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A Technology Solution to Over the Counter Drug Issues

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Allan Mugambi Gitobu as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Information Systems and Technology.

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Abstract

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Reading and comprehending the drug packaging information to guide the selection of an appropriate over-the-counter (OTC) drug is a common challenge given concerns of abuse and misuse, addiction, overmedication, and inability to select the drugs in cases where the guidance of a medical professional is not available. This research reviews data on OTC usage in the United States, reviews the process followed by the Food and Drug Administration (FDA) in the transition of drugs from prescription to nonprescription status, and highlights some risks and benefits of OTC medication. It reviews issues in OTC medication, including decision-making in selecting OTC medication, shows a relationship between health literacy and effective use of OTC medication, and covers readability and comprehensibility of the drug label as a concern in OTC drug acquisition and usage. It also reviews some studies on technology approaches in decision-making that supports the selection of OTC medication.

The research proposes a technology artifact in the form of a mobile application that consumers would use to guide the selection of a drug by augmenting the drug package information with questions that a pharmacist would ask a customer looking for OTC medication. It also investigates whether the facts of medicine, as presented to a customer, cause information overload to an extent that hampers the selection of a drug, and whether the methods of information presentation differ in terms of knowledge retention, information overload, and perceived usability. The research also evaluates different multimedia methodologies in how they aid the understanding of drug label information to support the selection of an appropriate OTC

drug. The study found greater knowledge retention and less information overload on users using the audio-based and video-based mobile apps than those who used text-based apps.

Dedication

Dedicated to my father and first teacher *Mwarimu* Wilfred Mugambi, who had me memorize my multiplication tables by age five, and to whom getting an education was life's most noble ideal. I also dedicate this to my wife Mercy who has given everything for me to get my degrees.

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Chapter 1: Introduction and Problem Statement

Medical practice is medical decision-making, so most applications of computers in health care are intended to have a direct or indirect effect on the quality of healthcare decisions(Musen et al., 2014, p.644)

A casual look at a drug aisle in a pharmacy will show that there are multiple types of drugs for the same ailment with subtle differences between them. Some of those differences are cost, active ingredients, dosage, and packaging. How one selects the appropriate drug, by being able to relate illness symptoms to the drug on the shelf, is a challenge in getting the correct medicine. Medical professionals rely on their experience and knowledge to make decisions about how to administer health care, including deciding on appropriate prescriptions for patients using computerized clinical decision support systems (CCDSS). "CDSSs for drug therapy management are used to facilitate evidence-informed medication use, reduce the incidence of harmful medication errors, and improve healthcare system efficiency" (Hemens et al., 2011, p1). Decisions related to the acquisition and use of the drugs, tasks that belongs to physicians and are supported by CCDSS in the case of prescription medication, become the responsibility of a consumer when drugs switch from prescription to nonprescription status. These decisions include determining if the drug is appropriate for the consumer's condition, using the drug in terms of appropriate dosage and frequency of administration, recognizing contraindications of use, and knowing what to do in the case of adverse drug events (Brass & Weintraub, 2003).

Drugs at pharmacies have two broad classifications. The first is prescription medication, which is drugs acquired by a patient following a doctor's orders. The second is nonprescription drugs, also called over-the-counter (OTC) medications that a patient could obtain for self-

medication without the guidance of medical personnel. This dissertation explores how technology can aid understanding of drug label information on OTC drugs to support appropriate selection and usage of the drugs.

The Durham-Humphrey amendments to the Food, Drug, and Cosmetic Act of 1951 established the idea of the two classifications of medications in the United States (Temin, 1983). Prescription medications require a prescription from a physician and are dispensed by retail or mail-order pharmacies (Brass et al., 2011). OTC drugs are "used to self-treat mild transitory symptoms, conditions, and illnesses that do not require the approval and supervision of a physician" (DeLorme et al., 2010, p. 210)

There are two types of OTC medication: national name-brand and private label. Private label drugs, also known as generics drugs, are also called store brands. Private label drugs are owned and branded by retail stores whose primary function is distribution rather than production. They are marketed by retail stores and have the store name as part of the drug packaging (Ju & Lee, 2017). OTC drugs in the United States are categorized as restricted and unrestricted. Restricted OTC drugs are kept under the control of the drug store and are given to the consumer on pharmacist approval (DeLorme et al., 2010). OTC drugs with a potential for abuse such as pseudoephedrine are a type of restricted drug under the law in which "limits the monthly amount any individual could purchase, requires individuals to present photo identification to purchase such medications, [and] requires retailers to keep personal information about these customers for at least two years after the purchase of these medicines."(US Food and Drug Administration, 2017b). Unrestricted OTC drugs are already packaged and presented on pharmacy aisles and store outlets ready for purchase (DeLorme et al., 2010).

OTC medications are approved for immediate symptomatic relief and are assumed to have met a threshold of safety by the Food and Drug Administration (FDA), meaning that there is perceived safety and accessibility (Chui et al., 2013). The most highly used OTC classes are allergy, analgesics, antifungals, cough/cold/flu, lower and upper gastrointestinal, and medicated skin products (Consumer Health Products Association, 2012, p. 4). Using OTC drugs "is said to offer convenient access to, and choice of, medicines as well as involving patients as active participants in their own health and the treatment of illness" (Cooper, 2013, p. 82). Even though all drugs are “articles intended for use in the diagnosis of, cure, mitigation, treatment, or prevention of diseases in man or other animals” (Albert et al., 2014, p. 910), according to the Federal Food Drug and Cosmetic Act, OTC drugs are distinguished from prescription drugs in that they are safe and effective for use by the public without a physician’s prescription (ibid.). OTC medications also differ from prescription drugs in that prescription drugs sometimes require a measure of preparation by pharmacy personnel, some of which include preparing specific combinations of ingredients. Another difference between prescription and OTC drugs is that the range of OTC drugs is often more restrictive compared to prescription drugs and that there are limitations to indications and doses.

Being able to obtain effective medication without prescription results in an overall change in healthcare costs and prescription patterns. Self-medication facilitates better use of clinical skills of pharmacists, increases access to medicines, and may contribute to reducing prescribed drug costs associated with publicly funded programs (Wazaify et al., 2005). OTC drugs are used for self-management of most common illnesses such as heartburn and allergies. These drugs are used to self-treat “many commonly occurring conditions including the common cold, headaches, body pain, allergies, heartburn, lower gastrointestinal (GI) tract issues,

dermatitis, and fungal infections" (Consumer Health Products Association, 2012, p. 3). These potentially eliminate the need for medical office visits and prescription medication (Fidler & Massachi, 2016). OTC drugs are available at pharmacies, and in some cases, grocery outlets.

Interviews

Two unstructured interviews with pharmacists were conducted to evaluate issues surrounding OTC medications. The questions presented in the interviews as shown on Appendix A. The interviews were conducted over the phone and recorded. Transcription of the interviews is shown in Appendix B as Interview 1 and Appendix C as Interview 2. A third interview, Interview 3, was administered as a questionnaire on Facebook. This questionnaire, which used the same questions as used in Interview 1 and Interview 2, was posted by a pharmacist to a Facebook group of pharmacists. I provided the questions to the pharmacist, and requested that she post them on a Facebook group forum. Some questions on the Facebook questionnaire had up to ten respondents. The least number of respondents on any question was six pharmacists. Interview 1 was conducted on May 27, 2018, and Interview 2 was conducted on May 28, 2018. The Facebook questionnaire was administered on June 3, 2018, and the responses were posted between June 3, 2018 and June 4, 2018. The interviews pointed to issues of selecting among several drug types, readability and comprehensibility of drug labels, risks and abuse of OTC drugs, and general consumer experience in selecting medications in the absence of a pharmacist. This is reported on AppendixD.

The interviews showed that consumers have different methods by which they select an OTC medication on a pharmacy aisle. Besides cost, some consumers choose what has worked for them in the past, while others go with word-of-mouth, as other people have advised. "I know a lot of people just go by word of mouth, you know, like so--and--so told me this works well for

them, and they assume what works well for one person works well for them, and that's not the case all the time" (pharmacist, Interview 2). Others select the drug based on "what you have used in the past or what people around you have used in the past" (pharmacist, Interview 2). The pharmacist from Interview 1 likes to ask his customers about products that they have tried in the past and which of those were effective. Another way people select, according to the pharmacist from Interview 1, is by media advertisement and in-store price deals. "It could also be advertisement like based on the TV or the radio or even within the stores; you have all these posters on the wall or whatever, maybe they have a deal, or sale, or something." Some people will always pick the brand name as a habit. In Interview 1, the pharmacist reported that people will select a drug based on dosage where one will pick a drug to be taken twice daily over one to be taken thrice daily. The form of a drug can be a factor of selection with a preference for pills and capsules "because in general a lot of people don't like the taste of those liquids." Older adults might have a problem swallowing capsules and pills, while children do best with tasty syrups. The pharmacists responding to the Facebook questionnaire observed that "liquids work faster than tablets because the stomach doesn't have to break them down" (Facebook questionnaire).

The pharmacists from the interviews had varied views on the drug labels. In Interview 2, regarding the amount of information printed on the drug label, the pharmacist said that "everything is important. It's just that there is so much information and that patients want an answer right away." The pharmacist in Interview 1 stated, "there probably [is] some language in there that they do not understand, and there is also so much information that they are responsible to put on this little box and the print becomes almost microscopic." Besides the nature of the label, there are also behavioral issues related to the label in that "people sometimes don't

understand the label or don't read it properly" (pharmacist from Interview 1). The Facebook group interview respondents pointed out that ingredients could be easier to find and designed to have the ingredient and what it treats "right beside it." Other issues reported were about the font size being too small, and that the label could emphasize "important parts either by color or by bolding" (pharmacist from Interview 1). Many users do not pay attention to the information on the label. "When someone walks in to get an over-the counter-medication they basically just read the dose information … and unfortunately there is a population that doesn't really get what they are reading" (pharmacist from Interview 1).

All the pharmacists saw drug abuse of OTC medication as a severe issue due to unintentional overdoses and drug interaction between individual OTC medications and prescription medications that one is already taking. A case of overdose could happen when someone selects a drug for sneezing and another for coughing not realizing that the drugs have the same ingredients. A pharmacist on the Facebook group summarized inadvertent overdosing as being a factor of "not understanding that a lot of cough and cold products are the same medications in different packaging. A lot of these have Tylenol in them and they still want to take their Tylenol pm, which is still just acetaminophen and diphenhydramine. There is so much cross branding and marketing that it can be confusing and potentially dangerous" (pharmacist on the Facebook group).

Considering these issues, this research will venture into aiding selection of OTC medication using information technology. It will provide an information technology solution to selecting a drug by replicating the questions a pharmacist would ask to aid effective selection of an OTC medication in the absence of, or choice not to ask, a pharmacist. It will point out pertinent information on the label regarding selection and use. It will also highlight factors of

abuse that come from not understanding or paying attention to the drug label. To reiterate the research questions: How can a mobile application aid understanding of drug information on OTC drugs to support appropriate selection and usage of the drugs? Is there a relationship between different approaches of presentation of drug label information and knowledge retention regarding OTC drugs?

Chapter 2: Literature Review

OTC Usage in the United States

The Consumer Health Product Association (CHPA) reports that 93% of US consumers use OTC drugs to relieve their symptoms before seeking professional help (Consumer Health Products Association, n.d.). This is understandable given that 57% of all US health problems are treated with over-the-counter medications (Hong et al., 2005). Increased interest in self-medication is reflected by more OTC drug sales, which increased from $15 billion in 2005 to $32.1 billion in 2015 - an increase of 214% (Ju & Lee, 2017). According to the FDA, there are more than 80 classes of OTC drugs available, and that includes more than 100,000 OTC drug products with about 800 active ingredients (US Food and Drug Administration, 2020). In 2012 there were over 300,000 marketed OTC products (Chui et al., 2013). The use of OTC saves the US healthcare system $102 billion annually, relative to alternatives (Consumer Health Products Association, 2012), because these products allow consumers' effective self-treatment of commonly occurring health conditions (Albert et al., 2014).

The usage of OTC medication is prevalent among older adults. While people aged 65 years and older make up only 13% of the American population, this age group accounts for 30% of OTC medication use (Martin-Hammond et al., 2015). This, according to Martin-Hammond et al. (2015) is because older adults "tend to be at a higher risk of chronic illness and are more likely to take more medication increasing their risk of ADE's" (p. 114). ADE's are adverse drug events caused by medication.

One of the downsides of OTC is medication abuse. Approximately 3.1 million young people aged 12 to 15 have used nonprescription cough and cold medication to get high. Also, 4

percent of 12th graders have abused some form of cough medicine (Addiction Center, n.d.). According to the National Institute of Drug Abuse (NIDA), 2.1% of 8th graders, 3.6% of 10th graders, and 3.2% of 12th graders abused nonprescription cough medicine in 2017 (National Institute of Drug Abuse, 2017).

Transition to OTC

There are formal and implicit requirements that should be in place before a drug transitions to OTC status. The formal ones are those enforced by governments through regulatory bodies such as the Food and Drug Administration (FDA) in the United States. The implicit requirements are those that create the class of drugs called OTC. According to Brass and Weintraub (2003), these include the presence of a consumer population that would benefit from the drug, and that the drug would be appropriate for them. A second requirement is the absence of issues specific to a drug that preclude consumer self-treatment. A final requirement is the "ability of the consumer to monitor the impact of treatment on his or her disease condition" (Brass & Weintraub, 2003, p. 406).

The FDA in the United States gradually regulates prescription drugs and makes them available to users for purchase without a prescription making sure that they are safe, effective, and properly labeled (US Food and Drug Administration, 2016). These are drugs that "are assumed to have met a threshold of safety by the Food and Drug Administration" (Chui et al., 2013, p.1098) and have more safety data accruing over time to create an understanding of the risk of the drugs (Trivedi et al., 2014). Safety data is said to be attained when the FDA is satisfied that sufficient information exists to show that the drugs are safe. This regulation follows an understanding that the drugs are safe and that the ingredients have been used for a long-enough time to be considered safe for use by patients without much guidance from medical

personnel. The impetus to switch from prescription status to OTC is “increasing consumer awareness, growth of the self-medication movement, pharmaceutical companies’ attempts to increase sales and government efforts to curtail public spending on prescription products for minor, self-treatable ailments” (Kartha et al., 2017, p. 3) where drugs that were once provided with a prescription become available to users purchasing directly.

There are three significant factors to be considered before a drug changes its status from a prescription drug to an OTC drug: benefit-risk comparison, consumer-friendly labeling, and how to make the drug an appropriate choice as an alternative to prescription medicine (Chang et al., 2016). Kartha et al.'s (2017) viewpoint is that drugs that switch to OTC are those that have inherent traits that cause them to be amenable to self-medication. Some of the traits include cognitive concepts such as symptoms intended to be treated by the drug being ones that can be "recognizable by an individual of average intelligence", ease of administration, and that the treatment regimen is “uncomplicated enough for a layman" (Kartha et al., 2017, p. 3). A drug can transition to OTC medication status when “it can be used safely and effectively by consumers, without physician supervision, with the drug label that can be understood by the average person” (Brass & Weintraub, 2003, p. 406). The emphasis is on readability and understandability of the drug label to guide the usage of the OTC medication.

Benefit-risk comparison, according to (Chang et al., 2016) considers the capability of a patient to reach “the intended medical result in a safe manner” (p. 149). Although the FDA understands that all drugs pose some risk, the benefit-risk comparison looks at the probability of those risks and side effects occurring when a patient self-medicates. Regarding labeling, the FDA must be satisfied that the language must be clear to decrease instances of unsafe dosages and administration. The labels must show the active ingredients, uses, warnings, inactive

ingredients, indication, directions, and other information pertinent to an understanding of what the drug is and does. A manufacturer is required to demonstrate that the drug label is appropriate for determining proper usage. To this end, drug manufacturers conduct empirical studies to assess label comprehension (Catlin et al., 2012). The regulatory body also requires that the risks are clearly communicated on the labeling, while prescription drugs would have a medical professional discuss and clarify the risks and side effects. The requirement is that the drugs should be relatively "safe in regards to toxicity, drug-drug interactions (DDIs), and side effects as well as a minimized potential for abuse" (Chang et al., 2016, p. 150). The benefits of the drug to the consumer should outweigh the risks of its usage.

In the United States, the switch from prescription to OTC could be done in one of three ways: firstly, by the OTC drug review that is initiated by the Food and Drug Administration (FDA) commissioner, secondly, by submission of an efficacy supplement to the existing National Drug Code (NDC) wherea sponsor to switches the product in its entirety from prescription status to OTC, and thirdly by submission of a New Drug Application (NDA). "This is required for a sponsor to partially switch some of the indications to OTC, while retaining others within a prescription status" (Kartha et al., 2017, p. 4). Three consumer behavior studies accompany the application: label comprehension (LC), self-selection, and actual use studies. LC studies judge "the ease of a layman comprehending key facts" (Kartha et al., 2017, p. 4) on a drug label. The FDA must be satisfied that pertinent information on the label is effectively communicated to the consumer. Self-selection studies evaluate if the customer could extrapolate the information on the label to their personal medical history and make a correct self-decision selection, which is making an appropriate choice of the drug from among others. While these studies are repeated with label variations until an apparently satisfactory score is achieved, the

criteria to define “satisfactory” are not uniformly defined because rarely are comparative communication strategies compared head-to-head (Brass & Weintraub, 2003). Actual studies include a simulation of how the drug would be used safely and effectively after a user selects the drug. This test also confirms that the drugs would not be abused or misused.

Risks and Benefits of OTC Drugs

Brass, Lofstedt, and Renn (2011) have discussed the benefits and risks of nonprescription drugs. This section is a review of the benefits and risks of OTC drugs which points to lower costs and convenience as benefits, as well as value created for several stakeholders. The benefit domain includes improved access to effective drugs, improved clinical outcomes, improved public health, enhanced involvement by consumers in their healthcare, and economic benefits of the nonprescription medication. Risks appertaining to nonprescription drugs are based on the ability of the consumer to make decisions without the guidance of medical professionals. Risks due to the use of nonprescription medication are an issue of concern even if these drugs have a favorable safety profile as shown in the widespread use of these drugs. The risks are mostly due to “some form of inappropriate use and may stem from poor knowledge and risk perception” (Calamusa et al., 2012, p. 395). The assessment of benefits and risks showthat most of the risks stem from inappropriate usage of the drug by the consumer.

