant

first interacted, the alternative mockup did not prompt the user to select any medications or conditions they had or were taking; and did not provide a recommendation of whether the medication was appropriate.

To the surprise of the researchers, all participants (n=7) indicated a system that provided a recommendation would be more beneficial to them than a system that provided information only. The researchers were torn on whether or not users would trust or find a recommendation provided by a machine useful. This is a well-known concern when designing persuasive technology (Fogg, 2002). However, when asked, all participants (n=7) indicated they would be comfortable acting on a recommendation made by the system and preferred the prototype that made a recommendation over the prototype that only provided information. On the other hand, most participants also discussed the need for a stronger disclaimer/language to ensure consumers would be aware that the system did not replace the advice of a medical professional.

Participants also talked about the benefit of having the system provide alternative medication options if the medication they selected was not appropriate. This feature was provided as an alternative to receiving a message stating that the medication is not appropriate. All participants (n=7) preferred to receive recommendation of other medications that might be appropriate as opposed to a "not appropriate" message only.

Consumer-Friendly Health Language

The prototype provided consumer-friendly explanations of different medical terms with the goal of helping participants better understand the overall risks or warnings

being presented to them. This was an attempt to simplify the medication information and motivate consumers to complete the task. Although most participants did not notice this option when interacting with the prototype, all participants later indicated that the consumer-friendly explanations of medication terms would be beneficial to helping them better understand the information if they needed it.   Participant 4 stated:

"I think people would know I'm taking something for anxiety or I'm taking something for depression. They may not even remember the name of it. I don't pay attention. I take blood pressure medication and cholesterol medication. When I fill out a form what medication I'm on, I can't remember." (P4)

Another participant discussed his frustration with medication information and why he felt language support was useful:

"It's intimidating because it's so much information and what am I supposed to do with it? Am I supposed to understand it? Am I supposed to recognize those chemicals? It's a bit intimidating." (P6)

Although most participants indicated that they found the language support useful, the interview data also reveals that more attention needs to be paid to how consumer-friendly language can best assist in the task at hand. For example, most participants did not think that the inactive ingredients needed explanation although they too can be seen as complex medical terms. On the other hand, some participants describe that they would like to be alerted of potential interactions with ingredients. Most participants indicated

that the explanations provided about medications in the warnings section were useful but data reveal that the concept of providing consumer-friendly language should be further studied to understand what information should be included, the language that should be used, and how to increase the visibility of the feature.

Support for Sharing

Initially, the prototype presented to the participants did not include any options for sharing information about an OTC medication selection or the results obtained from the system. However, interview data revealed that options for sharing the information provided by the system might not only be helpful for making an independent decision, but also for initiating discussions with the pharmacist or doctor. The words doctor, pharmacist, drugstore man, and druggist (pharmacist) were mentioned 34 times by participants over all interview data. Six of the seven participants discussed that they may talk with a doctor or pharmacist in addition to using the system, if they had follow-up questions or were still unsure about a medication. Participant 5 stated:

"I mean, you're always going to need the pharmacist's help, ... but this would help you… that would save ... you can find a lot of stuff yourself" (P5).

The other five participants made similar comments in their interview. This suggests that the system was viewed as designed, a supplement (not a replacement) to the doctor or pharmacist. However, the data also reveals the importance of providing users with information that can assist in their conversations with the doctor and/or pharmacist. This feature was not considered as a primary concern in the preliminary design.

However, interviews suggest that providing sharing options that support communication between the consumer, doctor and/or pharmacist may also be beneficial to assisting in the decision-making process. Keeping the consumer informed helps them to become more knowledgeable and aware of their own medication management practices. This can help to create an informed consumer that comes to the conversation more ready to participate. Sharing also provides the doctor with information on how his or her patient's medication practices at home and helps to facilitate a conversation in which the consumer already has some knowledge or stake.

DISCUSSION AND CONCLUSION

Including older adults in the early stages of design for this novel technology helped to refine the initial prototype design and also helped to refine the initial model of how technology can be used to support older adults in this task (See Figures 3-8 & 3-9).
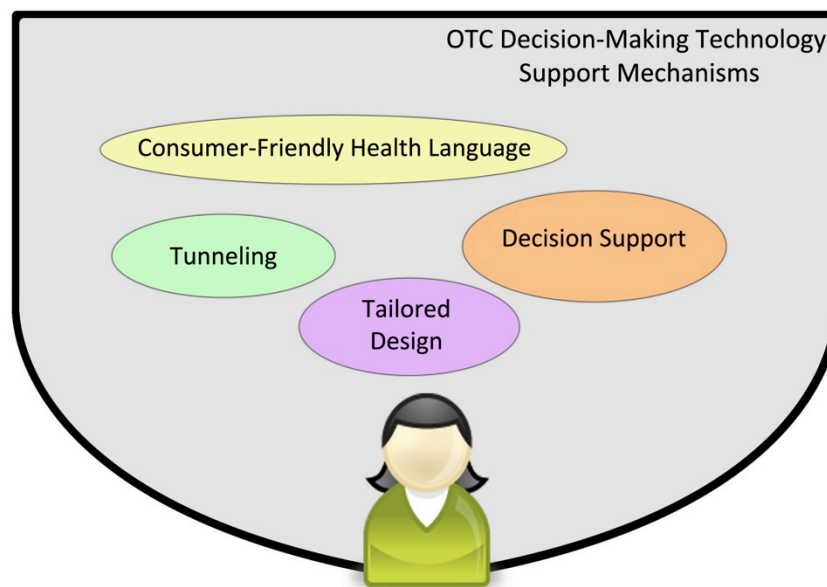
Figure 3-8. Initial Model of OTC Decision-Making Technology Support Mechanisms
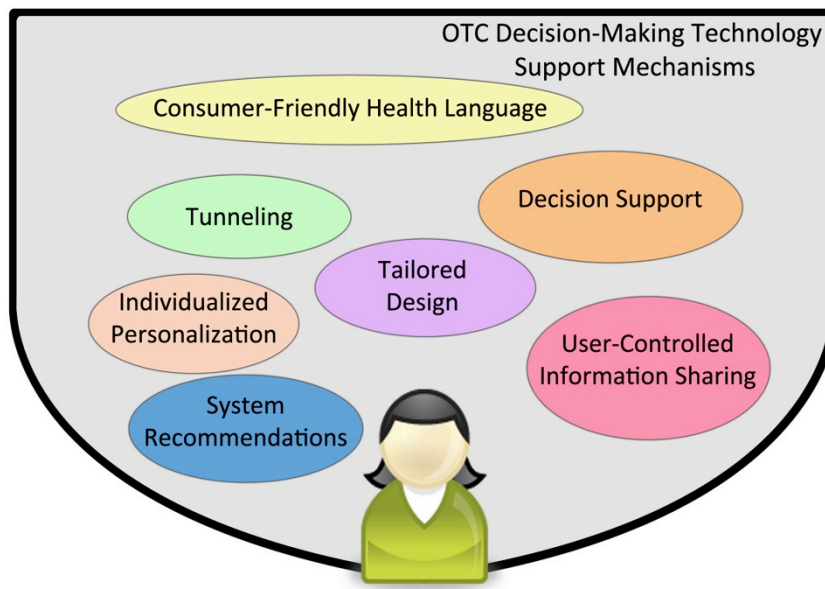
Figure 3-9. Revised Model of OTC Decision-Making Technology Support Mechanisms

Initially, the prototype included four types of technology support mechanisms in the design. The initial design included the concept of tunneling or guiding the user through a set of defined steps. This helped to highlight information that was important for older adults to consider when selecting an over-the-counter medication. The prototype was designed for the older adult population using guidelines (e.g. font-size) that are suited for the older population. In addition, the design included consumer-friendly health language provided through automatic generated explanations of health terms and decision support of whether or not a medication was appropriate given the users input. Obtaining feedback from older adults helped to refine this model by identifying other ways technology could support the OTC decision-making process.

In addition to the initial support mechanisms, data revealed that technology could also be helpful by providing the user with system recommendations through information filtering of user data to predict other medications that may be appropriate. Users expressed that they would also be interested in having more control over the system's input and output. Some participants expressed the need for a more individualized level of personalization by allowing input of information about chronic illnesses or medications to help refine the decision support. Similarly, some participants also discussed going beyond the information on the box to include other information about potential interactions that might be beneficial to the decision-making process. This also included a suggestion for including an additional level of reasoning for identifying potential adverse reactions to the medications ingredients. Finally, because nearly all users stressed the importance having the option to keep the pharmacist/nurse/or doctor in the over-the-counter medication process in some way, user-controlled information sharing was added to the model to not only support consumers in the decision-making process, but also to help facilitate discussions about potential OTC medications with persons of their choosing.

Helping consumers understand health information is a challenging task (Nielsen-Bohlm, 2004). OTC medications are of particular concern among older adults, however some believe that technology can help address this challenge (Healthy People, 2010; Martin, Jones and Gilbert, 2013; Neafsey, Strickler, Shellman and Chartier, 2002). The goal of this study was to refine the design, understand, and explore technology features that may be beneficial to assisting older adults in this task. Through expert review and

brainstorming, researchers designed a concept for a novel prototype system to help older

adults with OTC medication selection. In addition, seven older adults users were

engaged in user sessions to identify usability issues in the initial prototype system and to

identify features and functionality that might be useful in system designed to assist with

over-the-counter medications. Nine usability issues were identified by 7 users in the

current design representing a probability of detection of .917. Therefore, 99.1% of

usability issues would be identified with the 7 users included in the study. In addition,

five design considerations were identified for technology to assist older adults in the task

of selecting appropriate OTC medications.

LIMITATIONS AND FUTURE WORK

The results of this study provide discussion of the process of designing an

interface that supports older adults in the OTC medication decision-making process.

Through user sessions with older adults, existing usability concerns were identified

(Tullis and Albert, 2008). In addition, qualitative data was collected to identify ways

technology can support older adults in the over-the-counter decision-making process.

