

## ABSTRACT

Title of Dissertation: “ALEXA, DO I HAVE AN STD?”: AN  
EXPLORATION OF YOUNG ADULT  
INFORMATION SEEKING BEHAVIORS  
WHEN ENGAGING WITH HOME  
ASSISTANT DEVICES ABOUT SEXUALLY  
TRANSMITTED INFECTIONS

Junaed Ahmad Siddiqui, Doctor of Philosophy,  
2023

Dissertation directed by: Dr. Cynthia Baur, Professor  
Department of Behavioral and Community  
Health

**BACKGROUND:** Sexually transmitted diseases and infections continue to disproportionately affect young adults in the United States, with half of all new STIs annually occurring in young adults between the ages of 15 and 24. Advances in digital technologies have allowed for the facilitation of fast and discreet information about sexual health but remains understudied in the context of newer technologies. There is limited research on the effectiveness of Home Assistant Devices as channels to facilitate the information seeking process in young adults. To address this gap, this study explored whether Home Assistant Devices can facilitate the sexual health information seeking process in young adults between the ages of 18 and 26 who already use the internet to search for health information. The purpose of this dissertation was to explore the perspectives of young adults to understand the depth of their sexual health information needs and

whether a user-centric designed HAD can be a suitable alternative for fulfilling those information needs.

**METHODS:** Informed by the Theory of Motivated Information Management and Technology Acceptance Model, this qualitative study used the Design Thinking framework to understand young adults' information needs and created a prototype voice skill to address that need. In-depth interviews were conducted virtually on Google Meet or Zoom and were recorded. This qualitative study occurred in three phases: in the first phase, 10 young adults were interviewed about their information seeking needs, current gaps, and how they thought Home Assistant Devices could fill that need. Insights from those interviews were then analyzed and used to create a prototype that would address sexual health information needs. The prototype was then tested with a new group of ten young adults, and their reactions to the prototype was recorded via interviews. In the third phase, the prototype was refined based on feedback from the previous group, and then re-tested with a new group of 10 young adults. In total, in depth interviews were conducted virtually with 30 young adults to understand information needs and create a prototype voice skill that could serve to facilitate the transfer of sexual health information in a convenient and relevant manner. Inductive thematic analysis was conducted to identify emergent themes.

**RESULTS:** Overall, the sample (n=30) was 63% female, 43% White, with 53% having completed a bachelor's degree, and 47% having owned a Home Assistant Device for over 12 months. The average age of the sample was 24 years old. After analyzing interviews through inductive thematic analysis in NVivo, four themes that were noted in the first phase as it related to Home Assistant Devices and information needs: the use of HADs as a means of convenience,

preferring to use screen-based devices for research, tradeoffs between privacy and functionality, and the ability to emergency triage users for medical attention based on symptoms. Three main themes emerged in the second phase after reacting to the first version of the prototype, including anxiety and frustration when experiencing the unknown, pre-existing positive perceptions of Home Assistant Devices, and negative perceptions of Home Assistant Devices. In the third phase, two main themes emerged: a desire to share visuals to build comfort and bridge the information gap, and an ambivalence towards privacy.

**DISCUSSION:** Privacy concerns remain prominent with Home Assistant Devices when engaging with them for information seeking purposes. These concerns are sometimes met with ambivalence by young adults, who were willing to trade some of their privacy for added features or functionality that could improve their user experience. Furthermore, challenges remain with voice search and screen-based devices are perceived to be easier to use. Lastly, the sexual health information seeking process is sensitive, and many young adults in this sample expressed wanting to have a more personalized experience that acknowledged their specific situations. To the author's knowledge, this is the first study that explored the factors contributing to the sexual health information seeking process using Home Assistant Devices among young adults between the ages of 18 and 26. The results of this study have several implications for public health practice and research, especially as it relates to the Design Thinking approach for public health voice skill development, as well as addressing a new approach to providing sexual health information to young adults that may be more discreet and relevant to them. The findings from this study contribute to the emerging literature base on the use of Home Assistant Devices to address sensitive health information seeking behaviors.



AN EXPLORATION OF YOUNG ADULT INFORMATION SEEKING  
BEHAVIORS WHEN ENGAGING WITH HOME ASSISTANT DEVICES ABOUT  
SEXUALLY TRANSMITTED INFECTIONS

by

Junaed Ahmad Siddiqui

Dissertation submitted to the Faculty of the Graduate School of the  
University of Maryland, College Park, in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy  
2023

Advisory Committee:

Professor Cynthia Baur, PhD, *Chair*  
Elizabeth Aparicio, PhD, *Assistant Professor*  
Devlon Jackson, PhD, *Assistant Research Professor*  
Neil Sehgal, PhD, *Assistant Professor*  
Beth St. Jean, PhD, *Dean's Representative*

© Copyright by  
Junaed Ahmad Siddiqui  
2023

## Dedication

First, all praises are due to The Most High, without Whom I would not have made it this far. This dissertation is dedicated to my wife, Afeera – a constant source of support, encouragement, and care throughout the challenges of balancing a doctoral program and life. I am immensely grateful for having you in my life. This dissertation is also dedicated to my parents, Kinza and Idnan Siddiqui, who taught me that it is a blessing to not only seek knowledge, but to impart it. Thank you for all the sacrifices you made for me and Sonia and Sophia to be where we are today. To the two pieces of my heart outside of my body - my wonderful daughters Leena and Zeyna – you both inspire me constantly and helped me maintain my own child-like curiosity throughout my dissertation – Baba loves you!

## Acknowledgements

I would like to acknowledge and give my deepest gratitude to my Committee Chair and advisor, Dr. Cynthia Baur, who made this dream a reality. Her guidance and advice carried me throughout all the stages of this dissertation, and inspired resilience and perseverance. Thank you so much for keeping me accountable, your feedback to my countless drafts, and pressure testing my approach. I thank Dr. Elizabeth Aparicio for sharing her qualitative expertise and technical NVivo expertise with me and reviewing my analysis to ensure the highest level of fidelity. Thank you to Dr. Neil Sehgal for the mentorship and support as I tried to intertwine my passions for both technology and public health into a dissertation. I thank Dr. Devlon Jackson for her thoughtful feedback to my drafts and support. I thank Dr. St. Jean for the expertise in information studies and her support in recruiting what turned out to be a hard to access sample. To Dr. Katherine Sharp – thank you for offering a kind word whenever we spoke and holding me accountable throughout the program.

As the late Kobe Bryant once said, “Rest at the end, not in the middle”. I thank all the people that helped motivate me and push me to complete this dissertation, and not resting until it was done.



# Table of Contents

Dedication .....	ii
Acknowledgements .....	iii
Table of Contents .....	iv
List of Tables .....	vi
List of Figures .....	vii
List of Illustrations .....	viii
List of Abbreviations .....	ix
Chapter 1: Introduction .....	1
Problem Statement .....	1
Purpose of the Study .....	8
Specific Aims and Research Questions .....	10
Public Health Implications .....	11
Theoretical Framework .....	11
<i>Theory of Motivated Information Management</i> .....	12
<i>Technology Acceptance Model</i> .....	15
<i>Intersection of TMIM and TAM</i> .....	17
Summary .....	18
Chapter 2: Review of the Literature .....	20
Introduction .....	20
Focus Area 1: Home Assistant Devices as an Assistive Technology .....	26
Focus Area 2: Technology Use During Emerging Adulthood .....	36
Focus Area 3: Young Adults and Information Seeking .....	38
Chapter 3: Methods .....	43
Methods Overview .....	43
Design Thinking: An Overview .....	44
Inclusion of Human Subjects and IRB Review .....	47
Participant Eligibility .....	47
Recruitment .....	48
Research Design .....	52
Study Procedures .....	53
Procedures .....	54
Measures .....	57
Data Analysis .....	61
Chapter 4: Results .....	67
Introduction .....	67
Recruitment .....	68
Study Setting and Sample .....	71
Aim 1 .....	71
Aim 2 .....	85
Feedback Incorporation into new prototype .....	98
Aim 3 .....	107
MHealth App Usability Questionnaire (MAUQ) .....	115
Chapter 5: Discussion .....	116

Summary .....	116
Overview of Findings .....	118
Discussion .....	125
<i>Privacy Concerns Persist</i> .....	126
<i>Voice Search Remains Difficult</i> .....	128
<i>Beneficial Features</i> .....	129
<i>Acknowledging the Sensitive Nature of Sexual Health Information Seeking</i> ...	131
<i>Digital Health Equity</i> .....	131
Study Strengths .....	133
Limitations .....	134
Implications for the field.....	136
Policy Implications .....	137
Future Research .....	138
Appendices.....	140
Appendix A. Screener Questionnaire for on-campus participants (to be done via Qualtrics for all aims) .....	140
Appendix B: Background Questionnaire to be emailed to all participants prior to completion of study activities .....	142
Appendix C. Aim 1 Interview Guide .....	146
Appendix D. Aim 2 and 3 Interview Guide .....	148
Appendix E: Aim 2 Prototype.....	150
Appendix F: Aim 3 Prototype .....	158
Appendix G: mHealth App Usability Questionnaire (adapted from Zhou et al., 2019) .....	167
Glossary .....	173
Bibliography .....	175

## List of Tables

Table 1.1. Overview of Specific Aims and Research Questions

Table 3.1. Operationalized Design Thinking constructs by study aim.

Table 3.2 Overview of Recruitment Channels

Table 4.1 - Recruitment breakdown by channel

Table 4.2 - Sociodemographic characteristics of participants

Table 4.3 – Overall theme and subtheme list

Table 4.4 – Aim 1 theme and subtheme list

Table 4.5 – Aim 2 theme and subtheme list

Table 4.6 – Aim 2 prototype use case descriptions

Table 4.7 – Aim 3 theme and subtheme list

Table 4.8. MAUQ Questionnaire Results

## List of Figures

Figure 1.1 Home Assistant Devices as a subset of artificial intelligence, machine learning, and voice assistants

Figure 1.2. Theory of Motivated Information Management (adapted from Afifi & Weiner, 2006)

Figure 1.3. Technology Acceptance Model (TAM) (adapted from Davis, 1989)

Figure 1.4. Proposed Theoretical Framework combining Technology Acceptance Model (TAM) and Theory of Motivated Information Management (TMIM)

Figure 2.1. Personal Smart Assistants Hierarchy (adapted from Russel & Norvig, 2003)

Figure 3.1. The Design Thinking Model. (adapted from Gibbons, 2016)

Figure 3.2. An example hypothetical situation (Illustrative – actual hypothetical situations was based on IDIs in Aim 1)

Figure 3.3. Study Overview

Figure 4.1 – Aim 1 Recruitment Overview – mTurk

Figure 4.2 – Aim 1 Recruitment Overview – Positly

Figure 4.3 – Aim 1 Recruitment Overview - Aggregate

## List of Illustrations

Illustration 4.1 – Prototype 2

Illustration 4.2 – Change 1 to prototype

Illustration 4.3 – Change 2 to prototype

Illustration 4.4 - Change 3 to prototype

Illustration 4.5 - Change 4 to prototype

Illustration 4.6 - Change 5 to prototype

Illustration 4.7 - Change 6 to prototype

Illustration 4.8 - Change 7 to prototype

Illustration 4.9 - Change 8 to prototype

Illustration 4.10 – Change 9 to prototype

## List of Abbreviations

HAD: Home Assistant Device  
VA: Voice Assistant  
DT: Design Thinking  
ML: Machine Learning  
NLP: Natural Language Processing  
STI: Sexually Transmitted Infection  
STD: Sexually Transmitted Disease  
TMIM: Theory of Motivated Information Management  
TAM: Technology Acceptance Model  
TRA: Theory of Reasoned Action

# Chapter 1: Introduction

## Problem Statement

### *Young Adults and Sexual Health*

STIs are a major public health problem in the United States, with 26 million new STI cases in 2018 (Weinstock et al., 2021). STIs can result from bacterial (chlamydia, gonorrhea, syphilis) and viral (HIV/AIDS, herpes, hepatitis B, human papilloma virus) exposure. Symptoms of STDs can vary from mild to deadly, and while bacterial pathogens can be cured through medication, viral infections are incurable (Sexually Transmitted Infections (STIs), 2019). One in every five people in the United States have a STI; a total of 68 million infections as of 2018 (Kreisel et al., 2021). The cost of STIs also places a heavy strain on the healthcare system and economy, accounting for about \$16 billion dollars in direct medical costs. (Chesson et al., 2021, Weinstock et al., 2021). The financial burden is further exacerbated by the long-term effects of STDs on health, including infertility, increased susceptibility to HIV/AIDS, and lost productivity at work (Kumar, Chesson, & Thomas, 2021; Tsevat et al., 2017). Half of all new infections annually occur in young people aged 15 to 24 (Weinstock et al., 2021). With such a high incidence and early onset of sexual activity, it is important to educate individuals at earlier ages about the risks and consequences of sex and provide them the resources to make protective and wise choices about their health.

### *The Use of Technology in the Information Seeking Process*

One method of educating individuals on sexual health is to leverage digital technology to facilitate fast, discreet information retrieval. Technology has the potential to remove the stigma, fear, and anxiety experienced by health information seekers when they look to other sources for sexual health information, such as friends, family, physicians, and other experts. Young adults have high levels of technology use, with 95% of young adults having access to a smartphone and 94% of them using the Internet at least once a day (Anderson & Jiang, 2018). Young adults are more likely to use a variety of technologies to obtain information, often at the same time (Anderson & Jiang, 2018; Kachur et al., 2013; Radovic et al., 2018). Over 70% of young adults report always using the Internet as a primary source of obtaining health information (Basch et al., 2018). Online, technology-based interventions have been shown to be preferable to young adults compared to the traditional in-person, telephone, and paper mediums (Radovic et al., 2018; Ranney et al., 2013). It has been well documented that adolescents and young adults use the Internet to find sexual health information (Decker et al., 2020; Malbon, Ojong, & Nucci-Sack, 2012; Selkie, Benson, & Moreno, 2011). Based on their high level of familiarity and skill with technology and an existing pattern of searching online for health information, there exists opportunities to leverage emerging technologies to continue to provide sexual health information to this population.



### *Research Question*

The overarching research question of this dissertation is “What are the sexual health information needs of adults 18 to 26 years old, and how relevant and useful does this population rate a prototype HAD skill for sexual health information seeking?”. This qualitative study also sought to answer six secondary research questions:

- *Research Question 1:* What are the current information needs and information seeking behaviors of adults 18-26, relative to their sexual health?
- *Research Question 2:* What barriers and facilitators exist for adults 18-26 to seeking and finding health information via Home Assistant Devices?
- *Research Question 3:* What types of sexual health information do adults 18-26 want to consume via Home Assistant Devices when they choose to engage with them?
- *Research Question 4:* What type of user experience would be ideal for a voice skill designed to convey public health information to adults 18-26?
- *Research Question 5:* How responsive is a user-focused prototyped voice skill to individual’s sexual health information needs?
- *Research Question 6:* Would participants choose a user-focused prototyped voice skill over alternative information sources for information on sexually transmitted diseases?

### *History of Information Dissemination Channels*

Traditional public health interventions utilize methods such as factsheets and in-person sessions for participants, and briefs/publications for the research-oriented

population (National Cancer Institute, 2006; Glanz, Rimer, & Viswanath, 2015; Rosenstock, 1988). In recent years, digital products (social media, mobile apps) have begun to be emphasized as part of the dissemination process for both research and information dissemination, in large part due to their speed at which they can deliver information, and their leverage of advanced computing and processing methods that result in relevant information for a user. With the internet becoming part of mainstream culture in the late 1990s into the 2000s, information has become available in a quantity and speed never seen before (Tonsaker, Bartlet, & Trpkov, 2014). Health information is no exception; according to the latest analysis of the Health Information National Trends Survey (HINTS), over 45% of adults in the United States report using the Internet as the first source of information when searching for health or medical topics (Jacobs, Amuta, & Jeon, 2017). Growth in internet use is driving a paradigm shift in the landscape of accessing health information (Jacobs, Amuta, & Jeon, 2017; Powell, Darvell, & Gray, 2003; Tonsaker, Bartlett, & Trpkov, 2014). Internet connectivity provides an opportunity to disseminate information directly to a borderless audience, which is especially appealing to hard-to-reach populations with limited access to newspapers, televisions, and magazines (Biddinika et al., 2019).

Leveraging Artificial Intelligence (AI) has provided new ways to parse and interpret enormous amounts of information in a fraction of the time it would take the average consumer (Schank, 2014). AI, which refers to the simulation of human intelligence (i.e., learning/problem-solving) in machines, has become an important topic over

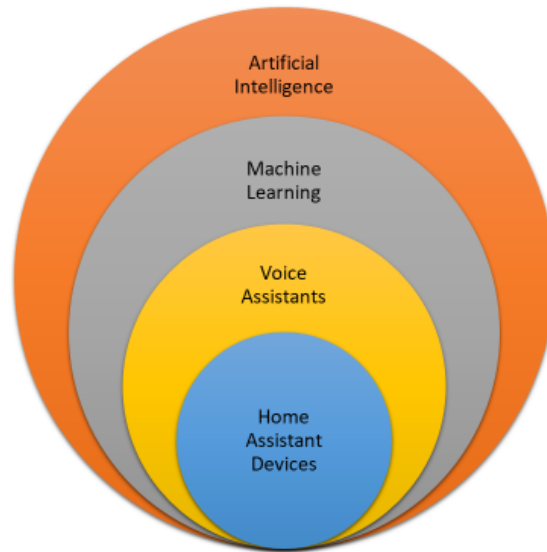
recent years as tech giants like Google, Facebook, and Amazon have begun to develop voice assistants such as Amazon's Echo, Google's Google Assistant, Microsoft's Cortana, and Apple's Siri (Ghosh, Chakraborty, & Law, 2018; Khurana et al., 2023; Schank, 2014). All the voice assistants (VAs) have contributed to the changing way individuals consume, process, search, and interact with information by leveraging machine learning (ML), an application of artificial intelligence in which programs and applications can access data and learn from it to refine their effectiveness (Guzman, 2018) (Figure 1.1). ML has been leveraged in VAs through Natural Language Processing (NLP) algorithms, in which models are trained on large datasets of voices to understand nuances in the human voice (Khurana et al., 2023). VAs have recently been incorporated into consumer-facing devices called Home Assistant Devices (HADs), further increasing the likelihood of adoption of voice search instead of traditional, hand-held methods. For those individuals with low health and technological literacy, being able to search for information using their voice interaction with HADs may provide an easier way to find pertinent information.

#### *Home Assistant Devices*

HADs are devices that exclusively rely on voice interaction to relay information and are designed to accept user input from a touch screen, voice and or hand-controlled interfaces, and natural language to perform a wide variety of tasks (Canbek and Mutlu, 2016). The Echo, Amazon's HAD, is a platform designed to operate on the multiple Amazon devices and perform voice-operated functions while communicating with a local wireless network connection with cloud-based web servers to carry out

the functions. Alexa is activated when its speech recognition software recognizes a “wake” word, which is used to activate the device (this can also be customized by the user) (Clauser, 2017). The devices have multiple microphones that use noise cancellation and “far-field voice recognition so that it can pick up speech patterns from any direction and filter through other co-occurring noise” (Amazon.com, Inc.). When Alexa is voice-activated, the device briefly lights up, allowing for voice-interactions and feedback, if the user chooses to engage with the device. The platform can be used to perform task-specific applications called “skills”. While skills have been developed for HADs to focus on categories ranging from home lighting, playing music, and controlling features of cars, the platform itself has not been examined in how effectively it can relay information pertaining to health and general well-being, or whether these devices are effective from an information dissemination perspective. It is important to note that historically, there has been a focus on being “first-to-market” with HAD skills, a phenomenon that also occurred with mobile apps when smartphones were first popularized (Bresnahan et al., 2014). The desire to accelerate product development without the necessary research with end-users and collaboration with all stakeholders has resulted in many poorly developed digital products that go unused by the consumer (Bresnahan et al., 2014).