Chang et al. (2016) list four stakeholders that benefit in the transition of prescription drugs to OTC status – consumers, healthcare providers, drug manufacturers, and health insurers. Consumers enjoy the ease of access to essential medication. This is because a consumer could have access to drugs without the need for an appointment with a physician. Consumers also save time in not having to wait for the processing of their prescriptions. Costs are potentially reduced in the acquisition of OTC drugs because the price must be competitive when introduced to the

market, OTC drugs are ineligible for reimbursement schemes, and costs are lowered to ensure larger volumes of sales. Drug prices fall after the drug switches from Rx to OTC status, firstly, because the cost of selling OTC drugs is lower than that of prescriptions; and secondly, because a consumer can obtain the drug without seeing a doctor saving personal time and the doctor's fee (Temin, 1983). There are lower prices also because stores that do not have pharmacies can also carry OTC drugs. Getting OTC drugs also affords comfort to patients as they are "more comfortable purchasing medication discreetly...When the emergency contraceptive went OTC, it saved women and men the need to discuss their personal lives with more people" (Chang et al., 2016, p. 151) such as in obtaining birth-control pills.

Healthcare providers indirectly benefit from switches to OTC because they have a reduced number of patients coming in for ailments that could be self-treated, and they do not have to spend already limited time on diagnosing obvious, self-treatable conditions. Pharmacists' time is saved in being able to serve more people when they have fewer prescriptions to fill as people switch to OTC medications. Drug manufacturers benefit from the switch to OTC by being able to sell their generic equivalents when their patents run out. If the drugs they had as prescription medications become available as OTC, they gain a better handle on their sales because "products with a strong and well-recognized brand name can leverage on their identity to continue to ensnare large sections of the consumer market post making their product available as OTC" (Kartha et al., 2017, p. 3). The pharmaceutical industry benefits from increased access and use of OTC medication in that access to their products increases. A switch from prescription to nonprescription status protects against generic competition, while an existing brand that is also available on prescription may also be promoted (Hughes et al., 2001). Health insurers, where they cover their members for certain medications, also benefit with changes to OTC medication,

because their costs are reduced by not having to cover OTC medications through their plans (Chang et al., 2016).

While consumers could purchase drugs without the guidance of professionals, OTC drugs are not lacking of dangers from their use, although “there is a tendency for the public to perceive OTC medicines to be safer than prescription medicines” (Cooper, 2013, p. 83). Risks of OTC medications include misuse and abuse. The National Institute of Drug Abuse (NIDA) describes misuse of OTC medicine as “taking medicine in a way or dose other than directed on the package, taking medicine for the effect it causes – for example to get high, [and] mixing OTC medicines together to create new products” (National Institute of Drug Abuse, 2017, p.1) (NIDA, 2017, p. 1). Wazaify et al. (2005) define misuse as “using an OTC product for legitimate medical reason but in higher doses or for a longer period than recommended” (p. 170). An overdose occurs when a person uses enough of the drug to produce a life-threatening reaction or death (National Institute on Drug Abuse, 2017).

Consumers are responsible for all decisions regarding the selection and use of drugs. This relates to drug use, recognizing appropriate indications and doses for amount, frequency, and duration of use. The risk domain includes unintended misuse, intentional misuse with therapeutic intent, accidental ingestion, intentional overdose, and worsened outcomes due to self-management. Cooper (2013) has documented abuse due to OTC medications using three broad categories. The first is direct harms "related to pharmacological or psychological effects of the drug of abuse or misuse" (p. 98). Secondly, physiological harms related to adverse effects of another active ingredient in a compound could occur. The third viewpoint of harms relates to other consequences, such as progression to abuse of other substances, economic costs, and effects on an individual’s social life.

There are documented cases of addiction and abuse of OTC drugs. This is because some OTC medications have active ingredients with the potential for misuse at higher-than-recommended dosages. The five groups of drugs most susceptible to abuse, according to Cooper (2013), are codeine-based medicines, cough products, sedative antihistamines, decongestants, and laxatives. The Addiction Center (2018) lists the most commonly abused drugs like cough medicines (Dextromethorphan, or DXM), cold medicines (Pseudoephedrine), motion sickness pills (Dimenhydrinate), and pain relievers (Acetaminophen). The site also shows that common symptoms of drug withdrawal include confusion, hostility, anxiety, and mood changes. Since there is no physician guidance on how to use an OTC drug there are cases of overdose or stoppage of use before one has taken an appropriate dosage. Using OTC drugs also has the potential of delaying or masking serious ailments that may have required a doctor's office visit hence delaying treatment.

Interventions to address the abuse of OTC drugs include strategies aimed at minimizing the harm associated with medicine abuse, as well as supporting and treating individuals affected. Strategies to address abuse include pharmacy-based approaches reported by pharmacists in their actual work, increasing awareness of an abuse problem, providing additional training to pharmacists, and allowing pharmacists to provide treatment withdrawal programs (Cooper, 2014). Wazaify et al. (2005) suggest record-keeping as a method of restricting access to OTC drugs. This could have individuals registering with a certain community pharmacy and all purchases of restricted OTCs being recorded. Wazaify et al. (2005) suggest controlling quantities that people could purchase in a way supported by technology using smart cards with patient data related to OTC purchases being stored confidentially to prevent hopping between pharmacies.

Issues in the Use of OTC Medication

Areas of interest in research on OTC medication use relate to questions about how people select an appropriate drug for the symptoms that lead them to acquire the drugs without the guidance of medical personnel. Much, if not all the guidance on how to select and use a specific drug, is printed on the drug packaging. The drug label is intended to provide sufficient information to a user on what the drug treats, active ingredients, the dosage and method of administration, risks associated with the drug, and all other aspects of the drug that are supposed to guide the selection of the medicine. For this, the drug label must "guide and orchestrate a complex set of behaviors by the consumer" (Brass & Weintraub, 2003, p. 406).

Selecting an OTC Drug

A study by Wazaify et al. (2005) shows that factors that influence the public choice of OTC medicines include a doctor recommendation, a pharmacist recommendation, the opinion of a member of family or friend, advertisement, and prior use. The most important factor according to the study, was a pharmacist recommendation. This is where a customer, either the patient or someone looking to buy medicine for another person, seeks the advice of a pharmacist on what drug to select for the described ailment. Chui et al. (2013) report that only 40% of consumers consult a pharmacist before buying an OTC drug.

A study carried out in Northern Ireland in 2007 by Hanna and Hughes (2010) showed that safety was the most important factor that guided pharmacists in recommending an OTC drug to a customer. This is the perception that the drug would not harm the patient. Elements subordinate to safety were the product, patient, and professional considerations. If looking for a specific product, the researchers found that some patients would be looking for a product they already know about at the drug store. In this case, the drug would be provided if deemed safe for

the patient. Professional factors such as ethical considerations and meeting customer needs were third in importance.

Another critical factor in the selection of an OTC drug is advertising. According to Calamusa et al. (2012), advertising in mass media is a "potent source of information and influence on the purchase and use of OTC medicines" (p. 395). Also, OTC medication enters the market like other products and for that, business owners run advertisements like they do for any other products. The OTC market, being highly competitive, calls for consumer advertising for the success of the drugs “to inform, persuade, and to remind consumers about the attributes, functions, and benefits of OTC drugs” (DeLorme et al., 2010, p. 213).

Price consciousness, which is “the degree to which the consumer focuses exclusively on paying a low price” (Ju & Lee, 2017, p. 90) for an item, can be an important factor in selecting an OTC drug. This is the driver behind store brands of medication – a factor that has become important due to the high cost of medication. Store brands, also known as private label drugs, are considered important alternatives to national brands. Ju and Lee (2017) have observed that private label drug sales have advanced faster than the overall OTC segments in drug categories. Private label drugs generally have a lower price tag than national brands. The study by Ju and Lee (2017) shows that if the consumer considers price as the most important factor, they are less persuaded to look at other factors between the drugs and choose the less expensive one.

For self-medication to be effective, people should be able to recognize symptoms, and choose the appropriate drug, being aware of the potential risks, and reading and following the instructions on Package Information Leaflets (PILS) (Calamusa et al., 2011). The brand names of the drugs have also been known to influence the selection and evaluation of a drug. Other factors

influencing the choice of OTC drugs are health literacy, readability, and comprehension of the OTC medication drug label, as discussed below.

Health Literacy and Effective Use of OTC Medication

Health literacy, which is "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (Nielsen-Bohlman et al., 2004, p. 2), is an important consideration in looking at how people select and use OTC medication. Brass and Weintraub (2003) show that behaviors regarding the selection and appropriate use of the drug "must all be completed by a typical consumer using only the label to guide his or her actions" (p. 406). Calamusa et al. (2012) have reported three levels of health literacy as being functional, communicative, and critical. Functional health literacy (FHL) represents baseline literacy skills such as reading, writing, and making simple calculations that enable people to read and understand health information. This is the level of literacy considered in much of research in clinical settings. "Adequate functional health literacy means being able to apply literacy skills to health-related materials such as prescriptions, appointment cards, medicine labels, and directions for home health care" (Parker et al., 1995, p. 537).

FHL is "considered as mediating factor in health and clinical decision-making" (Calamusa et al., 2012, p. 396), which is different from formal education, because one could have the education competency of reading drug labels and still be unable to comprehend a drug label or make an appropriate choice for the drug. Health literacy is recognized to influence consumer comprehension of Drug Facts Information. For that, the FDA "requests that sponsors recruit participants with varying levels of literacy when conducting label comprehension studies to ensure that comprehension is adequate in the subgroup" (Catlin et al., 2012, p. 265) under

study. The Institute of Medicine (IOM) also estimates that 90 million adults in the United States may have trouble understanding and acting on health information since "medication container labels, in particular, may be confusing and difficult to comprehend for many patients" (Davis et al., 2006, p. 887).

According to Davis et al. (2006), patient-initiated errors can be found in both prescription and OTC medications. In the case of OTC, a patient could misunderstand or fail to comprehend warnings, directions, and dosages of drugs. Davis et al. (2006) also concluded that "patients of all ages would benefit from additional efforts to improve the clarity and comprehensibility of labeling on prescription drugs" (p. 893).

Readability and Comprehensibility of OTC Medication Drug Labels

Labels are the primary means of communication with consumers for OTC drugs. Being able to read and understand the content provided on them is critical in effectively selecting appropriate drugs. "The increasing number and complexity of drugs under consideration for OTC approval make it imperative to better understand how to effectively communicate health information via OTC labeling" (Catlin et al., 2012, p. 264). OTC drug labels contain instructions for use, warnings, dosage, and other pertinent information that a user would need to select and use the drug effectively. Trivedi et al. (2014) reporting cases of people harmed by being unable to read and understand a drug label observed that "the label is the only safeguard against improper use" (p. 473). This makes it important to understand how to communicate the needed information more effectively on the drug label because labeling is critical to the safe and effective use of OTC drugs. The FDA requires that the labels be prominent and conspicuous because certain warnings are meant to be read at the point of purchase (Bix et al., 2009). For this reason, labels play a vital role in ensuring safe medication usage (Catlin et al., 2012). Brass and

Weintraub (2003) point out that the drug label must be sufficiently specific "that the consumer will not view the drug as appropriate if his or her symptoms are the result of an alternative condition or are of a severity that requires evaluation by a healthcare professional" (p. 406). In the (Wazaify et al., 2005) study, 74.5% of those interviewed reported always following the directions on the OTC packaging.

The drug label, while mandated by the FDA, is not without problems. Readability and comprehensibility of the information on the drug label is an important issue. Trivedi et al. (2014) found "nonprescription medication labels, which bear important information about directions, risks, and warnings, are written in a language with poor readability and comprehensibility characteristics" (p. 474). Readability of the label is hampered by the size of the font, placement on the packet, and colors used on the writing and on the packaging. Older adults are particularly impacted by readability and comprehensibility factors of drug labels, because one of the primary challenges regarding OTC medication for older adults is the size of the font used in labels (Martin-Hammond et al., 2015). Pires et al. (2016) point out socio-demographic features such as age, gender, education, literacy, employment status, and frequency of medication use may have an impact on readers' comprehension of written information about medicines. Also, according to Trivedi et al. (2014),

> *The elderly may have impaired sensory pathways and subtle often undetected cognitive impairment may be more prone to self-medication errors. Such patients probably face greater challenges in reading the small font and understanding the complexity of terms often used in nonprescription product labels (p. 476).*

The state of literacy in the United States is also a factor of the comprehensibility of the drug label. With the functional illiteracy rate of the country being 20%, coupled with 35% of the

American adult population reading and comprehending at 6th to 10th-grade levels (Covington, 2006), the label content is difficult to understand for all but the most capable readers.

Comprehensibility relates to an understanding of the information provided. Some of the information is in medical terminology that some people do not understand. This is also a factor in literacy level. In many cases, most users do not read the drug label and depend on other factors in the selection such as prior use, consultation with a pharmacist, or advertisement of drugs. Comprehensibility and readability of the labels is not only a factor of language, but also of design. Some health authorities have called for label standardization. A study by Tong et al. (2014) that focuses on readability showed that small font, minimal white spacing, and poorly positioned page breaks hamper readability and hence comprehensibility of drug labels and written medicine information (WMI), particularly for older users. "Specifically, an ill-positioned page break led to 63% of consumers being unable to locate information pertaining to the action required in the event of an overdose in the ibuprofen OTC WMI, reinforcing the negative impact of suboptimal OTC WMI design" (Tong et al., 2014, p. 869). Catlin et al. (2012) feel that the drug label is not sufficient for all information on a drug and that health care providers who recommend OTC drugs should accurately communicate difficult label information to patients.

Drug label sizes and jargon make it increasingly difficult for consumers to read and comprehend information on the labels. Wolf et al. (2010) have noted that drug labeling itself is not patient-centered and is a root cause of a large proportion of medication errors. The drug label should provide enough information to enable a consumer to select a drug to select for a malady from among many other drugs. Labels contain much information restricted to a very small space, resulting in printed information being compacted and reduced to very small fonts. Drug labels present more information than is required for selection, and consumers must sift through the

label text to identify the pertinent information for a selection decision. This is also hampered by legibility difficulties coupled with comprehensibility. Here is where technology could help.

Trivedi et al. (2014) reported a study on readability and comprehensibility of drug labels using the Flesch-Kincaid and Gunning-Fog methods (Thomas et al., 1975). The Flesch-Kincaid method is used to provide reading ease and a reading grade level score for textual material. It uses word and sentence lengths in formulae to provide a score of readability and education level for a piece of text and it has been shown to have "excellent reproducibility and high correlation to other readability scales and have been used in numerous previous studies" (Trivedi et al., 2014). A "higher reading ease score implies the text is proportionately easier to read, and the grade level score refers to the grade level required to have entered to understand the material" (p. 474). They used the Gunning-Fog (Gunning, 1952) method to determine the grade level of education required to comprehend the labels. After evaluating forty nonprescription drug labels, they found out that all but one of the labels was at eighth-grade level and all others were at a reading level greater than eighth grade. This showed, according to the Gunning-Fog method "all the labels were at a reading grade level greater than eighth grade" (Trivedi et al., 2014, p. 474).

Information Overload

Besides incomprehensibility of the drug label, customers are also faced with information overload when looking at the amount of information provided on the drug label to guide the selection of an appropriate drug. Information overload is described as "the point where there is so much information it could no longer be used effectively" and it occurs "when potentially useful information received became an hindrance rather than help" (Jackson & Farzaneh, 2012a, p. 523). Information overload is not a fact of the information only, but also due to other aspects of the information such as "uncertainty, ambiguity or equivocality, novelty, complexity and

intensity" (Schneider, 1987, p. 144). Eppler and Mengis (2004) go further and see information overload as being related to five constructs: the information itself; the person recieveing, processing, or communicating it; the tasks or processes that need to be completed by the person; the organizational design; and the information technology used in supporting processing of the information (p. 330). They note "usually, information overload emerges not because of one of these factors by because of a mix of all five causes" (Eppler and Mengis, 2004, p. 330). The time available to process new information has been cited by Schick et al. (1990) who state, "information overload occurs for an individual when the information processing demands on time to perform interactions and internal calculations exceed the supply or capacity or time available for such processing" (p. 206). This is important given that customers are not able to allow too much time in making up their minds about the drug to pick from among many.

Duke et al. (2011) observed that the "effectiveness of labeling in communicating adverse drug events (ADEs) may be diminished by the problem of 'overwarning' in which excessively long and complex lists of potential reactions can result in information overload" (p. 944). The concept of information overload as it applies to drug labels is not just a factor of ADEs. Aspects of dosage, usage, and restrictions also pose the information overload problem. According to Eppler and Mengis (2004), information overload occurs when someone receives more information than they can process to make a specific decision. The quality of decisions "of an individual correlates positively with the amount of information he or she receives, up to a certain point. If further information is provided beyond this point, the performance of the individual will rapidly decline" (Eppler and Mengis, 2004, p. 326). There may be an optimum amount of information on the drug label or that is provided by a pharmacist beyond which there is no value in decision making to be used in selecting and appropriately using OTC medication. Miller

(1956) argues that there is a limit in our capacity to accurately process interacting elements in our minds with some accuracy and validity. That that the number is "seven, plus or minus two" (p. 81).

Information Overload Models

There are several models proposed in the literature for assessing individual information overload. Jackson and Farzaneh (2012) have formulated a theory-based model. Their model states that there are factors that are for and against information overload. The factors against information overload are information processing capacity, characteristics of information, and available time. Factors that influence information overload are personal factors, task and the process parameters, quality of information, and quantity of information. The first law guiding their theory is for factors against information overload which states that "Information Processing Capacity, Characteristics of Information and Available Time, cooperate with each other to decrease the probability of information overload occurrence" (Jackson and Farzaneh, 2012, p. 528). The second law states "Quantity of Information, Quality of Information, Task and the Process Parameters, and Personal Factors cooperate with each other to increase the probability of information overload occurrence" (Jackson and Farzaneh, 2012, p. 528).

The seven factors are further divided into two broad categories that they have called intrinsic factors and extraneous factors. Intrinsic factors directly influence information overload. This category has the Quantity of Information and Information Processing Capacity. Extraneous factors "indirectly contribute to information overload and have a direct effect on intrinsic factors" (Jackson and Farzaneh, 2012, p. 528). In this category are Characteristics of Information, Quality of Information, Task and Process Parameters, and Personal Factors. While the labels given to the seven constructs clearly defined them, Characteristics of Information is a

multi-factored construct that includes complexity, ambiguity, uncertainty, and novelty. Quality of information is a "combination of relevancy and validity of information" (Jackson and Farzaneh, 2012, p. 529). The other component of the model is Tipping Point defined as "the point at which information overload occurs … the critical point of the presented model by which the model is led from one state to another, overloaded or not-overloaded" (Jackson and Farzaneh, 2012, p. 527).