Because no such technology currently exists for assisting older adults in these tasks, it

was important to gain feedback early in the design to understand what features and

functionalities provided by technology would be most supportive in this task. The study

included several rounds of expert review and interviews with seven participants (age

65+), which is more than the recommended number of participants for usability testing

(Lewis, 1994; Nielsen & Landauer, 1993). A rich, thick description (Creswell, 2013) of

the study and its participants is provided and although user sessions were conducted until no new data emerged from the accompanying interview with participants, the study may be limited by number of people interviewed. Therefore, additional studies will be performed on the revised prototype to determine if the findings of this study can be generalized to a larger population.

The design considerations, feedback, and model identified in this study will be used to inform the design of current and future technologies developed to help with OTC decision-making tasks. The data from the expert review and study with older adults revealed several opportunities for technology to support older adults in the OTC decision-making tasks. The new model will be used to guide design changes in the current prototype interface and to guide the implementation and study of other technology support mechanism (e.g. decision support algorithm, health text-simplification approach) that will be included in the system implementation. Although many of the features identified relate specifically to the task of selecting appropriate over-the-counter medications, some considerations may be useful to the design of other consumer-decision making applications for older adults.

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CHAPTER FOUR

DESIGNING AND EVALUATING A PROTOTYPE TRANSLATOR TO SUPPORT

OLDER ADULTS COMPREHENSION OF OVER-THE-COUNTER MEDICATION

INFORMATION

ABSTRACT

Understanding health information is a huge public health concern that affects many in the population. Every year thousand are injured or die due to adverse medication interactions. Over-the-counter medication (OTC) can be purchased at will by consumers and contribute to a number of adverse medication interactions. Older adults are at higher risk of adverse medication interactions due to factors related to aging. Technology is thought to be advantageous for communicating health information to various users. Further, technology that is customized to the needs of the target population has been found to improve health outcomes.

This study evaluates the feasibility of a prototype translator designed through a human-centered process that simplifies over-the-counter medication information for older adults. This study is part of a larger Exploratory Sequential Mixed-Methods study that aims to understand how technology can be used to improve the understanding of OTC medication among the older adult population. The effectiveness of the prototype translator for providing patient-centered information about OTC medication compared to information that does not use the translator was evaluated. Older adults were asked to participate in an experiment that examines the effect of the translator on the participant's beliefs about the difficulty of the information. The experiment followed a within study

design. Perceived difficulty of the information, participants' confidence in using the

information and their belief about how much control they have over using the

information to complete the tasks was measured. In addition, participants were asked to

answer comprehension questions to determine if the technique makes the process of

understanding the information less difficult. Results suggest that the prototype translator

may improve beliefs about self-efficacy, the participants preferred using the translator,

and the participants found the translator helpful for understanding the OTC medication

information.

INTRODUCTION

Helping consumers understand health information is a sizable public health

concern (Nielsen-Bohlm, 2004). In a non-clinical setting, consumers often rely on clear,

easy to understand health information to make important decisions regarding their health.

Tasks such as choosing appropriate over-the-counter medication (OTC) become

primarily the responsibility of the consumer. Quality measures exist to support consumer

safety and improve consumer knowledge but gaps in communication still exist putting

consumers at risk (DeWalt, 2010; Institutes of Medicine, 1999). This research focuses on

improving the communication of OTC medication information to the older adult

population.

Advances in technology provide new opportunities and mediums for

disseminating and communicating medication information to various user groups.

Coupling effective communication with health information technology is thought to

improve the consumer experience irrespective of computer skills, and may lead to improved health outcomes (Radvan, Wigger, & Hazell, 2004). To date, researchers have explored ways of designing computer-based medication interventions that can assist various populations with different aspects of their medication management regimen including: scheduling, ordering, compliance or adherence, concordance and/or medication education (in-hospital or at home) (Bickmore, Pfeifer and Jack, 2009; Hoogendoorn, Klein, and Mosch, 2008; Qudah, Leijdekkers, and Gay, 2010; de Oliveira, Cherubini, and Oliver, 2010; Silva, Mouttham, and El Saddik, 2009; Siek et al, 2011; Wilcox, Feiner, Liu, Restaino, Collins, and Vawdrey, 2012; Neafsey, Strickler, Shellman and Chartier, 2002; Harjumaa, Isomursu, Muuraiskangas, and Konttila, 2011). However little to no research has focused on the specific task of OTC decision-making especially among the older adult population. Like some of the other medication management tasks, OTC decision-making requires the consumer or another vested party to take on a role that a healthcare provider might administer in a clinical setting (e.g. administering medication, ordering medication). However, this task is unique in that, the consumer or other vested party must also take on the task of understanding the medication information provided, the benefits and risk, how the medication may or may not fit into his or her existing regimen, and/or how the medication may affect his or her existing health all with little or no healthcare provider oversight (DeWalt, 2010; Institutes of Medicine, 1999). The consumer in some way takes on a role that is similar to a healthcare provider but may not have the training of a healthcare provider. For older adults, the task of choosing appropriate OTC medication is made more complex due to factors related to the natural

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process of aging. Therefore, this study extends previous research by taking a first step at exploring ways technology may be useful in the OTC decision-making process for older adults. The study will evaluate the feasibility of a prototype translator that was designed to address one of the barriers to communicating OTC medication information, complex medical terminology, identified in a preliminary study with older adults.

This study was conducted in locations within the local community with adults 65 years and older. Community dwelling older adults were chosen because the prototype translator used in this study is being evaluated for use in an intervention tailored to the needs of older adults that select or purchase their own OTC medication.   Older adults participated in an experiment that examined 1) perceived difficulty, self-efficacy, and controllability 2) comprehension and 3) actual difficulty. Well-developed measures for evaluating information difficulty and OTC medication comprehension were used. In addition, observational measures (event coding and task completion of comprehension questions) were recorded and an informal questionnaire was administered at the end of the interview to collect information preferences, helpfulness, and suggested improvements. Therefore the specific aims of this study were to:

1. Evaluate the feasibility and effectiveness of a prototype translator designed to reduce the difficulty of OTC medication information for community-dwelling older adults.

2. Identify additional opportunities for the prototype translator to reduce the difficulty of OTC medication for older adults.

BACKGROUND AND RELATED WORK

Over-the-Counter Medication and Consumer Safety

Every year thousands die or are injured due to adverse drug events (ADEs) as a result of taking medication (DeWalt, 2010; Institutes of Medicine, 1999). Overall, medication interactions have been found to be the main cause of ADEs. Although legislation exists that provides guidance for accurate and easy-to-read labeling for medication, ADEs due to medication still occur (United States Food and Drug Administration, 2009). Furthermore, older adults or individuals 65 years and older are potentially at higher risk of ADEs due to several factors. Unlike prescription medication, OTC medication can be purchased at will by a consumer and requires the consumer to facilitate the process of determining if the medication is appropriate given their health history (DeWalt, 2010; Institutes of Medicine, 1999). Older adults account for nearly 40% of all OTC medication use, use twice as many OTC medications compared to prescription medications and on average, take between 6 and 9 medications concurrently (Conn, 1992; Glaser and Rolita, 2009; Rolita and Freedman, 2008). Older adults are also at higher risk for chronic illness, placing them at increased risk of drug-disease interactions. Older adults also tend to have lower health literacy levels compared to other age groups meaning that older adults may find it more challenging to "understand and act upon health information" (Nielsen-Bohlm, 2004). Therefore, OTC consumer decision-making can become daunting and complex task for older adults (Martin, Jones, and Gilbert, 2013; Neafsey, Strickler, Shellman and Chartier, 2002). This research therefore

focused on evaluating the effectiveness and feasibility of translator designed for older adults that aims to reduce the difficulty of OTC medication information.

Challenges to Communicating Medication Information

Currently, the primary information source for OTC medication information is the OTC medication label or Drug Fact Label (United States Food and Drug Administration, 2009). The purpose of the label is to orchestrate a complex set of behaviors by the consumer (Brass and Weintraub, 2003). Most consumers who decide to read the label use only the label to make his or her decision and many do not read the label at all (Brass and Weintraub, 2003; Covington, 2006). Several studies have identified barriers to communicating OTC medication information through a print medium and have suggested improvements for making medication information more useful and useable by different populations (Brass and Weintraub, 2003; Klein and Issacson, 2003; Morrow, Weiner, Young, Steinley, and Murray, 2003; Sansgiry, Bix, Clarke., and Pawaskar,2005). However, print mediums still have limitations. Some researchers believe that technology may be a potential medium for addressing some of the limitations of print-based text (Healthy People 2020; Gibbons et al, 2009).

Consumer Health Informatics (CHI) is an area of public health that is concerned with how to communicate health information to consumers through technological means (Gibbons et al, 2009). CHI researchers attempt to "analyze" consumers' need for information; and study and implement methods for making information usable to consumers (Eysenbach, 2000). A review of CHI literature shows that CHI applications,

in particular those that include tailoring, personalization, and/or behavioral feedback contribute to favorable health outcomes (Gibbons et al, 2009). Both tailoring and personalization involve building customized interventions based on knowledge of an individual's or group's characteristics (Gibbons et al, 2009). This research focuses on evaluating a tailored intervention designed for older adults through a human-centered design process. Data gathered from prior studies informed the design of the first version of the translator that is used in this study. Additional opportunities for reducing the difficulty of OTC medication for older adults will be identified in this study and integrated into forthcoming versions of the translator.

Human-Centered Text Simplification

Simplifying text is a one way to reduce the complexity of text. Government advocacy groups have emphasized the importance of the role of simplified text for helping consumers better understand health information (Center for Plain Language, 2012; PlainLanguage.gov, 2012; U.S. Department of Health and Human Services, 2012). The Plain Language Act of 2010 requires federal agencies to use "clear Government communication that the public can understand and use" (U.S. Congressional Committee of Oversight and Government Reform, 2010). PlainLanguage.gov was created to provide guidelines to the public on how to comply with the law (PlainLanguage.gov, 2012).