**Figure 1.1.** Home Assistant Devices as a subset of artificial intelligence, machine learning, and voice assistants.



### *Home Assistant Devices and Information Retrieval*

It is estimated that 50% of people in the United States use voice search daily (Brin, 2022). Gartner (2016) estimates that HADs will eventually replace other technology such as personal computers and laptops for tasks such as shopping and consuming information. HADs and “smart devices” have not been explored as a means of disseminating information for public health. Most “smart” devices (devices with an active connection to other devices and/or networks that can operate interactively) have a voice assistant, which has been effectively utilized by users in the performance of simple tasks on the device.

As of 2019, over 25% of adults in the United States own at least one HAD, with over 40% of those adults owning 2 or more (voicebot.ai). This number varies by age

groups, with 32% of those between the ages of 18 and 29 owning a HAD (Pew Research Center). Overall, 61% of the domestic HAD market share belongs to Amazon Alexa, as of 2020 (voicebot.ai). In 2021, thirty-four percent of 18- to 29-year-olds in the United States owned a HAD, a number that is expected to grow in the coming years (voicebot.ai). In addition to high ownership rates, this age group tends to be more technically literate, and have experience interacting with a broad array of technologies and devices compared to older adults (Joshi et al., 2019; Olson et al., 2011).

HADs provide a potential new avenue of information-seeking to individuals between 18 and 29 seeking to learn more about STIs, all in an intimate setting. This study seeks to explore the information seeking process of adults between 18 and 26 as it pertains to STIs and to create an effective, appropriate tailored voice skill for use on HADs to provide alternative methods to find information for those with limited health and technological literacy.

### *Purpose of the Study*

The purpose of this qualitative study was to explore the perspectives of young adults to understand the depth of their sexual health information needs and whether a user-centric designed HAD can be a suitable alternative for fulfilling those information needs. The study accomplished this purpose by exploring whether adults 18 to 26 years old who already own an HAD and have information needs for STIs find HADs relevant for meeting that need. Using the Theory of Motivated

Information Management and the Technology Acceptance Model and core tenets of the Design Thinking method, this dissertation study conducted empathy research to identify a typical young adult seeking STI information, create a prototype voice skill for those individuals, and evaluate the prototype for responsiveness to information needs. The study also considered whether a voice skill is a preferred medium compared to a traditional sexual health information source. The study was conducted in three phases:

- *Phase 1 (Specific Aim 1): Empathy Research*
  - Formative research was conducted via 8-10 in-depth interviews lasting one hour each to better understand the end-user, their current sexual health-related information needs, barriers encountered when seeking information, their feelings about HADs, and their needs in a skill.
- *Phase 2 (Specific Aim 2): Ideation and Creation*
  - Using Amazon mTurk, 10-12 individuals were recruited to individually give feedback on a low fidelity prototype voice skill created based on the feedback gathered from Phase 1. It was a linked wireframe in a slide format. Once feedback was obtained from the first group, it was incorporated into the low fidelity prototype to create a new iteration of the prototype.
- *Phase 3 (Specific Aim 3): Evaluation of Prototype*
  - Using a think-aloud protocol, a low-fidelity prototype was presented to 10-12 individuals recruited in the same manner as in Phase 2 and were

given 3-5 hypothetical situations to navigate using the voice skill and obtain the necessary information.

- Individuals were asked questions about their current attitudes towards HADs, the usability of the prototype, and how well it was able to answer their information needs in the context of the hypothetical situations.

### Specific Aims and Research Questions

This qualitative study was conducted across three aims, addressing a total of six research questions. Table 1.1 below illustrates the linkage between each aim and research question/s.

**Table 1.1.** Overview of Specific Aims and Research Questions

<b>Aim</b>	<b>Research Question Addressed</b>
<i><b>Aim 1:</b></i> To conduct empathy research to better understand the information seeking process of English-speaking adults 18-26 as it relates to sexual health.	<ul style="list-style-type: none"> <li>• <b>RQ 1:</b> What are the current information needs and information seeking behaviors of individuals relative to their sexual health?</li> <li>• <b>RQ 2:</b> What barriers and facilitators exist for adults 18-26 to seeking and finding health information via Home Assistant Devices?</li> <li>• <b>RQ 3:</b> What types of sexual health information do adults 18-26 want to consume via Home Assistant Devices when they choose to engage with them?</li> </ul>
<i><b>Aim 2:</b></i> To create an effective tailored voice skill for accessing information about sexual health on Home Assistant Devices.	<ul style="list-style-type: none"> <li>• <b>RQ 4:</b> What type of user experience would be ideal for a voice skill designed to convey public health information to adults 18-26?</li> </ul>
<i><b>Aim 3:</b></i> To evaluate the likeability and usability of a prototype voice skill designed to access sexual health information via Home Assistant Devices.	<ul style="list-style-type: none"> <li>• <b>RQ 5:</b> How responsive is a user-focused prototyped voice skill to individual's sexual health information needs?</li> <li>• <b>RQ 6:</b> Would participants choose a user-focused prototyped voice skill over alternative information sources for information on sexually transmitted diseases?</li> </ul>



### Public Health Implications

This dissertation informs the work of researchers that are striving to meet Healthy People 2030 objectives to reduce the number of sexually transmitted infections among young adults (Office of Disease Prevention and Health Promotion, n.d.). A technology-based approach to addressing this issue has the potential to increase knowledge of individuals seeking sexual health information, in turn potentially being able to reduce the incidence of STIs and increase the linkages to the appropriate resources for those who may already have one. The information that could be obtained from a relevant, useful voice skill could then be directly applied to individuals' sexual health behaviors to reduce the number of STIs.

### Theoretical Framework

This study used a combination of the Theory of Motivated Information Management (TMIM) (Afifi & Weiner, 2004) and the Technology Acceptance Model (TAM) (Davis, 1989). The TMIM was used because of its emphasis on intrapersonal challenges associated with the gap between the current knowledge one has and the knowledge that they desire. In addition, Afifi & Weiner's conceptualization of multiple information management strategies is generative for grasping how individuals can vary in how they process the information they receive, even if it can be of benefit to them (Afifi & Weiner, 2004). Furthermore, Afifi & Weiner's attention to how outcome assessments can affect efficacy beliefs is of value for informing how HADs are utilized in this young adult population.

The TAM was used because of its emphasis on the role that the perception of technology plays in its actual use (Davis, 1989). The focus on perception was especially useful to this study as it helped contribute to the understanding of how the perceptions of newer technologies like HADs can affect how sexual health information is obtained and utilized from them. Davis' attention to the role of the intention to use technology being separate from the actual use of technology was valuable in considering broad drivers of engagement when creating voice skills on HADs.

#### *Theory of Motivated Information Management*

The Theory of Motivated Information Management is a communications framework that focuses on active information management efforts, and generally focuses on the management of information that occurs through interpersonal channels (Afifi & Weiner, 2004). The framework blends constructs from multiple socio-behavioral and communications theories, including Efficacy Theory, the Theory of Uncertainty Management, Problematic Integration Theory, and the Comprehensive Model of Information Seeking (Afifi & Weiner, 2006). The theory proposes that information management decisions at an individual level can generally be captured in three phases: interpretation, evaluation, and decision.

### *Interpretation Phase*

In the interpretation phase, the individual becomes aware of a difference in the amount of uncertainty they want to have about an issue important to them and the amount of uncertainty that they currently have. The difference between desired uncertainty and actual uncertainty serves as a catalyst that leads to anxiety in the individual. The actual level of uncertainty does not need to be quantified; rather, the perceived discrepancy in uncertainty is enough to lead to anxiety and a desire to rectify the situation.

### *Evaluation Phase*

The evaluation phase immediately follows the anxiety experienced at the end of the interpretation phase. It involves the assessment of the expected outcomes of an information search (outcome expectancies), and the perceived ability to obtain the desired information (efficacy assessment). Like the Social Cognitive Theory, the construct of outcome expectancies is represented in TMIM as an individual's assessments of the benefits and drawbacks of particular information-seeking strategies. Efficacy assessments are an individual's perception of whether they have the tools to obtain the information they want. TMIM also posits that outcome expectancies are partially mediated by the perception of three different types of efficacy:

- *Coping Efficacy*: “the extent to which information managers believe they have the emotional, instrumental, and other resources (e.g., network support) to

manage the outcomes they expect from the information-seeking strategy under consideration” (Afifi & Weiner, 2004)

- *Communication Efficacy*: “reflects individuals’ perceptions that they can successfully engage in the communication or observational task required to gather the sought-after information” (Afifi & Weiner, 2004).
- *Target Efficacy*: “belief that the information target is able and willing to produce the sought information” (Afifi & Weiner, 2004).

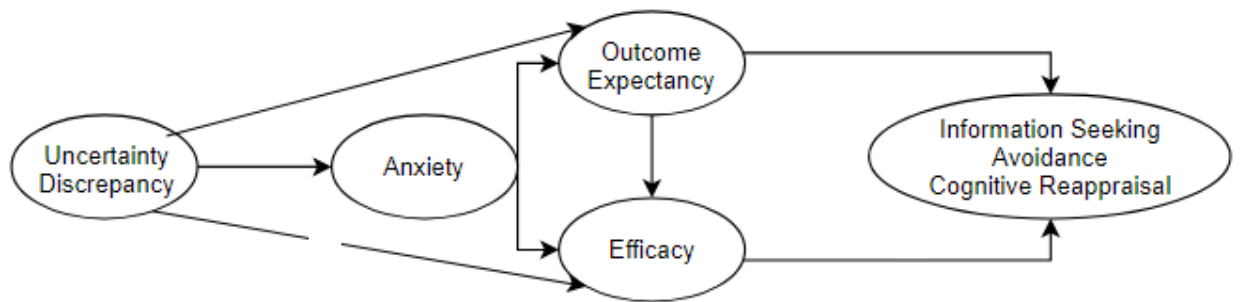
Whether the outcome assessments can impact efficacy beliefs is based on how each individual determines the benefits and drawbacks expected from an information-seeking action prior to making assessments about their ability to enact it and/or cope with the benefits and drawbacks (Afifi & Weiner, 2006). TMIM also proposes that the role of efficacy as a mediator is also lessened in cases where outcome expectancies are generally positive, because in these cases, there is generally no fear associated with enacting a communication strategy or the coping abilities associated with an information seeking strategy (Afifi & Weiner, 2006).

### *Decision Phase*

After the evaluation phase, individuals enter the decision phase, where they consider three information management strategies, and choose one to move forward with: information-seeking, avoidance, or cognitive reappraisal. Information seeking would result in obtaining more information about the topic of focus, thereby directly reducing the amount of uncertainty. Avoidance would involve either a passive or active avoidance of information related to their uncertainty. Lastly, cognitive

reappraisal would involve the individual making psychological adjustments with regards to how certain they are to reduce the discrepancy between desired uncertainty and actual uncertainty.

**Figure 1.2.** Theory of Motivated Information Management (adapted from Afifi & Weiner, 2006).



### *Technology Acceptance Model*

The Technology Acceptance Model (TAM) was developed from the Theory of Reasoned Action (TRA) by Davis (Davis, 1989) (Figure 1.3). The model used TRA as a theoretical basis for specifying the causal linkages between perceived usefulness and the perceived ease of use and users' attitudes, intentions, and actual computer usage behavior. Behavioral intention is jointly determined by attitude and perceived usefulness. Attitude is determined by perceived usefulness and perceived ease of use. TAM replaces determinants of attitude of TRA by perceived ease of use and perceived usefulness with the technology. Generally, TAM specifies general determinants of individual technology acceptance and has been applied to explain or predict individual behaviors across a broad range of end user computing technologies

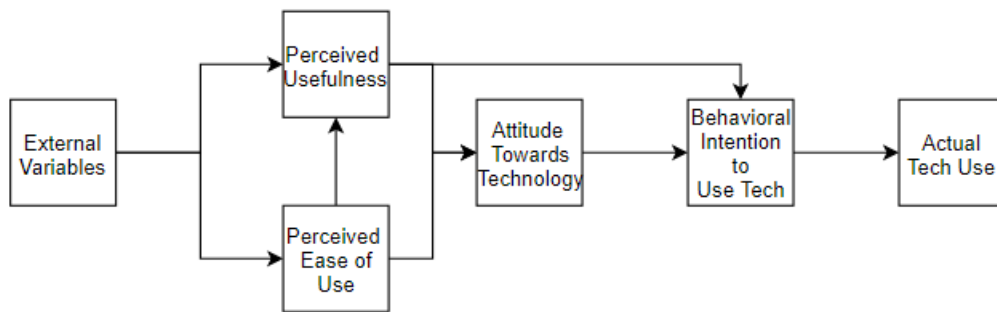
and user groups (Davis, Bagozzi, and Warshaw, 1989). The theory continues to be used today as different computing technologies continue to emerge.

TAM provides an explanation of the determinants of technology acceptance that can explain user behavior across a broad range of end-user computing technologies and user populations, while being encompassed within a behavioral theory. According to the founders of TAM, since it incorporates findings accumulated from over a decade of IS research, it may be especially well suited for modelling computer acceptance (Davis, Bagozzi & Warshaw, 1989). TAM is considered a strong model for predicting user acceptance (Venkatesh & Davis, 2000). Davis (1989) developed and validated better measures for predicting and explaining use which focused on two theoretical constructs: perceived usefulness and perceived ease of use, which were theorized to be fundamental determinants of system use.

TAM posits that the effects of external variables (e.g., system characteristics, development process, training) on intention to use are mediated by perceived usefulness and perceived ease of use (Figure 1.3). Perceived usefulness is also influenced by perceived ease of use because if other things are equal, the easier the system (technology) is, and the more useful it can be (Venkatesh & Davis, 2000). There are a few key assumptions made by TAM. One assumption is that usage of a particular technology is voluntary (Davis, 1989). Another assumption is that, given enough time and knowledge about a particular behavioral activity, an individual's stated preference to perform the activity (e.g., behavioral intention) will in fact

closely resemble the way they do behave. This assumption only applies when the behavior is under a person's volitional control (Ajzen & Fishbein, 1980). Moreover, TAM has strong behavioral elements, and assumes that when someone forms an intention to act, they will be free to act without limitation (which may not always be the case in real life). In the real world there will be many constraints, such as limited ability, time constraints, environmental or organizational limits, or unconscious habits which will limit the freedom to act (Bagozzi, 1992).

**Figure 1.3.** Technology Acceptance Model (TAM) (adapted from Davis, 1989).

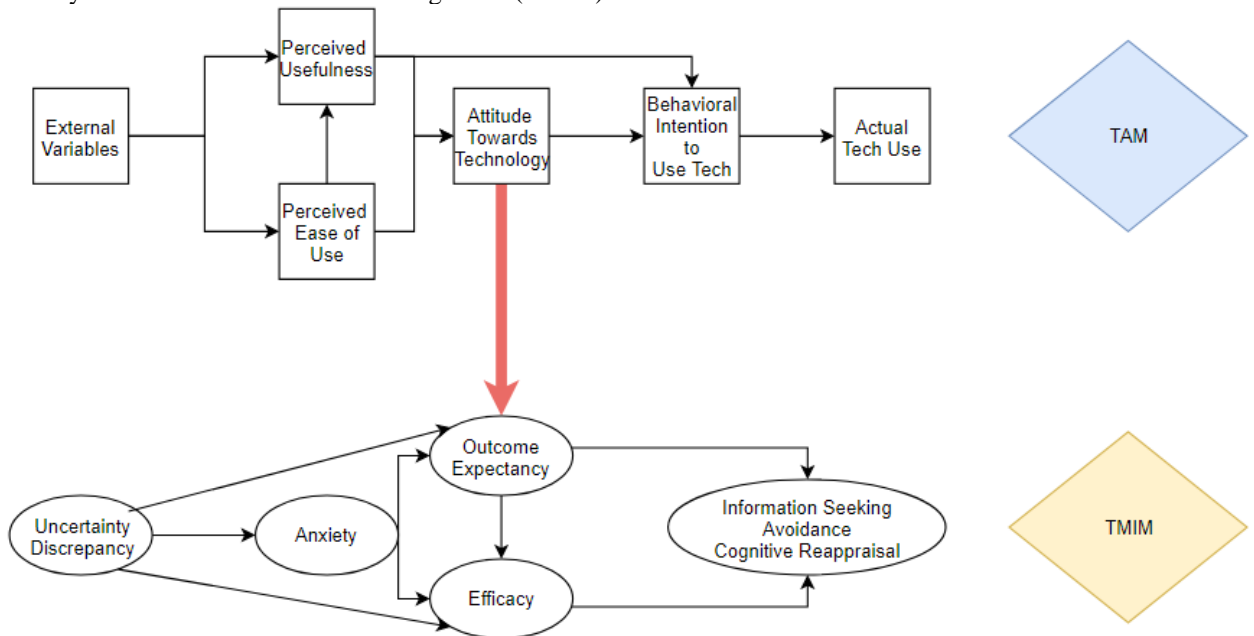


#### *Intersection of TMIM and TAM*

This dissertation proposes that TMIM and TAM are interrelated. According to TMIM, an individual experiences anxiety when they discover a discrepancy between the amount of knowledge they have, compared to the amount of knowledge they should have on a particular topic. As they go to reduce that gap, they assess a series of information seeking strategies, as well as the benefits and drawbacks of particular information-seeking strategies (outcome expectancies), which in turn relates directly to their confidence in their ability to effectively utilize an information seeking strategy. In TAM, an individual's perception of technology creates an attitude towards it, which can then affect both the intention to use that technology as well as

the behavior itself. This dissertation study proposes that an individual's technology perception is another outcome expectancy not explicitly stated in TMIM, but that can be incorporated accordingly (Figure 1.4). In the context of TMIM and TAM, the attitude towards technology may affect the level of anxiety experienced by the individual, due to the downstream effect on outcome expectancies. It is theorized that an individual's attitudes towards HADs used in the sexual health information seeking process will affect what they expect from both the technology and the information they receive from it.

**Figure 1.4.** Proposed Theoretical Framework combining Technology Acceptance Model (TAM) and Theory of Motivated Information Management (TMIM).



### Summary

Young adults experience the highest rates of STIs in the United States, setting them up for negative health, professional, and economic consequences later in life. When



young adults first want to access information on STIs, the majority use the internet, due to both the speed by which information can be gathered and to avoid the discomfort and anxiety associated with other information sources that may require human interaction. Young adults also have the highest ownership rates of Home Assistant Devices (HADs). Researchers and professionals have been building voice-skills for their specific industry applications without a solid understanding of whether users will engage with their products, or even have a desire to use it, following a similar trajectory that mobile apps experienced when they were first introduced. The pre-occupation with building applications rather than conducting pre-testing, design sessions, and program analytics post-creation is resulting in many poorly developed applications. The lack of focus on user needs can result in wasted time, money, and may not even have the desired outcome. When combined with the fact that there is a lack of literature documenting the effectiveness of these devices for conveying sexual health information, there exists a notable gap in the literature around this area. This study sought to create and test a voice-based public health application prototype for sexual health information dissemination utilizing human-centered design principles and appropriate public health theory. The results from this study can be used to better understand how young adults prefer to interact with sexual health information delivered via HADS and how voice-skills can be leveraged to best resonate with them. The results can also inform future research on how older age groups interact with HADs around other sensitive health topics, such as mental health and vaccination uptake.