The not-overloaded state is where "the individual can handle the Quantity of Information that they are required to process" (Jackson and Farzaneh, 2012, p. 528) while the overloaded state is the opposite of that. Their model is depicted as a level with factors for and against information overload placed on either side with the tipping point as the fulcrum. The not-overloaded end of scale has Characteristics of Information, Information Processing Capacity, and Available Time while the overloaded end has Personal Factors, Task and Process Parameters, Quality of Information, and Quantity of Information. Characteristics of Information is on the not-overloaded side because of its direct influence on Information Processing Capacity and Available Time. Each of the seven factors has a weighting and the state of the system (overloaded or not-overloaded) is determined by the weighting of the factors of either side.

The model proposes a weighting allocation that shows the importance of intrinsic factors over extrinsic factors by using a weight of 10 for extraneous factors and 100 for intrinsic factors as shown in Figure 1. With that though, Jackson and Farzneh (2012) admit that the weightings "still need to be determined and substantial research will have to be undertaken in order to establish them" (p. 529). For a balanced system, the maximum result is 100,000 calculated by multiplying out the factors on either side. To determine if the person is overloaded the model subtracts the product of the factors on the "not-overloaded" side from factors of the "overloaded"

side. This shows that "any result less than zero means the person is overloaded by information and a score greater than zero refers to a state whereby the individual has control over the problem" (Jackson and Farzaneh, 2012, p. 529).

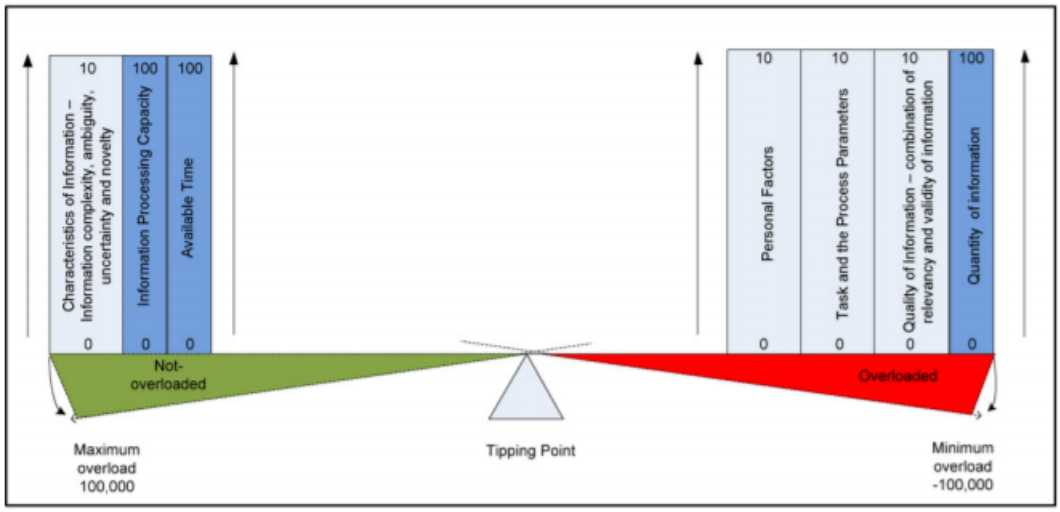

Figure 1:Weighted factors for information overload (Jackson & Farzaneh, 2012)

Jones et al. (2004) discussed a theoretical model that focuses on the impact that information overload coping strategies for individuals have on the dynamics of open, interactive, online group discourse. This model assesses how individuals respond to information overload in the online space. It relates more to how people respond to an increase in information as measured by how much they engage with the information. One of the areas where this is measured is UseNet which looks at how users engage in information. The model theorizes that as discourses increase past the average maximum communication load, "a further increase in communication load should result in an increased preference by individuals to engage in communicative actions that require less cognitive effort" (Jones et al., 2004, p. 198). This would, in turn, be reflected by a change in the communication dynamics of the group. Unlike the model proposed by Jackson

and Farzaneh (2012), where the information overload measures are centered on an individual, the model by Jones et al. (2004) looks at information overload from the standpoint of a group of people participating in online communications and grades it as being more or less as opposed to the model by Jackson and Farzaneh (2012) that assigns quantitative measures.

Losee (1989) shows that electronic message systems contribute to information overload and proposes a method to measure the usefulness of a message considering its contribution to information overload on an individual. This model assesses information overload with respect to the quality and quantity of the pieces of information. It proposes to rank the piece of information in the order of its usefulness. The model is "designed to economically optimize the information reaching the user" (Losee, 1989, p. 180). The model does not point out how an individual is overloaded and to what extent. Jackson and Farzaneh (2012) discuss how one could get information overload from the process of interacting with information and propose a model to evaluate that quantitatively.

Hofstede's model (as described in Kock et al., 2008) creates scores for countries and regions based on five factors. The five are power distance, uncertainty avoidance, individualism versus collectivism, masculinity versus femininity, and long-term versus short-term orientation. The expectation is that countries and regions that are grouped together based on these parameters are similar based on the construct on which they are grouped. For example, the US and New Zealand have a score of 46 and 49 and are ranked 43rd and 39th to 40th, respectively, on uncertainty avoidance. Kock et al. (2008) applied the uncertainty avoidance parameter from Hofstede's model as a measure of information overload positing that "if uncertainty avoidance is high in a particular group of individuals, then one would expect those individuals to seek to

obtain and process information, which likely contributes to them experiencing information overload" (p. 33).

To test the idea that there would be similarity in information overload between the cultures now that the model shows them as close, Kock et al. (2008) created an information assessment instrument based on a theoretical assumption that there are two main latent variables that affect perceived information overload: individual factors and task factors. They measured individual factors by looking at work knowledge and skills acquisition, decision scope, and decision rationality. The model measures task factors by pages read, pages written, work-related activities per day, information giving interactions, and information receiving interactions.There is also one measure of perceived information overload.

Kock et al.'s instrument differs from Jackson and Farzaneh's model in that in addition to individual and task factors, the latter's model has individuals evaluating characteristics of information and the quality of information. The characteristics of information, as discussed by Jackson and Farzaneh (2012), is a multi-faceted construct that includes information complexity, ambiguity, uncertainty, and novelty. Quality of information covers a combination of relevancy and validity of information. In the case of individuals interacting with a mobile app to select a product, in this case, an OTC drug, Jackson and Farzaneh's model is more suited to measuring information overload based on the breadth of the items covered in the model. Another difference and advantage that this model has is that the measures do not have to be self-reported. Available time, interruptions, and tasks and process parameters are to be observed by a researcher.

A Critique of the Model Proposed by Jackson and Farzaneh (2012)

While the model proposed by Jackson and Farzaneh is usable for evaluating perceived information overload it does not suggest how a user of the model would come up with

measurements for each of its constructs. The authors described each construct in sufficient detail to guide in constructing measurement scales for each one. The model has suggested weights as shown on the model diagram, and that they have left it to the researcher to determine if the weights are appropriate. The weightings “still need to be determined and substantial research will have to be undertaken in order to establish them” (Jackson and Farzaneh, 2012, p. 529). They acknowledge the complexity of measuring the construct “information processing capacity” as being easier in a computer system than it would be in humans. The construct cognitive style would also be difficult to measure and could warrant its own measurement instrument. Since 2012, when the model was first proposed, literature does not show a documented use of the model to establish the weightings. There is also no reported validation of this model.

However, this model can be used in an experiment where the researcher has direct observation of the participants. In this case, the researcher could measure how long a participant takes to complete a task and measure interruptions. This would not be easy, or in some cases possible, if the participants would self report these values.

Global Drug Identifier

The FDA has mandated a specific identifier for every drug. This is printed on the drug label and encoded on a bar code. The three-segment number, called National Drug Code (NDC), is a universal product identifier for human drugs. The three segments identify the labeler, product, and trade package size (National Drug Code Directory, 2019). The labeler code is assigned by the FDA and represents a firm that manufactures or distributes the drug. The product segments identify “a specific strength, dosage form, and formulation for a drug" (US Food and Drug Administration, 2019) while the package code describes the package sizes and types. The FDA mandates that the code be provided on the drug packaging requiring "registered drug

establishments to provide the Food and Drug Administration (FDA) with a current list of all drugs manufactured, prepared, propagated, compounded, or processed by it for commercial distribution" (US Food and Drug Administration, 2017a). The code is used to uniquely identify a drug.

An example of a drug code number is 0573 0150 30 that represents brand drug Advil with a generic name Ibuprofen. There are several strength values for Advil such as 200mg, 256mg, and 500mg. For this drug, the code 0573 represents a labeler company Wyeth Consumer Healthcare LLC (National Drug Code Directory, 2019). This labeler has several drugs and strengths represented by different NDC codes. Also, this labeler is not the only one for Advil 200mg. Another labeler, Lil' Drug Store Products, Inc., also makes the same drug and strength but differs in packaging. While Wyeth Consumer LLC packaging is one "1 BOTTLE in 1 CARTON (0573-0150-30) > 50 TABLET, COATED in 1 BOTTLE" (FDA, 2018) the labeler Lil' Drug Store Products, Inc packaging is "1 POUCH in 1 CARTON (66715-9700-1) > 2 TABLET, COATED in 1 POUCH" (FDA, 2018). Simply put, one company distributes in cartons and another in pouches. For example, the company also labels the drug Alavert Allergy that has the NDC 0573-2620-01. This specific drug is labeled Advil 200 Mg Tablet, information that must also be shown on the drug packaging. With each drug having a unique number it is possible to have the drug information of any drug stored in a database and looked up based on the number. The drug number is printed on the label of the drug packaging, and can be read using a barcode scanner.

Technology Approach

The Gerontological Society of America (GSA), in partnership with the Consumer Healthcare Products Association (CHPA), convened a summit that reviewed adults' OTC

behavior. Some of the ideas discussed in the summit addressed five areas of research for use of OTC consumption: “Health literacy and OTC behavior, decision making and OTC use, the role of clinicians in OTC medication behavior, older adult OTC behavior and family care, and technologies to promote optimal use of OTC medication” (Albert et al., 2014, p. 909). Albert et al. (2014) noted that technologies, such as smartphone applications, can “enhance accessibility to relevant information when and where it is needed, provide reminders when medication is due, and alert patients to hazards” (p. 915) of OTC drug use. Regarding technology, the summit posed two research questions – how electronic health records could be enhanced to include OTC medication and whether smartphones and other internet applications promote safe and effective OTC medication use. Martin-Hammond, et al. (2015) looked at decision-making applications for older adults concerning selecting medications. Da Rocha et al. (2016) created a decision-making application to assist pharmacists in helping customers select an appropriate drug. Their technologies are reviewed next.

The creation of the tool developed by Martin-Hammond et al. (2015) follows an observation that technology has taken three approaches regarding medication. The first approach is technologies; adhering to human-computer interaction (HCI) techniques has provided applications that cater to medication adherence, reminders to take medication and correct dosage. The second approach has focused on keeping patients informed about their medication and treatment when they are in or out of the hospital. The third approach has looked at designing patient education systems used by nurses to aid patients in understanding potential drug interactions with alcohol (Martin-Hammond et al., 2015). The researchers observe that the technologies under the three categories address medication adherence while noting that nothing is done on providing guidance on designing “medication management applications that focus on

helping consumers make a decision about a medication" (p. 114), observing that this is a different task.

The Martin-Hammond et al. (2015) application placed much emphasis on HCI issues that were ratified in interaction with older adults through semi-structured interviews. The application was developed in an iterative design process "employed to conceptualize and design a novel interface to assist older adults with the task of selecting appropriate OTC medication" (p. 115). They came up with the initial prototype after conducting a study of older adults to identify an initial set of challenges in and barriers to OTC medication information. When the prototype was ready there were two review sessions with HCI researchers to evaluate the design based on their knowledge of design principles for older adults. The design was evaluated for support of consumer-friendly presentation of medical terminology, design for older adults, and accessibility by people with diverse computing experiences. Their application is mainly a recommender system where users select a possible drug and respond to whether it has side effects; then the system notifies the user whether the drug selected is appropriate. In selecting the drug, the user scans a bar code to display the drug information. If it is not, the system recommends a different set of drugs for which the user goes through an evaluation of the appropriateness of the drug.

The application by Rocha et al. (2016) followed a study in northwestern Brazil focused on pharmacists in a developing country where the adoption of self-medication through OTC drugs has different drivers from those that would be found in the United States. The drivers for OTC medication practices are low availability of healthcare coupled with poverty and scarcity of doctors. In Brazil, self-medication is practiced by 76.4% of the population where the decision to purchase is advised by family and friends. Rocha et al.'s (2016) application was based on a desire to "appropriate medicine effectively, safely, and conveniently" (p. 153).

The Rocha et al. (2016) application helps the pharmacist determine appropriate medication by inputting patient information on symptoms. The symptoms yield a short list of ailments. With that, the pharmacist, using his or her judgment settles on an ailment. Once an ailment is determined, the software generates a set of questions that address chronic diseases, medications, and allergies. This narrows down the possible set of drugs that the pharmacists finally choose based on considerations such as health risks.

Theory Base for Research Design

Choosing a drug based on the information on the drug label can be mapped on the theory of probabilistic mental models (PMM) (Gigerenzer et al., 1991). The theory assumes that inferences about unknown states of the world are based on probability cues. It accounts for choice and confidence showing how the mind makes choices. The theory also replaces the "cannon of classical rationality with simple, plausible psychological mechanisms of inference – that a mind can actually carry out under limited time and knowledge" (Gigerenzer & Goldstein, 1996, p. 652) that try to find some optimal integration of all information available with simple, plausible psychological mechanisms of inference. The other contrast between PMM and classical rationality is that search in memory for decision-making information is reduced to a minimum with no integration, but rather, the substitution of the pieces of information. The algorithms of PMM have a user performing intelligent guesses about unknown features of the world, based on uncertain indicators much as in the selection of an OTC drug.

The basic algorithm of PMM theory is called Take The Best (TTB) with a policy of "take the best, ignore the rest" (Gigerenzer & Goldstein, 1996, p. 653). It assumes a subjective rank order of cues and has the choice made based on the first cue that discriminates between the two choices being made. The steps of the algorithm are that the user checks to see if they recognize

the items they are choosing between. If they do, they go on to the second step of searching for the cues based on their ranking (importance). Thirdly, they decide if the cue discriminates between the choices. If it does, the fourth step requires that the user stops searching and makes a choice.

PMM Theory's TTB algorithm relates to how shoppers for medication could choose between two OTC drugs for the same ailment. The choice of an OTC drug, in the absence of a pharmacist or other medical practitioner, is made with limited time and knowledge. After a shopper identifies candidate drugs, a decision could be made by ranking the most important cues. Those could be the purpose of the drug (uses), age limitations, dosage, warnings, and overdose information. A shopper will compare these factors (cues) until there is a difference (discrimination). Two pain medications could differ on side effects, and the shopper could select the more tolerable one. When the choice is made on that cue, it shows that the shopper is not influenced by, or even considers lower-ranking cues such as drug form – tablets, syrup, or ointment.

Multimedia Methodology for Drug Information Presentation

One of the fundamental parts of this research is in the method by which the drug label information is presented. Without consulting a pharmacist, the drug label should be the source of information on selection and use of drugs. The label is the safeguard against improper use (Trivedi et al., 2014). of the ways of presentation of drug information in this research was the use of the capabilities of multimedia technologies to generate an understanding of the drug information using computer technologies. These capabilities were extended to the acquisition of information regarding OTC drugs from pharmacies. This research evaluated the use and effectiveness of multimedia in the presentation of drug information and how media richness

enhances an understanding of this information. According to media richness theory, "communication transactions that can overcome different frames of reference or clarify ambiguous issues to change understanding in a timely manner are considered rich. Communications that require a long time to enable understanding or that cannot overcome different perspectives are considered low in media richness" (Sun & Cheng, 2007, p. 663). This research evaluated the richness of media and the extent to which the richness corelates with knowledge retention of the drug information and information overload.

Given the amount of information that needs to be presented to gain a clear understanding of information about the drug, it is essential to evaluate the extent of the development of media used in the presentation of the information to make it easy to understand and retain. Sun and Cheng (2007), in discussing media richness theory, point out that efficient and effective communication requires matching of media richness with the task at hand, in this case, presentation of pertinent information guiding the selection and proper usage of OTC drugs. They note "using high richness media for simple tasks may cause distraction or loss of focus, while for tasks with a high level of uncertainty and equivocality using lean media cannot convey information efficiently and effectively and results in poor communication" (p. 665). Presentation of drug information to a customer who needs to quickly decide on the drug to purchase may not require a highly rich medium.

Research Questions

There are three research questions. The first is how could technology aid understanding of drug information on OTC drugs to support appropriate selection and usage of the drugs? The second research question is how could information overload be evaluated in the amount of information provided to people looking to purchase OTC drugs? The third research question

looks at the most effective methods of presentation of drug information and is addressed in three parts. Firstly, is there a relationship between different multimedia approaches of presentation of drug label information and knowledge retention regarding OTC drugs? Secondly, is there a relationship between diferent multimedia approaches of presentation of drug information and information overload? Thirdly is there a relationship between different multimedia approaches and perceived usability?

Chapter 3: Methodology

Using a Pharmacist Recommendation

Wazaify et al. (2005) and Chui et al. (2013) have pointed out that the recommendation of a pharmacist is the most important factor guiding the selection of an OTC drug by stating that 40 percent of customers consult a pharmacist for help in deciding on the drug to purchase. The role of the pharmacist in self-medication is important considering that "in management of common ailments, pharmacists play a vital role in supporting responsible self-medication by giving people advice and reassurance, supplying non-prescription medicines when appropriate, and referring people to other health care professionals when necessary" (Anderson, 2002, p. 393). When recommending a drug, a pharmacist asks about the symptoms of the customer covering issues such as drug and/or illness history, age, gender, and other preferences. One of the pharmacists (#1) I interviewed (see next section) stated that he always asks about drug history.

> Usually, what I ask them first if they ask me, I will ask them, 'Which products have you tried in the past and were any of them effective?' That kinda gives you a feel for if there is something that they feel didn't work at all.

Another pharmacist (#2) reported,

> So, one of the issues you always make sure you bring up with the patient is 'Are you allergic to any drugs? Are there medications you cannot take?', and if that's the case, then maybe some of these allergy medicines or cough medicines pain medicines may not be right for you.

Using a pharmacist recommendation only works when one is available, such as when one purchases the drug during a pharmacy's open hours. This research investigates methods of

presenting pain relieving drug information, in the absence or unavailability of a pharmacist in using computer technology.