Similarly, in Natural Language Processing, researchers have created techniques for simplifying health information automatically using various translators. This

approach, known as text simplification, takes a sentence in a document, runs it through

the technique, identifies "difficult terms", and systematically replaces the terms with

synonyms and/or explanations until the sentence has been simplified (Siddharthan, 2004).

This process is repeated until all sentences in the document have been simplified (See

Figure 4-1). Difficult terms and the level of simplicity needed is often defined by the

designer and often evaluated through readability testing (Kandula, Curtis, and Zeng-

Treitler, 2010; Boyce, Hrakema, and Conway; 2010; Elhadad, 2006). Few studies,

evaluate the technique directly with users. This study examines the effectiveness of a

prototype translator designed for simplifying OTC medication information directly with

older adults users.
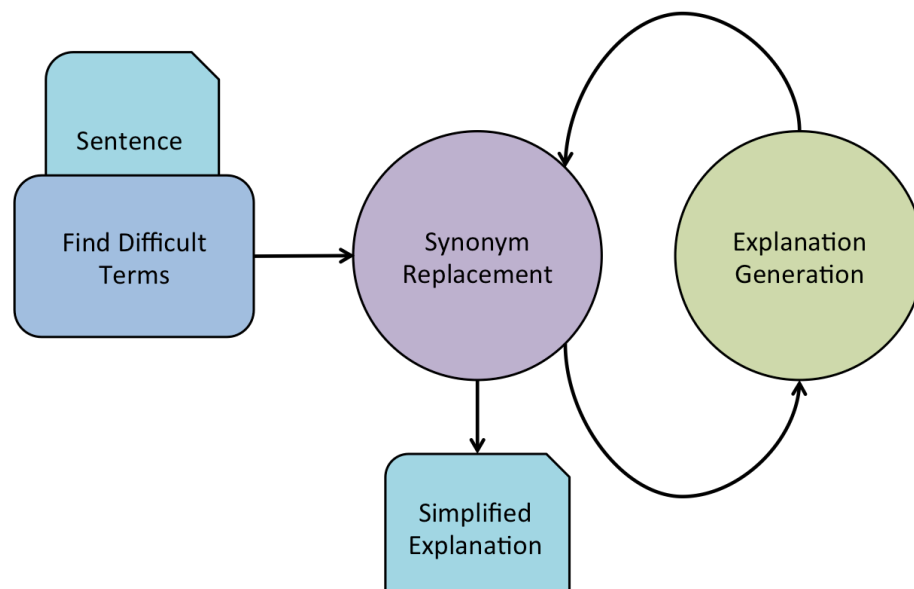
Figure 4-1. Text Simplification Process (Siddharthan, 2004)

STUDY DESIGN

This study examines the feasibility and effectiveness of a prototype translator designed to assist older adults with over-the-counter medication information. The translator was designed through a human-centered process in which information needs were gathered and later included in a prototype to elicit additional feedback from participants. The results of prior studies were used to inform the design of the translator being examined in the proposed study.

Due to the limited resources available to support automated text simplification of health information, few studies exist that focus on designing and evaluating such techniques. This study is innovative because no study has examined how to design a translator for simplifying over-the-counter medication information automatically. In addition, most studies that focus on automatic text simplification of health information do not evaluate the effectiveness of the technique directly with the targeted user group. Instead, most studies use readability testing (e.g. Flesch Kincaid, SMOG) to evaluate the effectiveness of the technique for simplifying health information (Kandula, Curtis, and Zeng-Treitler, 2010; Boyce, Hrakema, and Conway; 2010; Elhadad, 2006). Although readability tests provide a indirect measure of how simple the information is, the proposed study aims to understand if the technique impacts users intention to use the medication information in the decision making process and also older adults comprehension of the medication information. This study, therefore, aims to advance previous research in this area by examining the effectiveness of the technique directly with users from the target population as opposed to indirect measures. The goal is to

better understand the effect of the translator on intention of older adults to use the OTC medication information in their decision-making process and also to gain feedback on how to improve future iterations of the technique.

THEORY OF PLANNED BEHAVIOR (TPB)

TPB definition and background

The theory of planned behavior has been used widely in healthcare studies that focus on human action (Ajzen, 1991, 2002, 2013). In TPB, it is believed that human behavior is guided by three types of beliefs: behavioral, normative, and control (See Figure 4-2). Behavioral beliefs are "beliefs about the likely outcomes of the behavior and the evaluation of these outcomes" (Ajzen, 1991, 2002, 2013). Normative beliefs are "beliefs about the normative expectations of others and motivation to comply with these expectations" (Ajzen, 1991, 2002, 2013). Control beliefs are the "beliefs about the presences of factors that may facilitate or impede performance of the behaviors and the perceived power of these factors" (Ajzen, 1991, 2002, 2013). These beliefs help to form a behavior intention. According to the theory, an individual's intention to perform some behavior is indirectly influenced by one or more of the three beliefs. In addition, if given enough actual control over a behavior an individual is expected to carry out the behavior (Ajzen, 1991, 2002, 2013). Interventions that aim to change behavior should therefore address one or more of the three factors. In other words, interventions that persuade humans to change behaviors should focus on changing individual normative, behavioral, and/or control beliefs.   However, when choosing which factor(s) to address, it is

important to consider the potential degree of change that can be made in the area being targeted. Therefore, formative research can be a very important step on choosing which belief(s) to target in an intervention (Ajzen, 1991, 2002, 2013).
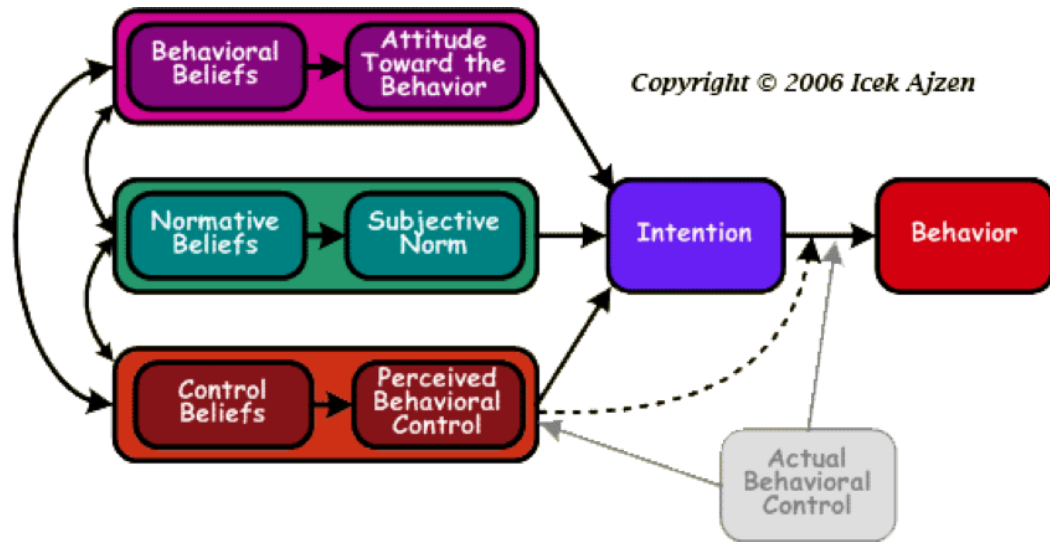
Figure 4-2. Theory of Planned Behavior (Ajzen, 1991, 2002, 2013)

Why TPB?

The TPB is one of many theories about human behaviors, but is thought to be one that is more suited for studies involving communication and media (e.g. computer-based interventions) (Finnegan and Viswanath, 2008). When humans communicate, they produce and exchange information using symbols and signs and communication is thought to be a central tenant of understanding human behavior (Finnegan and Viswanath, 2008). For studies examining the impact of media exposure on individual

behavior, several theories have been used. However, expectancy value theories such as the TPB are more often used and found to offer explanation for media effects on behavior at the individual level.

In this study, the effect of the prototype translator (the media) on the control beliefs (perceived difficulty and perceived controllability) of older adults will be examined (Finnegan and Viswanath, 2008). According to the TPB theory, control beliefs are often measured by a perceived control component. Although there is some guidance provided for measuring perceived control, no single measure exists (Kraft, 2005). For the purposes of this study, two measures will be used: perceived difficulty (self-efficacy) and perceived control (controllability). Perceived difficulty is defined as a "person's belief as to how easy or difficult performance of the behavior is likely to be" (Ajzen, 1991, 2002, 2013). Perceived control is defined as "the extent to which a person perceives the behavior to be under their control" (Ajzen, 1991, 2002, 2013). These components together were used to measure older adults control beliefs about the difficulty of the OTC medication information presented to them with and without the translator.

In a previous study, the difficulty of medical terms on OTC medication labels, were found to be a barrier to communicating OTC medication information to older adults (Martin, Jones, and Gilbert, 2013). In other words, the older adults interviewed found it difficult to understand some of the medical terms that appeared on the OTC medication label. A translator was developed to improve the difficulty of the medical terms and provide older adults with more control over the task of using the label information to decide whether or not an OTC medication is appropriate. Therefore, the OTC medication

information simplified by prototype translator is expected to support more favorable control beliefs and thereby increase older adults intention to use the label information for making decisions about an OTC medication.

APPROACH

Simplification Technique

This study is part of larger Exploratory-Sequential Mixed-Method study on the use of technology to assist older adults in the OTC decision-making process (Creswell, 2013). Prior to this study, a preliminary study was conducted that focused on the design of the OTC medication translator being evaluated in this study. Information retrieval approaches were identified for providing synonyms and explanations of complex medical terms appearing on OTC medication labels. The synonyms and explanations were first identified using a manual search method. The manual search method was informed by results of previous studies that suggested that older adults may have trouble understanding certain terms on the OTC medication label (e.g. chronic illnesses, medication names) (Martin, Jones & Gilbert, 2013).