## Chapter 2: Review of the Literature

### Introduction

Young adults between the ages of 18 and 26 fall into a category often described as “digital natives” – born and/or raised during the age of the Internet and equipped with a deep familiarity with its associated technologies from an early age (Prensky, 2001; Selwyn, 2009). Rather than using technology as part of their everyday lives, researchers argue that technology is essential to their existence, a function of being surrounded by it constantly and immersed in a digital environment more so than anyone before them – an argument that has only strengthened over time (Selwyn, 2009). The full digital environment in which young adults live consists of an abundance of technologies, including but not limited to cell phones, tablets, laptops, wearable sensors, smart home devices, touchscreen displays, and even internet connected workout equipment. Young adults are connected constantly and through multiple channels. However, the lived experience with technologies has not been studied extensively. How young adults interact with different technologies during specific health-related events in their lifespan is an emerging area of research. At the same time, technologies continue to develop that make the lived experience with technology even more intimate. Those who are defined as both emerging adults (those between the ages of 18 and 29) and digital natives are a particularly relevant population to study as new technologies emerge for obtaining information from the internet.

One example of intimate technology is the emergence of Home Assistant Devices (HADs). HADs have become a new way for young adults to interact with the Internet verbally through a question-and-answer format. While audio channels have been a popular way for emerging adults to ingest information (podcasts, YouTube), HADs offer a unique audio experience without the need for a mobile device. It has been viewed as a useful technology for those who either do not have a mobile device near them or have a preference to search for information through an auditory channel. Examining how young adults interact with HADs for specific health-related questions has not been adequately studied, and the current literature base remains sparse. This study examined how young adults between 18 and 26 interact with HADs as it relates to their sexual health, and further examined how they search for sexual health information by creating a prototype voice skill for use in HADs. The literature review below examines the intersection of three distinct topics: young adults, HADs, and information seeking preferences as it relates to sexual health needs.

### Theoretical Review

Theories can help structure and explain our understanding of how individuals process sensitive information and leverage technology to do so. Public health and communications theories capture the intersection of health information seeking of a sensitive health behavior using technology. While theories of health behavior offer a unique value in understanding intrapersonal behaviors, the information seeking component was missing. Conversely, communications theories provided a strong overview and structure to how individuals gather and assess but did not touch on the

impact of health-specific information in the gathering process and how technology can affect that relationship. Furthermore, an examination of the current HAD literature yielded no results of HAD skills/approaches that had any theoretical underpinning. Based on these findings, it was determined that the best approach was to combined constructs from the Theory of Motivated Information Management and the Technology Acceptance Model to best explain the relationships in this study.

### Theory of Motivated Information Management

The Theory of Motivated Information Management (TMIM) is a communications framework that centralizes around the management of information in an active manner, specifically focusing on intrapersonal channels (Afifi & Weiner, 2004). The TMIM takes constructs from some of the most prominent health behavior theories (Theory of Planned Behavior, Health Belief Model, Social Cognitive Theory) and incorporates them with communications principles to explain the intra-personal information seeking experience, making it well-aligned to explain health-specific behaviors in the information seeking process.

The TMIM proposes that individuals' information management decisions can be deconstructed into three categories: interpretation, evaluation, and decision. In the interpretation phase, the individual becomes aware of a discrepancy in the amount of uncertainty they want to have about a certain issue (ex. sexual well-being) and the amount of uncertainty they currently have. This difference in desired and actual uncertainty serves as a trigger for anxiety in the individual and a desire to rectify the

situation. The evaluation phase immediately follows the end of the interpretation phase. The individual is in an anxious state and now begins to evaluate the expected outcomes of an information search (often termed as outcome expectancies), and the perceived ability to obtain the desired information (i.e., an efficacy assessment). The outcome expectancies in this phase can be mediated by coping efficacy (how confident an individual is in their resources (emotional, instrumental, and otherwise) to manage the outcomes expected from the information search), communication efficacy (an individual's perception of whether they can successfully engage in the communication task required to gather the necessary information), and target efficacy (belief that the information target can produce the information they are seeking) (Afifi & Weiner, 2004). The conclusion of the process results in one of three outcomes for the individual: information seeking, information avoidance, or cognitive reappraisal. If the individual feels that the gap between their current and desired uncertainty is unsurmountable based on their efficacy assessments, then they will disengage from the information seeking process and avoid information altogether. Another possibility that can occur is cognitive reappraisal, which involves the individual reducing the gap between their actual and desired uncertainty to avoid the information seeking process. The cognitive reappraisal process occurs internally, without the use of any information. The cognitive reappraisal process serves as another way in which an individual can disengage from the information-seeking process (Afifi & Weiner, 2004).

The TMIM has been applied successfully to the information seeking process of sexual health information in multiple populations (Afifi & Weiner, 2006; Jayasundara, 2021). While the TMIM explains the information seeking behavior process and aligns well with health-related behaviors, it does not consider technology and comfort with technology as it relates to the efficacy assessment process. Studies applying TMIM have often resulted in participants expressing their difficulties with obtaining appropriate sexual health information, often because of a gap in both technological and health literacy (Jayasundara, 2021). For this reason, the Technology Acceptance Model was considered as a strong complement to the TMIM to address the role technology plays in the information seeking process.

#### Technology Acceptance Model

The Technology Acceptance Model (TAM) was developed from the Theory of Reasoned Action (TRA) by Ajzen & Fishbein (Ajzen & Fishbein, 1980; Davis, 1989). It is widely considered to be one of the most influential applications of the TRA in practice (Legris, Ingham, & Colletette, 2003; Lee, Kozar, & Larsen, 2003). The TAM specifies general determinants of individual technology acceptance and has been applied to explain or predict individual behaviors across a broad range of end user computing technologies and user groups (Davis, Bagozzi, & Warshaw, 1989). The TAM is versatile and has been applied to numerous emerging technologies successfully and is considered a strong model for predicting user acceptance (Davis, Bagozzi, & Warshaw, 1989; Venkatesh & Davis, 2000). Recently, Kamal and colleagues (2020) examined the acceptance of telemedicine services through the

TAM framework (Kamal, Shafiq, & Kakria, 2020). It has also been used successfully to examine the acceptability of a digital environment amongst students because of the coronavirus pandemic (Lazim, Ismail, & Tazilah, 2021). The TAM explains that the acceptance of a technology is driven primarily by two factors: perceived usefulness of the technology, and the perceived ease of use of the technology. The TAM has been examined extensively since its creation (Marangunic & Granic, 2015).

There are limitations and concerns with the TAM as it relates to newer technologies. Chuttur and colleagues questioned the true value add of the TAM, citing its limited explanatory and predictive power, and the lack of any practical value being added through it (Chuttur et al., 2009). Benbasat & Barki (2007) questioned the true versatility of the theory as well, arguing that the theoretical landscape for TAM as it becomes adapted to new and emerging technologies has resulted in confusion among the theoretical foundation and how best to use the theory (Benbasat & Barki, 2007). Lastly, Lunceford (2009) correctly identifies the main weakness of TAM, which is the fact that it solely focuses on perceived usefulness and perceived ease of use, while ignoring numerous other issues that can affect acceptance of technology, including but not limited to cost factors, structural barriers, and the nature of the information to be obtained with the technology in question (Lunceford, 2009). Other researchers have made attempts to integrate other constructs into TAM to strengthen it. For example, Holden and Rada (2011) found that by integrating perceived usability (as an external variable) into the TAM, more variance was explained and it was more influential to the other TAM constructs, supporting the importance of the usability of

technology when examining the adoption of technology (Holden & Rada, 2011).

Based on the documented limitations, the TMIM and TAM align with each other well to address both information seeking behaviors as it relates to health, as well as the ability of technology to aid in that process.

### *Focus Area 1: Home Assistant Devices as an Assistive Technology*

Over the last decade, devices which allow user-machine interaction via voice (Interactive Voice Response Systems, or IVRS) have grown in popularity, due to their recent commercial availability and effectiveness in providing information alongside unique home interactions in the Internet of Things (IoT) ecosystem. With the introduction of Apple's intelligent personal assistant Siri and its integration into Apple's iOS operating system in 2011, IVRS have become commonplace today with its widespread availability on cell phones ("Digital Health Technology Vision 2017: Technology for People", 2017). Definitions and descriptions of IVRS can vary based on the types of systems developed and the purposes they were developed for.

Historically, IVRS were automated call-in systems (where users interact with an interface over telephone by pressing numbers on the keypad) that have permeated numerous industries, including finance, commerce, business, and healthcare. Over the last 5 years, this field has begun to rapidly evolve with advances in machine learning and artificial intelligence (AI). The most recent commercial applications of IVRS involve the convenience of voice response in the home. Two of the biggest technology companies in the world, Amazon and Google, released HADs, a type of IVRS (Amazon Echo and Google Home, respectively), harnessing sophisticated AIs



and deep learning algorithms to provide a household device capable of not only providing information from the internet, but controlling devices in the home ranging from light bulbs to door locks. While Amazon released the Echo in 2014, it was not until 2016 that Google released their Google Home device. Both products were the first two home devices to be offered commercially that could use voice interaction with intelligent personal assistants as the primary interaction.

Research on different types of HADs have shown that most users use them primarily for three skills: setting alarms, playing music, and controlling another integrated device within their home (Ammari et al., 2019; Sciuto et al., 2018). There has been less information released about the use of HADs for information, specifically as it relates to public health. There are emerging concerns about the use of HADs for personal health, due mainly to privacy concerns that have become prevalent in the media (Chung et al., 2017; Lau, Zimmerman, & Schaub, 2018). The key differentiating feature of HADs are that they are designed to be conversational devices in the home, capable of two-way interaction between the user and the device. The level and depth of conversation depends on the sophistication of the AI, and can be considered functional, but not advanced at this early stage of these products. As an increasing number of ‘skills’ (for Amazon Alexa-enabled devices) and ‘actions’ (for Google devices) for these devices continue to be developed by third party software companies, the sophistication of two-way interaction will continue to be refined to best address the needs of individuals using the device. A major limitation in the development of these applications is the lack of theory grounding them.

The ability of HADs to quickly retrieve information from the internet in the form of ‘skills’ provide a unique opportunity for public health information to be quickly provided in the comfort of a user’s home, in contrast to traditional public health information dissemination approaches, which occur in the community or at a designated research site. Furthermore, whereas searching the internet requires a particular combination of search terms in the right order to retrieve results, HAD skills can be structured in a way to work best with conversational language, making it easier and faster to retrieve relevant public health information to the user. There is also potential for HADs to proactively provide information for individuals who have expressed interest in information related to their health, creating an avenue to provide consistent messaging that may have the potential to improve an individual’s self-efficacy and knowledge without them having to look for the information themselves. Thus, there exists potential for the technological power of HADs to be harnessed and the devices utilized as purveyors of public health information.

#### *Personal/Smart Assistants*

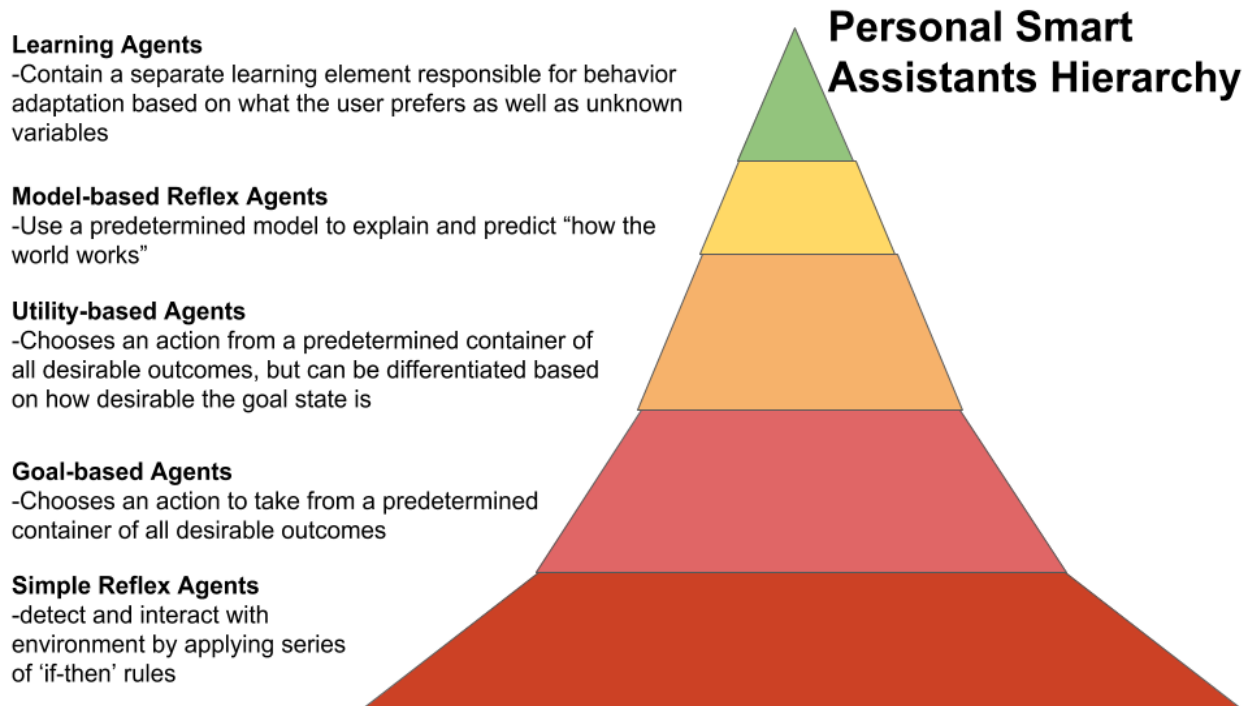
Personal Smart Assistants (PSAs) are designed to help users achieve goals in their daily lives. PSAs can achieve tasks directly delegated to them by the user, monitor digital actions, as well as recommend alternative methods for users to achieve their goals. PSAs rely on both natural language processing and artificial intelligence to support their predictive capabilities and can proactively provide insight into what users seek to accomplish before they articulate it. One of the most well-known

personal smart assistants is Siri. Siri was released with the Apple operating system and was designed to help mobile phone users harness the power of the internet to achieve activities in their day-to-day life. PSAs are well-used worldwide; some studies predict that the half of all internet users in the United States will be using a PSA by 2026 (Lis, 2022).

One of the foundational concepts underlying the PSA technology is context-awareness (Knote et al., 2018). Context-awareness is defined as “any information that can be used to characterize the situation of an entity (i.e., a person, place, or object that is considered relevant to the interaction between a user and an application), including the user and applications themselves” (Abowd & Dey, 1999). The use of context-aware computing helps devices such as PSAs provide curated information very specific to the user’s situation at invocation. Another key feature of PSAs are the pieces of hardware used for context detection. Context detection is generally achieved through a series of acoustic and optical sensors (microphones, cameras), combined with accelerometers, temperature, and/or humidity sensors, all working together to provide a detailed picture of the user’s environment (Czibula et al., 2009; Ficco & Russo, 2009; Knote et al., 2018). Data is collected using these technologies and organized based on the voice interactions of the user and using natural language processing capabilities, a tailored response is provided to the user (Czibula et al., 2009).

Some of the more advanced PSAs such as Amazon's Alexa and Apple's Siri are capable of actively learning and evolving. PSAs have a hierarchy based on their capabilities (Figure 2.1). Amazon's Alexa and Apple's Siri are most identified as being learning agents, capable of evolving their "intelligence" through repeated interactions with users. For example, Amazon Alexa's natural language processing capabilities allow it to process "nontraditional" pronunciations of words using lexical approximation (matching the phonetics, syntax, and pronunciation to the existing vocabulary of the PSA) and semantic approximation (identifying what words are semantically related to the said word and processing). If the user does not say the response is incorrect, the PSA's learning unit is able to store the new pronunciation characteristics to its existing lexicon and query it using its natural language processing abilities in the future (Knote et al., 2018).

**Figure 2.1.** Personal Smart Assistants Hierarchy (adapted from Russel & Norvig, 2003)



Lastly, the exhibition of human-like characteristics by PSAs (often called anthropomorphism) is an emerging foundational factor for this technology. While the degree of anthropomorphism varies by PSA, there have been concerted efforts by companies such as Microsoft, Amazon, and Google to make PSAs relatable and as human-like as possible in their interaction. For example, users have noted that the human-like features of Siri and Alexa makes them more likely to assign human traits (feelings of trustworthiness or empathy) to them and perceive them to be more user-friendly than their less anthropomorphic counterparts (Purinton et al., 2017). Machine learning has recently been able to allow for many advances in automated speech generation which has allowed Siri and Alexa to have more nuanced language

output than ever before. PSAs are now able to change intonation to express certain “attitudes”, naturally pause between words and sentences, and more quickly respond to voice inputs by users, allowing for a more seamless conversation between the device and user (Dunn, 2016; Lopatovska et al., 2018; Porcheron, Fischer, & Sharples, 2017).

### *Perceptions of Home Assistant Devices*

End-users have expressed many concerns around different features of HADs, partially because of how the devices have been portrayed in the media. Both the media and users have expressed concerns while others express relief and satisfaction from the ability to automate and search the Internet via voice-interactions. The Computers as Social Actors (CASA) paradigm, a well-regarded human-computer interaction framework, is a sound approach in better understanding users’ experience and perception of this technology (Nass, Steuer, & Tauber, 1994). According to the CASA framework, people respond to technologies as though they were human, despite knowing they are interacting with a machine (Nass, Steuer, & Tauber, 1994). A user’s perception of human-like tendencies of the machine leads them to attribute personalities to computers, as well as interaction norms (Nass, Moon, & Carney, 1999; Nass et al., 1995). Furthermore, the specific perception of the technology’s machine-generated “voice” is influenced by the end-user’s own personality traits; for example, individuals perceive a stronger social presence by a machine-generated voice that sounds similar to their own, combined with an extroverted “personality” (Purington et al., 2017).

The ascribing of traits to PSAs such as Alexa includes an implicit level of comfort with the technology and its utilization. Studies have linked the degree of device personification with the sociability of interactions with the device, and more interactions with a device such as the Amazon Echo is linked to greater personification (Purinton et al., 2017). Greater personification of a device is related to greater comfort with the technology in performing tasks, including those considered sensitive, such as a discussion or query related to finance, mental health, sexual awareness, and interpersonal relationships (Cohen et al., 2016; Kwon, Jung, & Knepper, 2016). A level of trust with PSA-enabled devices is crucial for users to fully engage with them about meaningful parts of their lives.