Gathering Requirements from Pharmacists

The questions to be used in this research were determined by surveying pharmacists. I had four interactions with pharmacists at various stages of the development of the app. My first meeting with a pharmacist (#1) was on August 14, 2019, in a recorded phone interview. In that discussion, I wanted to know the type of information a pharmacist gathers from someone looking for pain medication. I also wanted to know if pain medication differs based on the location of pain in the body. The pharmacist stated that onset, duration, location, history, and cause of pain are essential in determining if or what medication to provide. Another guiding factor is a patient's preference for taking an oral drug or using a local application such as a pain reliever patch. Pharmacist 1 stated,

> Some people might prefer just something local to help them with something like a local knee pain rather than taking some oral medication. They may want something like those pain relief patches or pain relief gel. It all depends. Some people cannot tolerate some medications, so I do not think there is one particular answer that would fit everybody.

Pharmacist 1 stated he pharmacist stated that if someone has had pain for over three days and if it does not subside, they should seek medical advice. The pharmacist listed general body aches, headaches, and muscle strains as the most common pain issues brought up at the pharmacy. There are pertinent questions to ask the customer before recommending pain medication. According to pharmacist 1,

> First, there are several questions you would have to ask to find out if this is a case that you can help or you would have to refer them to a physician. You start with how far has

that been going on, has it gotten worse or what have you done to relieve it, and before you make any recommendation, you have to check and see whether they have any allergies [because] you can't recommend something if they are not able to take it. And then you give them some expectation on how long they should try the over the counter options before seeking medical help.

From this interview, I learned about a general order of questions that a pharmacist would ask before recommending a drug. I checked an Advil drug carton to see how these factors are represented on the drug labeling. There are warnings and precautions on a drug box that are consistent with the pharmacist's statements the pharmacist had made in this interview. With that, I made the first version of the mobile app that replicated the questions but mapping it back to the drug box. In this version of the app, I presented the questions dynamically based on the answer a user would have previously given.

My second session with pharmacists was in December 2019. In this session, I met with two pharmacists in a room at their workplace. I showed them a draft of the first app I had made and told them about my first interview. In this session, they added a few more of the questions a pharmacist would present. They expanded on common areas of pain to include stomach pains. They pointed out that pain areas could differ by gender. They expanded on the description of the symptoms of pain to include aching, burning, progressing, radiating, stabbing, throbbing, and tingling. They suggested adding a measure of a patient's assessment of pain in numeric values of 1, for the least pain or none at all, to a 10 for the most extreme and unbearable pain.

I made a follow-up meeting with the same pharmacists I met in the December 2019 meeting for a review of our previous meeting. This time, they recommended a model that they had learned in pharmacy school used to guide the factors that a pharmacist should review before

prescribing medication for an analgesic. The model states that one should look for symptoms, characteristics, history, onset, location, aggravating factors, and remitting factors of pain (Buring et al., 2007). The model is abbreviated SCHOLAR where each letter represents the step of inquiry. With that, I attempted to map the requirements of the SCHOLAR model to the information on a drug box but I did not find it to map precisely. For example, the SCHOLAR model calls for obtaining aggravating and remitting factors. These are not provided on a drug box.However, I saw that the types of pain are listed on the drug box and that the onset of pain is also included in drug labeling. I used the information from this session to create the second version of the mobile app. In this version, I separated the patient's information into two screens that I have labeled "personal information" and the second screen as "health check". I changed the screen that collects personal information from presenting the questions dynamically to asking for all of a user's information through text input fields. The "health check" screen continued to be dynamic to make sure that a user responds to each question before being allowed to move to the next question.

My last meeting with a pharmacist was on April 2, 2020. I showed the pharmacist the app as I had built it. The pharmacist was agreeable to the new features introduced by the other pharmacists and suggested that if someone had reported having had pain for more than three days they should seek the advice of a medical professional. Also, the pharmacist advised that if someone does not know what might have caused the pain that person should also seek medical advice. I updated the app to reflect those recommendations.

Information Overload Model for OTC Medication Information

The theory-based model of factors affecting information overload as proposed by Jackson and Farzaneh's (2012) was used to test for information overload in this research by adopting their

proposed weightings. This was done by treating the model factors on the model as independent constructs. The constructs are as follows:

a) Characteristics of information
    a. Information complexity
    b. Ambiguity
    c. Uncertainty
    d. Novelty
b) Information processing capacity
c) Available time
d) Personal factors
e) Task and process parameters
f) Quality of information
g) Quantity of information

Artifact Development and Use of Mobile Apps as a Research Tool

Three mobile applications were developed (text-based, audio-based, and video-based) with the final version of each being the third iteration. I chose these three as representative visual and audio media methods. Feedback from pharmacists and test users guided the steps of the evolution of the design. The applications were developed using XCode, a native development platform for iOS mobile applications. All versions of the app used the relational database that is standard with XCode.

First Version

I started building the first version of the apps in December 2019. My first pharmacist interview guided the questions and options for this version of the app. This version required four inputs on the initial screen to initiate the question tree. The app presented options of the drug to select from using a picker view (XCode's option for selecting from multiple choices). The format of the presentation of information to users/customers is a question tree. The version displayed the following four question in the order listed:

- Where do you feel the pain?
- How long have you had the pain?
- How old are you?
- Have you had this kind of pain before?

Depending on the answer to the first question, the software presented the subsequent questions one at a time. For example, if a user reported having had a certain kind of pain previously, the next question was what medicine they took for it. If not, the next question was to determine if the user was allergic to any pain medication. The rest of the question logic is found in Appendix F. Finally, the app listed drugs that met the criteria and presented the dosage for each.

Second Version

I built a second version of the mobile app after meeting with the pharmacists for the second time. They suggested additional pain descriptions, and the use of a numerical (1-10) rating scale used by medical professionals to gauge patients' assessment for pain intensity. The pharmacists suggested the following as descriptions of pain but cautioned that these descriptions are subjective and might mean different things to different patients:

a) Aching
b) Burning
c) Progressing
d) Radiating
e) Stabbing
f) Throbbing
g) Tingling

There are two significant distinctions between the first version and the second version of the app. The first change was that the app presents all the questions regardless of a user's answers and uses the answers in the logic to select medications. The second change is the addition of navigation, where a user would choose the method of app usage. The three methods are by text, audio, and video. The initial screen is presented with options for the three methods. On any of the versions, the software collects the illness and personal data in text form, and the user selects responses from a picker view. After submitting this information, the text version provides dosage, warnings, precautions, and caution information via text.The audio version and the video version provides information by audio and video respectively.

Third Version

In the third version, I separated the app into three different apps where one app presented drug information in text only, another in audio only, and the third in video only. Like in the second version, all the apps gather the illness and personal information using the picker view as the option selector, and video or audio for usage details. The initial screen of the text-based app shows the app information in text format. The audio-based app is presented in an auto-playing

audio file, while the video-based app starts with an auto-playing video file that gives the users the instructions on how to use the app.

Updates to the Third Version

After creating the three apps (see Figure 2), I showed them to the pharmacist 1. The pharmacist suggested that I make two updates. The first one was that if a person reports having had pain for three or more days, they should consult a doctor. The second change was that if a person reported the pain intensity as being greater than four in the pain rating scale they should also consider consulting with a doctor. I updated the code to reflect the suggested changes.

When the app launches, it creates an instance of the database for the medications used in this study. The user does not write any data to the database. The application does not collect any user information in keeping with my IRB approval.

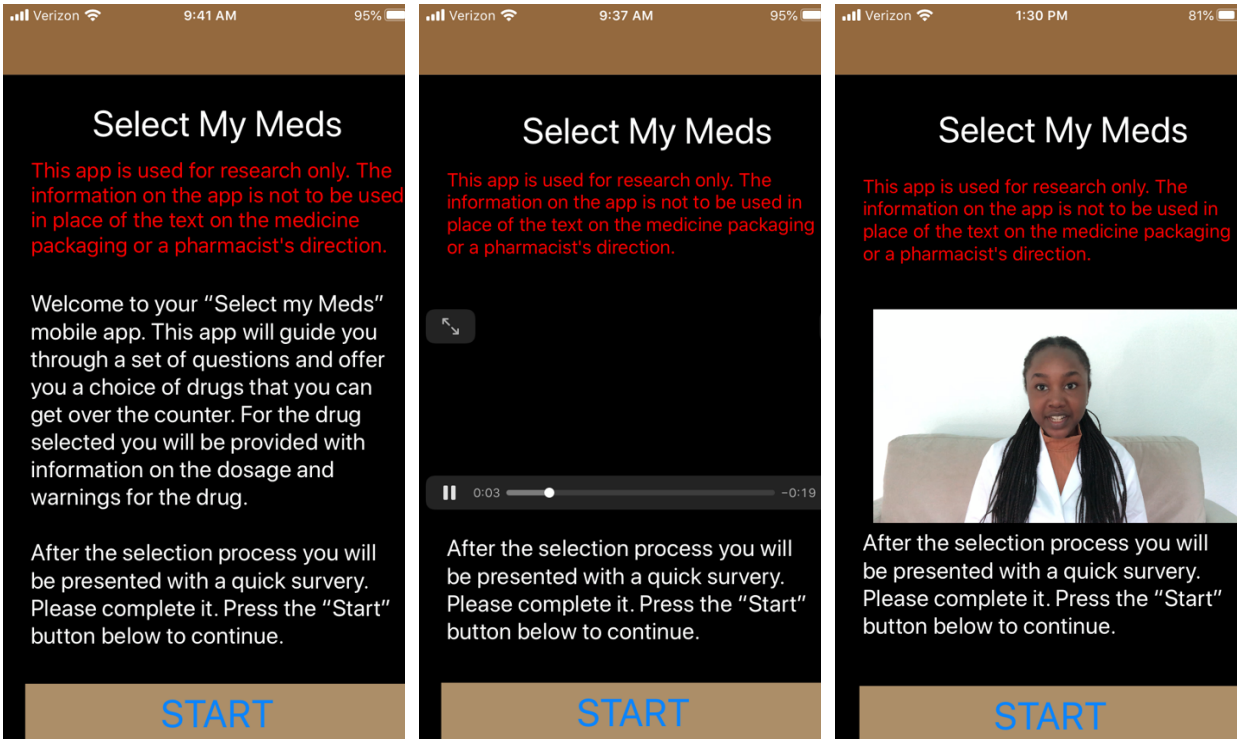

Figure 2: Initial screen of each app

Table 1 shows the most current status of each of the three applications.

App	Current Release	TestFlight Name
Text-based	Version 1.7 Build 10	"otctext"
Audio-based	Version 1.0 Build 3	"otcaud"
Video-based	Version 1.3 Build 5	"otcvideo"

Table 1: Applications configuration management

Using the Apps for Research in TestFlight

TestFlight is a program offered by Apple to that allows users authorized users to test an app (Kauffman L et al., 2020). A user is referred to as a tester in TestFlight. It allows users to install and use the app. Through TestFlight end users could also provide feedback directly to the developer. In this research I invited testers to download only one of the mobile applications via an email from Apple. The information provided by the user determines the over the counter (OTC) medications for pain that the user could select. All the applications use text fields to collect basic personal data by having a user select each response from a pull-down menu. This information is passed through the program logic that is based exclusively on the information on the drug boxes to recommend pain medications.

Table 2 shows the questions used to gather a user's information and recommend one or more medications. The information collected is not stored in a database in compliance with my IRB approval. It is active only during an open session. It is used to gather information about the illness and other conditions.

Information item	Question text	Options
Gender	Your gender	a) Female b) Male

Information item	Question text	Options
Age	Your age	a) Under 12 b) Over 12
Cause of pain	What might have caused the pain?	a) Headache b) Muscular aches c) Menstrual cramps d) Common cold e) Backache f) Toothache g) Minor pain of arthritis h) I do not know
Pain description	How do you describe your pain?	a) Aching b) Burning c) Progressing d) Radiating e) Stabbing f) Throbbing g) Tingling
Pain duration	When did it start?	h) Today i) Yesterday j) Two days ago k) More than two days ago
Pain location	Where do you feel the pain?	a) Head b) Back c) Chest d) Stomach
Pain intensity	1 (mild) to 10 (extreme) how bad is your pain?	a) Numbers 1 through 10
Fever check	Do you have a fever?	a) Yes b) No
Doctor's care	Are you under a doctor's care for a serious condition?	a) Yes b) No
Other medication	Are you taking any other medication?	a) Yes b) No
Stomach problems	Do you have stomach problems?	a) Yes b) No
Pregnancy check	Are you pregnant?	a) Yes b) No

Information item	Question text	Options
Aspirin allergy	Are you allergic to aspirin?	a) Yes b) No
Stomach ulcers and bleeding problems	Have you had stomach ulcers or bleeding problems?	a) Yes b) No
Blood-thinning and steroids	Do you take blood thinning or steroid drugs?	a) Yes b) No
Other drugs	Do you take other drugs containing aspirin, Ibuprofen, or naproxen?	a) Yes b) No

Table 2: User Questions along with Answer Choices

Question Rationale

a) Gender

The gender selection is to improve question selection logic. If a person selects "Male" as gender, the pain cause option "Menstrual cramps" is not provided. Also, the question "Are you pregnant?" is not presented to males.

b) Age

For this research, all users were at least 18. However, an adult may be buying pain medication for a minor. If a user states that they are under 12, the app recommends seeking a medical professional's advice.

c) Cause of pain

The options for the cause of pain are those listed on a drug box. If a user selects "I do not know," the app recommendation is to seek a medical professional's advice.

d) Pain description

Pharmacists provided the pain description options. While these do not factor into the recommendation of a drug, they serve to assure a user that their pain description is covered.

e) Pain duration

According to the warnings on medication packaging, one should consult a doctor if the pain lasts more than ten days or fever lasts more than three days. If a user selects "More than 2 days ago," the app recommends seeking a medical professional's advice.

f) Pain location

Like pain location, this question adds the assurance that a user's pain area is covered. Pharmacists highlighted the head, back, stomach, and chest as the most common pain areas.

g) Pain intensity

This question presents a subjective evaluation of the patient's pain intensity. When a patient reports a pain intensity of greater than four, the program recommends seeking the advice of a medical professional.

h) Fever check

If a user states that they have a fever, the application recommends pain medications that are also fever reducers. Aspirin drugs used in this research are not fever reducers.

i) Doctor's care

If a patient selects the option of being under a doctor's care, the application recommends seeking the advice of a medical profession. One of the drug facts for Advil

is “Ask a doctor or pharmacist before use if you are under a doctor’s care for any serious condition.”

j) Other medication

If a patient selects the option of taking medication, the application recommends seeking the advice of a medical professional. One of the drug facts for Advil is “Ask a doctor if you are taking any other drug.”

k) Stomach problems

This applies to NSAIDS. The stomach bleeding warning states, “This product contains an NSAIDS, which may cause severe stomach bleeding.”

l) Pregnancy check

This question is presented to females only. One of the drug facts on NSAIDS states, “If pregnant or breastfeeding, ask a health professional before use”.

m) Aspirin allergy

This question is presented as a warning against taking ibuprofen. The drug box states, “ask a doctor if you are taking aspirin for heart attack or stroke, because ibuprofen may decrease this benefit of aspirin.” A warning on aspirin drugs Ecotrin and Bayer is that one should not use the drug “if you are allergic to aspirin or any other pain reliever/fever reducer.” It also warns that aspirin “may cause a severe allergic reaction which may include hives, facial swelling, asthma, and shock”.

n) Stomach ulcers and bleeding problems

The stomach ulcers and bleeding problems questions are used because NSAIDS drugs Ecotrin, Bayer, Advil, Motrin, and ibuprofen have a warning that the “product contains an NSAID, which may cause severe stomach bleeding.”

o) Blood-thinning and steroids

This question is presented because ibuprofen drugs Advil, and Motrin increase the chance of stomach pain if one is taking a blood-thinning (anticoagulant) or steroid drug.

p) Other drugs containing aspirin, Ibuprofen, or naproxen

One should not take other medicines containing aspirin, Ibuprofen, or naproxen when using Ibuprofen Advil, Motrin, and Pain Relief Ibuprofen. Usage of such other medications would be a usage of the same drug causing contraindication.

Drug Recommendation Logic

The mobile applications recommend medications that are consistent with the facts on the drug boxes. For this research, there are no medications recommended for children under 12. While the application recommends medication based on a user's stated conditions, if one is under 12, the application states, "Please consider consulting with a medical professional before purchasing over the counter drugs." Besides being under 12, the following are other conditions for which a user is warned to consider consulting with a medical professional.

1) Selecting "I do not know" as a probable cause of pain

According to the pharmacists interviewed, if a user states that they do not know what caused the pain and that the reason is not one of those listed on the drug carton, they might have suffered a more severe problem for which they need to consult a doctor.

2) Selecting "More than two days ago" as the time pain started.

All the pain medication cartons carry the warning that one should stop use and consult a doctor if a fever lasts more than three days and pain for more than ten days. In

the pharmacists' interview, they stated that if the pain has lasted for more than two days without subsiding, one should consider seeking medical advice.

3) Selecting a pain level that is five or greater.

The numerical rating scale for pain ranges from 0 for no pain to10 for extreme pain. The scale divides the data points into groups of three with mild pain being a 0 to 4, 5 to 7 being moderate pain, and 8 to 10 being severe pain. This scale "has the advantage of being quick and simple, requires no equipment and does not depend on intact motor skills" (Mohan et al., 2010, p. 372)

4) Answering in the affirmative to any the following questions.
   a) Are you under a doctor's care for a serious condition? For example, the Advil carton advises a user to "Ask a doctor or pharmacist before use if you are under a doctor's care for any serious condition".
   b) Are you taking any other medication? For example, the Motrin carton advises a user to "Ask a doctor or pharmacist before use if you are … taking any other drug."
   c) Do you have stomach problems? For example, the Bayer carton warning states, "Ask a doctor before use if you have a history of stomach problems, such as heartburn."
   d) Are you pregnant? For example, the ibuprofen carton warning states, "If pregnant or breastfeeding, ask a health professional before use."

The warning on the application for someone who meets any of the above conditions is, "Please consider consulting with a medical professional before purchasing over the counter drugs."

Drug Usage Information

After the user selects a drug, the application presents drug usage information including dosage, warnings, the precautions of use, and cautions of use. Precaution of use is the factor someone should consider before using the medication. This information comes from the section titled “Do not use” on a drug box. For example, on an Aleve 220 mg drug box the precaution of use reads “Do not use if you have ever had an allergic reaction to any other pain reliever/fever reducer [or] right before or after heart surgery.” Additional precaution information is on the section titled “Ask a doctor before use if.” The caution of use is the factor someone should consider while using the drug. These are side effects of the medication for which a person might stop using the drug. The data is drawn from the drug carton on the section headed “Stop use and ask a doctor if.” For example, on the Aleve 220 mg drug box this section reads “Stop use and ask a doctor if you experience any of the following signs of stomach bleeding … you have symptoms of heart problems or stroke … pain gets worse or lasts more than 10 days, fever gets worse or lasts more than 3 days, you have difficulty swallowing, it feels like the pill is stuck in your throat, redness or swelling is present in the painful area, [or] any new symptoms occur.”