Building the Controlled Vocabulary

One limitation of providing automatic text simplification for health information is that there are limited data sources (e.g. corpora, dictionaries, controlled vocabularies) that exclusively support automatic translation from medical terminology to consumer health terminology (Zeng & Tse, 2005). Therefore, one of the first steps in designing an

automatic simplification technique was to identify data sources that could support the translation from medical terminology to consumer health terminology. Because, the purpose of the translator is to provide decision support, it was important that any data source that was used be validated. As mentioned before, many resources for automatic text simplification that are available do not exclusively support translation of medical information. Further, many do not provide support for the translation of medical terms. One of the few resources that showed promise was an effort by Zeng and Tse (2005) to create an open-source consumer health vocabulary. However, after examining the feasibility for this experiment, many of the terms that were identified were not yet included in the database. Therefore, although this effort shows a move toward supporting automated simplification of health text; it was not yet sufficient for use in this experiment.

Because, an existing data source could not be identified, the researchers instead created a controlled vocabulary from a validated paper-based resource. The Plain Language Thesaurus for Health Communications published by the National Center for Health Marketing, The Department of Health and Human Services, and the Centers for Disease Control is a validated resource that provides plain language equivalents to medical terms, phrases, and references (National Center for Health Marketing, Department of Health and Human Services, and the Centers for Disease Control, 2007). However, to date, the thesaurus only exists in paper-based form. For the purpose of the experiment, the researchers created a script that parsed the document to create a digital

version of the thesaurus. This served as the basis for the controlled vocabulary used to support the tool.

Fifty medications were chosen randomly from the Food and Drug Administration (FDA) Drug Database and were used as a training set. The FDA Drug Database uses Structured Product Label Format (a type of XML). Medication manufacturers use SPL to create labels that comply with FDA requirements use this format.   Currently there is no Application Programming Interface (API) for accessing medication label information. Therefore, the raw data files for Human OTC Medications were downloaded and used as the overall data set for creating the technique. At the time of download there were 22,698 Human OTC Medications in the dataset. This data set included all OTC medications including pain medication, allergy medication, and cough syrup, but also lotions, hand sanitizers, and medicated lip balm. Therefore, the researcher chose randomly from the set, selecting only medication that could be administered through ingestion (e.g. liquids and tablets) until the training set included 50 medications.

To supplement the terms included in the Plain Language Thesaurus, the terms included in the 50 medications in the training set were analyzed manually for potential inclusion as a difficult term. In doing so, the researcher focused on identifying medical conditions, chronic illnesses, and medication names/types because these were identified in a previous study as being difficult to understand.   Two hundred unique difficult terms were identified in the first round of manual analysis of the 50 medications. Terms were compared with the terms in the Plain Language Thesaurus to determine if it could sufficiently provide mappings to consumer-based terms. From this round of analysis, it

was determined that although the Plain Language Thesaurus provided support for many of the condition names, however many of the medications that had been identified as difficult terms were not currently present in the database. Therefore, Medline Plus Health Topics was used to provide definitions for the terms not included in the database.

Mediline Plus is a validated course of consumer-based health information. It provides and API and a search tool for retrieving information about health terms. Forty-six additional terms were added to the database using Medline Plus. Terms in this group appeared 388 times over all 50 documents. Definitions for the 46 additional terms were generated using Medline Plus based on a "is a" rule meaning that the text following TERM "is a" was used as the consumer health explanation equivalent. In total, the controlled vocabulary created for this experiment includes 2689 terms with corresponding consumer-based definitions. The vocabulary served as a database for the translator for simplifying terms identified as difficult medical terms.

The Prototype Translator

The prototype translator implemented for this study borrows from the idea of text-simplification (See Figure 1). In simplest form, the process of text-simplification, lexical simplification, involves mapping and replacing more complex terms to simpler terms or phrases. While this may seem trivial, one of the major hurdles of this approach is finding a dictionary to provide these one-to-one mappings (Zeng & Tse, 2005). Syntactic simplification is the process of automatically restructuring complex sentences into simpler sentences. When considering the idea of replacing terms with phrases or

restructuring sentences, the syntactic structure of the sentence must also be considered since the goal of text simplification is to make the text simpler while preserving the meaning of the sentence (Damay, Lojico, Lu, Tarantan, & Ong, 2006).

The translator used for this project borrows from lexical simplification by providing mappings from complex terms to their consumer-based equivalents (terms or phrases). Lexical simplification was chosen as a first step because one goal of this study was to determine additional ways to deliver the health information to user. In addition, lexical simplification has been one to approach that researchers employ for simplifying health text (Leroy, Endicott, Kauchak, Mouradi, and Just, 2013; Leroy, Endicott, Mouradi, Kauchak and Just, 2012; Kandula, Curtis, and Zeng-Treitler, 2010). The translator that was created was therefore designed to provide a 1-1 mapping to terms and phrases provided in the controlled vocabulary.

The translator retrieves text from a database of medications, parses the text to identify difficult terms, and provides simplified terms or explanations to the user in the form of an alternative consumer-based term or phrase (See Figure 4-3). Difficult terms were defined as any term appearing in the controlled vocabulary. The controlled vocabulary included single terms such as "diabetes" and compound terms such as "bowel movement". Because some terms appeared both as a single term and as part of a compound term (e.g. "allergic" and "allergic reaction") in the controlled vocabulary, when parsing the original medication text, the parser used a sliding window approach to identify compound medical terms. In addition, before comparing terms found in the

medication text with terms in the controlled vocabulary, punctuation was removed to increase the hit rate for matches.
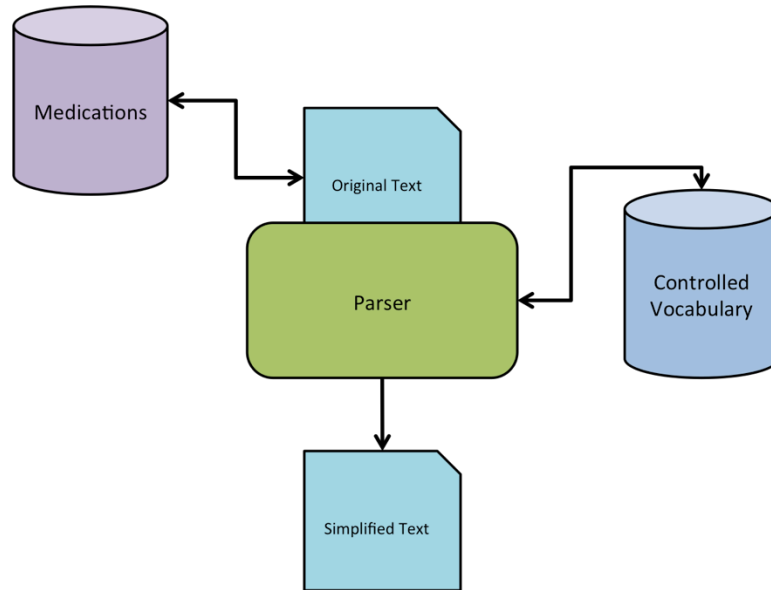
Figure 4-3. Translator Design

The original text was parsed at run-time and was modified to include interactivity that provides alternative consumer-based term or phrase. This approach was taken in lieu of replacement for two reasons. First, because of the nature of the domain being studied, it was important not to alter the text in any way that would change the meaning of the text. Second, for lexical simplification where there is a 1-1 match of terms the challenge of restructuring sentences is minimized. However, when replacing terms with phrases, one must consider if the sentence makes sense or if it needs restructuring. In the past, researchers have addressed this through a manual review of the text after the simplification has been completed (Leroy, Endicott, Mouradi, Kauchak and Just, 2012; Kandula, Curtis and Zeng-Treitler, 2010). However, one of the design goals for this

translator is that it is flexible enough to be used in a system "in the wild" where manual review of the text after simplification would be cumbersome and inconvenient. Supplementing or augmenting the original text with simplified alternative is another approach that removes the need for manual review and several researchers have found this approach to be useful in lieu of full replacement of the text (Wilcox, Morris, Tan, Gatewood, and Horvitz, 2011; Leroy, Endicott, Kauchak, Mouradi, and Just, 2013).

Testing the Translator

During training, the translator was designed to successfully replace the 246 difficult terms identified in the manual review of the medication documents. After implementation, the translator was tested using another set of 50 medications chosen at random from the FDA Human OTC Medication data set. Medications included in the training set were excluded from the selection process. Similar to the training set, medications were chosen at random from the entire set of Human OTC medications. If the medication met the requirements for inclusion, it was added to the test set. This process continued until there were 50 medications in the test set. The 50 medication documents selected for the test set were scrubbed and included in a test database. This database served as the data source for the translator.

Over the 50 documents included in the data set, 1357 1-1 matches were made, 1002 unique 1-1 matches were made, 536 near-match words were identified, and 368 unique near-match words were identified by the translator (See Table 4-1). On average, 27 1-1 matches were made per document, 20 unique 1-1 matches, 11 near-matches, and 7

unique near-matches were made per document. A porter stem algorithm was included in the translator to remove ("stem") word endings and find near-match terms in the controlled vocabulary.

	1-1 Match Words Identified	Unique 1-1 Match Words Identified	Near-Match Words Identified	Unique Near-Match Words Identified
Total Over All Documents	1357	1002	536	368
Range Over All Documents	7 - 53	7 - 40	2 - 25	2 - 14
Average Per Document	27	20	11	7

Table 4-1. Results of Translator Testing

Prototype Interface

An interface was designed to facilitate an experiment to better understand the effect of the translator on perceived and actual difficulty of older adults' understanding of over-the-counter medication information. The interface was designed to display warning information for four medications (See Figure 4-4). Medication information was queried from the medication database and depending on whether the flag for the translator was set, the interface presented information with or without the text translated. Therefore each of the four medications had a translated and non-translated version.