#### *Security Concerns Around HADs*

The Mirai DDoS botnet attack that disrupted the Internet for millions of users brought the security of HADs to the forefront of national media, and computer security researchers began scrutinizing the safety of these devices (Newman, 2016). There are an array of security concerns with HADs, ranging from applications with too many enabled privileges on a smart home platform to malware threats that can compromise all connected devices on a network (Fernandes, Jung, & Prakash, 2016; Ronen, O'Flynn, Shamir, & Weingarten, 2016). Other concerns include privacy risks due to pairing and discovery protocols that secretly leak device information, and vulnerabilities in devices that can allow a cyber-attacker to remotely spy on residents (Denning, Kohno, & Levy, 2013; Denning et al., 2009; Wu et al., 2016). A recent

study interviewed individuals who had set up a HAD in their home and had connected it to multiple devices across their home (Zeng, Mare, & Roesner, 2017). Despite being made aware of the numerous security concerns, several users (with self-reported computer science knowledge) noted that it was a worthwhile trade-off to experience the increased functionality, ease, and home automation with their HADs (Zeng, Mare, & Roesner, 2017). Other participants mentioned that they have nothing to hide, a common sentiment that has often been documented in the online behavior academic research (Conti & Sobiesk, 2007). Other individuals indicated that they had complete trust in the companies handling their data, such as Amazon and Google, and believed that it would only be used for refining the HAD models and for advertising, while some did not perceive themselves to be a “worthwhile” target for a botnet attack like the one that occurred in 2016 (Zeng, Mare, & Roesner, 2017). Overall, regardless of familiarity with computer science principles, owners of HADs appeared to be more concerned about physical security issues than privacy issues (Zeng, Mare, & Roesner, 2017). This may be more pronounced, however, when individuals consider health information seeking, given the nature of the information. For example, when searching for information on sexual health, the concern for information being exposed during a search is much higher than the concern around information about smart home device usage (Cho, 2019).

### *Opportunity for HADs*

HADs are devices that are engaged with consistently, with 62% of users using the device at least once daily, and over 80% using it at least monthly (voicebot.ai., 2018).



There are often multiple connected devices in the household, with 46% of users having two or more devices in the household (voicebot.ai., 2018). HADs are being used to obtain information frequently; consumers have reported that general information search tasks rank ahead of entertainment when it comes to voice assistant use on smartphones (voicebot.ai., 2018). When it comes to HADs, general information search tasks again top the use case list, with over 70% of users asking their HAD a question at minimum every month (voicebot.ai., 2020).

HADs offer a unique opportunity as an assistive device, allowing individuals who cannot use screen-based devices an opportunity to conveniently interact with all the content the Internet has to offer. The ability of HADs to search via voice has multiple implications for populations such as the elderly, those with visual impairments, those without a screen-based device, and those who choose not to use screen-based devices at home. Furthermore, the ability to search with voice offers a new channel for populations who are keener to try new technologies, such as young adults and digital natives, who are often the earliest adopters of new technologies. The literature base is limited on how emerging adults use HADs, and this study o contributes to the understanding of how HADs can be used by this population as an assistive technology. There is potential to have more privacy and less anxiety associated with obtaining information around stigmatized health behaviors by using aural channels such as HADs.

## *Focus Area 2: Technology Use During Emerging Adulthood*

The transition from childhood to adulthood involves considerable changes in physical, cognitive, social, and emotional development (Poole & Peyton, 2013). Emerging adulthood has been defined as the period between the ages of 18 and 29 (Coyne, Padilla-Walker, & Howard, 2013). It is developmentally distinct from adolescence and young adulthood and has often been associated with a period of identity exploration, housing instability, self-focus, independence, and optimism (Arnett, 2006; Nelson & Barry, 2005). What is considered one of the most notable features of emerging adulthood is the increased use of technologies (Brown, 2006; Coyne, Padilla-Walker, & Howard, 2013; Ohannessian et al., 2017).

In the past 10 years, the Internet has become the sole destination for young adults to communicate with peers, play games, and connect with their community simultaneously, primarily due to its ease of use and usefulness/relevance to their lives (Lenhart, 2015). Emerging adults are also uniquely positioned in modern-day society, being the only generation currently that spent their formative years during the emergence of the Internet into the vital resource it is today. Emerging adults use technology from a young age and in multiple settings, starting at home, continuing at school, and in their personal time as well. Technology is being used by youth in a variety of ways, from texting and social media to online gaming, to posting messages on forums and websites (Joshi, Li, & Hilty, 2019). Ninety-nine percent of young adults between 18 and 29 use the Internet (Pew Research Center, 2021). According to the latest survey of Pew Research Center, 100% of young adults between 18 and 29

own a cellphone, with 96% owning a smartphone (Pew Research Center, 2021). This population is often considered the ‘digital native’ population, defined as being born in a generation where digital technologies are a way of life (Lareki, Martinez de Morentin, Altuna, & Amenabar, 2017). While Pew Research Center has examined Internet connected devices over the last decade, they have not focused on emerging technologies such as HADs, especially as it relates to the young adult population.

Emerging adults spend significant amounts of time on the Internet, with the most time being spent on e-mail/social networking, entertainment, and school/work related tasks (Padilla-Walker, Nelson, Carroll, & Jensen, 2010). Overall, over 85% of emerging adults say they are online daily, with 31% indicating they are online constantly (Pew Research Center, 2021). Co-occurring with increasing use of the Internet is a decrease in reading frequency. Emerging adults report reading for pleasure/non-essential reading one hour per week, a lower level than other forms of media (Coyne, Padilla-Walker, & Howard, 2013; National Endowment for the Arts, 2019). Additionally, a report by the National Endowment for the Arts (2019) found that less than half of emerging adults had read a book other than for work or school in the previous 12 months, the lowest number on record. Given the focus and need for a screen-based device for school and personal communication, most studies have focused on the usage of screen-based Internet connected device usage, while the usage statistics for HADs has been limited. Furthermore, the lack of emphasis on books has led to the majority of information seeking by this population to be done primarily online, further increasing the usefulness and necessity of the Internet for emerging adults.

Emerging adults report being more willing to explore new technologies, often being early adopters for new mobile apps, websites, games, and devices (Skinner et al., 2003). While the literature base has examined the use of technology with emerging adults, it has not examined their interactions in the household with devices like HADs. Additionally, the literature does not have any articles that have been found to date examining how individuals are using HADs and socializing that impact amongst their peer groups. HADs present a powerful tool for bringing health information to low health-literate and technology-literate audiences in ways that are easier to search than screen-based devices. A strong HAD skill would focus on the user first and have them incorporate their thoughts into how they would use a HAD and voice skill. Through a user-centered process, there exists the opportunity to create something with their insights, thereby increasing the likelihood of engagement, retention, and deriving value long-term, which can hopefully alter behavior permanently.

### *Focus Area 3: Young Adults and Information Seeking*

Young adults are independent seekers of health information and resources, and often leverage a complex network spanning physical, digital, and interpersonal resources. They often rely heavily on their social environment to provide them reliable health information (Freeman et al., 2018; Gray et al., 2005; von Rosen et al., 2017). As it relates to health information, they confer with others for information ranging from exercise to sexually transmitted diseases (Freeman et al., 2018; Gray et al., 2005). For

adolescents, personal sources tend to be the most significant source of information as it relates to health, namely parents (Ackard & Neumark-Sztainer, 2001; Rafaelli et al., 1998; von Rosen et al., 2017). As the Internet has become widely available and accessible, it has become the preferred method of information gathering among young adults, with 70% of adults between 18 and 29 saying they used the Internet in 2000 to 99% in 2021 (Pew Internet/Broadband Fact Sheet, 2021). A recent survey from Pew Research Center suggested that over 60% of individuals who own smartphones used their phone to acquire information about a health condition or topic (Pew Research Center, 2020).

Historically, health literacy was defined by the way in which people obtain, understand, use, and communicate about health information to make informed decisions (Berkman, Davis, & McCormack, 2010). Health literacy was recently redefined in Healthy People 2030, and split into two definitions: personal health literacy, which is defined as “the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for themselves and others”, and organizational health literacy, which is defined as “the degree to which organizations equitably enable individuals to find, understand, and use information and services to inform health-related decisions and actions for themselves and others” (*Health Literacy in Healthy People 2030*, 2021). The ability to critically evaluate health information is an important part of health literacy, which is one of the social determinants of health (Diviani et al., 2015;

Berkman et al., 2011). Emerging adults are more likely than their counterparts to seek health information online (Jacobs et al., 2017).

The Internet is accessed to mainly retrieve sexual health information from articles, publications, blogs, social media, and videos with anonymity (Borzekowski & Rickert, 2001; Buhi et al., 2009; Patterson et al., 2019; von Rosen et al., 2017).

Young adults often report a preference of using the Internet for accessing sexual health information for a variety of reasons, including convenience, accessibility, anonymity, and the lack of relevant information offline (Flanders et al., 2017).

Furthermore, a concern around the anxiety around the patient-provider interaction for emerging adults is a factor in preferring the Internet as a source of sexual health information (Flanders et al., 2017). Health information is one of the primary reasons emerging adults use the Internet aside from personal and school-related tasks. Social media is also used for sexual health information seeking, with user needs focused on obtaining information that is relevant and empathetic (Yi, 2018). Additionally, despite indicating that a medical professional or school being the best source for information, over 60% of individuals in a study conducted by Rodriguez (2017) indicated that they would personally acquire sexual health information through Internet websites.

A study by Johnson (2014) states that out of five common habits people have when searching for health information, one of them is that people look for information that is accessible, even if the source is not trustworthy. Despite questioning the validity of

information on social media as it relates to sexual health, individuals were less likely to question the validity of information found on websites, and more readily believed what they read (Rodriguez et al., 2017). It is important to note that information seeking can be adversely affected if designers of information sources (whether mobile apps, HAD skills, or websites) do not keep in mind the needs and preferences of lower health-literacy audiences (Mackert et al., 2016).

This literature review discussed the three focal points of this study: emerging adults between the ages of 18 and 26, HADs, and the sexual health information seeking process. Emerging adults are often leveraging multiple types of technology during the health-information seeking process, especially as it relates to sensitive behaviors such as sexual health. The existing array of technologies being used by emerging adults often present one main problem: the inability to provide relevant, appropriate information quickly. Compared to other previous technologies, HADs present a newer channel through which we can begin to understand how individuals initiate and phrase the information seeking process in a more intimate setting. The potential for HADs to provide insight into the lived experience with technology for this population is important as it relates to the sexual health information seeking process. As discussed above, the sexual health information seeking process for emerging adults is often entwined with concerns regarding privacy, judgement, the type of technology to use, and the information appraisal process. Despite efforts being made to improve sexual education and resources, a significant number of emerging adults still report being unsure of how best to obtain sexual health information (Jayasundara, 2021).

Furthermore, the amount of sexually transmitted infections among emerging adults remains high, despite years of focused funding efforts ((“Sexually transmitted diseases (stds)”, 2019; Sexually Transmitted Infections (STIs), 2019).

HADs are currently in the beginning stages of its development, having only been available for sale in the last seven to eight years. Developers for HAD voice skills are following the same approach that most mobile developers followed when the first smartphones began to be sold: prioritizing a first-to-market approach for applications rather than focusing on a theory-grounded application with emphasis on good user experience and design while soliciting feedback from the end-users themselves. As more voice skills begin to be developed and the voice-only search channel begins to rise in popularity and frequency of use, there will be a greater need for easy-to-follow logic when users are searching for information. The use of Design Thinking principles with the emerging adult population to create a voice skill tailored to their sexual health information seeking experience distinguishes this study from others before it. Through a user-centric design approach for voice skills, a higher level of engagement and information relevance can be realized by emerging adults seeking sexual health information. The next chapter outlines the methodologies that were followed to understand information needs and create a voice skill with the considerations mentioned above.



## Chapter 3: Methods

### Methods Overview

This dissertation used qualitative methods, specifically in-depth interviews (IDIs) and iterative technology prototypes, to understand the motivations, perceptions, and preferences of adults between 18 and 26 as it relates to their use of technology for sexual health information seeking and the potential of HADs to provide that information. In-depth interviews were leveraged to better understand the sexual health information seeking preferences of this population. They were also used to solicit feedback and reactions to iterative prototypes created in the Design Thinking framework. Lastly, in-depth interviews were used to understand how end-users might interact with a prototype HAD in hypothetical scenarios. Inductive thematic analysis was conducted to understand the emergent themes from participants. Together, this work will help provide more clarity on the role technology plays to aid or hinder sexual health information seeking in this young adult population.

### *Restatement of Purpose*

The main research question of this dissertation is “What are the sexual health information needs of adults 18 to 26 years old, and how relevant and useful does this population rate a prototype HAD skill for sexual health information seeking?” The purpose of this dissertation was to explore the perspectives of young adults to understand the depth of their sexual health information needs and whether a user-centric designed HAD can be a suitable alternative for fulfilling those information

needs. Concepts such as information seeking preferences, user perceptions of the ability of technology to fulfill an information gap, and the role of technology through the information seeking process were examined.

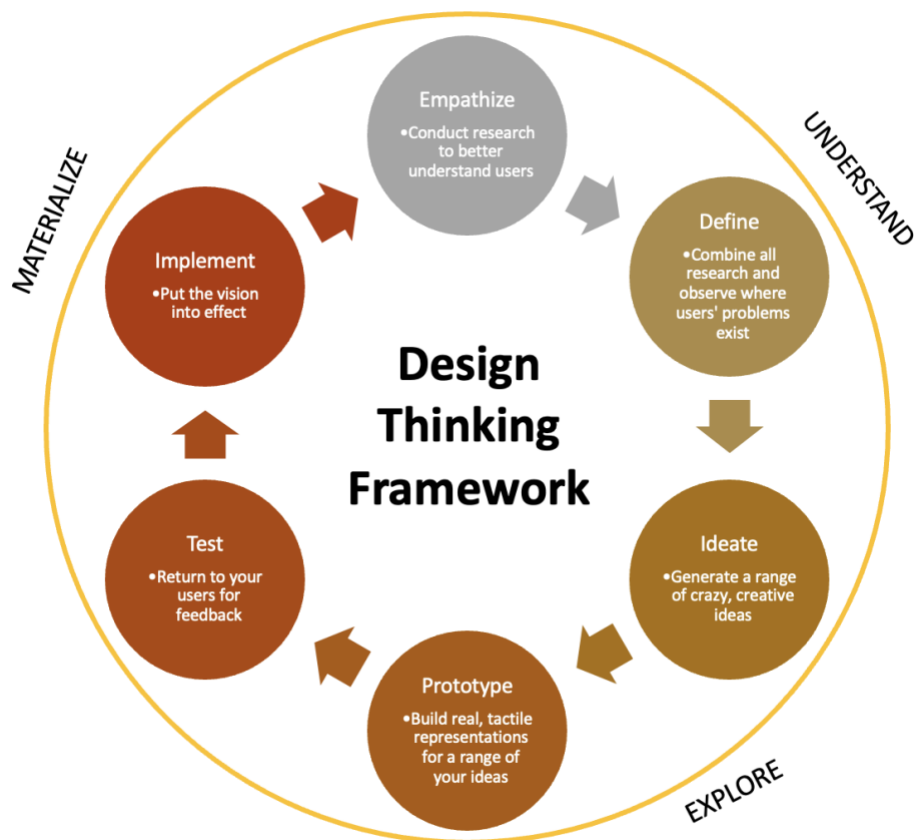
### *Design Thinking: An Overview*

Design Thinking is a process and design philosophy focused on continuously soliciting feedback and input from users, meaning the people who will use the product or service are the focal point of design decisions (Norman, 2013) (Figure 3.1). Investigators first conduct empathy research (defined as a deep understanding of the problems and realities of the users you're designing a solution for) to better understand the "end-user," the person who ultimately uses the product or service, and then define content accordingly (Bernstein, 2015; Brown, 2008). After the problem to be addressed has been defined, investigators create content and rapidly iterate upon them with users. After the cycle of iterations is complete (or finishes a certain number), the prototype can be built and can undergo usability testing with intended users. The end result of the design thinking process is a refined, tested, and visually designed prototype that has undergone some usability testing (Norman, 2003).

Design Thinking has been used to solve complex problems in numerous industries, such as curriculum redesign for elementary schools to increase child engagement, and redesigning air cabins with the traveler in mind (Hall et al., 2013; Kelley & Kelley, 2013; Norman, 2003). The benefits of Design Thinking have been well documented

in public health and have been used to address issues such as smoking cessation, pediatric asthma, enhancing park use, and mental health interventions (Abookire et al., 2020; Huang et al., 2018; Ku & Lipton, 2020; Scholton & Granic, 2019). To date, there has not been a study of HAD voice skills using Design Thinking principles. Without focusing on end-users and understanding what components/messages are necessary for them to engage most effectively with voice skills, they will likely encounter similar problems that prevent people from using other technologies: a lack of relevance, hard-to-use interfaces, and something that does not meet their needs and help them achieve their goals.

**Figure 3.1.** The Design Thinking Model. (adapted from Gibbons, 2016)



This dissertation used the Design Thinking framework to generate a prototype HAD skill through IDIs and multiple rounds of prototype presentation and refinement, incorporating feedback from users after each cycle to develop a tailored HAD prototype for sexual health information seeking. Whereas traditional approaches for understanding the end-user have focused on historical data or “gut” feelings, Design Thinking prioritizes the development of empathy for end-users – understanding the problems they face, as well as their needs and desires in a tool – by working in collaborative multidisciplinary teams and using “action-oriented rapid prototyping” of solutions via direct feedback from users (Brown & Wyatt, 2010; Sandhu, 2013; Simon, 1969). This study created and tested a tailored HAD prototype with new users through a series of hypothetical scenarios, following the Design Thinking framework outlined in Table 3.1.

**Table 3.1.** Operationalized Design Thinking constructs by study aim.

<b>Design Thinking Construct</b>	<b>Aim</b>
<i>Empathy Research</i>	<i>1</i>
<i>Defining the Problem</i>	<i>1</i>
<i>Ideation</i>	<i>2</i>
<i>Prototyping</i>	<i>2</i>
<i>Testing a Prototype</i>	<i>3</i>

### *Inclusion of Human Subjects and IRB Review*

All aims in this study consisted of IDIs with young adults 18 to 26 years old and asked them questions regarding their sexual health information seeking preferences. Given the sensitive nature of this research and research with human subjects, all procedures and materials were submitted and approved by the University of Maryland, College Park Institutional Review Board (Appendix H). Prior to the beginning of the data collection process, the PI completed CITI training. Once CITI training was completed, the PI maintained awareness of all best practices with data collection, standardization, integrity, and safeguarding.

### *Participant Eligibility*

The target population in this study (for all study aims) was individuals between the ages of 18 and 26 who have used the internet to search for health-related information, spoke English, and lived in the United States. Participants in the study were also required to be (at a minimum) aware of HADs and how they function, and either owned or had access to a HAD. Participants were eligible for the study only if they explicitly confirmed their comfort with discussing both health information seeking methods and sexual health information seeking behaviors. For Aim 1, purposive sampling was leveraged to understand technological and information seeking preferences for adults between 18 and 26. Aims 2 and 3 also leveraged purposive sampling techniques, but participants were recruited virtually via mTurk (discussed below) and relied upon the same selection criteria as participants for Aim 1.

Exclusion criteria for this study were non-English speakers and those who do not use the internet for health-related searches, as well as those who don't own or have access to HADs.

### Recruitment

Given the exploratory nature of this study, a purposive sample with snowball sampling procedures was used. All prospective participants were required to complete a screener questionnaire to ensure they meet the recruitment criteria (Appendix A).

All sessions were conducted virtually. The recruitment criteria ensured that all participants were between 18 and 26 years of age, had searched for health information on the Internet before, and currently owned or had access to a HAD.

For Aims 1, 2, and 3, the intention was to use MTurk as the recruitment method. The intention was to recruit 30 people to participate in this study (10 across each aim) and interview them on their information needs as it related to sexual health, and ideal features that would be beneficial in a HAD voice skill. As reported in the results section, zero participants were recruited through mTurk. An alternative, Positly, was tried, also with zero participants recruited to the interview phase. In the end, traditional approaches for recruitment using a flyer created by the Principal Investigator (sending flyers on email listservs, posts of the flyer on the Principal Investigator's social media accounts) were used (See Appendix J for the study flyer). Table 3.2 describes the different types of recruitment channels used for this study.