For the text application “otctext,” each of these pieces of information is presented on one mobile app screen with scrolling enabled. In the video and audio versions of the app, these pieces of information are presented in an audio or video clip after the user selects a drug.

a) Dosage and warnings
b) Precautions of use – this is the information under “Ask a doctor if” section of the drug carton.
c) Cautions of use – this is the information under “Stop use and ask a doctor if” section of the drug box.

The drug selection logic is based on the relational database. The main table in the database is the drug table and it contains the fields shown in Table 3. The other data tables that make up the entire database are shown in Appendix H.

Field name	Data type	Description
drug_id	Integer	The primary key of the table
drug_name	Text	Name of the drug
usage_group_ref	Text	Foreign key to drug usage table
age_group	Text	The age group of medicine users
dose_count	Text	Number of drug units taken at a time
dose_duration	Text	The time unit used in dosage
max_dose	Integer	The maximum number of units by time unit
time_span	Text	Time unit for dosage (Example 24 hours)
drug_form_id	integer	Foreign key to drug form table
strength	Text	Drug strength (Example 200Mg)
video_clip	Text	Name of the video clip
video_clip_type	Text	Type of the video clip (Example .mov)
audio_clip	Text	Name of the audio clip
audio_clip_type	Text	Type of the audio clip (Example .m4a)
active_ingredient	Text	The active ingredient of the drug (Example Aspirin)

Table 3: Data Elements of the Drug Table

The application gathers a user's data and runs a query against this table to determine appropriate drugs based on the data provided. An example of the query that lists possible drugs runs as follows

```
SELECT DISTINCT drug.drug_name || ' ' || drug.strength AS med,
active_ingredient
FROM drug, med_usage, usage_group
WHERE drug.usage_group_ref = usage_group.usage_group_ref AND
usage_group.med_usage_id = med_usage.med_usage_id AND
active_ingredient != 'Aspirin' AND
age_group = 'Over 12' AND
drug.active_ingredient NOT IN ('Ibuprofen','Naproxen') AND
med_usage.med_usage = 'Fever' AND
active_ingredient != 'Ibuprofen'
```

Information Not Covered

The following pieces of information are provided on the drug carton but are not accounted for in the selection of the drug.

a) Number of units in a carton
b) How to use the product. An example of how to use the drug is "When using this product take with food or milk if stomach upset occurs."
c) Information under the heading "Other information." This includes how to store the drug, and specific quantities of ingredients in a drug unit, such as 20 Mg of potassium in an Advil tablet.
d) Inactive ingredients

e) Contact information for the manufacturer

Research Design

The study is a between-groups field experiment. The participants were assigned to groups in the order by which they signed up to participate in the experiment. The design uses one independent variable and three dependent variables (see Table 4). The independent variable is the type of app used: text-based, video-based, and audio-based. The three dependent variables are information overload, understanding of drug information measured by the retention of drug data knowledge presented during the selection of a drug, and perceived usability of the apps. This is a between-groups study because each participant used only one type of app. All three groups of participants were presented with the same survey.

Type of app	**Knowledge Retention**	**Information overload**	**Perceived usabilty**
Text-based			
Audio-based			
Video-based			

Table 4: Research Design

After collecting data I did analysis of variance (ANOVA) for each dependent variable. These ANOVA scores were used to find if there is a difference between the means of the scores based on the method of information presentation in terms of information overload, understanding of drug information, and perceived usability.

Research Instrument

This research is guided by the media-richness theory and information overload theory. These two theories led to the creation of a survey instrument. The survey is the research

instrument. The survey questions evaluate both the information overload theory and the media-richness theory. The survey questions for perceived usability are carved out of those that cover information overload. The media-richness theory questions are those that check for understanding of the data on a drug box by comparing data from the three treatment groups. The questionnaire was constructed using Qualtrics. The universal resource locator (URL) from Qualtrics is linked on the last screen of the mobile apps.

After a user selects a drug and views dosage, warnings, precautions, and cautions of use, the mobile application presents a survey. The survey offers questions used to evaluate the three independent variables – knowledge retention, information overload, and perceived usabilty. Table 5 below shows the survey questions for knowledge retention.

Question #	Question	Answer mode	Answer options
1	Which drug did you select?	Multiple choice	○ Tylenol ○ Aleve ○ Motrin ○ Advil ○ Ecotrin ○ Bayer ○ Advil liquid-gels ○ Ibuprofen capsules ○ Anacin
2	What is the dosage of the drug you selected?	Multiple choice	○ Take 1 to 2 caplets every 4 to 6 hours. ○ Take one caplet every 8 hours ○ Take 2 tablets every 6 hours ○ Take 4 to 8 tablets every 4 hours ○ Take 2 caplets every 6 hours

Question #	Question	Answer mode	Answer options
3	What is the daily maximum dosage of the drug you selected?	Multiple choice	○ Do not exceed 6 caplets in 4 hours ○ Do not exceed 3 caplets in 24 hours ○ Do not exceed 8 caplets in 24 hours ○ Do not exceed 48 caplets in 24 hours
5	Which of the following is a possible side effect of the drug you chose?	Multiple choice	○ It may increase the rate of heart attack, heart failure, or stroke ○ It may cause severe stomach bleeding ○ It may cause severe lung damage ○ All of the above
6	Which of the following should you consider before using the drug you chose?	Multiple choice	○ Having a history of stomach problems such as heartburn ○ Taking a diuretic ○ Having problems or serious side effects when taking pain relievers or fever reducers ○ Having high blood pressure, heart disease, liver cirrhosis, or kidney disease ○ Taking a prescription for gout, diabetes, or arthritis
7	Which of the following is a reason for stopping to use the drug of your choice?	Multiple choice	○ If pain lasts more than 10 days ○ If you have problem swallowing ○ If redness or swelling is present in the painful area ○ If ringing in the ears or loss of hearing occurs ○ If it feels like the pill is stuck in your throat
8	Have you, in the past, bought the drug you selected?	Multiple choice	○ Yes ○ No ○ I do not remember

Question #	Question	Answer mode	Answer options
9	If, in the past, you bought this drug, have you learned any new information about this drug from using this app?	Multiple choice	○ Yes ○ No
10	The app provides most of the information provided on the drug box. Did you find any information about the drug you chose, that you had not seen on the drug box?	Multiple choice	○ Yes ○ No ○ I used the drug box in this research.

Table 5: Survey Questions for Knowledge Retention

Survey Questions for Information Overload

Table 6 below shows questions 11 to 21 used for information overload constructs as discussed by (Jackson & Farzaneh, 2012a).

Construct	Question number	Question in this research
Complexity of the information	11	How difficult or easy did you find the process of selecting an appropriate pain drug with the information given on the app?

Construct	Question number	Question in this research
Ambiguity of the information	12	The information provided on the app about the medication accurately describes my condition.
Novelty of the information	13	Which of the following statements describes the information you found on the app regarding the drug you selected?
Level of prior experience	8	Have you, in the past, bought the drug you selected?
Personal skills	20	Did you find yourself able to download and install the app and also completely follow the guidance of the app to select and appropriate drug for pain?
Cognitive style	14	Did you fully understand the information given to guide you in selecting the appropriate drug?
Motivation of the person	21	The mobile app is an appropriate tool to guide the selection of a drug
Personal situation	19	Would you consider yourself able to follow the steps and select an

Construct	Question number	Question in this research
		appropriate drug based on the information provided on the mobile app?
Task complexity	15	The information given on the app to select the drug was:
Task novelty	18	Have you ever used a mobile app to select a pain drug before?
Relevance of the information	16	How relevant or not relevant was the information about the drug form, warnings, side effects, and dosage in selection of the drug?
Validity of the information	17	The information on the drug type, side effects, precautions, purpose of the drug, and warnings to aid my selection of the medication is:

Table 6:Survey Questions for Information Overload

Research Instrument Review

For face validity, two graduate students reviewed the research instrument. One reviewer is an Information Systems and Technology major and the other an Economics major. They made recommendations about the structure and the order of questions. They reviewed the appropriateness of the questions to address the constructs of information overload. One of the

corrections by the reviewers was grouping the questions by the main idea. The reviewers recommended reordering the questions into three contiguous sets. The first set of questions addresses the medication information and measures knowledge retention variable. The second set relates to the nature of the information presented by the app and measures information overload. The third set is to do with installing and use of technology in the selection of the medication.

Evaluating the Dependent Variables

I used the survey results data to evaluate the three dependent variables: knowledge retention, information overload, and perceived usefulness. I downloaded the survey report from Qualtrics. I awarded individual scores for knowledge retention and information overload. I used the scores to assess the correlations between each dependent variable (knowledge retention, information overload, or perceived usefulness) and the independent variable (type of mobile app).

Knowledge Retention

For knowledge retention, I used the following questions and marked each answer as correct or incorrect. For each correct answer, I awarded a score of 1, giving a maximum possible score of 5 and a minimum of 0.

Q2. What is the dosage of the drug you selected?

Q3. What is the daily maximum dosage of the drug you selected?

Q5. Which of the following is a possible side effect of the drug you chose?

Q6. Which of the following should you consider before using the drug you chose?

Q7. Which of the following is a reason for stopping to use the drug of your choice?

Information Overload

For information overload, I used the formula from Jackson and Farzaneh (2012). The formula is based on the seven constructs of the model (see Figure 1). The data comes from the responses to the questions in Table 6. Based on this formula, information overload is calculated as follows:

> Information Overload = (Characteristics of Information x Processing Capacity x Available Time) – (Personal Factors x Task and the Process Parameters x Quality of Information x Quantity of Information) (Jackson & Farzaneh, 2012, p. 530).

The weightings for each of these constructs are shown in Figure 1 (Chapter 2). To calculate the weightings, the components of the constructs are multiplied together, except for Person Factors, which are summed (Jackson & Farzaneh, 2012). Based on the research design, I did not have values for the construct "Available Time" on one side of the equation and the construct "Quantity of Information" on the other side of the equation. These values could not have been correctly reported in an experiment without direct researcher observation. I was able to exclude those without impacting the calculation since both of these constructs are weighted at 100. For "Information Processing Capacity" I used the participant's score for knowledge retention. Jackson & Farzaneh (2012) have stated that this construct could be measured by the time it takes an individual to extract the required information from the "quantity of information one can integrate into the decision making process within a specific period of time" (p. 526). I used the weights suggested in the model for the scores for each of the constructs, as shown in Table 7. Having updated the formula to exclude a measure for Available Time (AT) and Quantity of Information (QTOI), I used the method below to evaluate information overload (OL):

OL = (COI * IPC) – (PF * TPP * QLOI).

If the difference is greater than zero, then the participant does not report information overload. The higher the information overload score the less overloaded the individual is.

Construct	Sub constructs	Data source	Weight	Total Weight
Characteristics of Information (COI)	Complexity	Q11	20.0	20*2*0.5*0.5 = 10
	Ambiguity	Q12	2.0	
	Uncertainty	Q14	0.5	
	Novelty	Q18	0.5	
Information processing capacity (IPC)		Knowledge retention score	100	100
Personal Factors (PF)	Level of prior experience	Q8	2	2+3+2+3 = 10
	Personal skills	Q29	3	
	Motivation of the person	Q21	2	
	Personal Situation	Q19	3	
Task and process parameters (TPP)	Task complexity	Q15	5	5*2 = 10
	Task novelty	Q18	2	

Construct	Sub constructs	Data source	Weight	Total Weight
Quality of information (QLOI)	Relevance	Q16	10	10*1=10
	Validity	Q17	1	

Table 7: Calculation of Information Overload

Perceived Usability

For perceived usability I used the score of the following questions and awarded the scores as shown below:

Survey question 11: How difficult or easy did you find the process of selecting an appropriate pain drug with the information given on the app?

- extremely easy (5)
- somewhat easy (4)
- neither easy nor difficult (3)
- somewhat difficult (2)
- extremely difficult (1)

Survey question 14: Did you fully understand the information given to guide you in selecting the appropriate drug?

- yes (2)
- no (1)

Survey question 15: The information given on the app to select the drug was:

- Extremely complex to follow (1)
- somehow complex to follow (2)
- neither complex nor simple to follow (3)

- somewhat simple to follow (4)
- extremely simple to follow (5)

Survey question 20: Did you find yourself able to download and install the app and also completely follow the guidance of the app to select an appropriate drug for pain?

- yes (1)
- No (2)

Survey question 21:The mobile app is an appropriate tool to guide the selection of a drug

- strongly agree (5)
- somewhat agree (4)
- neither agree nor disagree (3)
- somewhat disagree (2)
- strongly disagree (1)

The higher the score of from the perceived usability question the greater the perceived usability.

Posting to TestFlight

Apple rejected my initial application to post the apps on TestFlight due to several issues. The major factor of rejection was that the application was concerned with medication and dosages. Apple needed to see a disclaimer that the app was to be being used for research only and that I am permitted to carry out the research. Apple asked me to provide the study's IRB approval and to add a disclaimer that the tool would be used for research only. Apple also asked me to state that the source of the drug usage, side effects, precaution, and caution information

was drawn from the drug box. With that, Apple accepted the apps and allowed me to share them on TestFlight for review.

Initial Observations about the Survey and Updates

After Apple accepted the initial version of the apps and made them available on TestFlight, all the other updates I made of the application were easily accepted for downloading and testing. Two of the changes I made after the initial posting were layout issues and updating the picker view to close when a user made a selection. In the initial version, I had a user click on the submit button after selecting an option from the picker view. This button was not easily visible to everyone.

Finding Participants

All the research participants have been drawn from a convenience sample. The users are colleagues at work, neighbors, and friends. Before someone would participate, they had to complete a consent form and send it back to me via email or a printed signed copy. When I received the signed consent form, I assigned the user to one of the three apps. The user downloads the assigned app and follows the step as guided by the question:

> "Based on a recent experience on using or purchasing over the counter pain medication please use the app to select pain medication and complete the survey at the end of the process."

On the last screen, after a user has selected a drug, been informed of the dosage, warnings, precautions of use, and caution of use, the survey URL is presented.

Chapter 4: Results

This chapter addresses the following research question, which has three parts. What is the most effective multimedia approach in the presentation of drug label information to guide the selection of an OTC drug?

a. Is there a relationship between different multimedia approaches of presentation of drug label information and knowledge retention regarding OTC drugs?
b. Is there a relationship between different multimedia approaches of presentation of drug label information and information overload regarding OTC drugs?
c. Is there a relationship between multimedia approaches and perceived usability?

The rest of this chapter describes the research participants and analysis of the empirical study.

Participants

Ninety people were invited to participate in the research. To agree, they had to fill out the consent form. Then they were provided with information to download one of the three app versions described in Chapter 3. The first invitation was sent on April 12, 2020. Evenutally, 84 individuals filled out a consent form. After receiving the signed consent form, the researcher listed that user as a tester in TestFlight for one of the three app versions, “otctext,” “otcvideo,” and “otcaud.” Being listed as a tester initiated an email from Apple with instructions on how to download TestFlight on their phone, download the assigned app, follow the instructions to use the app to select an OTC medication, and complete the survey. Testers were assigned to either the audio-based or video-based app in a rotary manner. The first participant was assigned the

"otctext" app version, the next user was be assigned to "otcvideo", the third user was assigned to "octaud", and the cycle was repeated.

Of the 84 users invited to participate in the research, 64 installed the app, and 63 completed the survey. There was one instance where two members of a family used the same phone to run the test and complete the survey. In this case, they installed both "otcaud" and "otcvideo" but each of them, for their own reporting, ran their own test.Table 8 shows the assignment of testers to the apps and whether they completed the survey.

Number of testers invited	App	No of testers that returned a signed consent form	No of people invited to download the test app	No of people who installed the app	No of completed surveys
90	"otcaud"	22	22	20	20
	"otctext"	37	37	25	24
	"otcvideo"	25	25	19	19
Total		84	84	64	63

Table 8: Participant assignment

Three surveys were not used. These were where a tester did the survey more than once as indicated by the IP address registered in Qualtrics. That left 60 usable surveys. All participants were 18 and older. There is no identification about users with respect to age or gender as per the approved IRB application for this study.

Analysis of Variance (ANOVA)

One-way ANOVA was considered as a way to compare the means of the scores stated in the research questions above. Triola (2014) gives the following considerations for using one-way ANOVA.

1. The groups have approximately normal distributions
2. The groups have approximately the same variance
3. The data are based on simple random samples
4. The samples are independent of each other
5. The different samples are from one population.

Some literature holds that it is important to consider tests of normality before carrying out an ANOVA (Kozak & Piepho, 2018). Welch's ANOVA was considered as an alternative to the F-test one-way ANOVA because it can be used to compare the means without assuming equal variances (Jan & Shieh, 2014). The data available are amenable to establishing if all the dependent variables combined (knowledge retention, information overload, and perceived usability) have a strong relationship. This could be done using multivariate analysis of variance (MANOVA) to carry out a single, global analysis (Robson, 2011). With the research questions proposing to look at the dependent variables separately MANOVA was not considered.

While current literature recommends using a non-parametric statistical procedure when normality or equality of variance are doubtful (Feir-Walsh & Toothaker, 1974), "only with equal shape in the groups might the Kruskal-Wallis test be preferable, given the power advantage over *F*-test under specific distributions" (Blanca et al., 2017, p. 555). The data for KR values do not show equal shapes. For this reason, though the normal distribution requirement for using ANOVA is violated, I have chosen to use the Welch's ANOVA for analysis of both KR and IO

data. Feir-Walsh and Toothaker (1974), in comparing the F-test to the non-parametric test Kruskal-Wallis, concluded "when normality and/or homogeneity of variance is doubtful, the ANOVA *F*-test is recommended procedure for testing hypothesis about means" (p. 797).

Shapiro-Wilk Test of Normality on Dependent Variables

The Shapiro-Wilk test "is thought by some to be the best test for judging whether or not a sample is from a normal distribution" (Flynn, 2010, p. 265). The test was applied to the three dependent variables: Knowledge Retention (KR), Information Overload (IO), and Perceived Usability (PU) across the three levels of the type of app (the independent variable). The null hypothesis of this test is that the data has a normal distribution in the population and tests if the data are statistically significantly different from a normal distribution. The null hypothesis is rejected if the *p*-value is less than or equal to 0.05. If greater, the null hypothesis is not rejected.

Levene's Test for Equality of Variance

Lavene's test was applied to check for homogeneity of variance for each of the dependent variables based on the app used. The null hypothesis for this test is that there is no difference between the variance of the data sets for audio-based, video-based, and text-based apps.