MEDICATION NAME: MEDICATION #2

WARNINGS

antidepressants are medicines that treat depression

More

Do not use if you are now taking a prescription monoamine oxidase inhibitor (MAOI) (certain drugs for depression, psychiatric, or emotional conditions, or Parkinson's disease), or for 2 weeks after stopping the MAOI drug. If you do not know if your prescription drug contains an MAOI, ask a doctor or pharmacist before taking this product.
Ask a doctor before use if you have
  •heart disease
  •high blood pressure
  •thyroid disease
  •diabetes
  •trouble urinating due to an enlarged prostate gland
  •cough that occurs with too much phlegm (mucus)
  •cough that lasts or is chronic such as occurs with smoking, asthma, chronic bronchitis or emphysema
Ask a doctor or pharmacist before use if you are taking any other oral nasal decongestant or stimulant.
When using this product do not use more than directed.
Stop use and ask a doctor if
  •you get nervous, dizzy, or sleepless
  •symptoms do not get better within 7 days or are accompanied by fever
  •cough lasts more than 7 days, comes back, or is accompanied by fever, rash, or persistent headache. These could be signs of a serious condition.
If pregnant or breast-feeding, ask a health professional before use.
Keep out of reach of children. In case of overdose, get medical help or contact a Poison Control Center right away.

Figure 4-4. Screenshot of Interface Utilizing Translator

The four medications presented in the prototype included a medication for upset stomach, a cold medicine, an allergy medication, and a pain reliever. These medications were purposely chosen to provide variety and representation of the most widely used oral over-the-counter medications. Apart from these categories, medication texts were chosen to meet the criteria that each was approximately the same reading level. An 8th grade reading level was chosen since it is the average reading level in the United States (See Table 4-2). All documents had an approximate grade reading-level of 7th-8th grade and a reading ease score of approximately 60, which suggests the documents, should be easy to read for 13-15 year olds.

	Medication 1	Medication 2	Medication 3	Medication 4
Word Count	261	213	395	200
Unique Word Count	133	127	189	120
Flesch-Kincaid Reading Ease	61.5	59.8	57.7	59.7
Flesch-Kincaid Grade Level	7.2	7.9	7.9	7.3

Table 4-2. Description of Medication Texts

Research Questions

To better understand the impact of the translator on perceived and actual difficulty, and user satisfaction the following research questions were examined.

Research Question 1: Does the medication information simplified by the translator generate more positive control beliefs among participants compared to medication information not simplified by the translator?

a. Do older adults perceive the information to be less difficult when presented with the translator compared to information not simplified by the technique?

b. Are older adults more confident when presented with information simplified by the translator to identify risks and benefits of an OTC medication?

c. Do older adults believe they have more control of identifying risks and benefits of OTC medication when presented with information simplified by the translator?

Research Question 2: Is information simplified using the translator more effective at communicating OTC medication risks and benefits compared to information that is not simplified?

    a.   Is the number of participant errors reduced when using the translator?

Research Question 3: Does the translator increase task completion time?

Research Question 4: Were participants more satisfied using the simplified information compared to the non-simplified information?

    a.   Did participants prefer using the simplified information compared to the non-simplified information?

    b.   Did participants find the simplified information more helpful compared to the non-simplified information?

METHODS

Participants and Study Location

This study is focused on improving OTC medication communication for those 65 years and older. In addition, the focus of this study is to improve communication for older adults in the process of deciding appropriate OTC medication given their prior health history. Participants of the study were therefore be required to be 65 years of age or older and have experience purchasing or selecting their own OTC medication in the

past year. The study was be conducted at two organizations within the local community that cater to those older than 50.

Older adults were recruited through purposeful sampling from two organizations within the local community. The lead researcher met with directors of the two organizations to discuss the details of the study, what the study is about, and the requirements for volunteering. The directors of the organization made first contact with potential participants through email, flyers, or verbal announcement of the study. Participants were asked to contact the lead researcher if they were interested in volunteering for the study. Older adults were paid $15 for their participation.

Twenty-one older adults volunteered for the study. Approximately 62% of the participants were female (N=13) and all but three participants were retired (N=18). Eighteen participants were Caucasian and 3 were African-American. All participants selected English as their primary language. Participants' ages ranged from 64 – 90 (mean ~ 73 years, SD ~ 8 years). All participants were familiar with purchasing or taking over-the-counter medication.

Because the experiment was conducted using a computer, data was collected on participant's past use of computers and computational devices. All but 3 participants (N = 18) used a laptop or desktop computer at least 3 or more times a week. Nine participants used a smart phone or tablet device at least 5 or more times a week. Only two participants did not use a computer, smart phone, or tablet device weekly. Nineteen participants indicated that they used the Internet weekly. Eleven participants indicated

that they used the Internet to search for information about prescription medication, while only six used the Internet to search for information about over-the-counter medication.

Data collection methods

Institutional Review Board (IRB) approval was obtained before data was collected. Each older adult participated in an experiment that examines the impact of the translator on the perceived and actual difficulty of the OTC medication information. Before the participant began, the participant was asked to complete a demographic and computer use survey. This data was collected to 1) ensure the participant met the participation requirements and 2) examine the impact of the participants experience with using computers and using computers to search for medication information on the proposed study. In addition, participants were asked to complete a verbal health literacy test – REALM (Health Literacy Measurement Tools: Fact Sheet, 2009) to gauge how well the participant may be able to "understand and act upon health information" (National Center for Education Statistics, 2003). Participants in the study had on average a REALM score of approximately 6 (SD ~ 2). However, eighteen of the participants had a REALM score of 7, which is the highest score possible on the REALM test, meaning that the group of older adults participating in this study should not have much trouble understanding and acting upon health information.

After completing the REALM test, participants were presented with a demonstration of how to use the translator. The information presented in the demo was not related to medication but presented a short paragraph about a storybook character.

The participant was allowed to get acquainted with how to use the translator and was told

that they may see similar options in the experiment. Each participant received 4 different

treatments (medications) during the experiment (See Table 4-3). Counterbalancing of

treatments between participants was used to reduce carryover effects due to practice or

fatigue. Medications were grouped based on the similarity of their grade level score so

that each participant received one simplified and one non-simplified version of each

medication at that approximate level. However, each text was different within each

group to reduce learning effects. The order in which participants received the treatments

was alternated for each participant. The dataset therefore included a total of 84

observations from the 21 participants.

|		Method of Delivery (W)	
		Translated	Not Translated
Grade Level of Text	7.2 & 7.3	N = 21	N = 21
(W)	7.9 & 7.9	N = 21	N = 21

Table 4-3. Experiment Design
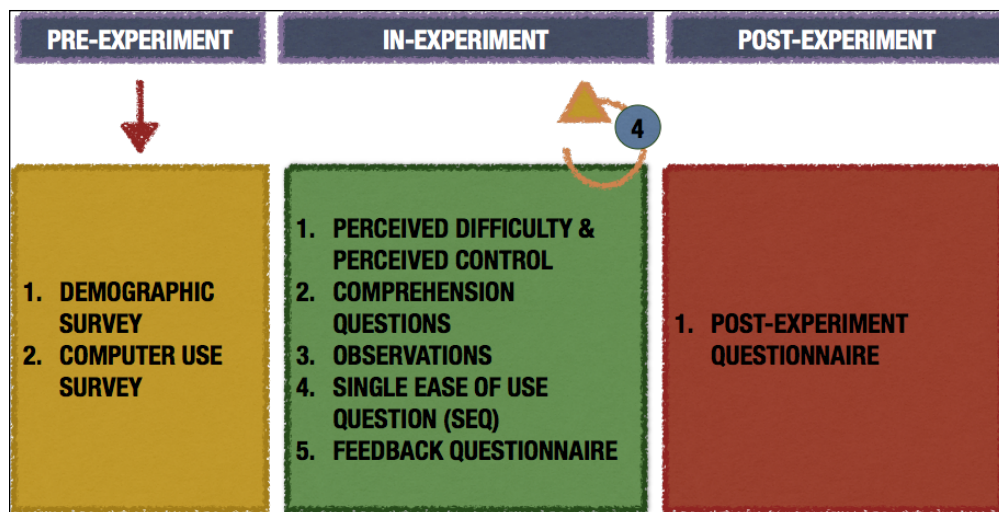
Figure 4-5. Data Collection Process for Each Participant

After being presented with the medication information, the participant was asked to rate the difficulty, self-efficacy, and their perceived control of the medication information on a 7-point likert scale (Kraft, 2005). The questions mapped directly to the research questions and provided insight on the participants perceived control beliefs regarding the medication information presented to them. Each participant was also asked several comprehension questions that were designed using the Food and Drug Administration Comprehension Testing Guide (U.S. Department of Health and Human Services Food and Drug Administration Center for Drug Evaluation and Research, 2010). A Likert-Scale item along with the comprehension questions was used to measure the actual difficulty of the OTC medication information presented to the participant. Finally, for each medication, the participant was asked to identify any additional issues they encountered with the OTC medication information. At the end of the experiment, the participant was also asked to revisit the types of information (simplified vs. non-simplified) used in the experiment and identify which type of information they preferred using and which type of information they found more helpful and to provide any additional suggestions.

Participant Observation

During the experiment, the researcher also recorded whether or not the participant made use of supplemental materials provided to help them answer comprehension questions. Time to complete comprehension questions was also recorded. Task

completion time was recorded as the time interval beginning when the participant began answering comprehension question until the participant completed the comprehension questions. A structured coding form was used to record observational data for each task in the experiment (Robson, 2011). This information was used to provide additional insight on the difficulty of the medication information and shortcomings of the current technique.

RESULTS

Self-Efficacy

Self-Efficacy is a person's confidence that they can perform a behavior if they wanted to do so (Ajzen, 2002). Self-Efficacy was measured using the 7-point Likert-Item, "Finding risks and warnings using this information would be …", anchored by very difficult/very easy. For analysis, participants' ratings were grouped in categories of positive (ratings of 5, 6, or 7) and negative (1, 2, or 3). A rating of 4 was considered neutral. Fifty-nine percent of observations were positive for the simplified information compared to 47% for the non-simplified information. To understand the impact of the translator on perceived self-efficacy, the proportion of observations in which ratings changed from positive to negative (or vice versa) across treatment was analyzed. Forty-two paired observations were included in the data set. The McNemar's test for changes is a nonparametric analysis that can be was used test for differences in proportions when analyzing nominal, paired data. Thirty-one observations showed no change across treatment groups. Nine observations moved from negative when participants were

presented with non-simplified information to positive when presented with simplified

information. Two observations moved from negative when presented with the

experiment to positive when presented with the simplified information. The results of

McNemar's provide sufficient evidence (df=1, N = 42) that participants' beliefs about

self-efficacy differed significantly between the two treatments (P ~ .0348). Participants

were more likely to report positive beliefs about self-efficacy when presented with the

simplified text compared to the non-simplified text.