**Table 3.2** Overview of Recruitment Channels.

<b>Aim</b>	<b>Channel Name</b>	<b>Description</b>
1	mTurk	A platform used for “workers” to complete “tasks” which they get compensated for. Generally cheaper than traditional research methods
1	Positly	A refined research platform designed solely for research purposes; more expensive from an incentive perspective
1,2,3	Listserv	A way to mass distribute the IRB-approved study flyer; used the University of Maryland School of Public Health general listserv and the University of Michigan School of Information Studies listserv
2,3	Social Media Accounts	A posting on Facebook and LinkedIn of the IRB-approved flyer on the PI’s personal accounts
2,3	Flyers	Print postings of the IRB-approved flyer
2,3	Referral from other participants	Asking existing participants in the study to share information about the study with others who they think may be interested and eligible.

MTurk is an online portal that is operated by Amazon. It is a portal where individuals can “request” workers to complete jobs. It is used extensively by academics as a quick, affordable way to collect data from a diverse sample of participants (Cunningham, Godinho, & Kushnir, 2017). Exclusively virtual interventions have been conducted using only participants from MTurk (Cunningham, Godinho, & Cushnir, 2017). MTurk is a crowdsourcing platform that enables Requesters to post Human Intelligence Tasks (HITs). HITs generally encompass tasks which require minimal training but can only be performed by humans, not computers, such as survey completion, image categorization, and more (Brawley & Pury, 2015). Each HIT has the Requester’s name, compensation, and a description of the work. Workers can choose any available HIT they want to complete. Once they submit a completed HIT, the Requester can review the submission prior to approving and paying the

Worker. The Requester can examine a submission and mark it as ‘unsatisfactory’ (ex. Randomly answering a survey, all wrong answers on simple image questions), they can reject the submission and deny payment. Workers can build an approval rating by successfully completing HITs. The mTurk population was likely more technically proficient, given their familiarity with completing tasks online, and possibly had more familiarity with HADs, especially those from the Amazon suite. Therefore, it was likely that they would have been able to answer the study questions in-depth.

For Aim 2, Mechanical Turk (MTurk) was to be used to recruit 10-12 individuals to give feedback on a low-fidelity prototype (LFP) voice skill, created based on IDIs from individuals in Aim 1. A HIT was to be posted for Aim 2 and interested Workers would be screened per the screener questionnaire. For Aim 3, 10-12 participants were again to be recruited with MTurk, following an identical recruitment process to Aim 2. As stated above, due to challenges in recruitment, other recruitment methods were used to recruit the actual sample (Table 3.2).

### *Study Benefits and Risks to Participation*

There were no direct benefits for participants who decided to be part of this study. Indirect benefits included being able to inform future research on HADs, as well as the Design Thinking process in public health and helping guide the development of a HAD skill designed to alleviate some of the information burden associated with sexual health information seeking. There were some potential risks from this study. Given that the nature of the information is sexual health seeking behavior,



participants might have experienced distress when thinking about their own information searching process. Participants might have also felt uncomfortable answering questions about sexual health in general or relying on previous experiences. To mitigate some of this risk, optional participation and voluntary opt-out at any time was emphasized throughout the recruitment and data collection process. It was also stated in the consent form. Additionally, participants were not asked to go through their personal scenarios when testing the skill; instead, hypothetical scenarios and questions relating to the specific scenario were created for the study, based on the IDIs in Aim 1.

#### *Participant Compensation*

Participant compensation was based on the time and effort the participant devoted to the study (Williams & Walter, 2015). For Aim 1, participants were compensated \$40.00 for the completion of a 45-minute interview on information seeking and HADs. For Aims 2 and 3, participants were compensated \$30.00 for a 30-minute interview and reaction to the created prototype.

#### *Informed Consent, Participant Confidentiality, and Data Privacy*

All participants in this study signed an informed consent form before participating in their IDIs. Informed consent forms were read verbatim to participants as they also read along, and after each page the PI offered time for questions or clarifications. After confirming their desire to participate in the study, each participant received an email with a copy of the consent form for their records. The consent forms, along

with all research data, was kept and stored on UMD Box, a secure cloud-based storage service provided by the University of Maryland, to prevent loss of confidentiality.

### *Research Design*

#### *Study Setting*

This study was conducted virtually and provided convenience to participants seeking to participate by minimizing any transportation obstacles that may exist. Given that this study relied on Design Thinking principles to study individuals and their preferences around HADs, conducting this type of research virtually has been useful especially in light of the COVID-19 pandemic and changing regulations (Thakur et al., 2020). Additionally, all sessions were conducted as individual in-depth interviews, eliminating the concern for an altered group dynamic that could occur in virtual sessions. Virtual IDIs have been shown to elicit more honest and open feedback from individuals, while they are in the comfort of their homes (Clay, 2020; DeMers, 2015; Nehls, Smith, & Schneider, 2015).

#### *Sampling Plan*

This dissertation utilized purposive and snowball sampling techniques to quickly recruit a sample meeting the study criteria. There has been considerable debate around what constitutes a sufficient sample size for phases in Design Thinking interventions. Nielsen suggests no more than five users need to be tested (Nielsen, 2000). Guest and colleagues found that 12 individuals were sufficient to sufficiently address the research (Guest, Bunce, & Johnson, 2006). Ten participants were

interviewed for Aim 1, as has been suggested to be within an acceptable range of participants (Guest, Bunce, & Johnson, 2006; Hennink, Kaiser, & Marconi, 2016, Schamber, 2000). The number of in-depth interviews was re-evaluated periodically to determine if more participants are needed or if a point of “saturation”, i.e., if we begin to hear similar findings from respondents, has been reached (Crouch & McKenzie, 2006).

### *Study Procedures*

#### *Background Questionnaire*

After obtaining informed consent (Appendix I), a background questionnaire was sent to all study participants in each study aim prior to their interview (Appendix B). The questionnaire consisted of demographic questions and questions on information seeking to create a descriptive profile of each participant. Prior to being used in the study, questions were tested with two students for face validity and to ensure comprehension.

#### *In-Depth Interviews: Interview Questions*

In this study, Design Thinking was operationalized via feedback from IDIs, one of the most common qualitative research methods used in Design Thinking. IDIs can be structured or unstructured in nature and are deployed as the first step in the Design Thinking process to conduct user empathy research. Given the exploratory nature of this study, there were some guided questions. Therefore, semi-structured IDIs were leveraged for this dissertation. They allow for the gathering of large amounts of

information with relative logistical ease, and are particularly helpful in situations where emotions, opinions, and values are an important part of the study. IDIs were used in Aims 1, 2, and 3. Interview questions for each aim were developed based on the main tenets of this dissertation: technology preferences, sexual health information seeking behaviors, and technology preferences as it relates to health information seeking in general. Similar to the background questionnaire, the interview guide for Aim 1 (Appendix C) was tested with two individuals from the University of Maryland representing the target sample in order to determine whether the questions are appropriate from both a comprehension and logical perspective.

The interviews in Aim 2 involved questions related to a created HAD prototype and to solicit design feedback. The interview guide for Aim 2 (Appendix D) involved the Principal Investigator screen sharing and progressing the user through the prototype while asking about their choices and providing follow-up questions about the prototype related to design, content, and the overall user experience.

### Procedures

All aims of the study were accomplished by the framework of the Design Thinking process, which emphasizes participant needs and rapid iterations to create a product that will incorporate their feedback into it, allowing for a feasible, viable product (in this case a voice skill) (*Design thinking*, 2021). Aim 1 was accomplished by a series of 30-minute, individual, virtual IDIs with the Principal Investigator and the participant to better understand the end users, challenges they face, and what needs

and expectations must be met when creating a prototype HAD skill. This aligned to the first step of the Design Thinking framework: empathy research. Prior to beginning the in-depth interviews, formative research was conducted to inform the development of an interview guide that served as the template for each interview. The interview sessions followed the interview guide, with the Principal Investigator asking probing follow-up questions as deemed necessary to gather more information (Appendix C, D). Interview sessions were recorded on Google Meet or Zoom, and the PI took notes. The output of Aim 1 was a clear problem statement that articulated the challenges addressed by the HAD skill, which was aligned to the second phase of the Design Thinking framework: Defining the Problem.

After recruiting individuals for Aim 2, participants participated in a 30-minute ideation session designed to brainstorm ideal features in a HAD and understand individual reactions to created prototypes from user feedback. The ideation session involved the Principal Investigator asking questions designed to explore new ideas and solutions to a specific design challenge. General prompts to ask the user during this session included questions beginning with “How might we...?” or “in what ways might we...?” with a goal of generating as many ideas as possible for an ideal end-state. The overarching goal of Aim 2 aligned with the goal of all ideation sessions in the Design Thinking framework: “not...coming up with the ‘right’ idea, it’s about generating the broadest range of possibilities.” (Plattner, 2010). IDIs were leveraged in the context of participants first reacting to a low-fidelity prototype (LFP) created from feedback from in-depth interviews in Aim 1, providing feedback via idea

generation and brainstorming. The LFP was an interactive wireframe created with linked slides in Microsoft PowerPoint. The group recruited was asked to react to the LFP individually. Each session was virtual and consisted of the individual being presented a slide-based “skill”, where an individual heard audio prompts alongside a visual cue. The output of Aim 2 was a refined prototype with some usability testing conducted through the ideation and prototyping cycle.

For Aim 3, participants participated in a virtual, 30-minute IDI to react to the LFP using a think-aloud protocol. This aligned with the last phase of the Design Thinking framework: Testing a prototype. Meetings were recorded via Google Meet or Zoom. The participants were presented with hypothetical situations and were asked to navigate through the LFP to obtain the information. An example situation would look like the following (Figure 3.2):

**Figure 3.2.** An example hypothetical situation (Illustrative – actual hypothetical situations was based on IDIs in Aim 1)

*Example situation:*

*“Casey is a sexually active 24-year-old female who lives alone. She moved to Washington, DC recently for work and doesn’t know much about the city. She noticed that her period is 2-3 days later than normal. She took a pregnancy test but still isn’t sure if it’s accurate. She wants to:*

- 1. Find a sexual health center she can go to and talk to a medical professional*
- 2. Casey has other symptoms which make her uneasy, like bumps near her pubic area. She wants to see what this could mean.*
- 3. Casey wants the information to not be saved. Ensure that this is not the case within the skill.”*

Three hypothetical situations were given to each individual to follow. They were asked to follow a think-aloud protocol to try and find information in the skill based on

each specific situation. The think-aloud protocol is a type of research technique often used in empirical translation process research. In think-aloud, the subjects are asked to perform a task and verbalize whatever they are thinking during the performance of that task (Ericsson & Simon, 1984). When compared to more introspective techniques (such as asking an individual their thoughts after the task in question), the think-aloud technique is considered a better way of eliciting data on cognitive processes (Ericsson & Simon, 1984; Jaaskelainen, 2010). The Principal Investigator probed and asked follow-up questions to better understand the thought process as an individual was progressing through the situations. At the end of the hypothetical scenarios walkthrough, each user was given the mHealth App Usability Questionnaire (MAUQ) (Appendix G) to assess usability of the HAD.

### Measures

#### *Demographics and Health Information National Trends Survey (HINTS)*

Prior to the start of the study, participants from each study arm were asked to complete a demographics survey (Appendix B), which included items on health information seeking behavior from the Health Information National Trends Survey (HINTS). HINTS is a cross-sectional, nationally representative survey of adults in the United States. It was developed to better understand American adults' knowledge of, attitudes toward, and behaviors related to cancer prevention, control, and communication. Researchers also use the data to identify trends in health communication, such as how different communication channels are being used to obtain health information. The Principal Investigator created questions around current

sexual health information seeking, which was also administered to study participants in Aim 1. Their feedback was used to refine the question content accordingly.

#### *mHealth App Usability Questionnaire (MAUQ)*

The mHealth App Usability Questionnaire (MAUQ) was created to assess the usability of mHealth apps created for patients and providers. The usability characteristics help determine the effectiveness of the app. To the best of the PI's knowledge, there is no scale that assesses HAD information seeking and usability. Instead, an adapted version of the mHealth App Usability Questionnaire (MAUQ) created by Zhou and colleagues was used to evaluate the HAD skill (Zhou et al., 2019) (Appendix G). The MAUQ was designed for an end-user who uses a mHealth app to maintain, improve, or manage their own health (Zhou et al., 2019). The MAUQ is device agnostic, making it a suitable option for gathering feasibility information for HADs. It was used for Aim 3 as participants react to a prototyped HAD skill.

#### *Design Thinking Measures*

Questions for the design thinking process included the following:

##### *Empathy Research*

- *How would you describe your interactions with HADs?*
- *What features of HAD skills you use are especially appealing?*
- *What features of HAD skills you use don't you like?*
- *What would your ideal HAD for health look like?*
- *How do you normally obtain health information? What sources do you use and/or avoid?*



- *When you have questions about general sexual health (doesn't have to be related to yourself), how do you search for that information? Are there sources you use/avoid?*
- *What type of sexual health information would you feel comfortable/uncomfortable with searching for? Do you search differently based on the type of information?*

#### **Defining The Problem**

- *What are your concerns with your current way of obtaining health information?*
- *What are your concerns about your current way of obtaining information in general?*
- *What do you like/dislike about HADs?*
- *What obstacles would stop you from using a HAD regularly/for information?*
- *Is there a type of information you would not feel comfortable using a HAD for?*
- *How would you describe your information search process for information you consider private?*

#### **Ideation**

- *What must have features for your ideal HAD?*
- *What's the worst feature for a HAD in your opinion?*
- *What would make you definitely use a HAD for health information?*
- *What are your priorities when searching for information?*
- *What doesn't matter to you when searching for information?*
- *What's your personal health information seeking process?*
- *What would be a good feature if you were searching for information on your own well-being?*
- *What would be a good feature for questions about your (or someone else's) sexual health?*

#### **Prototyping**

- *What works well for this prototype?*
- *What are limitations of this prototype?*
- *How can this prototype be improved?*
- *How can this prototype use other functionality?*
- *As is, would you use this prototype to search for health information?*

#### **Testing**

- *Can you tell me why you did \_\_\_\_?*
- *Walk me through why you chose \_\_\_\_.*
- *What were you deciding here?*
- *How do you feel about the design here? Functionality?*

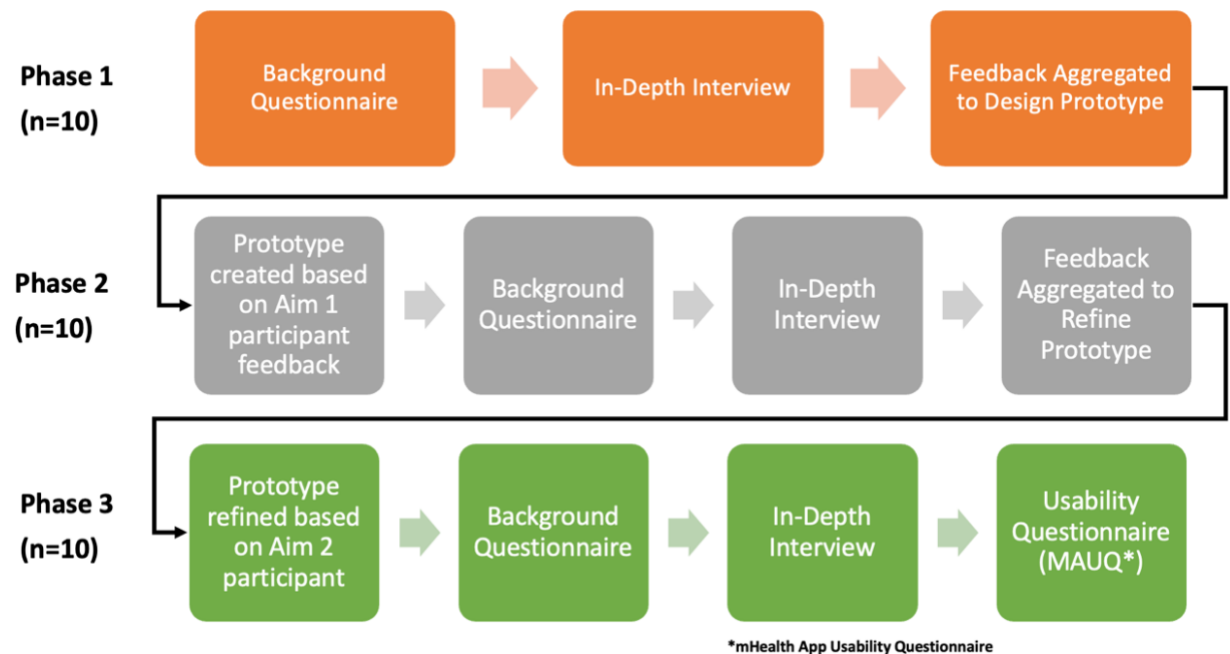
#### ***Impact of Technology on Outcome Expectancies***

To understand the role of technology in the study, a series of questions were asked in the IDIs. They included questions such as:

- *How do you use technology when searching for information currently?*
- *How would you use technology when you're looking for something familiar?*
- *What is your level of confidence with your ability to use technology? How does this impact your ability to seek information?*
- *What technologies do you use when searching for information that's familiar vs. unfamiliar?*
- *What concerns do you have with particular technologies that could stop you from seeking information using it, even though it may be more useful than other ones?*
- *How would you use technology when you are unsure of something you need information on?*
- *What is your comfort level with technology and using it to search for information?*

Figure 3.3 illustrates an overview of the project phases and sample sizes.

**Figure 3.3.** Study Overview



### Data Analysis

All interviews in Aims 1 through 3 were recorded on Zoom or Google Meet, and the auto-transcription feature was leveraged from the software. The transcripts were reviewed by the PI to ensure they were accurate. The transcripts were then uploaded to NVivo (QSR International, n.d.). The qualitative findings from Aims 1-3 were separately coded in NVivo and synthesized to elicit common themes that arose throughout the study. Inductive thematic analysis was used to elicit commonalities from the in-depth interviews in Aim 1. Questionnaire data were analyzed using Python version 3.7 to generate descriptive statistics to better understand the study group from a demographic perspective. This was a small sample used for this study, which is commonly done in Design Thinking sessions: individuals are recruited for a very specific set of characteristics, and convenience samples are preferred to better understand the users and get a good design. In future research, once a design has been created, further value could be derived from recruiting a more representative sample and having them react to a fully developed skill.

### *Coding*

A code is defined as a “label that provides symbolic meaning to the descriptive or inferential information compiled during a study” (Miles, Huberman, & Saldaña, 2014). Coding is the process of defining what data are about so that analytic interpretations can be made (Creswell, 2015). It allowed the PI to label groups of data to give meaning to each segment. The data can then be sorted, extracted, and analyzed to make comparisons with other groups. Through this process, commonalities can begin to emerge, and can be extracted for analysis. For this study, two types of coding

were performed: open coding and focused coding. Prior to the beginning of coding, data was transcribed by the Zoom auto-transcription tool and validated by the Principal Investigator, with corrections being made as errors were encountered. Qualitative data was stored on UMD Box, with all coding occurring in NVivo for Mac (QSR International, n.d.).

#### *Codebook*

This study leveraged an inductive coding method, in which a codebook was used as a reference throughout the coding process. A codebook is a working document that is used throughout the qualitative interviewing process. For our study, the codebook was created by pulling five interviews from Aim 1, and transcribing, cleaning, and open coding them. The open codes from those five interviews was used to develop focused codes (i.e., commonalities that emerge throughout the interviews). The codebook was refined throughout the qualitative data gathering process which occurred in Aims 2 and 3.