Relationship Between Multimedia Approaches and Knowledge Retention

Welch's ANOVA was performed to evaluate if there is a relationship between multimedia approaches of presentation of drug label information and knowledge retention regarding OTC drugs. Table 9 below shows observed mean scores and standard deviations of Knowledge Retention (KR) based on the type of app used. The complete summarized dataset for knowledge retention scores is shown in Appendix H.

App used	N	Mean	Standard Deviation
Audio-based	20	0.82	0.16
Video-based	19	0.84	0.17
Text-based	21	0.68	0.21
Total	60	0.78	0.20

Table 9: Knowledge retentions scores

The Shapiro-Wilk test showed a significant departure from normality. In this test the audio-based app showed $W(20) = 0.09$, $p = .001$, video-based app showed $W(19) = 0.765$, $p = .001$ and the text-based app reported $W(20) = 0.857$, $p = .006$. The Lavene's test indicated equal variances with $F(2,57) = 2.50$, $p = 0.91$. The Welch's ANOVA test for knowledge retention scores shows that the type of app used has a significant impact on knowledge retention, $F(2,37.67) = 4.13$, $p = .024$. Post hoc test using Games-Howell revealed no significant difference between the video-based app and audio-based app with $p = .908$, a significant difference between the video-based app and the text based app with $p = .026$, and a significant difference between the audio-based app and the text-based app with $p = .048$

Relationship Between Multimedia Approaches and Information Overload

A Welch's ANOVA was performed to evaluate if there is a relationship between multimedia approaches of presentation of drug label information and information overload regarding OTC drugs. Table 10 shows the observed scores for Information Overload based on the type of app used. The complete summarized dataset for information overload scores is shown on Appendix I.

App used	N	Mean	Standard Deviation
Audio-based	20	372.80	251.42
Video-based	15	351.11	228.92
Text-based	13	272.84	133.99
Total	48	338.95	217.92

Table 10: Information overload scores

The Shapiro-Wilk test showed the sample sizes as not being drawn from a normal distribution. In this test the audio-based app showed W(20) = 0.953, p = .416, the video-based app showed W(15) = 0.961, p = .707 and the text-based app reported W(13) = 0.966, p = .843. The Lavene's test indicated homogeneity of variance with $F(2,45) = 1.76$, p = 0.18. The Welch's ANOVA test for information overload scores shows that the type of app used has no significant impact on information overload, $F(2, 29.1) = 1.33$, p = .28.

Relationship Between Multimedia Approaches and Perceived Usability

A Welch's ANOVA was performed to evaluate if there is a relationship between multimedia approaches of presentation of drug label information and perceived usability regarding OTC drugs. Table 11 shows the observed scores of perceived usability based on the type of app used. The complete summarized dataset for perceived usabilty scores is shown in Appendix J.

App used	N	Mean	Standard Deviation
Audio-based	20	17.95	2.42
Video-based	15	18.40	1.92
Text-based	13	17.92	2.36

Total	48	18.08	2.22

Table 11: Perceived usabilty scores

The Shapiro-Wilk test showed W(20)= 0.935, $p = 0.196$ the for audio-based app, W(15) = 0.872, $p = .036$ for the video-based app, and W(13) = 0.907, $= 0.165$ for the text-based app data, hence rejecting the null hypothesis of the data being from a normally distriubuted population. The Lavene's test indicated equal variances with $F(2,45) = 0.12$, $p = 0.883$. The Welch's ANOVA for perceived usability scores shows that the type of app used does not have significant impact on perceived usability, $F(2,29.97) = 0.29$, $p = 0.78$.

Chapter 5: Conclusion

This chapter summarizes the research findings, provides answers to the three research questions, discusses the implications of the research for researchers and practitioners taking into account limitations, and suggests future research.

Three research questions were developed. The first question is: How can technology aid understanding of drug information about OTC drugs to support appropriate selection and usage of these drugs? This question was addressed and answered in Chapter 2. An analysis of the relevant research literature showed that technology, if adequately appropriated, has a significant chance of aiding understanding of drug information as presented on OTC medication labeling. Technology can support the accessibility of relevant information regarding medication, including selecting drugs and when and how to consume them (Hemens et al., 2011). The creation of mobile apps used in this research demonstrateshow technology can be used to aid the understanding of drug label information.

Some of the concerns with OTC medications include the font used on drug labels, formatting, information order, and language used to communicate drug information. Health Information Technology (HIT) is a promising approach to address these communication concerns. The effectiveness of HIT, however, depends on its usability (Martin-Hammond et al., 2015). Computer Decision Support Systems (CDSS) have long been used to support medical professionals in hospital settings and, to a lesser extent, in pharmacies, to guide their customers on appropriate medications. Curtain et al. (2011) report seeing "very little literature describing the use of CDSS within community pharmacy practice and providing information directly to patients" (p. 781).

While there has been growth in pharmacy software to aid pharmacists, technology options have also been increasingly available for individual consumer use. Such technologies have been extended to support individuals in selecting drugs, and many have been in the form of mobile apps. Such computer systems not only recommend appropriate OTC drugs but also add a cost element to help consumers determine what drugs are also economical to purchase. Systems that would support selection of medication are increasingly available. One such platform is WebMD (Horowitz, 2012) that has provided mobile apps that share data with physicians and pharmacies enlarging the vision of healthcare technologies.

The second research question is: How can information overload be evaluated in the context of providing people (shoppers) with answers to questions about purchasing OTC drugs? This question was addressed in Chapter 3. Jackson and Farzaneh's (2012) method to evaluate information overload was identified as being relevant to OTC drug purchases. This method evaluates information overload in an equation that pivots three constructs on one side against four constructs on the other. The seven constructs are characteristics of information, information processing capacity, and available time on one side; and personal factors, task and process parameters, quality of information, and quantity of information on the other. The higher the values on the left, side the less the information overload. The higher the scores on the right side, the more the information overload. The model works by assigning weightings on each of the seven constructs and subtracts the values on the left from the values on the right. If the difference is equal to or greater than 0 the person does not report information overload. The data from this model is discussed in Chapter 4.

The third research question is: What is the most effective multimedia approach in the presentation of drug label information to guide the selection of an OTC drug? This question is

addressed by evaluating audio-based, video-based, and text-based presentation of drug information; and assessing knowledge retention, information overload, and perceived usability. Effectiveness of multimedia approaches is addressed in three parts; each looking into the relationship between the multimedia approach and each of the three constructs. Knowledge retention is measured by a score of a test of comprehension of the drug information that a user selected. The scores were aggregated by the type of app used to investigate the relationship between the type of the app and the score. Information overload is based on the score produced by the model designed by Jackson and Farzaneh (2012) also aggregated by the type of app used. The higher the score the less the information overload.

Usability, a test of how convenient a system is to use as measured by ease of learning and ease of use (Dennis et al., 2009) or the degree to which a system is easy to learn and use (Satzinger et al., 2009) is an important factor in the adoption of HIT by users. Usability is also defined as "the extent to which a system with given functionality can be used efficiently, effectively, and satisfactorily by specified users to achieve specified goals in a specified context of use" (Te′eni et al., 2007). According to Martin-Hammond et al., (2015): "The goals of usability are to ensure that technologies are effective, efficient, safe, have a good utility, are easy to learn, and easy to remember" (p. 114). This shows that there is a need to not only investigate technology design to ensure that it supports its intended use but also to ensure that it meets the usability need. This study uses a score of self-assessment questions. The scores were aggregated by type of app used. The higher the score on these questions the greater the perceived usability.

Summary of Findings

The results indicate that the multimedia method (text, audio or video) used to communicate drug information has an impact on an understanding of the drug information. The

study indicates a correlation between the method used to present drug information and comprehension of drug information. The participants who used the audio and video apps reported greater knowledge retention than those who used the text-based app. The results also show higher knowledge retention scores for video- and audio-based apps than for participants who used the text-based app. This was demonstrated by a lower mean score of 0.68 for the text based-app compared to 0.82 for audio-based and 0.84 for video-based apps. Post hoc tests also showed this significant difference by grouping the data for audio and video being different from that of text.

The study indicates a relationship between the method used to present drug information and information overload. The participants who used the audio and video apps reported less information overload than those who used the text-based app. This is shown by the participants who used the text-based app having lower information overload scores than those who used the audio-based or video-based app. The lower the score on information overload the higher the information overload on the participant. The mean for information overload scores for text-based app participants was 272.84, which is less than audio-based ($M = 372.8$, $SD = 251.42$) and video-based ($M = 351.11$, $SD = 228.92$) participants. Only one participant had an information overload score of less than 0. The participant used an audio-based app and their score was -72.19.

The study indicates no relationship between the method used to present drug information and usability. The means for the scores of the participants using the three apps is nearly equal.

Interpretation of Findings

While the study does not have a large number of participants, the findings corroborate theories that show that there is higher knowledge retention and understanding with auditory cues

than text cues. Edgar Dale's cone of experience (Dwyer, 2010) places auditory channels higher than visual symbols such as written text. While the percentages on the model are in contention (Subramony et al., 2014), the ordering supports the idea of greater remembrance from audio cues in stating that "the basic contention attributed to the Cone of Experience was that as the learning experience became more realistic and interactive, learning would be more complete implying that the more realistic or lifelike the stimulus was, the greater the probability it has for facilitating learning" (Dwyer, 2010, p. 432). Audio, and hence video, channels are more interactive than text channels.

The idea of greater remembrance from audio stimuli compared to text is also supported by the modality principle which "states that learners are more successful with understanding information that uses narration than on-screen text, because the on-screen text may produce a cognitive overload if it is accompanied by other visual elements" (Oberfoell & Correia, 2016, p. 608). The modality principle is also seen in the fact that the research participants that used an audio-based app also indicated less information overload than those that used the text-based app.

Contribution to Information Overload Assessment Model

This study contributed to design science research by creating a design theory for gathering information from patients who want to purchase OTC drugs using a protocol designed by pharmacists, and based on this information, suggesting drug options. In this case, there was a separate mobile app for each treatment, each to measure one or more dependent variables. The treatments were the methods used in the presentation of the OTC drug medication information. The three ways were audio, video, and text. It is technically possible to create all three methods as options in a single mobile app where a tester chooses the option of information presentation that he or she wants. However, creating a different app for each method provides greater control

in that each independent variable is measured independently. Creating three independent apps is also a departure from creating a single app where information might have been provided on a single screen in text, audio, and video. With this method, a researcher would not have known the variable that influences the measures of the dependent variable.

This research provided a model for designing an artifact used in recommending a product or service. The study showed of the value of gathering and incorporating expert knowledge in design and creating an artifact based on those recommendations with room for revision as new knowledge becomes available. In this case, the mobile apps were designed following the advice of pharmacists. The pharmacists advised on the order and content of the information to be gathered and presented to someone looking for OTC drugs. After developing the apps, the pharmacists had a chance to review them and make further recommendations. The model divides the information into two parts: the information collected from the user and the information presented to the user. The information collected from the user is in text for all three apps, while the information presented, which is the subject of this research, is provided in ways mapped to the dependent variables. The model works as follows:

a) Collected information
    i) Collect user's symptom information
    ii) Collect user's pre-existing health and contraindication data
b) Presented information
    i) Recommend drugs based on collected user symptom and health data
    ii) Present dosage and warnings information. This information was from the "*warnings*" and "*allergy alert*" sections of the drug box.
    iii) Present precautions. This information was from the "*Ask a doctor if*" section of the drug box.

iv) Presented caution information. This information was from the "*Stop use and ask a doctor if*" section of the drug box.

c) Getting user feedback

i) Presented a research survey

Using experts to guide the process could have accounted for no difference between the groups regarding information overload. The pharmacists guided the creation of the mobile app in ways that replicate how they would present questions and guide the drug selection.

This research added value to the model proposed by Jackson and Farzaneh (2012) that was used in this research to test for information overload by demonstrating that the model could work in an experiment where the participants are not directly observed by the researcher. The model has seven constructs where some are compound constructs (see Chapter 2). In this research I did not use the constructs "Available Time" and "Quantity of Information". These measures have the same weightings and are on the opposite sides of the information overload equation. For that, I could remove them without impacting the calculation. The constructs "Available Time", "Multi-tasking", and "Task-interruption" are designed to be observed by a researcher in a controlled environment. Eliminating these constructs yet leaving the model mathematically accurate is a demonstration that the model is robust enough to work in an experiment where participants are not directly supervised.

Study Limitations

While the study results point to significant differences between the dependent variables, this study could have been enhanced by using pharmacy shoppers in the process of looking for pain medication. Conducting the research in a pharmacy setting could be possible if users would be willing to accept to use a device other than their own. In this, the participants would not have

had to download and install the mobile app considering that some participants reported difficulty in installing the mobile app on their devices. A pharmacy setting could also have been a way to validate the user's choice based on the mobile app by cross-checking with a pharmacist to confirm the drug selected. This would not have been easy to do since at the time this research was conducted there were controls on human interractions and mandated social distancing due to the Covid19 pandemic.

The information overload modeled by Jackson and Farzaneh (2012) requires "Available Time", or the time someone took to decide a factor be included in the information overload formula. Using time as a factor was not possible in this research since the participants are not observed by the researcher. It could have been possible in a controlled environment such as a laboratory or an observation in a pharmacy setting. An option might have been including a method to measure how long a participant took while doing the drug selection. This, though, would not have been a reliable time metric because it could not have accounted for the time a participant might have experienced interruptions that took time away from completing the process. While the model provides for interruptions as a factor for the information overload construct, a user would not be expected to report the interruptions. The number of times that a participant is taken away from the task would have been studied best when the subjects are in a controlled setting. The original design of the experiment was to have researcher observation in which case it would have been possible to account for all the varialbles in the model including available time and interruptions. This happened because of the limitations of human interations occasioned by the Covid19 pandemic response guidelines.

Store brands, also called generics, for pain medication, are typically sold for less than the brand name drugs. This research did not include the cost of a drug as a factor of drug selection. The cost of the medication might have had practical implications in the selection of the medicine.

The mobile apps were all developed in iOS and configured for iPhone version 7 or newer. The video-based and audio-based apps were optimized for iPad devices. While I would have expected the same functionality in the iPhone as would have been on an Android device, this limited the number of possible participants. Some of my willing participants later reported to me that they did not have an iPhone. Each platform has rules that govern the publishing of apps. Given the stringent regulations for publishing an app in the iOS platform, it may have taken a shorter time to get the apps to the participants if I would have developed in Android. "Apple is especially meticulous about these rules. Every app is reviewed before it is published, and if your app does not conform, it will be rejected… Google may publish an application that does not meet its store requirements, but will remove the app from the store later if it finds that the app violates its rules" (Iverson & Eiman, 2018, p. 291). It took several attempts and days to get approval from Apple to accept my apps as a research tool. While Apple allows a developer to have a sizeable number of testers, the company only allows 100 days to have the app in the testing phase, which limits how long someone would have to test the app.

Another limitation of the study was that the participants needed to have been able to download and install a mobile app. This also limited participation and could have accounted for the 21 people that expressed interest in participation and signed the consent form but did not install the app to participate in the research. The limitation due to the need to be able to install the app could have been mitigated if the testers were able to use a mobile device that had the apps already installed.

There are two limitations that may have skewed data analysis. This study did not collect demographic data. Level of education and age could have been a factor in knowledge retention, information overload, and perceived usability. In addition, there are no extant studies for use or validation of the model proposed by Jackson and Farzaneh (2012).

Suggestions for Further Research

This research centered on developing an application for aiding OTC drug selection and whether there is a difference in the understanding of drug information based on the methods used to present it via the application. Further research could combine multimedia methods to check if there is greater knowledge retention, less information overload, and greater perceived usability of the mobile app. In this study there were three different apps, and each was exclusively audio, video, or text for the part that describes the dosage, precautions, and cautions of a drug. Combining the multimedia methods would have the drug information presented in audio, video and text at the same time. A study that uses this format would check if there may be less information overload and greater knowledge retention when a participant sees, hears, and reads the drug information presentation.

In this study, 76% of the respondents reported having purchased the same drug as they did in this research. It would suggest that they had some prior knowledge of the drug information. An experiment in which participants have not interacted with the same item that they have selected and have learned about it for the first time in the research setting would corroborate this research. It could also have been done with the actual drug names masked to avoid users going back to the drug names that they already know.

This study used pain medication only. Further research could broaden the drugs in the study for other illnesses and check if the type of drug is a factor on any of the three dependent

variables of the research. It might also be expanded to include generic medications since this study was limited to brand drugs only.

Conclusion

Research shows that most customers consult a pharmacist to determine the best drug to buy and how to use it. Chui et al. (2013) report that only 40% of consumers consult a pharmacist before purchasing an OTC drug. However, given certain circumstances, some patients are not able to consult a medical professional or pharmacist about choosing the medicine to use. The FDA has continued to find ways of improving the readability and comprehensibility of the drug label (Catlin et al., 2012). The usefulness of the OTC drug label is predicated on comprehensibility and design. The need for improvement of the drug labels shows that there is a need to optimize them (Tong et al., 2014). Although the drug label is a static method for guiding a consumer in the selection of an appropriate drug and also providing information on how the drug should be consumed, it remains the only safeguard against improper use (Trivedi et al., 2014). It still uses text on the drug label as the only method of informing the selection and use of the medication. In some other studies, the medicine label is difficult to read and understand. This study focused on how technology can be used to guide the selection of medication and also provide guidance on how to use it, considering multimedia approaches, information overload, and perceived usability.

This study reviewed the place and value of technology in meeting an everyday problem of the selection of over the counter medications and demonstrated the value of using a mobile audio and video, compared to text, application in briefly introducing the application to the consumer and in presenting the recommended information at the end of the selection process. The continued interest in self-medication (da Rocha et al., 2016; Ju & Lee, 2017; Wazaify et al.,

2005) opens the chances of errors in the selection and usage of drugs. While OTC medication is considered safe to purchase without the guidance of a medical professional, they are not devoid of the dangers inherent in any other medicines such as abuse and misuse (Cooper, 2013). Unlike prescription medication, where a medical professional gets a chance to guide a patient on the use of the medication, the information on the selection and use of OTC drugs can come from a pharmacist, if one is available, or from information provided on the drug label. It is the only safeguard against improper use of OTC medication (Trivedi et al., 2014) and, in the absence of a pharmacist, the only way to guide a user on the selection and use of the medication. This study sought to provide an additional method to aid the understanding of the drug information to support the safe and appropriate selection and use of OTC medication.