Contingency Table			
		Control	
Count Total % Col % Row %	Negative	Positive	
Negative	13 30.95 59.09 86.67	2 4.76 10.00 13.33	15 35.71
Positive	9 21.43 40.91 33.33	18 42.86 90.00 66.67	27 64.29
	22 52.38	20 47.62	42

Table 4-4. Contingency Table for Self-Efficacy Ratings

Figure 4-6. Result of McNemar's Test

Perceived Control

Perceived Control is a person's beliefs about how much control they have over the targeted behavior (Ajzen, 2002). Perceived Control was measured using the 7-point Likert-Item, "If I wanted to, I could find risks and warnings using this information", anchored by strongly disagree/strongly agree. For analysis, participants' ratings were grouped in categories of positive (ratings of 5, 6, or 7) and negative (1, 2, or 3). A rating of 4 was considered neutral. Eighty-five observations had positive responses for both the simplified and non-simplified versions of the text. To understand the impact of the tool on perceived control, the proportion of observations in which ratings changed from positive to negative (or vice versa) across treatment was analyzed. Forty-one paired observations were included in the data set. The McNemar's test for changes was used to test for differences in the percentages. Twenty-nine observations showed no change across treatments. Six observations showed a change from positive to negative and

100

negative to positive. Results of McNemar's test do not provide sufficient evidence (df=1, N = 41) that participants' beliefs about control differed significantly between the two treatments (P ~ 1).

	Control		
Count Total % Col % Row %	Negative	Positive	
Negative	0 0.00 0.00 0.00	6 14.63 17.14 100.00	6 14.63
Positive	6 14.63 100.00 17.14	29 70.73 82.86 82.86	35 85.37
	6 14.63	35 85.37	41

Table 4-5. Contingency Table for Perceived Control Ratings

Agreement Statistic

Kappa Coefficient

Degree of Agreement	Kappa	Std Err	Lower 95%	Upper 95%
	-0.17143	0.048755	-0.26699	-0.07587

Asymptotic Test	Prob > z	Prob>|Z|
	0.1362	0.2723

Bowker's Test

Symmetry of Disagreement	ChiSquare	Prob>ChiSq
	0	1.0000

For 2–by–2 tables, Bowker's Test is equivalent to McNemar's Test.

Figure 4-7. Result of McNemar's Test

Perceived Difficulty vs. Actual Difficulty

Perceived and Actual Difficulty was measured using a 7-point Likert-Item, anchored by strongly disagree/strongly agree. For analysis, participants' ratings were grouped into categories of positive (ratings of 5, 6, or 7) and negative (1, 2, or 3). A rating of 4 was considered neutral. Fifty percent of responses about perceived difficulty were positive when interacting with the simplified information compared to 38% of responses for the non-simplified information. Further, when examining whether the simplified information had any effect on actual difficulty, there was a significant improvement in the proportion of participant whose ratings improved from negative beliefs about difficulty to positive beliefs about difficulty when interacting with the simplified information (W = -87.5, P ~ 0.0049). However, a similar trend was observed for the non-simplified information.

Test Mean		
Hypothesized Value		0
Actual Estimate		-0.4524
DF		41
Std Dev		1.29167
	t Test	Signed-Rank
Test Statistic	-2.2697	-87.5000
Prob > |t|	0.0285*	0.0097*
Prob > t	0.9857	0.9951
Prob < t	0.0143*	0.0049*

Figure 4-8. Result of Wilcoxon Signed Rank Test

Comprehension

Comprehension was measured using a 3-item questionnaire. The number of participant errors included questions the participant answered incorrectly or questions for which the participant did not know the answer. For both treatments, participants made 34 errors. Therefore, number of errors did not differ across treatments. To validate there was no difference, the Wilcoxon Signed Rank Test was used to test for difference. Results suggest there is not sufficient evidence to support that there was a significant effect of treatment (W = -1.5, P ~ 0.5393) for reducing participant errors.

	t Test	Signed-Rank
Test Statistic	0.0000	-1.5000
Prob > |t|	1.0000	0.9214
Prob > t	0.5000	0.5393
Prob < t	0.5000	0.4607

Figure 4-9. Results of Wilcoxon Rank Test

Task Completion Time

Task completion time was recorded on an observational coding sheet and was defined as the interval between the participant completing the Pre-Survey questions and completing the last question of the Comprehension questionnaire. Task completion time was recorded for each of the four tasks the participant completed throughout the study. The average task completion time for participants when using the simplified information

was 3 mins/8 secs (185.03 secs). The average task completion time for participants when using the non-simplified information was slightly higher at 3 mins/19 secs, an increase of 11 secs. The Wilcoxon Signed Rank Test was used to test for differences between groups. Results suggest that there is not sufficient evidence (W = 5.5, P ~ 0.4721) to support that there was a significant effect of treatment for increasing or decreasing task completion time.

	t Test	Signed-Rank
Test Statistic	0.5103	5.5000
Prob > |t|	0.6126	0.9442
Prob > t	0.3063	0.4721
Prob < t	0.6937	0.5279

Figure 4-10. Result of Wilcoxon Rank Test

Observational Data

When asked to comment on difficulties or how the information could be improved, participant responses varied widely. Many participants felt that the information was well organized, easy to navigate and thorough. However, others commented that they felt that formatting including spacing, font size, and organization could be improved. In addition, several participants commented on the amount of information, some felt that some of the information was unnecessary and others felt that there was too much information crowded into the Warnings section.

Concerning the technique, most participants commented on terms such, as "salicylates" that were not translated that they felt should be. This was consistent with the

observational data collected for the number of times support materials were used. Between the control and the experiment, participants used support materials 33 times suggesting that some information was not readily clear and/or missing from the information provided by the prototype. Three participants commented that they felt that having certain words highlighted made the information easier to read, made it easier to focus, and helped to organize the information. One participant felt that the simplified terms were not helpful in their current form.

User Satisfaction

Two open-ended questions were used to measure user-satisfaction. Participants were asked to discuss which version of the information (simplified vs. non-simplified) they preferred using and which version of the information they found more helpful. Participant's responses to these questions were coded to fit in one of three categories 1) Experiment (simplified version) 2) Control (non-simplified version) or 3) Neutral (no strong preference). Nineteen participants responded to both questions and 2 participants did not provide a response to either question. When asked to discuss which system they preferred, 68% of participants expressed that they preferred using the translator, 26% were in favor of the non-simplified information, and 6% were neutral. When asked to elaborate on why they preferred the simplified text, nearly all participants commented that they liked having the additional information available when and if they needed it. One participant stated, "*The pop-ups, because it provides additional information in laymans terms*". Comments from the five participants who preferred the non-simplified

information were more varied. One participant felt that not having the tool-tips forces a

person to focus more on the warnings. Another felt that the tool-tips were not necessary

and similar to the previous statement encouraged people to skim the information. A third

participant felt that the tool-tips made the information too complicated.

When asked which version of the information they thought were more helpful,

participants' responses were the same as the responses for preference. Sixty-eight

percent of participants expressed that they preferred using the translator, 26% were in

favor of the non-simplified information, and 6% were neutral. When asked why they felt

the simplified text was more helpful, once again, nearly all responses alluded to having

simplified information available when needed. Of the 26% that found the non-simplified

text more helpful, similar to preference, responses were related to the complexity added

by the tool-tips or as one participant stated, "*I found the highlights annoying*".

To determine if these observed frequencies for satisfaction deviated significantly

from the expected frequencies a One-Way Chi-Square Classification was conducted (See

Table 4-6).

Outcomes	Observed	Expected	$(F_o - F_e)$	$(F_o - F_e)^2$	$(F_o - F_e)^2 / F_e$
Experiment	13	6.33	6.67	44.49	7.03
Control	5	6.33	-1.33	1.77	.28
Nuetral	1	6.33	-5.33	28.41	4.49
	19	19			$X^2 = 11.80$

df = 3 − 1 = 2

Table 4-6. Result of One-Way Chi Square Test

Based on the Chi-Square reference table, a X^2 of 5.99 or greater is needed for X^2 to be significant at the .05 level. Therefore, a result of X^2 of 11.80, suggests that there is enough evidence to reject the hypothesis that the results of the study could have happened by sampling error alone and the deviations between the observed and expected frequencies are significant.

DISCUSSION & IMPLICATIONS

The goal of the study was to evaluate the feasibility and effectiveness of translator designed through a human-centered process that simplifies OTC medication information for older adults. In its current state, results suggest that the prototype translator evaluated shows promise as a method for providing simplified OTC medication information to the older adult population. Participants' confidence in their ability to complete the task at hand improved significantly from negative to positive when provided with OTC medication information enhanced by the translator compared to information not enhanced. In addition, a significant proportion of the participants preferred using the information enhanced by the technique compared to information not enhanced. Similarly, a significant proportion of the participants found using the information enhanced by the technique more helpful than information not enhanced by the technique. Although, results were not significant, participants provided more positive belief ratings of perceived difficulty and the presence of the technique did not increase task completion time.

In addition, the study provides interesting insights on the feasibility of the technique. With further improvement the technique may be a feasible option for delivering simplified OTC medication information to users. Because of the number of participants' comments on formatting, coupling the technique with good information presentation and design practices may improve the overall effectiveness of the translator while further assisting participants with the task at hand. Participants' comments also reveal that some of the terms that were simplified did not need to be and others that were not simplified should have been. From a technical standpoint, validated data sources to support the tool are limited however research in this area is growing and several promising resources exist. The Plain Language Thesaurus for Health Communications provided a good starting point for building a controlled vocabulary for this study. However, based on participants' comments, more research is needed to better understand how and when terms should be translated in the context of supporting OTC medication understanding. Additionally, although the controlled vocabulary supported simplified versions of several terms, there were terms that were not covered. Therefore, continued research on creating data sources for consumer-based text simplification of health information is needed. In particular, for this study, consumer-based explanations of many of the medications and ingredients identified in this study were not covered in the thesaurus and a good validated data source was not found elsewhere.