#### *Initial Coding*

The initial coding process involved reading through the qualitative data and getting a general idea of similarities, differences, frequencies, sequences, correspondences, or causations. At this point, codes were descriptive, low-inference level codes, which were used to summarize the data (Punch, 2014). A broad code name was given to each section and the Principal Investigator wrote down notes as they progress through the transcripts.

#### *Open Coding*

Open coding involved searching the qualitative data for the most frequent or significant codes, and creating broad code categories (Creswell & Poth, 2018). The data were categorized based on thematic or conceptual similarities using classifying expressions, whether single words or short sequences of words, to attach concepts to data (Flick, 2009). The Principal Investigator reviewed the transcribed IDIs and notes collected during the data process, searching for emerging themes. Using NVivo, the Principal Investigator coded the data into broad categories.

### *Reflexivity*

Reflexive practice, which emphasizes the self-reflection of the Principal Investigator to mitigate personal bias, was used in this study to increase transparency and address personal bias in the study. One typical reflexive practice is journaling. In this dissertation, the Principal Investigator practiced reflexivity by exploring self-interests and assumptions and how they shaped this dissertation. A reflexive statement was written at the beginning of the dissertation and was continuously refined throughout the study to reflect the current knowledge and understanding of the study. The Principal Investigator also practiced reflexivity during meetings with the dissertation committee, sharing self-reflections and thoughts throughout the process.

### *Reflexive Statement*

I have always been enamored with technology since my dad brought home our first computer in 1996. The whopping 512-megabyte hard drive and dial up modem speeds are a far cry from the specs in your average laptop today, but I distinctly remember viewing the world differently from that day. As I became more familiar

with the internet, I became more and more captivated with the possibilities. The ability to shrink the world and have all the information in the world, ever, in the palm of my hand is something that continues to excite me to this day. As I started progressing through school, I always looked for a way to be around technology. Whether it was robotics, virtual reality, mobile apps, or programming, I've always felt that technology has the power to revolutionize any field you apply it in.

I currently work as a public health data scientist at PricewaterhouseCoopers and my day-to-day role includes applying new and novel technologies through programming languages like Python to improve public health. Based on my experiences in both my personal and professional life, I tend to prioritize and favor technological approaches based on my personal experiences and have preconceptions that stem from my prior positive experiences with technology. I want to be cognizant of my feelings towards technology during the dissertation process, from recruitment to the interview process, to the coding of qualitative data and extraction of relevant themes. I hope to keep an open mind and remember that technology is not always the solution to every problem, and that some folks (even people that I know) have had terrible, horrifying experiences with technology. As I begin to recruit and talk to potential study participants, I will need to be fully aware of my own biases and assumptions about the potential of technology as it relates to sexual health information behavior. As I progressed through the interviews across my aims, I began to appreciate the concerns about Home Assistant Devices that were voiced by the participants. There is often a very implicit tradeoff between privacy and functionality, and it is often colored by

your past experiences. Hearing young adults from my sample speak about their experiences helped me realize that no two people are exactly the same (even within a group) when it comes to perceptions of new and emerging technologies. I hope to continue this research in the future and continue these reflexive practices to keep myself grounded while conducting this type of research.

#### *Data Cleaning & Reliability*

Reliability can be a concern in qualitative research and is generally addressed through methodological safeguards during the data collection process (Silverman, 2013). To ensure the best possible output of the IDIs, the recording feature in Zoom and Google Meet (with consent) was used for all sessions. Furthermore, the Zoom and Google Meet auto-transcription feature was used and cross-examined by the Principal Investigator to record each process accurately and precisely. The data were stored in UMD Box.

#### *Audit Trail*

An audit trail involves keeping a full record of the research plan, detailing all steps and decisions throughout the research process (Robert Wood Johnson Foundation, 2008). For this study, the PI created a digital audit trail via the memoing process. A digital audit trail allows for a future researcher to replicate the study, should they choose, and lends credibility to the rigor of the research process through its reproducibility.

#### *Memoing*

Memoing is often done to document key ideas, themes, and concepts that the Principal Investigator considers throughout the research process. It was used to take

notes as the Principal Investigator read interview transcripts, which provided a stronger code development during the analysis process. A common misconception of memoing is that its sole purpose is to document and summarize the research process. Memoing can also provide insight into emerging themes, as well as an understanding of how a thought process evolves over the course of a research study. Furthermore, in this study, memoing formed the digital audit trail for the research process.



## Chapter 4: Results

### Introduction

The focus of this qualitative study was to determine whether young adults 18 to 26 years old who already own a HAD and have information needs for STIs find HADs to be relevant in meeting that need. Concepts from the Theory of Motivated Information Management and the Technology Acceptance Model provided a framework to conceptualize the impact technology can have on the information seeking process as it related to sexual health. Using Design Thinking methods, this study gathered insights from participants regarding their current STI information needs via in-depth interviews, used the feedback to develop a prototype voice skill, and then tested that prototype with two different groups of young adults, refining the prototype after each group had provided their feedback. A total of 30 participants participated in the study across three phases:

- *Phase 1 (Specific Aim 1): Empathy Research*
  - Formative research was conducted via 10 in-depth interviews lasting one hour each to better understand the end-user, their feelings about HADs, and their needs in a skill.
  - Total participants: 10
  
- *Phase 2 (Specific Aim 2): Ideation and Creation*
  - 10 individuals were recruited to individually give feedback on a low fidelity prototype voice skill. The feedback on the voice skill was

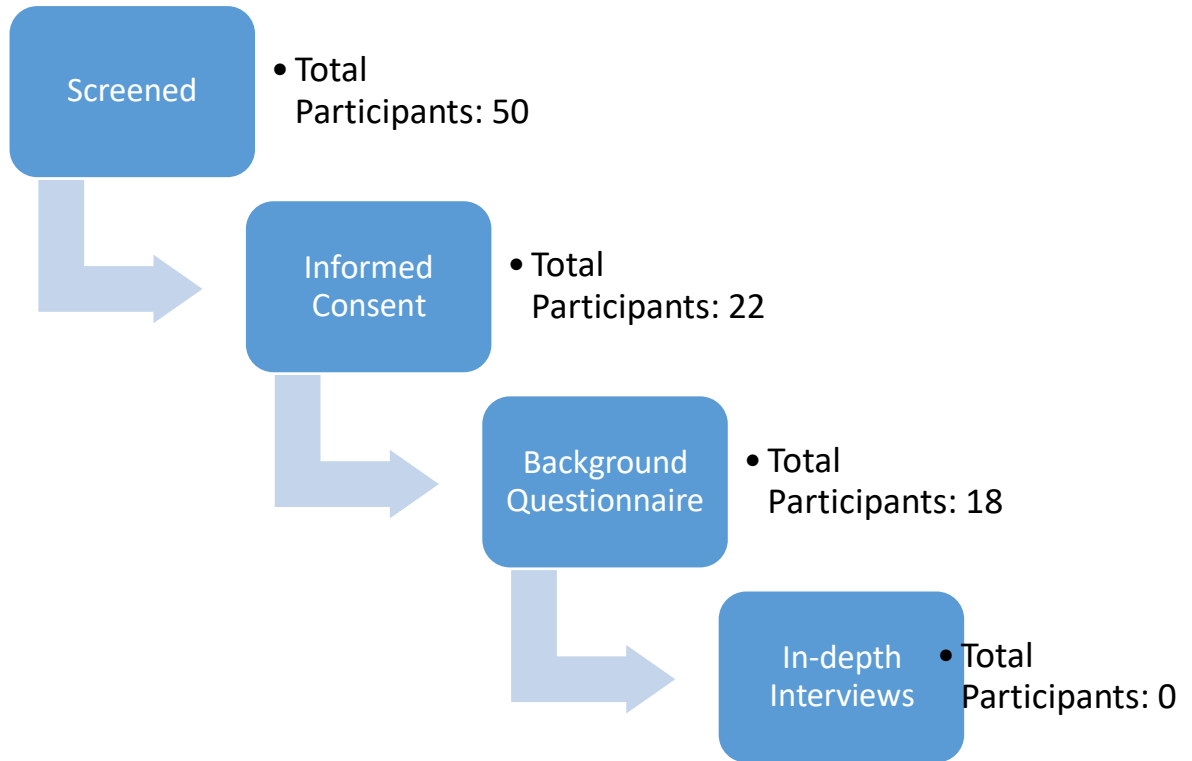
incorporated to refine the prototype and created a second version of the voice skill, to be tested in Aim 3.

- Total participants: 10
- *Phase 3 (Specific Aim 3): Evaluation of Prototype*
  - The refined prototype (based on the IDIs from Phase 2) was presented to 10 individuals recruited in the same manner as in Phase 2 and were given 3-5 hypothetical situations to navigate using the voice skill and obtain the necessary information.
  - Total participants: 10

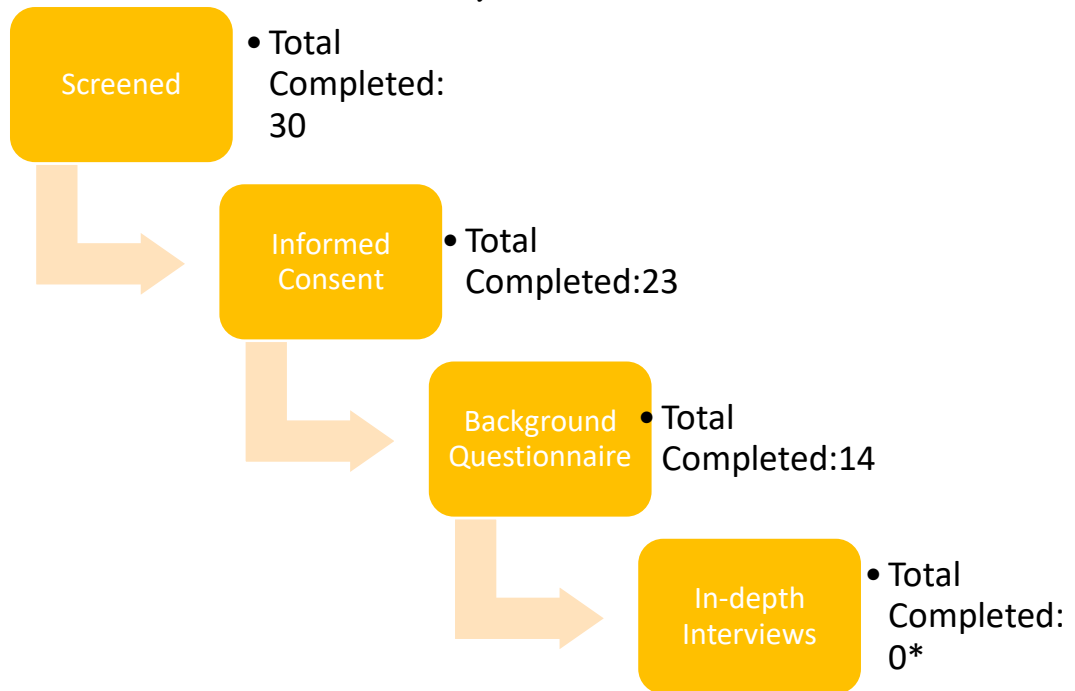
### Recruitment

Recruitment began in May 2022. For Aim 1, Amazon mTurk was used to recruit participants. Over a period of two weeks, there were 0 participants that met the screening criteria and completed informed consent, background questionnaire, and an IDI (Diagram 4.1). A different platform, Positly, a research-specific platform, was tried to recruit participants, but the results were the same: 0 participants met the screening criteria and completed informed consent, background questionnaire, and an interview (Diagram 4.2). Finally, recruitment via email listservs, flyers, social media, and intercept interviews was tried. Through this last method, recruitment was more successful for Aim 1 and the same recruitment method was used for Aims 2 and 3. Table 4.1 contains a classification of participants by recruitment channel.

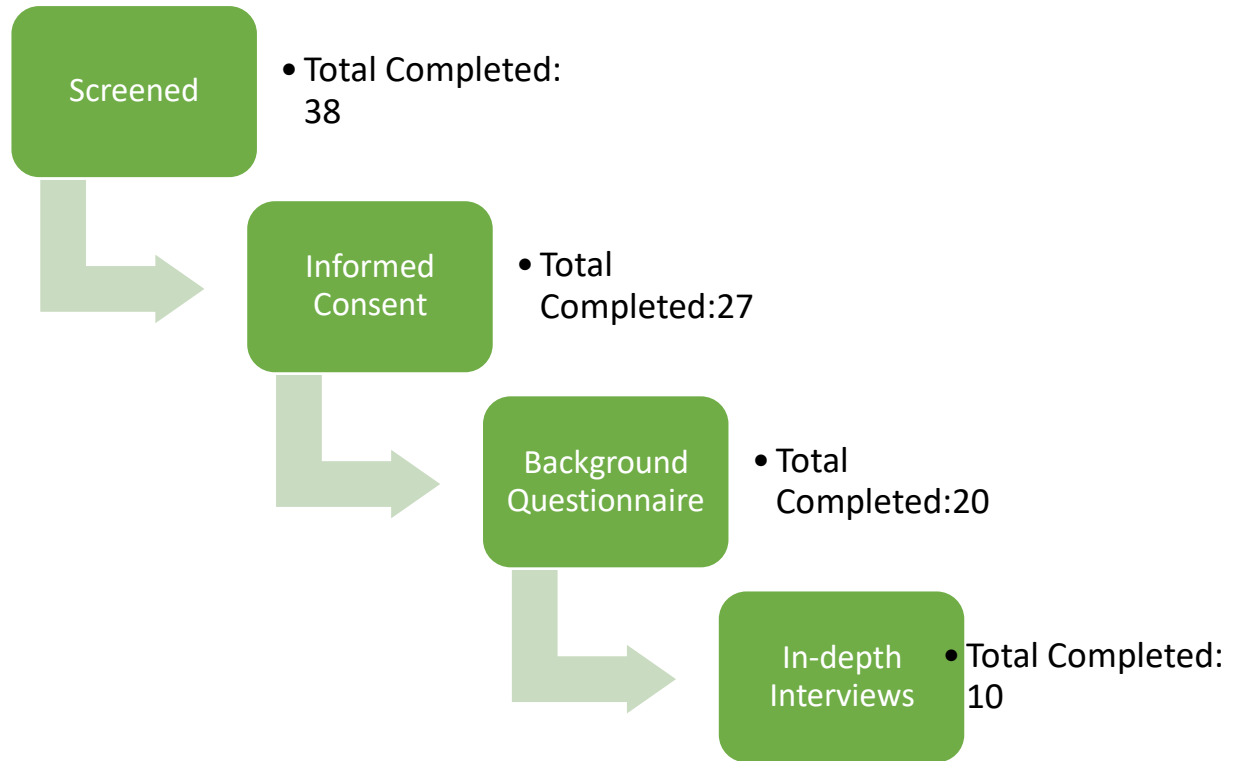
**Diagram 4.1.** Aim 1 Recruitment Overview – Amazon mTurk



**Diagram 4.2.** Aim 1 Recruitment Overview – Positly



**Diagram 4.3.** Aim 1 Recruitment Overview – Aggregate (listservs, flyers, social media, intercept interviews)



**Table 4.1.** Recruitment breakdown by channel.

Aim	Channel Name	Description	Number of Participants Recruited
1	mTurk	A platform used for “workers” to complete “tasks” which they get compensated for. Generally cheaper than traditional research methods	0
1	Positly	A refined research platform designed solely for research purposes; more expensive from an incentive perspective	0
1,2,3	Listserv	A way to mass distribute the IRB-approved study flyer; used the University of Maryland School of Public Health general listserv and the University of Michigan School of Information Studies listserv	20
2,3	Social Media Accounts	A posting on Facebook and LinkedIn of the IRB-approved flyer on the PI’s personal accounts	2
2,3	Flyers	Print postings of the IRB-approved flyer	0
2,3	Referral from other participants	Asking existing participants in the study to share information about the study with others who they think may be interested and eligible.	8

### Study Setting and Sample

The study activities were conducted virtually. All 30 participants completed the screener, reviewed the informed consent form, and completed the background questionnaire using Qualtrics. All in-depth interviews were conducted on Google Meet and Zoom. While recruitment methods varied, participants responded via email to either the flyer posting on listservs, social media account postings, or referrals from other participants. All study materials (screener, informed consent form, and background questionnaire) were sent via email and consisted of a link to Qualtrics to access the material.

### Aim 1

Ten participants participated in the Aim 1 interviews. Below is a thorough description of their responses to both the background questionnaire and the IDIs. A total of 118 individuals were screened, with 72 meeting the inclusion criteria. Of the 72 prospective participants, 20 completed background questionnaires and scheduled interviews. Ten participants did not show up for scheduled interviews. All background questionnaire data of participants who did not participate in an interview was excluded.

### Demographics

Aim 1 participants (N = 10) had a mean age of 21.5 (range of 20 to 26 years; SD = 1.84 years) and the majority (70%) were Asian (Table 4.2) Six out of 10 participants were women, and half of all participants had completed at least a bachelor's degree.

Seven participants found searching for health information on a screen-based device is time consuming. For information seeking related to health information, 6 participants (60%) reported primarily seeking it through the internet, while 4 (40%) reported primarily seeking information from their family and friends. When searching for health information, 9 participants (90%) reported primarily obtaining that information from the internet, with 1 participant (10%) seeking it from friends and family. Survey participants also preferred to seek information from medical professionals (n = 4, 40%). Lastly, medical professionals were considered the preferred source that would best help make an informed decision about health for 70% of participants (n=7). Table 4.2 highlights the sociodemographic characteristics of the sample.

**Table 4.2** Sociodemographic Characteristics of Participants

Baseline characteristic	Aim 1 (n=10)	Aim 2 (n=10)	Aim 3 (n=10)	Full sample (n=30)	
	<i>n</i>	<i>n</i>	<i>n</i>	<i>n</i>	%
Gender					
Female	6	5	8	19	63
Male	4	5	2	11	37
Race					
White	2	4	7	13	43
AA	1	2	1	4	13
AI/AN	-	-	-	-	-
Asian	7	4	1	12	40
NH/PI	-	-	-	-	-
Race not listed	-	-	1	1	3
Latino/a					
Yes	-	1	2	3	10
No	10	9	8	27	90
Education					
High School	2	-	-	2	7
Some college	2	1	-	3	10
Community College		-	-	-	-
Bachelor's	5	6	5	16	53
Master's	1	3	5	9	30
Doctorate	-	-	-	-	-
Primary HAD					
Amazon Echo	4	3	4	11	37
Amazon Echo Show	-	3	-	3	10
Amazon Echo Dot	4	2	5	11	37
Google Home	1	1	1	3	10
Google Home Mini	-	1	-	1	3
Apple HomePod	1	-	-	1	3
Length of HAD					
Ownership*					
Less than 1 month	2	1	-	3	10
1 to 6 months	3	3	-	6	20
6 to 12 months	-	-	1	1	3
Over 12 months	3	6	9	18	60

\*Some participants from Aim 1 (n=2) did not respond

### *In-Depth Interviews*

The purpose of the first aim of the study was to better understand users' information needs as it related to sexual health, and preferences for content in a voice skill. Ten in-depth interviews were scheduled and conducted on Google Meet and Zoom. Each interview lasted 45 minutes. The interviewer used a structured questionnaire with three questions about preferences in a HAD voice skill, eight questions on information seeking behaviors, and 7 questions on technology (Appendix B). All questions were open-ended with probes. Interviews were recorded and the auto-transcription feature used for Zoom. For Google Meet, recorded interviews were manually transcribed by the Principal Investigator.