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Appendix A – Pharmacist Interviews / Discussion Questions

a. What are some of the issues brought up to a pharmacist by someone who needs help when looking for over the counter medication - such as pain or allergy meds that do not require a prescription?

b. Do you think people have a problem deciding the appropriate medication for common issues such as allergy? If so, what are the common problems in selection. How do people pick one over the other in case of selecting pain meds - Advil, Tylenol, Aleve etc.?

c. Do you think the drug form (capsules, ointment, syrup etc.) are important factors in deciding over the counter medication? Which are the preferred drug form? Is there a substantial cost difference between the forms?

d. Are store brands (such as CVS Tylenol) preferred to the brand names?

e. When a person is purchasing over the counter medication and there is no pharmacist available, such as purchasing meds in a grocery store when the pharmacist has left, what would you say are some of the problems faced by such a customer when there is no one to ask?

f. What are factors that lead to misuse and abuse of over the counter medications?

g. Do you think people read drug labels, or read them well? Of the information printed on the drug label (use, age restriction, dosage, side effects) what would you say is most pertinent information in selecting medication?

h. What would you say are the problems with drug labels? What would you like to see improved or changed?

i. Do you have any reservations on the way drugs are advertised on TV or radio?

Appendix B – Pharmacist Interview 1

First is it ok if I record the conversation and I would type it out?

Yeah, sure.

I will not put your name anywhere just write out what you said

Yeah, ok

One of my questions generally, when people come to a pharmacy, they look for whatever drug they want, and I am talking about over the counter not the prescriptions. So, somebody has a pain, or a headache, or an allergy, or something, and then they have a problem and they come ask you – what are some of the issues they bring up to you when they come to speak to the pharmacist?

You mean when they are coming over the counter what are their common complaints?

Yes

M. Most people that come in either have like a common cold, or some kind of cough, or they are congested. Most questions when they come in, is like "I have a cough, what can relieve my cough?", or "I have a cold, what can help with the symptoms?", but it can vary but that is the most common person who comes in; then there can be a range, we have people who come in asking for vitamin supplements – things like that, but the most common ones are people who have a form of infection that want something to help with their symptoms.

Do you know if there any difficulties in selecting the drug, if someone doesn't want to talk to a pharmacist, or they come to you looking for help, lets say I came with an allergy issue, and I go to the allergy aisle, and I look at them, and I have a specific problem deciding which one it is, do you think people have a problem deciding or selecting the right one?

M. Obviously, there are a lot of choices, so I will say yes. Its common that people just aren't clear, because the common theme is "I want the best product". There might be twenty different things that say, for example, FOR ALLERGIES, so they definitely want some clarity on "what product gonna work the best for me". So, I would say that is pretty common. And then obviously there are limits on what we can recommend over the counter. It is also important that we talk to them because we need to assess, "is this really just a minor thing that they are having or something they really symptomatic that they need to go get checked out?". That is the other important thing, we have conversations with those patients, and help them decide "is it like a seasonal allergy or are they having an allergic reaction that they need to go get assessed for". For example, if they are looking for allergy meds.

Right, when they come down to, say, a pain medication like Advil where there is a store brand, or Ibuprofen, or Tylenol, how do people pick one over the other, from your experience?

M. Usually what I ask them first, if they ask me, I will ask them "Which products have you tried in the past and were any of them effective? That kinda gives you a feel for if there is something that they feel didn't work at all. I say most people are most familiar with Advil, but then it comes down to also I say also There is products like Advil that you take three or four times a day, there is a product like Aleve that you only have to take twice a day, so also like are you willing to take this dose three times a day or would you prefer to have something that you take twice a day. other than that there is not much difference between these anti-inflamatory so in the absence of any of those factors they are all pretty similar so any of the choices would probably work for that person, but I always try to get an assessment of "have you tried this product? Did it work or not work for you in the past"?

In your own opinion because I know there are some drugs that are available as pills, or as drinkable ones – the liquids – do you think those are important factors in deciding which one to take?

M. Yeah, from that standpoint If you are doing like young children meds they always gonna prefer like liquids because kids don't tend to like to take like solid tablets. Some elderly people can't take solids tablets or feel like they can't so they lean towards liquids. Most adults though are comfortable with pills or capsules. If it is just a normal healthy adult I would say liquids usually are not their preference. Because in general a lot of people don't like the taste of those liquids. So, unless they have a factor of being really young or really old most of the time people are fine with capsules and tablets.

Are they less expensive or not? I don't know that.

They are probably, generally in the same ballpark. Those things people don't realize though is that the liquids or the capsules or tablets the price is about the same but you gonna have more doses in the tablets bottle than you gonna get in that bottle of liquids. It is kinda deceptive because they think it's the same but you are really getting more doses in the other form.

Do you know if store brands are less expensive or just about the same? CVS or Walgreens whatever?

I definitely tend to recommend generic to people, because some people are comfortable with brand like say Tylenol, which I tell them that's fine. I generally tend to recommend generic because they can be a good 30 to 40% cheaper than brand. So, everything being equal I usually tell them I would take the generic I was purchasing.

So, the generic are the ones that are labelled for the store.

Yeah, exactly.

If someone was purchasing a drug in a pharmacy and there was no pharmacist, especially in a grocery store, when, maybe the pharmacist left at 8 o'clock but the pharmacy is still open and there is no pharmacist, and someone wants to pick some medicine what would you say are some of the problems someone with no one to ask could face?

Even though they are over the counter someone needs to make sure that they are dosing appropriately, though people sometimes don't understand the label or don't read it properly so in many cases I would say that's an issue. In the absence of being able to ask a pharmacist or professional like even though they are over the counter there are potential interactions with drugs that they are on, like prescription drugs, so they would not know that necessarily just by purchasing the products, so drug interaction with their prescriptions meds is a big issue in the absence of somebody but I would say the biggest one is just to make sure they are not overdosing. Also, some people tend to think more is better so gonna opt to purchase more product, so sometimes they double up which is completely unnecessary.

Double up in consumption or buying?

In buying, so they are like "I have cough, so I'm gonna get this, and another for sneezing, so the don't realize they are getting products that have the same product systems so when they are there they ask do I get all three, and I say you do not need all three of these.

So, if there is no one there someone could pick all three and go and consume them and next thing you know they are going to hospital with a different issue.

Exactly, I would say those are the biggest issues or concerns when there is no one there to monitor and then also people tend wanna dose their kids and usually I don't recommend. I always recommend if you are going to buy over the counter medication for you children, even

though it might say it on the bottle probably make sure like you have the dosing correct, then you gonna give them the right amount. Even Tylenol is like the fourth leading cause of liver transplant in the US so Tylenol overdose is like the leading cause of liver transplant.

Why do you think people overdose on Tylenol?

Number one they are not clear on what the maximum dose is for that person is. So, if it's a child it is obviously smaller than of an adult and I think it say give this person this amount every four to six hours but it doesn't mean like around the clock. Sometimes people give a dose, or sometimes people give the dose and then they repeat forgetting that they gave a dose, and so there are a lot of factors

Going back to the example of going to the grocery store without a pharmacist, people are supposed to depend on the labels. Do you think people read labels, or read them well?

I don't think they read them well. I think basically when someone walks in to get an over the counter medication they basically just read the dose information, they basically, most of the people, I'm getting it for myself, if it's for adults you give this much. And I think that is as far as they read. Every once in a while, you will get a person who is very conscious of the things they are taking and they read it and realize I shouldn't be taking this because I'm on antidepressants but a lot of people just read "it says for my 13 year old child I'm supposed to give two teaspoons" that's all they read.

In your own opinion, what do you suggest should be done about the label, because the label is not clear, or that there is a lot of jargon that people do not understand.

I think it is a combination, there probably some language in there that they do not understand and there is also so much information that they are responsible to put on this little box that the print becomes almost microscopic. But that is also a factor of that they are required

to put all this information on there. Some of it is not really relevant to most people, you know, unless they make a box, like a gigantic box, and basically make the print large, they have to be small and I think that factors into it. A person of average intelligence can probably handle it but then they are also selling it to people who don't understand what they are reading and so you can't cater to everybody but unfortunately there is a population that doesn't really get what they are reading

So, what do you suggest you would like to see a change on the labels?

I think they can probably find a way to emphasize most important parts either by color or by bolding. like Tylenol, like I said, is pretty easy to overdose it is very easy to overdose on Tylenol and so dosing information on Tylenol should be really prominent, but also, its not in those companies best interests to accentuate the danger the fact that you can potentially be harmed by this product.

They can probably design the label, if they would change some of their requirements so that the most important things to the lay person are what needs to be accentuated, that would probably be better

What do you say are the important things on the drug label because there is drug name, dosage, who should have it and who shouldn't, there is what it treats?

I think those are probably key. They do not do the greatest job on who should and shouldn't be taking it, so exclusions, you really have to read the fine print on certain over the counter medication to see "oh if I'm on an antidepressant I shouldn't also be taking that, if I AM on a blood pressure medication I shouldn't be taking this. So, do a good job of labeling products like specialty such as those made specially for diabetics so they are sugar free, so they are good at labelling say, this is a sugar free product, but they are not good at labeling like say if you have

high blood pressure you shouldn't be taking this. But that is difficult because how do you advertise "like don't take this if you have all these conditions but that would be more relevant because people would understand like "oh this product helps me if I have high blood pressure, but the other products don't say "Don't take this if you have high blood pressure" so that would be helpful.

On the television commercials you get to see, someone says this drug is for this, but then the do not tell you fifty other things that are the side effects.

And that is also because the law says so. Basically, those drug companies either have to tell you nothing about the drug or they have to tell you everything. There are commercials where it is kind of vague where you wonder what they are advertising, you see it is some kind of drug, and that's because they don't. if you choose not to list all the side effects where they run through it like rabbits, you cant really tell them this drug is for this.

Appendix C – Pharmacist Interview 2

What are some of the issues that are brought up to a pharmacist by someone who needs help and when looking for over the counter medication, so if someone is looking for an allergy medication what are some of the issues they bring up to the pharmacist if there is one?

Some of the issues that I have seen, I know a lot of people just go by word of mouth you know like "so and so told me that this works well for them", and they assume what works well for one person works well for them and that's not the case all the time. People have different medical conditions, so some allergy medicines may not be good for some people and, you know, you don't know that when your friend tells you this works well for them. People will talk and compare notes on what works well for them but at the same time you are an individual and your medial conditions do play a part in selecting what is right for you.

Of course

So, one of the issue always make sure you bring up with the patient is "are you allergic to any drugs? Are there medications you cannot take?", and if that's the case then maybe some of these allergy medicines or cough medicines pain medicines may not be right for you

Yes

So, you also have to look at the age group, like "Is this for you or are you picking it up for somebody else?" Is it for a child? Coz if its for a child I mean children's medication are dosed by weight and sometimes they don't know the child's weight.

Of course

They might just say "It's for my seven-year-old. Some seven-year old's weigh more than adults some are very small, so you know sometimes they think patients want a quick answer they want to avoid going to their doctor because the wait, it's just a hustle so the want and answer

there and then. But sometimes it doesn't work like. We have to do our own research and see whether this is appropriate for the patient or not.

Yes

And you know sometimes you have to refer them to the doctor. Sometimes it not a quick answer like get some ibuprofen. Based on your interview with the patient you kind of have to decide if this is something you have to refer the patient to their doctor or whether they can actually benefit from over the counter drugs.

When it comes to picking one over the other let us say someone say I have a headache and I'm looking for Advil or Tylenol, Aleve something like that, how do they decide, how do people mostly decide one over the other? I know this is something everybody does. I have done that myself.

Most of the time, I have seen it could either be based on the price of the drug, brand versus generic. It could also be by what you have used in the past or what people around you have used in the past. Like some people, "Oh my mom says this works very well. She has been giving me ibuprofen since I was a kid". You assume it's still good for you. It could be also advertisement like based on the TV or the radio or even within the stores, you have all these posters on the wall or whatever, maybe they have a deal, a sale or something. There is a new formulation or something and they what to give it a try but for the most part it comes down to the price and pas experience with a particular drug.

And some of that can be incorrect wrong, where all that could lead to the wrong medication.

Exactly.

Because some people might self-diagnose themselves and then they don't want to go to the doctor. They feel like maybe I have had this ache and so let me take something over the counter. But sometime that's not the right choice to make because if it's something that has gone on for a while then maybe its time to have it checked out. It could be something serious more than just a quick fix it over the counter kind of thing.

Some of my reading has been, especially my literature review, I've been seeing that self-medication is becoming a big deal now. People feel more informed or empowered to make a decision that this is what it is. I know there are some websites such as WebMD that someone can look up their symptoms and be like I can select this. What do you think about that?

I like to have the patient to have as much knowledge as possible about their condition but get it from the right sources. Some patients do that because again, it could be out of fear, you know not knowing what is going on and you are scared of knowing the diagnosis and you just want to treat yourself with whatever is out there and hopefully it gets rid of the problem.

It could also be they don't have insurance, so they cannot get a prescription. So, information is good but get the right information. You can go to the internet and look it up, but I would definitely follow up with a consultation with a pharmacist or talk to your doctor maybe and even if you can't go in for an office visit. I know some doctors you can communicate online with your doctor or email your doctor and have a discussion and get as much information from the right sources as possible. Information is key. I'm totally for informing the patient. Then be aware of what's going on in their body and the whole process of diagnosing and treating and other options you have out there.

I have a question on drug form as in capsules, ointment, tablets, syrup. Are those important factors in selecting over the counter medication? For example, a drug that is available in all those forms does that become a factor in selection?

That does become a factor especially if you are considering what you are treating. Not only what you are treating but also look at the patient. Of course, if it's a little baby who can't swallow Ibuprofen tablets then a syrup is a better choice. Or with an old person who has trouble swallowing pills then you have to give them additional options. It also becomes an option especially the patient does not want to take one full tablet and you can't cut capsules in half, so you might have to give them tablets where they can cut in half or take half the dose. It also becomes a factor in some conditions that its best to have oral medication rather than a cream or an ointment. I know in some instances when the patient has poison they can use a topical ointment or a cream, but the oral medication might work out best for them, like some Benadryl tables over the counter instead of a cream. Or sometimes they may have to use a tablet at night coz it makes them drowsy or they might use the cream or ointment during the day. There are different reasons why someone may use one over the other.

How about the cost? Do they cost just about the same? Also, talking about costs I know nowadays almost every drug chain has a store brand – the CVS, the Walgreens they have the store brand Aleve or something like that. How do the costs compare between the brand one and the store one, and also the drug form are costs about the same? How do the costs compare between the store brand and the brand drugs? How about the drug form like is syrup more or less expensive than tablets?

So, on the store brand and brand names are the same active ingredients and they are the same medication. Store brands will definitely be cheaper but then I get some people swear by the

brand name, only works for them. In that case who am I to say you cannot afford it? You know, if that's what you want, then that's what you want.

But you are really saying, it's the same thing?

It's the same thing. We have also experienced this thing with prescription medicine also. Its not just over the counter stuff. But what we tell patient is that the active ingredient is exactly the same. It will be cheaper to you? You probably might get more tablets than a brand name package. Its more efficient for you to just get the store brand. But if you are better experienced with the brand name and that's what you want then it's totally fine.

As far as capsules tablets I think that would be hard to kind of compare but in general store brands anything store brand would be cheaper. Weather its an ointment or cream tablet, anything store brand would be cheaper. So, I think where it becomes expensive is like if it is compounded in which case that is not for over the counter medications. Over the counter those products are really not compounded. If something is commercially available, then the store brand is cheaper than the brand name.

When a person is purchasing an over the counter medication and there is no pharmacist available, like someone goes to Albertsons late in the night what would you say are some of the problems that are faced by that kind of a customer/ consumer / buyer?

I would say a lot of selections. Too many selections that you don't know which one you should pick and which one you should avoid. You don't know what dosage is appropriate. Its written on the box but sometimes, you know you could be buying it for somebody else. But there is too many choices and things that things that are homeopathic, so they will say no active drug ingredient or things like that and you are not sure or you are not sure that is appropriate. So, I think a lot of selections is one issue with getting the right product. Also, some patents they self-

diagnose, and you don't know if you are getting the right product for your condition. There really is no one to confirm that you are getting the right product to confirm whether you have any allergies for the medication whether you are getting the right dosage and form.

When you do not have anybody to talk to kinda rely on your own knowledge which can be limited at times.

In that case they would have to depend on labels and talking of labels there is a whole issue about labels one like the print being so small or people not being able to understand what's written on them. But of the thing on a drug label the use, the age restriction, dosage, side effects. Which of those do you think are pertinent for selecting the drug?

Personally, I think every ting is important. If you don't look at the active ingredient patients don't know brand and generic names, so when you have drug and it has a generic name on it you may not recognize, you may not identify with the drug or you may think this is something else that or may be this is a new product on the market. And you don't know that it is something you are already taking or something you are familiar with. If you look at the age restrictions, that's important also because some medications should not be given to kids.

Some medication should not be given to the elderly or people that are on certain other types of medications. If you look at the dosage that's important. How much you have to give, side effects that's also important coz how are you to know you are getting too much or normal side effects of medicine or do you need to seek medical attention if you get a certain side effect. So, I think everything is important It's just that there is so much information and that patients want an answer right away. They just want something to work for them at that particular moment. So, sometimes it can get overwhelming for them they are not quite sure what to do.

In your own personal opinion what would you say are problems with drug labels? What would you like to see improved or changed on a box of Advil, allergy drugs, something?

For me the font size would be good, it could be a little bit bigger, that would be good. I know sometimes they just have a few of the major side effects. I think some of them don't have a lot of side effects to them written on the bottle.

So, there are some probably missing?

It would be good for some patients to know that you shouldn't be consuming the medication if you experience some certain side effects of if you have some certain condition. And I know they do that I think a may be a little bit more. Like if you have a renal problem, maybe some ibuprofen might not be good for you. But that goes back to how much information can you really put on the label.

Because it's very small.

Its very small

I can't think of anything else.

Do you have any reservations on how drugs are advertised on radio and television especially the over the counter medication? Do you feel that TV and radio are missing something or overemphasizing something? When you look at it as a pharmacist you might wonder if the ad is right?

I like to get the information out to the patient and let the patient be aware of what is out there. The key thing is you see the advertisement but always consult the doctor always have a conversation with your doctor as in whether your condition will be helped by a certain medication. I know they do say consult your doctor or don't self-diagnose. But I think a lot of it has to do with pharmaceutical companies just trying to sell their products – its all about the

money but as patients its good to get that information but be aware that that company is trying to make money and you health, you as an individual you need to take that initiative and go and have a talk with your doctor. And let your doctor know you are interested in that you saw and are interested in getting more information. Don't just rely on the TV and radio for that kind of stuff. But information is good. And sometimes some doctors that is probably the only way they get new information about new drugs. Other that pharmaceutical companies knocking on their doors. I think information is good.

So, there is benefit either way both to the customers and also to the doctor.