To summarize, the goal of this study was to examine the feasibility and effectiveness of a technique for delivering simplified OTC medication to older adults. Because there is limited research that examines that specific challenge of delivering

simplified OTC health information to older adults, this study also provides a basis to guide future studies. The technique evaluated in this study had a positive impact on participants' confidence in completing the task at hand. In addition, participants preferred using the technique and found the technique more helpful than not using the technique. Results suggest that with more research and further improvement, the technique is a feasible option for providing simplified OTC medication information to older adults. Additionally, the technique may increase user confidence and be a preferred and helpful tool for navigating OTC medication information.

LIMITATIONS

Participants in the study were purposefully recruited and although participants ranged in age, education level, and familiarity with OTC medications, most participants had very high health-literacy levels. This may have impacted the study results as at this level, participants are expected to easily understand and act upon health information. Although, participants' responses were varied, results may not be generalizable to a group of participants with more varied health literacy levels. Therefore, in the future, a different recruitment method will be employed to ensure that the sample includes participants with more diverse health-literacy levels. In addition, in the future more participants will be needed to detect significance differences at the .05 level based on the differences observed in this preliminary study.

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CHAPTER FIVE

CONCLUSIONS & FUTURE WORK

The outcomes of this research have potential implications in several fields including human-computer interaction (HCI), public health, consumer health informatics (CHI), and information retrieval (IR). Specifically, the contributions of this research are to:

1. Better understand older adults current over-the-counter medication selection practices and challenges and identify opportunities for technology to assist older adults in the OTC medication selection process.

2. Conceptualize and design a novel interface for assisting older adults with OTC medication information and examine the usability of the novel interface for assisting older adults with over-the-counter medication information in order to identify aspects of the design and technology features that are useful and not useful for assisting older adults with over-the-counter medication.

3. Design a prototype translator that delivers simplified OTC medication information to older adults and examine the effectiveness of the prototype translator for affecting older adults control beliefs, comprehension, and satisfaction of OTC medication information.

4. Provide recommendations for improving future version of the translator and similar techniques as well as suggestions for using such techniques in consumer-based technology that assist older adults with OTC medication.

Obtaining user-feedback early and including users throughout the process are cornerstones of HCI and UCD research. The design process and design recommendations resulting from this work will help to further inform the design of technology to address gaps in health-related communication, especially in older users. In addition, this research highlights design considerations specific to older adults for increasing the usability and effectiveness of technologies to communicate health information. Similarly, this research also contributes to the field of consumer health informatics. The design process and artifacts produced from this research will highlight ways in which technology design can be used to better and more effectively inform older adults of OTC medication risks and more generally, to address gaps in communicating consumer health information. Finally, the results obtained from examining the prototype translator designed and examined in this research provide insight on the feasibility and usefulness of this and similar approaches in helping older adults understand OTC medication information. This research suggests various ways in which these approaches can be leveraged or improved to increase the usability CHI applications.

Although results from studies described in this dissertation provide several contributions to various fields, because of the limited research in the specific area of focus, much of the work in this dissertation was formative or exploratory. Therefore, there are several opportunities to expand on the research presented in this dissertation. Aspects of the prototype design and technology features that older adults find useful for OTC medication selection were identified through a preliminary evaluation of the novel prototype interface designed in this dissertation. In the future, further development and

evaluation of the interface designed would be beneficial to further understand the impact of the technology features on older adults short-term and long-term understanding of OTC medication information. In addition, long-term evaluation of a functional prototype may help researchers to further understand design requirements and the impact of the technology for decreasing adverse drug events due to OTC medication among older adults.

Evaluation of the prototype translator suggests that providing automatic simplification of OTC medication information may affect older adults confidence in their ability to navigate OTC medication information. In addition, older adults prefer using information that provide support for simplified information and finds this information more helpful. However, results also present several opportunities for future work. In particular, many of the older adults who volunteered in this study had high health-literacy levels. In the future, it would be beneficial to expand this study using a more purposed and stratified sampling strategy, to understand the impact of the translator on older adults with more varied health-literacy levels. In addition, although older adults found the translator useful, results suggest that more research is needed to understand how and when simplification support should be provided. For example, which terms need simplification (hypertension or silicate), in what way should they be simplified (full replacement or augmentation), and what are the tradeoffs (e.g. safety, reading ease). Finally, qualitative results from the final study of this dissertation suggest that text simplification alone may not be enough to assist older adults with the particular task of OTC medication selection. For example, although participants had high health-literacy

scores, the number of errors was high regardless of whether simplification support was provided. Therefore, in the future, additional research that focuses on how to integrate simplification techniques with other aspects of design or technology features and the effectiveness of those strategies on older adults understanding of OTC would be beneficial.

The major goal of this research was to better understand and abstract design recommendations used to inform the design of a novel technological artifact and its components that assists older adults in better understanding the risks and benefits of OTC medications. Furthermore, this research aimed to determine the usefulness, usability, and short-term effectiveness of that resultant artifact for improving understanding of OTC medication risks for older adults. A three-phase human-centered approach including formative research, user-centered design and evaluation was employed to understand the design recommendations, produce artifacts, and answer the major research questions. This dissertation describes the motivation for the research question(s) being investigated and demonstrates two ways that technology is useful for communicating OTC medication information to older adults. Future work in this area will be beneficial to further understanding design requirements for helping older adults navigate the OTC medication selection process. Additional research on the short-term and long-term effectiveness of the artifacts produced in this dissertation will be beneficial to further understanding the impact of these technologies on older adults understanding of OTC medication information. Similarly, additional research is needed to better understand how such technologies can be effectively integrated in the day-to-day lives of healthcare

consumers to improve interactions with health information and improve healthcare

quality and safety for patients.

APPENDICES

STUDY I & II PROTOCOL & MATERIALS

Exploring the Design Requirements for Technology to Help Older Adults Identify

Potential Over-the-Counter Medication Benefits and Risks

Session I Protocol

Script

[Introductions]

I appreciate you taking the time to talk with us today. I would like to start by telling you a little bit about our study and get your consent to participate.

[Present Participant with Informed Consent Form and Read Information]

This study focuses on creating technology to help older adult identify and understand potential over-the-counter medication benefits and risks. Today, I would like to interview you to learn more about you, your current medication management practices, how you currently go about purchasing over-the-counter medications and the challenges you may face, and also any technology you currently use or feel may be useful to support you in this task. Before we begin, I would like to ask for your permission to audio record this interview. This is for research purposes only and any identifying information will be removed from the data.

[Wait for Response]

 Do you have any other questions before we begin?

Background Information

1. What is your race/ethnicity?

      a. Black/African American

      b. White/Caucasian

      c. Asian/Pacific Islander

      d. Indian

      e. Native American

      f. Hispanic

      g. Other: Please Specify

2. What is your gender?

      a. Male

      b. Female

3. How old are you?

4. What is your primary language?

5. What is your highest level of education?

6. What is your occupation?

7. Which of the following most accurately represent your current living situation?

      a. House/Apartment/Condominium

      b. Independent Living Community

      c. With Friends or Family

      d. Other: Please Specify

Medication Management Practices

1. Do you currently take any medications (e.g. prescription)?

2. If so, how many medications do you take on a daily/weekly basis?

3. Have you taken an over-the-counter medication (non-prescription) medication in the last year?

4. On average, how many over-the-counter medications do you take per week/month?

<u>Current OTC Medication Purchasing and/or Selection Practices</u>

Think about your experiences selecting and purchasing OTC medications. I will now ask you questions related to purchasing or selecting OTC medications.

1. Do you purchase your own OTC medications?

    a. If not, who purchases your OTC medications for you?

    b. If so, do you always purchase your own OTC medication?

        i. Who helps you purchase your OTC medications?

2. Say that you want to take a certain OTC medication for the first time. Describe how you currently go about selecting and/or purchasing an over-the-counter medication for the first time.

    a. *Do you ask someone for an opinion? If so, who do you consult.*

    b. *Do you use the medication label or some other resource to make your decision? If so, please describe.*

    c. *Do you use technology in any way? If so, please describe.*

3. Say that you want to take an OTC medication that you have taken before. Describe how you go about selecting and/or purchasing an over-the-counter medication that you have purchased before.

a. *Do you ask someone for an opinion? If so, who do you consult.*

b. *Do you use the medication label or some other resource to make your decision? If so, please describe.*

c. *Do you use technology in any way? If so, please describe.*

OTC Medication Information Challenges

1. Thinking back on your OTC medication purchases over the past year, describe any challenges, if any, you have had with the information (e.g. OTC medication label) used to make your decision.

2. I will like to now show you examples of OTC medication information and I would like for us to discuss anything that you think may be challenging or helpful for making a decision on whether this medication is appropriate for you to take.

   • Font-size?

   • Organization?

   • Language used? Where there words that you didn't know.

   • Can you identify potential risks?

   • Did you understand the information in each section?

   • Is there something you feel that is missing?

   • Were there parts of the label that you found useful or liked about the label?

Technology Feasibility

As I mentioned earlier, we are looking at ways to design technology that could assist you in understanding and identifying potential over-the-counter medication risks. We are in the process of determining which type of technology may be useful in this task.

1. Do you use any of the following on a weekly basis?

    a. Smart Phone

    b. Tablet or Pad

    c. Kiosk

    d. Desktop or Laptop Computer

    e. Other. Please Specify

2. What type of tasks do you complete using these technologies?

3. What are you initial thoughts on potentially using one or more of these to support you in making OTC medication-purchasing decisions? Do you have any comments or concerns for using any of these?

Verbal Recruitment Script
Clemson University
Exploring the Design Requirements for Technology to Help Older Adults Identify Potential Over-the-Counter Medication Benefits and Risks.