The data from the IDIs were analyzed, and themes extracted using NVivo 1.7.1. Data were analyzed using inductive thematic analysis. The first step of the analysis involved the researcher listening to the audio recording of each interview multiple times and reading each transcript multiple times. At the end of each conducted interview, patterns observed were summarized, a recommendation taken from Braun and Clarke (2006). The researcher then generated an initial list of semantic codes, where as many codes were generated as possible, preserving the surrounding context, and coding lines in multiple ways, if necessary (Braun and Clarke, 2006). After data were coded, the researcher analyzed the existing codes and began to consider how they would form broader themes (Braun and Clarke, 2006). After broad themes were created, they were reviewed, as suggested by Nowell and colleagues (2017) and



Braun and Clarke (2006). The last step of the analysis involved the naming of themes according to the data (Braun & Clarke, 2006; Nowell et al., 2017).

A list of overall themes and subthemes for all three aims can be found in Table 4.3.

**Table 4.3.** Overall theme and subtheme list.

<b>Aim</b>	<b>Theme/Subtheme</b>	<b>Description</b>
1	Theme 1.1	HADs as a means of convenience
1	Subtheme 1.1.1	Information seeking preferences
1	Subtheme 1.1.2	Being able to connect to a medical provider
1	Theme 1.2	Preferences for a screen-based device
1	Theme 1.3	Ability to emergency triage based on symptoms
2	Theme 2.1	Anxiety and frustration when experiencing the unknown
2	Subtheme 2.1.1	A desire for more specific content
2	Subtheme 2.1.2	Additional content to screen-based devices
2	Subtheme 2.1.3	Symptom based guidance
2	Theme 2.2	Positive perceptions of HADs
2	Theme 2.3	Negative perceptions of HADs
2	Subtheme 2.3.1	Disengagement with device when there is a misunderstanding
2	Subtheme 2.3.2	Hesitancy in making complex decisions
3	Theme 3.1	Sharing visuals to bridge information gap
3	Subtheme 3.1.1	Wanting more than general content
3	Subtheme 3.1.2	Sending more information to screen-based device
3	Subtheme 3.1.3	Allowing for more time to decide to connect to doctor
3	Theme 3.2	Privacy ambivalence
3	Subtheme 3.2.1	Personalizing information experience
3	Subtheme 3.2.2	Gender-specific information

Four major themes and 6 subthemes emerged from the Aim 1 interview data (Table 4.4). Emergent themes from Aim 1 interviews included:

**Table 4.4.** Aim 1 themes and subthemes.

<b>Aim</b>	<b>Theme/Subtheme</b>	<b>Description</b>
1	Theme 1.1	HADs as a means of convenience
1	Subtheme 1.1.1	Information seeking preferences
1	Subtheme 1.1.2	Being able to connect to a medical provider
1	Theme 1.2	Preferences for a screen-based device
1	Theme 1.3	Ability to emergency triage based on symptoms

*Theme 1.1 – HADs used as a means of convenience.* All participants reported their current interactions with HADs were grounded in the need for information in a convenient manner. Commonly provided pieces of information involved the weather, recipes, time, and music. Participant 1.1 explained their biggest perceived benefit of HADs:

*“I think the biggest benefit is that it's hands free. I know for me, sometimes, like I said something quick, like whether you don't always want to go look it up on your phone or typing into a computer. And I think that just being able to multitask and ask the device questions while doing something else is probably the biggest benefit.”*

Participant 1.2 explained that the integration with other information increased the convenience factor for them to interact with their HAD, allowing them to get more use:

*“I mean, I think if I want some piece of information or a quick search, so I think I do ask Alexa to do that for me. But yeah, I think one thing is usually, I think I can ask Alexa to call someone in my contacts and you know, make a call for me.”*

Overall, the preferred use of HADs stemmed from convenience or the need for a particular piece of information at a specific time, regardless of whether it was for health or for general information. When asked about ideal features of a HAD voice

skill for sexual health information, the majority of participants mentioned that a HAD voice skill would need to be able to provide information quickly at a time when the user would need it. Given that in these situations where the participant may be experiencing a perceived sexual health emergency, they are likely in a period of stress and need quick answers to their concerns, a voice skill should be able to quickly mitigate those concerns. Participant 1.3 remarked that speed was most important in a voice skill for sexual health:

*“Definitely, very fast and quick information. Like if I can always be like, what's the weather? Or like, if I need help with a math question or something, I'll just like, quickly ask it. And yeah, I just like... easy to use.”*

When asked about the most beneficial features of a potential HAD skill to address sexual health, all participants emphasized that the skill would need to be convenient and provide the relevant information they needed, when they needed it. In addition, relevant features that were mentioned as contributing to their convenience included symptom tracking, symptom evaluation, and being able to connect to emergency services if medically necessary. Overall, convenience was a concept that permeated throughout the interviews, with participants considering it for all questions related to what constitutes an effective Home Assistant Device voice skill.

#### *Subtheme 1.1.1 – An Individual's Information Seeking Preferences*

Participants' information seeking preferences were a subtheme that emerged when discussing convenience. All participants indicated screen-based devices were the preferred channels for obtaining information currently. As it related to voice search, many participants expressed frustration with the difficulty of searching using voice,

especially on HADs. Half of participants expressed their frustration when they could not find information with Alexa, noting that the Alexa interface often misunderstood them, and they felt they had to repeat themselves many times to receive a relevant answer. Participant 1.4 expressed frustration in having to repeat their search query frequently, thereby taking away from the proposed convenience factor of HADs:

*“[My problem with] Home Assistant Devices is that a lot of times they mishear me. And like that can be frustrating, because then I have to restart the search after or reload the skill after they’ve already come up with the results. And it just takes more time.”*

The frustrations with using HADs for information seeking purposes were also attributed to its inability to provide the appropriate information based on a participant’s query. Participant 1.4 seemed resigned to the fact that HADs would frequently give the user information they did not need, due to the inability to understand nuance:

*“Some devices can't quite understand the nuance of the question you're asking. And they give you the answer you did not want.”*

Participants also mentioned preferring discussing information about sexual health with a medical professional, like a doctor.

#### *Subtheme 1.1.2 – A desire to be connected to a medical provider*

Most participants indicated feeling anxious or frustrated when asked how they would react when they experienced a gap in understanding – for example, being told they might have a STI/STD but not understanding how best to proceed. Many participants expressed a desire to address their anxiety as soon as possible by obtaining the most reliable information, as soon as possible. Six of ten participants expressed hesitation

in hearing answers about their health and sexual health from a HAD, without further context. When asked about ideal features in a voice skill for sexual health, participants mentioned that connecting to a medical provider within the voice skill interface would be convenient and useful for them as they were progressing through their own information seeking process. Even if the answer was anchored on information from reliable sources such as the CDC and Mayo Clinic, participants (such as Participant 1.4) still wanted to review the information they had obtained and receive information from a knowledgeable human source, such as a medical provider, nurse, or other medical professional (sexual health educators, etc.):

*“I would kind of calm myself down when I’m like not able to understand what I found. And when I’ve found a healthcare professional as soon as possible. I would bring the materials I found on the internet and ask them to go through the information so I could understand about my health concern.”*

### *Theme 1.2 –Preference of Screen-based devices*

All participants reported they used screen-based devices as the first step in the information seeking process to learn more about their health. Participant 1.5 this to the ability to digest complex pieces of information more easily:

*“But if I have like more complicated questions, I would myself use a computer rather than assisted home device to get that answered. Because personally, I feel... if you’re like responding to my answer, it can be like a really long response. And I prefer to visually see the information and be able to read it.”*

Some participants indicated “preferring my phone and computer over everything else”, and “my natural inclination is to search for personal things on my phone”. The preference of screen-based devices was also due to privacy concerns: Participant 1.6 mentioned that there were less privacy concerns with a screen-based device because

*“I would probably go into incognito mode. Either way, if I was like, nervous about information, or if I’m like, looking at flights I even do that. So that I don’t get like cookies or anything.”*

All participants consulted a screen-based device first when searching for health-related information. The consideration for using a voice skill for their health information search was predicated on relevance, speed, and convenience. Given the frustrations of some participants with the ability of Alexa to understand them, the margin for error when searching for sexual health information on a HAD was low. Most participants said that if a voice skill was not relevant, quick, or convenient then it would disincentivize their use of it.

When asked about ideal features in a voice skill for sexual health, participants felt that filtering information from a HAD and then sending further information to the participant’s phone for a more thorough review would be beneficial. Given that participants expressed a preference for screen-based devices, there was a desire from Participant 1.2 to get the information at the end of their information seeking process on the HAD to a screen-based device, primarily to have it for review later, or to digest all the information:

*“...Sitting through an entire article in Google’s AI voice would be rough, but it could like send it to my phone.”*

Participant 1.7 mentioned wanting to have the HAD voice skill serve as the starting point in the information seeking process, particularly as they were about to begin their search on a screen-based device:

*“being able to make a doctor's appointment and being able to tell your symptoms and describe it and like, have the home assistant device like google it for you, and put it into words.”*

participants remarked on the balance between privacy and functionality when it came to engaging with a HAD voice skill. Participant 1.4 was willing to forgo some of their personal information if it could be used to provide a more specific, tailored response that would be relevant to them:

*“That kind of feels like they're [Alexa] always gaining information. Um, and then also like, they obviously keep tabs on like, what I searched for so that they can like, better recommend and filter stuff for me.”*

When asked about why they would be willing to share more information, Participant 1.4 elaborated, acknowledging both the privacy concern and the benefit of sacrificing some of it:

*“Because you're gonna be getting better search results, once they accumulate every like, history you've ever like tab you've ever opened anything. And like, they will be getting you better results that apply to you, more so than they would if they had no previous history like you using the product. But um, it is weird, because like, I'll be searching things on my phone or like, using the show. And they'll like, hear me saying stuff and then put on my phone or like the show or the show device. So just is like it does, like creep you out a little. But I think people just think like, whatever, it's fine, it's fair.”*

Most participants raised concerns about privacy, either related to the storing of queries, the sharing of information to other apps/sites, or the constant “listening” of

the Alexa devices as a major area of concern. Overall, the privacy concerns associated with using a HAD (whether perceived or actual) took away from the potential functionality that could be associated with a HAD skill. For example, search history, which could be useful for trend analysis for HADs, was not desirable among participants:

*“Oh, I guess like maybe long-term memory? I would find not very helpful. Maybe it would be helpful. But personally, I would prefer it to not remember for a long time my search history.” – Participant 1.9*

*“I guess I prefer if Amazon just didn't have what I searched for in their history, like in their memory, like somewhere in the data set or something when I was searching for at what time? Why in the follow up searches? I just would prefer my privacy over a [Amazon Echo] dot.” – Participant 1.3*

*“Yeah, so I think there's definitely certain things that you don't want others to know about or to share with other people. And I think that can be a problem with the Internet. Because I mean, I've heard the saying my whole life when you put something on the internet is there forever. So that can definitely intimidate people. And like I mentioned earlier, I think being able to, like easily clear search history on a phone that inclines me to use my phone for those type of things. Where I know I can easily get rid of it. Because like I for example, I wouldn't look up anything that I felt was present on say like a work computer, or maybe a family shared or like a whatever sibling shared device. I think that if I'm looking something up on the internet that is sensitive. I want it to be between myself and the internet, and hopefully try to keep it that way.” – Participant 1.1*

All participants' perceptions of HADs, whether positive or negative, were affected by information they had obtained prior to this study. For example, concerns around the reliability of content on HADs and the effectiveness of some HAD functionality (ex. being able to use smart home integration effectively via voice commands on Alexa) were concerns that negatively impacted individuals' perceptions of HADs. As such, participants brought these preconceptions to the IDIs and they would mention their



concerns. Participant 1.2 gave a detailed example of factors that had resulted in their decreased likelihood to use voice skills:

*“If it can’t comprehend what I’m saying and always shows me the wrong results. I would stop using it... battery issues, Wi Fi issues just like basic things that ruin the user experience overall, I probably wouldn’t”*

Participant 1.9 highly valued their privacy, and regardless of functionality, were unwilling to compromise on what information they provided a HAD:

*“...it’s really obvious that it’s capturing a lot of information throughout the day. So definitely, it’s not very privacy friendly. And so I mean, I usually disconnect it from power or something like that... I turn it off. Or whenever if I’m having a really private conversation in my room or something.”*

Participant 1.10 associated HADs with delivering them the content they desired, and accepted the sacrifice of some privacy, not perceiving any negative impact on their life:

*“It’s just like so engrained in my daily life that is like, okay, are they breaching privacy, but it also like, doesn’t really affect me, it’s kind of just showing me things that like, I want to see. And it’s not, I don’t know, if it’s sharing my information with like, advertisers or like other things, but it’s not sharing it to people, like, personal to me, or my in my immediate circle. So it’s like, I mean, I do think it’s a breach of privacy, but I don’t really care.”*

As it relates to voice skills, the more information that is shared with the HAD, the more of a personalized experience the skill can provide. Most participants expressed some level of comfort with sharing information with a HAD voice skill, if it could use that information to provide an elevated experience. When asked about the reason participants were comfortable sharing that type of information, participant 1.8

remarked about the perceived need to do so with technologies today to have more “luxurious” features:

*“I’m okay with this ... because if I don’t do that, a lot of stuff I’m going to stop working for me. And then there’s something I don’t want. But yeah, I think, for features or for something that feels luxurious or that that is something in the way of progress, just don’t leave it. Life is not going to be as smooth.”*

When asked about potential beneficial features (the “magic wand” question in Design Thinking), participant 1.6 was willing to have the voice skill keep a log of all health issues to understand trends over time, and remember symptoms:

*“I think it would be cool to have something if the device could record and keep a log of...your health issues. So maybe it’s the morning and you walk down, and you can say, ‘Oh, at this time, my stomach hurts.’ And then a couple hours later, ‘Now I have a rash forming’ and a couple hours later, whatever it may be, I think that would be cool to have... a log of it. Because sometimes something pops up and... you forget to write it down or log it and keep track of it.”*

Overall, there were varying levels of comfort with sharing information, but if it was able to be used to contribute to a more refined insight, it was acceptable to them.

### *Theme 1.3 - Emergency Triage based on symptoms*

Some participants remarked about the ability of a HAD voice skill to quickly triage the user to emergency services or professionals if necessary, when asked about ideal features to incorporate into a voice skill for sexual health. The process would involve the verbal input of a participant’s symptoms, and based on that, determining the sense of urgency to refer to a medical professional, and the HAD skill prompting the participant to consider medical attention.

*“Or if I have this red rash on my body, like what could be and then the band further on based on what those results give me? And then kind of go in depth on the types of health issues that could be related to the symptom I have. And usually look at like,*

*health line or Web MD. This is demos before contacting my doctor, if to see if it's like really concerning based on the results I receive. But if I'm like just learning about a health concern, or issue I will just do Google about like the name of like the health concern, and just read more about it, and then click further on the details I see along the way.” – Participant 1.9*

All participants expressed interest in a voice skill that would provide guidance based on provided information, such as symptoms or expressing a desire for general information about sexual health. When asked about what type of guidance would be most beneficial, participants mentioned wanting to be connected to a doctor if they were feeling unpleasant symptoms. One participant mentioned being connected via a hotline available through a voice skill, specifically “hotlines for like nearby STI testing, or clinics, or anywhere that you can go see a medical professional”.

Participant 1.10 mentioned wanting to get connected to emergency services, especially in situations where they lived alone:

*“Calling the cops, calling an ambulance, calling someone of authority if it really is that deep of an emergency, then that could be done faster. Especially if there's only like one person and the other person in the house.”*

These statements demonstrate a wide variety of considerations and preferences by the sample when it came to creating content and designing the appropriate experience for creating a HAD voice skill related to health.

## Aim 2

The feedback from the IDIs in Aim 1 were aggregated, analyzed, and operationalized into content and corresponding voice prompts in a low-fidelity wireframe that

represented a HAD skill (for the screener questionnaire, see Appendix A). A total of 41 individuals were screened, with 40 meeting the inclusion criteria. Of the 40 prospective participants, 37 completed background questionnaires, and the first 10 were asked to schedule interviews. All individuals who scheduled interviews attended them. All background questionnaire data of participants who did not participate in an interview was excluded. Considering some of the themes from Aim 1, the prototype was developed to a) increase convenience, b) offer a tradeoff between privacy and functionality by asking for symptoms to then recommend whether medical attention is required, and c) triage a user to emergency medical attention based on their symptoms. Additionally, the use cases were created based on specific feedback from participants in Aim 1 (Illustration 4.1).

The wireframe was used with participants to address three use cases:

- *Use Case 1: Assume you've been experiencing some unpleasant symptoms after having unprotected sex the night before. The symptoms you're experiencing are not quite as urgent as needing immediate medical attention, but they are affecting you to the point where you would normally search the internet at this point to learn more.*
- *Use Case 2: You are trying to learn more about STDs/STIs for your own knowledge and are hoping to use this voice skill to learn more without having to search for it on your devices/have some uncomfortable conversations with individuals.*

- *Use Case 3: Assume you are looking to understand whether you should make an appointment for further medical attention, and you are going to use this voice skill to do so.*

**Illustration 4.1** Prototype 2- The prototype was a linked Wireframe in Microsoft PowerPoint that had clickable links and prompts representing a voice interaction with the HAD.



### *Demographics*

Aim 2 participants (n=10) had a mean age of 24 years old (range of 21 to 26 years; SD = 1.82 years) and were 50% male and 50% female (Table 4.2). Three participants indicated they owned an Amazon Echo Show, a HAD that also had a built-in screen for interactions. Six out of ten participants had owned their HADs for over a year. Table 4.2 illustrates the full demographic composition of this sample.

### *In-Depth Interviews*

Ten in-depth interviews were scheduled and conducted on Google Meet. Each interview lasted 45 minutes. The interviewer used a structured questionnaire with 8 questions about the prototype that was asked for each use case (Appendix D). All interviews were recorded on Google Meet or Zoom, and notes were taking during the sessions. Each interview was transcribed by either the auto-transcription feature on Zoom, or manually by the Principal Investigator. Each participant reacted to all three use cases, with them responding to the 8 questions separately for each one. All questions were open-ended with probes. The prototype was in PowerPoint, and prompts were on the screen for each use case. Each option in the use case was linked to a “response” that would appear on another slide in the PowerPoint prototype. Feedback from participants was aggregated and analyzed for each use case, and the feedback from users was used to refine the prototype by adding/removing features and/or content. Three major themes and six subthemes emerged from the IDIs in Aim 2 (Table 4.5).