Either way there is some benefit both to the doctors and to the patient also

Appendix D – Pharmacist Interview 3

a) *What are some of the issues brought up to a pharmacist by someone who needs help when looking for over the counter medication - such as pain or allergy meds that do not require a prescription?*

- Rash, cold, cough, cough for under 6, allergies, arthritis, is it safe in pregnancy, if it affects blood pressure, which supplements are safe with various health concerns, constipation, contraindications with other medications
- Drug interactions, is this going to affect my birth control?, can I drink alcohol with this?

b) *Do you think people have a problem deciding the appropriate medication for common issues such as allergy? If so, what are the common problems in selection. How do people pick one over the other in case of selecting pain meds - Advil, Tylenol, Aleve etc.?*

- Yes they do. Cost plays a factor in my neighborhood
- Drowsiness side effect. Brand name recognition plays a big part in trusting the safety and efficacy over the over all cost of the product.
- Yes, for sure. It seems pretty common that people confuse the actions of antihistamines and decongestants.
- Price is key. Also what they heard on Dr Oz!!
- Too many products with same ingredients with different names. Some are cheaper, and some are really expensive. Also, Benadryl allergy can be used for runny nose, allergic reaction and to help someone sleep. Not sure about what pain

meds people pick, but Aleve and Advil are NSAIDs for inflammation and Tylenol is just geared toward pain. Examples of the same meds - Exedrin Migraine and Exedrin Extra Strength have the same medications in them. Advil and Motrin have the same medications in them also.

- Dr. Oz recommendations DEF play a role in everything in general the public suddenly get interested in and start looking for. It becomes a challenge keeping up with the products and what to know about them when customers ask about them.
- Also, for pain meds specifically I recommend a product over another based on knowledge for anti-inflammatory levels and dosing schedules. I.e. Advil is used q 4 to 6 hours and Aleve 12 hours. I recommend Aleve to patients who might have stomach issues.
- I've noticed that those who might not speak very much English might also buy brand name because their Dr suggested or someone they trust suggested an OTC called ____ for their problem.
- Yes. People are not very literate about their health. Even with common terminology or recognizing that two products with the same ingredients might have two different brand names (eg. Excedrin Extra Strength vs. Excedrin Migraine vs. Store brand). There is a wide range of education levels where I work, but education level has nothing to do with health literacy.

c) *Do you think the drug form (capsules, ointment, syrup etc.) are important factors in deciding over the counter medication? What is the preferred drug form? Is there a substantial cost difference between the forms?*

- Yes formulation is important. Some adults claim to not be able to swallow pills so liquid is preferred. Depends on patient. Cost difference boils down to how much/long patient thinks they will need it
- Formulation is important and I always recommend rapid release, or liquid caps over others. I also realize that most people don't understand the difference. These formulations are definitely priced higher.
- Yes, formulation is important. Liquids work faster than tablets because the stomach doesn't have to break them down. Sometimes liquids are a little more expensive, but if patient can't swallow a tablet, then it's the way to go. Also, if you are having an allergic reaction and time is of the essence - the liquid Benadryl is probably your best option.
- Yes. Formulation is important especially for pediatric patients. Also flavor of the product is an important factor.

d) *Are store brands (such as CVS Tylenol) preferred to the brand names?*

- Sometimes, I worked retail in an affluent part of Manhattan for many years and Brand name recognition is associated with more quality products. I have had customers question where certain products were manufactured even. Having said that, we always recommended generics.

- I always recommend generic but certain affluent neighborhoods don't care
- I would say yes, I use the store brand on all medications. Was told by another Rph that the lamisil generic did not work as good as the brand for ringworm, athletes foot, etc., so if you can't afford the brand, the cheaper alternative is still better than nothing. But it may not work as "fast" as it's supposed to.
- I don't get headaches too often but when I do I know I take excedrin and I'm fine ALWAYS! I've never had a problem. One time I took a generic and my headache did not go away? Is a placebo effect? Maybe. I've also convinced myself Advil won't work, and I've tried so many times. Doesn't work. That's just my experience.
- No. People tend to go for the name brand OTCs where I work even if they are on public assistance.

e) *When a person is purchasing over the counter medication and there is no pharmacist available, such as purchasing meds in a grocery store when the pharmacist has left, what would you say are some of the problems faced by such a customer when there is no one to ask?*

- They typically want reassurance that the medication they are selecting is going to work. No one there, no reassurance. Or their expectations are not met. In this day and age people want instant results when reality is it may take a bit to feel better
- They pick cheapest option even if it's not the option that would help the most. Usually they end up coming back and picking up another product costing the

patient more money in the long run. My mother who has a hard time with English sometimes and won't always ask for help will call me sometimes because she doesn't recognize all the products even. For example she gets Zantac and Zyrtec name mixed up so she'll be standing in the allergy aisle looking for Zantac.

- Potential interactions
- Too many choices and they don't know where to start. My advice is to look at the ingredients. You want something for runny nose, make sure you have an antihistamine, you want something for stuffy nose, make sure it has a nasal decongestant. You want something for chest congestion- make sure it has guaifenesin in it. And for cough relief - DM or dextromethorphan. It's hard for them to pick based on their symptoms because there is such a wide variety.
- They probably ask a clerk who may share wrong information to the pt
- Oftentimes, they pick up their cell phone and call us. We are open every day of the year.

f) What are factors that lead to misuse and abuse of over the counter medications?

- Misuse is due to not understanding that medications such as Tylenol are metabolized at certain rates and that there are dosing limits for reasons
- Not realizing that they have max daily doses and if they exceed can have serious consequences.
- If 1 is good, 2 must b better

- Not understanding that a lot of cough and cold products are the same medications in different packaging. A lot of which also have Tylenol in them and they still want to take their Tylenol pm, which is still just acetaminophen and diphenhydramine. There is so much cross branding and marketing that it can be confusing and potentially dangerous.

- Reading the directions and following them. I heard someone tell me that they just took a big swallow of the NyQuil instead of measuring it out!

g) *Do you think people read drug labels, or read them well? Of the information printed on the drug label (use, age restriction, dosage, side effects) what would you say is most pertinent information in selecting medication?*

- People read what the medication will treat. They don't look at ingredients and will typically bring over 2-3 different items that both contain similar ingredients. Looking at the active ingredients is most important bc that could affect other issues the person suffers from

- People don't read or reafilt find directions on how to use. That is one of the most frequent questions I used to get at the pharmacy, how to take something.

- No. Dosage

- Age restriction- this is on there for a reason.

- They typically do not read drug labels at all. I get calls all the time, "I just took 10 tablets of Advil...is that ok??"

h) *What would you say are the problems with drug labels? What would you like to see improved or changed?*

- Warnings and caution labels.
- The ingredients should be easier to find. On the front with what the ingredient treats right beside it. On the front - not hidden! And not tiny!
- Print too small. Don’t like how they are sometimes folded on themselves either
- Hard to read

Appendix E – Mobile app questions

Question reference	Question text
Q1	Where do you feel the pain?
Q2	How long have you had the pain?
Q3	Have you had this kind of pain before?
Q4	What did you take for it?
Q5	Would you like to try the same medication again?
Q6	Are you allergic to any pain medication?
Q7	Which medication are you allergic to?
Q8	How old are you?
Q9	Something else?
Q10	Did that work for you
Q11	Which of the following would you like to try?

Appendix F – Question Selection Logic

Present questions q1, q2, q8, and q3 in order

if q3 is “Yes”

present q4

present q10

if q10 answer is “Yes”

present q5

if q5 answer is “Yes”

present q11

else if q5 answer is “No”

present q11

else if q10 answer is “No”

present q6

if q6 answer is Yes

present q7

present q11

else if q6 answer is “No”

present q11

else if q3 answer is “No”

present q6

if q6 answer is “No”

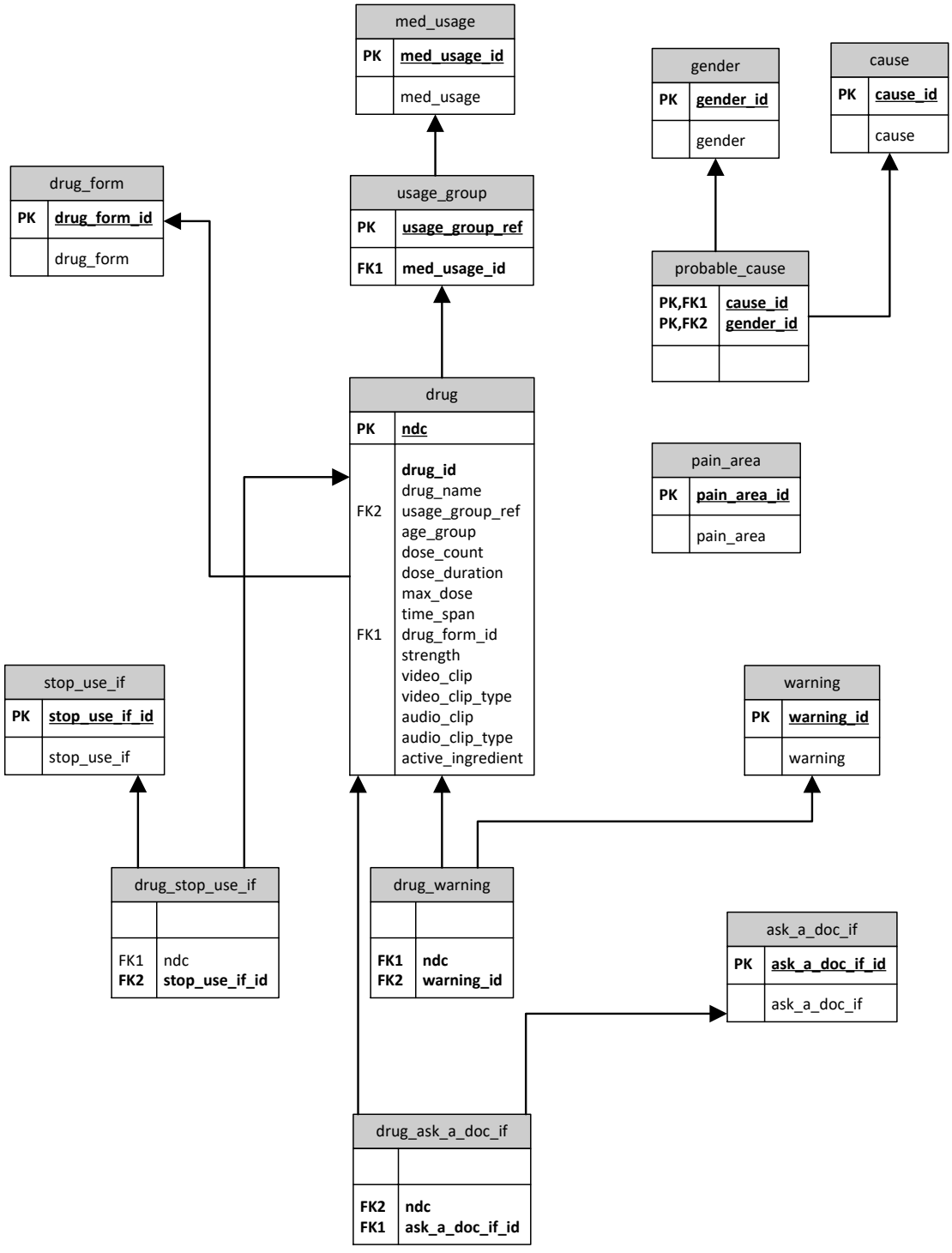
present q11

else if q6 answer is “Yes”

present q7

present q11

Appendix G – Entity Relationship Diagram for Pain Meds Database



Appendix H – A summary of knowledge retention scores

Tester id	app	Score	Remark
otcaud tester 1	audio-based	0.6	
otcaud tester 2	audio-based	1.0	
otcaud tester 3	audio-based	0.8	
otcaud tester 4	audio-based	0.8	
otcaud tester 5	audio-based	0.8	
otcaud tester 6	audio-based	1.0	
otcaud tester 7	audio-based	0.8	
otcaud tester 8	audio-based	1.0	
otcaud tester 9	audio-based	0.8	
otcaud tester 10	audio-based	0.8	
otcaud tester 11	audio-based	1.0	
otcaud tester 12	audio-based	0.6	
otcaud tester 13	audio-based	0.6	
otcaud tester 14	audio-based	1.0	
otcaud tester 15	audio-based	1.0	
otcaud tester 16	audio-based	1.0	
otcaud tester 17	audio-based	0.6	
otcaud tester 18	audio-based	0.8	
otcaud tester 19	audio-based	0.8	

Tester id	app	Score	Remark
otcaud tester 20	audio-based	0.6	
otcvideo tester 1	video-based	1.0	
otcvideo tester 2	video-based	0.8	
otcvideo tester 3	video-based	1.0	
otcvideo tester 4	video-based	0.8	
otcvideo tester 5	video-based	1.0	
otcvideo tester 6	video-based	0.6	
otcvideo tester 7	video-based	1.0	
otcvideo tester 8	video-based	1.0	
otcvideo tester 9	video-based	1.0	
otcvideo tester 10	video-based	0.6	
otcvideo tester 11	video-based	0.8	
otcvideo tester 12	video-based	0.8	
otcvideo tester 13	video-based	1.0	
otcvideo tester 14	video-based	0.6	
otcvideo tester 15	video-based	1.0	
otcvideo tester 16	video-based	0.6	
otcvideo tester 17	video-based	1.0	
otcvideo tester 18	video-based	0.6	
otcvideo tester 19	video-based	0.8	
otctext tester 1	text-based	0.6	

Tester id	app	Score	Remark
otctext tester 2	text-based	1.0	
otctext tester 3	text-based	0.8	
otctext tester 4	text-based	0.6	Unused score
otctext tester 5	text-based	1.0	
otctext tester 6	text-based	0.2	Unused score
otctext tester 7	text-based	0.4	Unused score
otctext tester 8	text-based	0.6	
otctext tester 9	text-based	0.8	
otctext tester 10	text-based	0.4	
otctext tester 11	text-based	0.2	Unused score
otctext tester 12	text-based	0.8	
otctext tester 13	text-based	0.6	
otctext tester 14	text-based	0.4	
otctext tester 15	text-based	0.8	
otctext tester 16	text-based	0.8	
otctext tester 17	text-based	0.6	
otctext tester 18	text-based	0.4	
otctext tester 19	text-based	0.8	
otctext tester 20	text-based	0.4	
otctext tester 21	text-based	0.4	
otctext tester 22	text-based	0.8	

Tester id	app	Score	Remark
otctext tester 23	text-based	1.0	
otctext tester 24	text-based	0.4	
otctext tester 25	text-based	0.8	

Appendix I – A summary of information overload scores

tester id	app	OL_Score
otcaud tester 1	audio-based	56.35
otcaud tester 2	audio-based	319.49
otcaud tester 3	audio-based	19.71
otcaud tester 4	audio-based	303.46
otcaud tester 5	audio-based	270.53
otcaud tester 6	audio-based	400.00
otcaud tester 7	audio-based	510.34
otcaud tester 8	audio-based	159.49
otcaud tester 9	audio-based	384.00
otcaud tester 10	audio-based	409.10
otcaud tester 11	audio-based	798.34
otcaud tester 12	audio-based	480.00
otcaud tester 13	audio-based	-72.19
otcaud tester 14	audio-based	384.00
otcaud tester 15	audio-based	798.34
otcaud tester 16	audio-based	800
otcaud tester 17	audio-based	230.4
otcaud tester 18	audio-based	402.944
otcaud tester 19	audio-based	161.568

tester id	app	OL_Score
otcaud tester 20	audio-based	640
otcvideo tester 6	video-based	191.97
otcvideo tester 7	video-based	599.58
otcvideo tester 8	video-based	799.98
otcvideo tester 9	video-based	359.90
otcvideo tester 10	video-based	287.90
otcvideo tester 11	video-based	153.18
otcvideo tester 12	video-based	383.49
otcvideo tester 13	video-based	397.09
otcvideo tester 14	video-based	230.30
otcvideo tester 15	video-based	188.26
otcvideo tester 16	video-based	380.67
otcvideo tester 17	video-based	640.00
otcvideo tester 18	video-based	54.40
otcvideo tester 19	video-based	0.00
otcvideo tester 20	Video-based	599.93
otctext tester 13	text-based	306.37
otctext tester 14	text-based	198.14
otctext tester 15	text-based	379.01
otctext tester 16	text-based	307.17
otctext tester 17	text-based	230.34

tester id	app	OL_Score
otctext tester 18	text-based	399.98
otctext tester 19	text-based	255.62
otctext tester 20	text-based	151.94
otctext tester 21	text-based	51.20
otctext tester 22	text-based	498.69
otctext tester 23	text-based	301.63
otctext tester 24	text-based	61.20
otctext tester 25	text-based	405.648

Appendix J – A summary of perceived usability scores

tester id	app	Perceived usability score
otcaud tester 1	audio-based	17
otcaud tester 2	audio-based	17
otcaud tester 3	audio-based	16
otcaud tester 4	audio-based	18
otcaud tester 5	audio-based	17
otcaud tester 6	audio-based	20
otcaud tester 7	audio-based	21
otcaud tester 8	audio-based	15
otcaud tester 9	audio-based	18
otcaud tester 10	audio-based	16
otcaud tester 11	audio-based	19
otcaud tester 12	audio-based	21
otcaud tester 13	audio-based	12
otcaud tester 14	audio-based	18
otcaud tester 15	audio-based	21
otcaud tester 16	audio-based	21
otcaud tester 17	audio-based	19
otcaud tester 18	audio-based	18
otcaud tester 19	audio-based	15

tester id	app	Perceived usability score
otcaud tester 20	audio-based	20
otcvideo tester 6	video-based	20
otcvideo tester 7	video-based	21
otcvideo tester 8	video-based	21
otcvideo tester 9	video-based	16
otcvideo tester 10	video-based	21
otcvideo tester 11	video-based	20
otcvideo tester 12	video-based	17
otcvideo tester 13	video-based	20
otcvideo tester 14	video-based	17
otcvideo tester 15	video-based	18
otcvideo tester 16	video-based	17
otcvideo tester 17	video-based	16
otcvideo tester 18	video-based	16
otcvideo tester 19	video-based	18
otcvideo tester 20	Video-based	18
otctext tester 13	text-based	19
otctext tester 14	text-based	18
otctext tester 15	text-based	18
otctext tester 16	text-based	19
otctext tester 17	text-based	17

tester id	app	Perceived usability score
otctext tester 18	text-based	21
otctext tester 19	text-based	21
otctext tester 20	text-based	18
otctext tester 21	text-based	20
otctext tester 22	text-based	17
otctext tester 23	text-based	14
otctext tester 24	text-based	13
otctext tester 25	text-based	18