Hello, I am Aqueasha M. Martin and I would like to look at ways that technology can be designed and may be useful in helping older adults identify potential over-the-counter drug benefits and risks. Each year, thousands of people die or are injured due to adverse medication interactions. Over-the-counter drugs contribute to these numbers. The potential risk of adverse over-the-counter drug interactions increase as we age due to the natural process of aging and factors such as chronic illness that are prevalent among the aging population. Because of this we would like to look at ways that technology can help older adults identify and understand benefits and risks. Your participation in this study will allow us to better understand the process in which older adults participate when purchasing over-the-counter medications and the challenges you face, to determine the appropriateness of various types of technology for completing the desired task, and/or to better understand the what should be included in the design of technology that can assist older adults in understanding the benefits and risks associated with over-the-counter medications given your personal health history.

The study will require 45 minutes – 4 hours of your time depending on your desired level of involvement. An introductory interview will be conducted and you will then be invited back to participate in 1-3 follow-up interview that will help us understand the design requirements for our technology. Each session will require approximately 45 minutes – 1 hour of your time. Participation in all parts of the study is voluntary and you may withdraw participation at any time. Please know that I will do everything I can to protect your privacy. Your identity or personal information will not be disclosed in any publication that may result from the study. Notes that are taken during the interview will be stored in a secure location.

Would you be interested in participating?

PROTOCOL – SESSION II

Introduction (10 - 15 minutes)

- Introductions
- Explain Study and Get Consent
- Thanks for Participating

Script

Investigator (I) Participant (P)

I: So, before we begin, I would like to explain a little more about what we will be doing today. First, I will ask some background questions (if do not already have this information). The goal of today's session is to have you interact with 2 versions of paper prototypes (screenshots) and get your feedback on those prototypes. I will provide you with a scenario that you can follow and I will ask you questions after you complete each. Basically, we are looking for you to help identify any concerns, things you like, or things you don't like so that we can make this a better project. Do you have any questions so far?

[Ask questions on Background Information Sheet]

[Give participant first prototype have them walk through] (30-40 minutes)

Ask questions to elicit feedback on design choices (e.g. colors, font size, layout, navigation), and to get a better understanding of the design requirements for technology to assist older adults in the task of identifying OTC medication risks.

Potential Topics to Cover	Potential Prompts
Motivation for Use	Is this something they would use? What would be the motivation? (Alternative mock-ups)
Ease of Use/Look and Feel	Was it easy to use? Did you understand everything? Did it provide enough info? Likes, dislikes, concerns?
Language Used in the System	Issues with terms used?
Instructions on how to use the System	Instructions helpful? (Alternative mock-ups)
Alternative Medication Feature	Would you use this feature? Would you trust this feature? Amount of information provided?
Recommendation or Information System	Which do you prefer? Why? (Alternative mock-ups)

If this technology were available, would you use it? Why or why not?

Any other comments on how we can improve?

<u>Background Information – Session II</u>

1. What is your race/ethnicity?
   - e. Black/African American
   - f. White/Caucasian
   - g. Asian/Pacific Islander
   - h. Indian
   - i. Native American
   - j. Hispanic
   - k. Other: Please Specify
2. What is your gender?
   - a. Male
   - b. Female
3. How old are you?
4. What is your primary language?
5. What is your highest level of education?
   - a. Some K – 12
   - b. High school/K-12
   - c. Some College
   - d. 4-Year College
   - e. Master's
   - f. Ph.D./Professional Degree
6. What is your occupation?
7. Which of the following most accurately represent your current living situation?
   - a. House/Apartment/Condominium
   - b. Independent Living Community
   - c. With Friends or Family
   - d. Other: Please Specify

<u>Medication Management Practices</u>
5. Do you currently take any medications (e.g. prescription)?
6. If so, how many medications do you take on a daily basis? weekly basis?
7. Have you taken an over-the-counter medication (non-prescription) medication in the last year?
8. On average, how many over-the-counter medications do you take per week? per month?

STUDY III PROTOCOL & MATERIALS

Protocol

Hello, my name is Aqueasha Martin. I am a graduate student at Clemson. Thanks for participating in our study. Before we begin, I would like to provide you with information about the study and get your consent to participate.

[Provide participant with informed consent.]

I will give you time to look over the information and please let me know if you have any questions.

[Give participant time to read document and ask questions]

Now that you have looked over the information, would you like to continue?

Before we get started with the experiment, I would like for you to complete a background survey and a short exercise that sees how familiar you are with different health terms. Do you have any questions?

[Background Survey & Health Literacy]

Thank you. Now, let me tell you how the rest of the experiment will go. On the computer, you will be presented with a sample of some over-the-counter medication information. You will then be asked a series of questions about the medication information. You will be presented with 3 sets of questions for each of the sample over-the-counter medication information. You will receive one set at the beginning (pre-survey), one set in the middle (comprehension survey), and one set at the end (post-survey). Please use the sample over-the-counter medication information to answer the questions. In total you will receive 4 versions of over-the-counter medication information At the end of the experiment, I will ask you to complete a short questionnaire about your experiences.

[Begin Practice]

Okay, now we will begin with experiment.

[Begin Experiment]

Thank you. Now I will ask you to complete a short survey about your experiences.
[Revisit Prototypes]

[Final Survey]

Thanks for you participation.

[Provide Participant with Incentive – Signoff]

Background Survey

Demographics

8. What is your race/ethnicity?
   a. Black/African American
   b. White/Caucasian
   c. Asian/Pacific Islander
   d. Indian
   e. Native American
   f. Hispanic
   g. Other: Please Specify _____

9. What is your gender?
   a. Male
   b. Female

10. How old are you?

11. What is your primary language?

12. What is your highest level of education?

13. What is your occupation?

14. Do you wear glasses or contacts? (If No, Skip #9)
    Yes   No

15. If so, are you wearing your glasses or contacts today?
    Yes   No

Medication Background

1. Do you currently take any over-the-counter medications?
   Yes   No

2. Do you purchase or select your over-the-counter medications?
   Yes   No

3. Have you ever taken any of the following types of over-the-counter medications? Select all that apply.
   a. pain relievers such as Tylenol or Advil
   b. medications for upset stomach or nausea such as Pepto Bismol
   c. sinus medications such as Benadryl or Allegra
   d. cold medication such as Nyquil or Robotussin

Computer Use

1. Do you use a computer often?
   Yes   No

2. How often do you use the computer each week?
   a. 1 - 2 days per week
   b. 3 - 4 days per week
   c. 5 or more days per week

3. What type of tasks do you use your computer for?
   a. Creating documents
   b. Internet
   c. Games
   d. Finance
   e. Other: _____

4. Do you use a smart phone or tablet device often?
   Yes   No

5. What type of smart phone or tablet device is it (iPhone, iPad, Andriod)?

6. How often do you use the smart phone or tablet each week?
   a. 1 - 2 days per week
   b. 3 - 4 days per week
   c. 5 or more days per week

7. What type of tasks do you use your smart phone or tablet for?
   a. Creating documents
   b. Internet
   c. Games
   d. Finance
   e. Other: _____

8. If you use the Internet, how often do you use the Internet?
   a. 1 - 2 days per week
   b. 3 - 4 days per week
   c. 5 or more days per week

9. How do you normally connect to the Internet (computer, phone)?

10. Do you use the Internet to search for information about prescription medication?
    Yes   No

11. Do you use the Internet to search for information about over-the-counter medication?
    Yes   No

Pre-Survey

Take a quick look of the medication information. Based on your first thoughts, please answer the following questions.

(Please Circle One)

1) This information is
   1. Very Difficult
   2. Quite Difficult
   3. Slightly Difficult
   4. Neither Difficult or Easy
   5. Slightly Easy
   6. Quite Easy
   7. Very Easy

(Please Circle One)

2) Finding risks and warnings using this information would be
   1. Very Difficult
   2. Quite Difficult
   3. Slightly Difficult
   4. Neither Difficult or Easy
   5. Slightly Easy
   6. Quite Easy
   7. Very Easy

(Please Circle One)

3) If I wanted to, I could find risks and warnings using this information.
   1. Strongly Disagree
   2. Disagree
   3. Mildly Disagree
   4. Neither Disagree or Agree
   5. Mildly Agree
   6. Agree
   7. Strongly Agree

Post Survey

1) Overall, how difficult was it for you to complete the questions (Circle One)?
      8. Very Difficult
      9. Quite Difficult
      10. Slightly Difficult
      11. Neither Difficult or Easy
      12. Slightly Easy
      13. Quite Easy
      14. Very Easy

2) Why did you choose the rating that you did?

3) Thinking about the information, was there any part of the information that was challenging? If so, please share.

Final Survey

1) Thinking about the two ways the information was presented, which do you prefer? Why?

2) Thinking about the two ways the information was presented, which do you think would be more helpful? Why?

3) Do you have any suggestions on how we can improve how the information is presented?

Oberservational Coding Sheet

Participant # _____

Medication #	Control?	# Times used support materials	Task completion time
Medication #1			
Medication #2			
Medication #3			
Medication #4			

Rapid Estimate of Adult Literacy in Medicine – Short Form (REALM-SF)
Available on Internet: http://www.ahrq.gov/professionals/quality-patient-safety/quality-resources/tools/literacy/index.html

REALM-SF Form

Patient name _____ Date of birth_____ Reading level_____

Date _____ Examiner _____ Grade completed _____

Menopause	☐
Antibiotics	☐
Exercise	☐
Jaundice	☐
Rectal	☐
Anemia	☐
Behavior	☐

Instructions for Administering the REALM-SF

1. Give the patient a laminated copy of the REALM-SF form and score answers on an unlaminated copy that is attached to a clipboard. Hold the clipboard at an angle so that the patient is not distracted by your scoring. Say:

    "I want to hear you read as many words as you can from this list. Begin with the first word and read aloud. When you come to a word you cannot read, do the best you can or say, 'blank' and go on to the next word."

2. If the patient takes more than 5 seconds on a word, say "blank" and point to the next word, if necessary, to move the patient along. If the patient begins to miss every word, have him or her pronounce only known words.