**Table 4.5.** Aim 2 themes and subthemes.

<b>Aim</b>	<b>Theme/Subtheme</b>	<b>Description</b>
2	Theme 2.1	Anxiety and frustration when experiencing the unknown
2	Subtheme 2.1.1	A desire for more specific content
2	Subtheme 2.1.2	Additional content to screen-based devices
2	Subtheme 2.1.3	Symptom based guidance
2	Theme 2.2	Positive perceptions of HADs
2	Theme 2.3	Negative perceptions of HADs
2	Subtheme 2.3.1	Disengagement with device when there is a misunderstanding
2	Subtheme 2.3.2	Hesitancy in making complex decisions

### *Theme 2.1: Anxiety and frustration when experiencing the unknown*

Most participants expressed frustration and anxiety when they were searching for information that was unable to be provided by Alexa. In Use Case 1 and 2, when faced with a situation where the wireframe could not find content, participant 2.1 said they would repeat themselves, assuming the way the voice prompt was worded was affecting the quality of the search:

*“So it usually happens when Alexa is not able to maybe understand me in the right way in the context that I want to. And it just gives me some random answers. And, yeah, I try. I try to twice or thrice, that’s it”*

Other participants noted that given the urgency of the situation (as presented in Use Cases 1 and 3), there was no tolerance for Alexa not providing relevant content immediately. Some participants mentioned going directly to another device immediately to obtain the information they needed as soon as possible. Participant 2.2 expressed feeling anger when presented with a situation in Use Case 1, where Alexa was unable to return an answer:

*“I’d be like, you’re good for nothing. And I’m going to return you. And..., I’d probably Google the symptoms and then make an appointment with an urgent care near me anyways...because it’s kind of frustrating. [Alexa’s] like, “I can’t answer that.” Like, okay, so what can you do? You know?”*

#### *Subtheme 2.1.1: Desire for more specific content*

Beneficial features mentioned by participants revolved around the ability to sort and filter medical providers. Participants wanted to have the ability to input more information as it related to their provider to minimize concerns around whether the medical provider would accept their insurance, be in-network, etc. Participants also

mentioned wanting to be able to sort by factors such as next open appointment, rating, and wait time (for urgent cases).

#### *Receiving too much/too little information*

Participants across the use cases felt certain times (such as in Use Case 2) the information provided was too long to listen to, noting that they were not able to remember the full output, or they would ask Alexa to repeat it:

*“If...the sentence went on for like, around 40 seconds, 45 seconds, maybe I would kind of forget how the sentence began. Specifics. Like if this if an unbroken sentence went on for too long, maybe I wouldn’t get everything like all of these, that it listed something but just slipped out of my mind. Or maybe by the end of the sentence when, when it asked me, “Would you like to learn more?” I would forget that this information is from the CDC, and then maybe I would wonder, “Where is this fetching the information from?” Stuff like that. So as a text format, I can’t really say what would be too long. But there would be a point certainly where the sentence feels like too long, and then you didn’t have enough time to process it enough.” – Participant 2.3*

In other situations, the information felt too short, and participants would follow-up with a request for more information. Participant 2.4 remarked that a request for more information on a screen-based device, at their convenience, was the preferred method:

*“I mean, usually if we say hey, Alexa, can you find this for me? Or can you send this information to my phone, so you know, I don’t have to physically type it up, that webpage just comes up and I just go ahead and read it just makes my life 10 times easier.”*

In one instance during Use Case 1, participant 2.4 felt they were provided with too little information relevant to their symptoms, and would want to directly ask questions related to symptoms, compared to general information:

*“But I will probably be more specific in what I would what I’m asking for... I will probably say, hey, Alexa, what? What if what I’ll be like, hey, Alexa, what happens if*



*I have a rash and like, my genital area? Or what happens if I'm experiencing burning in a certain part of my body? And I'll probably be more specific, rather than saying, you know, hey, like, so what does an STD STI? That doesn't really help me much."*

#### *Reliability of information received*

During the information seeking process for participants, the inclusion of a source for content was necessary for participants to feel that the information was reliable when hearing it. Sources such as the CDC and Mayo Clinic were perceived to be reliable by all participants as it related to sexual health content. Other sources recommended by participants included WebMD, Johns Hopkins Medicine, and Cleveland Clinic.

#### *Subtheme 2.1.2: Being able to push additional content to screen-based devices*

In terms of beneficial features, some participants mentioned wanting to have more content options as it related to their symptoms (ex. If the participant mentioned they had a rash, offering more insight than STIs/STDs manifesting as rashes). Two participants mentioned wanting the ability to push information to their phone, especially pictures. The benefit of pictures was to visualize and compare with something they might be experiencing (ex. A rash) so that they could more quickly ascertain whether they needed medical attention. For Use Case 1 and thinking about a hypothetical rash, one participant mentioned "I feel pictures always help, especially because I will be curious to know...if there's a rash or something in that category, what would it look like?". When interacting with Use Case 2 and searching for general information, participant 2.5 mentioned that they would like to have the content they found relevant sent to their phone so they could visually understand it:

*“I think visuals will help a lot, especially when you’re dealing with like STDs. STIs when you’re trying to if you’re looking at your body and you see something, but you’re not too sure kind of having something to kind of, you know, compare it with.”*

One participant mentioned having a way to monetize the skill and charge a fixed price to connect the user to a medical professional to discuss any further questions they may have about their sexual health.

#### *Subtheme 2.1.3: Symptom-based guidance*

Use Cases 1 and 3 involved experiencing hypothetical symptoms and using the voice skill to determine next steps. Participants mentioned that during Use Case 1, they felt anxiety around their symptoms. Furthermore, they wanted to quickly understand whether they needed further medical attention or not. Participant 2.6 was not interested in anything outside of an immediate way to address whether the symptoms were concerning or not:

*“If I have a few unpleasant symptoms that I’m already experiencing, I would search more specifically using those symptoms... At that point of time, I just need to know if there’s something that needs immediate attention or something that needs closer inspection.”*

In Use Case 3, other participants wanted to have more medical information and terminology related to their symptoms, so that they could get to a better understanding of whether their rash is a STD and decide on their own whether to seek medical attention. One participant noted wanting to “jump to different areas” within the skill based on their symptoms.

### *Theme 2.2: Positive perceptions of HADs*

Some participants had more favorable views towards technology and were more willing to share information with HADs, provided it could improve the health information seeking process. One participant mentioned they were willing to contribute to help bridge the gap of obtaining knowledge through different channels, noting that “even if it etches us closer to....finding information that we need, or just help us bridge that gap between us not knowing and knowing the best way to treat something...that’s just really essential”. The same participant was willing to share more information about their symptoms (Use Case 1) if it meant that they would receive a more personalized recommendation from the prototype. Four participants remarked on the general perception of HADs being positive, using descriptors such as “convenient”, “intuitive”, and “easy”.

The lack of insurance information was seen as a gap in the first iteration of the prototype in Aim 2. Participants indicated concerns about insurance coverage. In Use Case 1, when an option was presented for participant 2.2 to get connected to a doctor, they indicated they would say no, because of concerns around their insurance coverage:

*“I will say no, because I’m more so worried about my insurance coverage. And then making sure it’s a doctor in my network for sure...I’d rather go somewhere where...I have coverage, so it’s cheaper.”*

In Use Case 3, when participants were looking to decide about connecting to a medical provider, the same concern was raised, and two participants chose not to connect to a doctor until they knew if their insurance was accepted:

*“I feel like I have like more concerns. I would want to look into a practice, I would want to see if they take my insurance like things like that.” – Participant 2.3*

*“I probably say no, actually, just because Alexa doesn’t know like my insurance or like my insurance plan my health coverage.” – Participant 2.7*

The incorporation of insurance coverage before providing a feature to connect to medical providers was incorporated into the second iteration of the prototype to be tested in Aim 3.

### *Theme 2.3: Negative perceptions of HADs*

#### *Trust in HADs and technology*

A negative perception of HADs based on a participant’s experiences often affected how trusting they were of providing information to the HAD. When beginning the study, participant 2.2 remarked on how they would not want to voice search on HADs, because the devices were always collecting data:

*“For me, personally, I would not use voice search for all of these questions. Because it’s mainly a personal thing, because I don’t like having it having those kinds of searches associated to either my ID, that I’m logged in using Alexa or even my voice. So I don’t want my voice being recorded that asking these questions, or it being linked to my ID and being stored somewhere that I’m not aware of something because I always have this thing in my head, maybe there’s some privacy setting that I didn’t switch on or switch off, or something’s being recorded or something.”*

Interestingly, the participant 2.2 also indicated being willing to do a search on a screen-based device using a privacy mode:

*“So all of these questions would maybe be an incognito search for me, personally. So I am not really very comfortable using these kinds of questions. With my voice. It would mostly be trivia questions that I ask Alexa or like, home automation stuff, but not anything personal.”*

For Use Case 3, when they received a recommendation about seeking medical attention, participant 2.8 expressed their doubts in trusting recommendations from a HAD voice skill:

*“If I described more about my symptoms to the Alexa. And she gave information that I found unhelpful, I might just be like, Whatever, I’ll just Google it ... I don’t know if I would have the faith in the Alexa to even correctly diagnose me... because it’s like an AI like, what does it know about diagnosing like, actual, like STDs... I’d be like, What do you know you’re a robot. What do you know about my symptoms?”*

Participant 2.5 also echoed similar sentiments about the perceived privacy of browser-based interactions compared to voice-based, and believed that browsers were more secure than searching on a HAD:

*“My default is to always like to use a browser or something to look for information online because I feel like I have more control I have. And this might be a little bit particular to me because I understand kind of the security and privacy until like the privacy guarantees of using a browser... but I know that I can get certain privacy by going into like a private browsing mode, or I can use an anonymous browser or something. Whereas I don’t know whether I would have those kinds of like guarantees with this Alexa skill sets. So I think taking a step back, I would need to be convinced that the skill offers something more than like what searching the browser would for me to use it especially for something this kind of like this personal, you know?”*

### *Reliability of content*

The content provided by Alexa was often questioned by participants, who were adamant that the source be provided. When asked about which sources would be considered most reliable, all participants (n=10) indicated that a source such as the CDC or Mayo Clinic would provide content that is trustworthy:

*“Yeah, so providing of the source is very much important, especially when it comes to a voice assistant, like when I’m on the internet searching for something, I can actually pick the website that I want to read stuff from. And that thing really matters in today’s world. There’s a lot of misinformation and stuff like that. But if you provide the source, it will actually clear things out. And the thing is, since you saying according to the CDC, I can just open up my phone and search on CDC website. And I definitely get the same definition right there. So that is just a point of confirmation. For me, it gives me confidence to believe this.” – Participant 2.1*

If the source was reputable and provided in the content, participants were comfortable with trusting the content, provided it could be verified.

#### *Subtheme 2.3.1: Disengagement with Alexa when there is a perceived misunderstanding*

In Use Case 1, participants were asked to search for symptoms using voice search in a scenario where they were experiencing unpleasant symptoms and needed more information on whether it could be a STI/STD. When presented with a response where Alexa was unable to provide find any information relative to the symptoms in the use case (Ex. “I’m sorry, I’m having trouble understanding your request”), most participants expressed frustration with the voice skill. Participant 2.3 chose to immediately disengage from using the skill, instead moving to a screen-based device to continue their search:

*“That would be kind of disappointing because I’ve spent so much time but if it came within the first few questions, and it can’t, can’t answer that, I’ll be like, Okay, these are the limitations of Alexa right now. So I move on to a different search, something with a screen.”*

Additionally, the room for error for a HAD voice skill was low among participants for Use Case 1. Some participants indicated they would likely disengage with a HAD and opt for a screen-based device if Alexa were to misunderstand their query once or

more. One participant mentioned disengaging from using the prototype and picking up the phone to directly call a provider they are familiar with, compared to connecting with a provider that has been pre-selected by the voice skill.

*Subtheme 2.3.2: Hesitancy in making complex decisions immediately*

The use of HADs to filter through information to what was relevant was mentioned by some participants in Aim 2. Participants mentioned feeling rushed into deciding when interacting with the voice skill, especially as it related to use cases 1 and 3:

*“I wouldn’t want Alexa to connect me to a doctor. Not before I do some research on my own, like directly going to the doctor just based on what I heard from Alexa seems like a larger step. So if I think that it is serious enough for me to show it to a doctor, then I would rather read it out loud, read the whole documentation, or whatever the CDC has, make that decision, like, it will take me a few minutes, it won’t be like instantaneous” – Participant 2.6*

*“And I say hey, Alexa, what is the symptoms of a gonorrhea rash? Or can you send me more information about gonorrhea and rash to my phone, and kind of prompted that way to seek more information? And if I were to, if I were to assess and say, Hey, maybe I need to go see a doctor about this, then I could say, hey, Alexa, can you connect me to the nearest doctor? Can you help me book an appointment for a doctor to see my you know what I’m dealing with?” – Participant 2.2*

Participant 2.9 felt that they would need to provide Alexa with more information (ex. Insurance provider and medical provider) for them to use the voice skill:

*“I have a very specific doctor. I would want us to say do you want me to connect you to your doctor via phone? Do you want like advice? Perhaps you should contact your doctor... I don’t need Alexa to connect me to a doctor, because I luckily have health insurance and a doctor. I’m not gonna go. That doesn’t make any sense for me. I’m not gonna go see a Rando. Because my health insurance I won’t be taken. But perhaps the recommendation that you ...But perhaps you should talk to a doctor. That sounds good.”*

### Feedback Incorporation into new prototype

Based on the IDIs from Aim 2, codes were generated that related to ideal features that would be appropriate in a voice skill. The three most frequent suggestions for features and content were incorporated into the prototype (Table 4.3). The feedback during each of the use cases from the group was used to refine the low-fidelity wireframe prototype, ensuring that the next iteration of feedback during Aim 3 addressed user concerns brought up during Aim 2.

**Table 4.6.** Aim 2 Prototype Use Case Descriptions

Use Case	Description
1	You've been experiencing some unpleasant symptoms after having unprotected sex the night before. They are not quite as urgent as needing immediate medical attention but are affecting you to the point where you would search the internet at this point to learn more.
2	You're trying to learn more about STDs/STIs and are hoping to use this voice skill to learn more without having to search for it on your screen-based devices/have some uncomfortable conversations with individuals
3	Assume you have a rash after having unprotected sex and are looking to understand whether you should make an appointment for further medical attention. You are going to use this voice skill to do so.

### *Changes to Prototype*

#### *Change 1: Offering more direct choices related to symptoms*

Based on user feedback, for use case 1, the choices available were specific to a rash, and were more direct. The options were changed from starting with more general information ("Alexa, what should I do if I have a rash?") to more intentional prompts ("Alexa, I have a rash. Could it be a STD?").



**Illustration 4.2** Change 1, as seen in the new prototype



*Change 2. Describing symptoms and offering more sensitive options*

For use case 1, users mentioned not feeling comfortable sharing their symptoms with Alexa or having difficulties describing the rash in words. In the new prototype, options were given for users to not share that information, and mention that it is hard to explain the rash (if necessary).

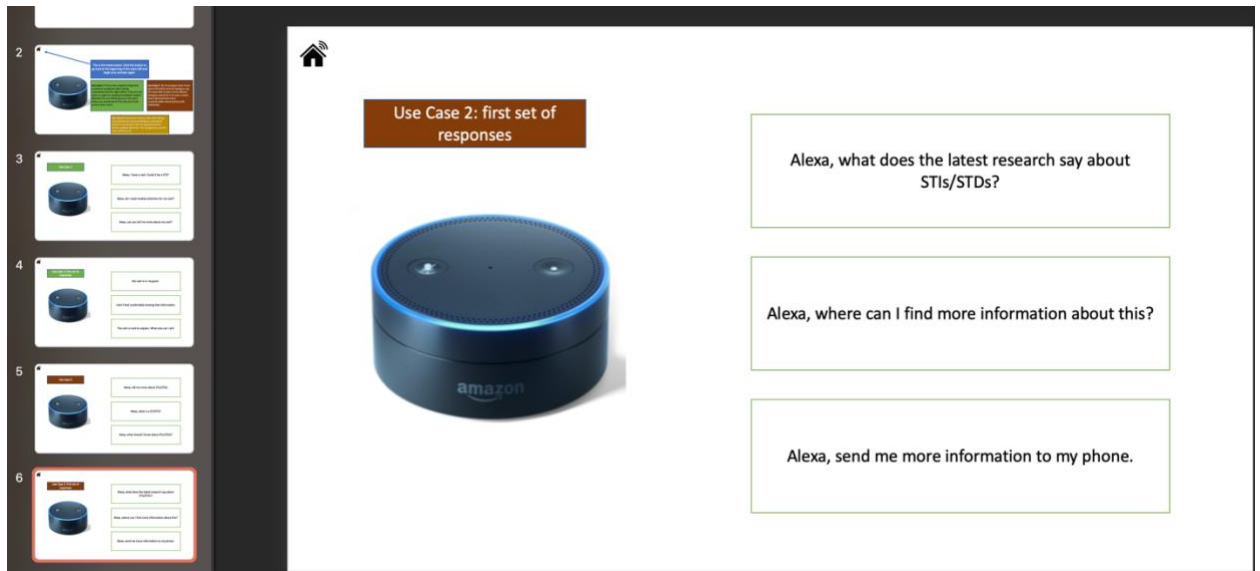
**Illustration 4.3** Change 2, as seen in the new prototype



*Change 3. Offering more information about STIs/STDs, and the option to send more information to a screen-based device*

Many users remarked that while it was beneficial to receive general information about STIs and STDs, it was often a lot of information to remember and act upon. From a convenience perspective, users wanted to have the information ready to view at their convenience and based on that feedback an option was provided where further information could be sent to the user's phone. Another option was provided to receive the latest research according to reliable sources such as the CDC, Mayo Clinic, and others.

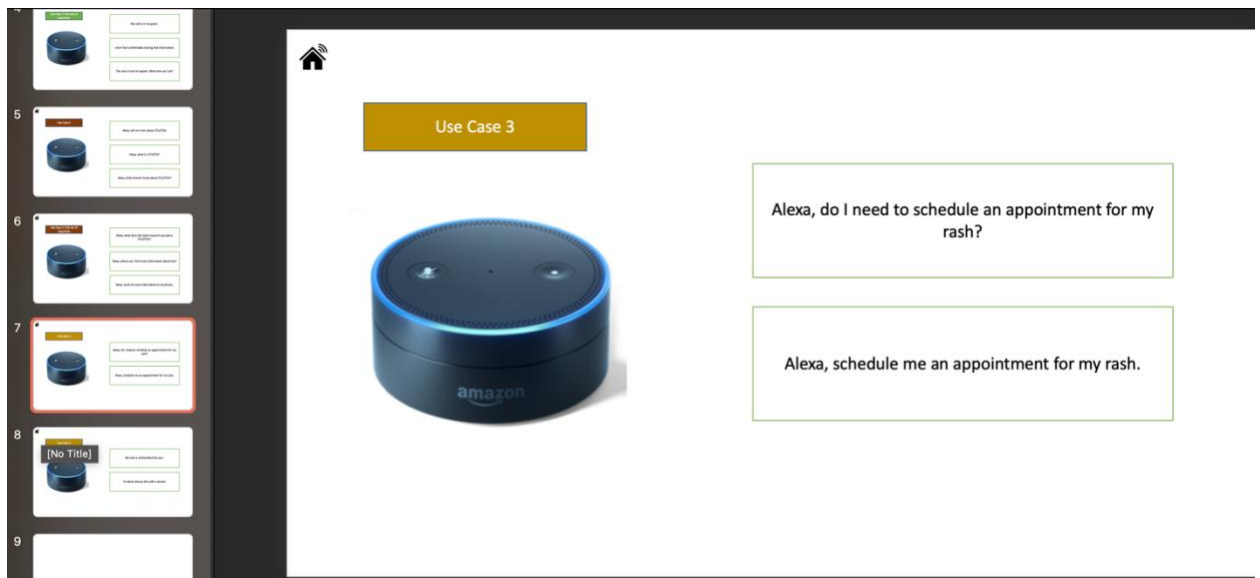
**Illustration 4.4** Change 3, as seen in the new prototype



*Change 4. More direct choices in response to determining whether to schedule a doctor's appointment*

For use case 3, the options were refined so a user could make a yes/no decision on whether they should schedule a doctor's appointment, as compared to going through background information about doctors.

**Illustration 4.5.** Change 4, as seen in the new prototype



*Change 5. Option to discuss further with a medical professional*

Some users expressed that they did not want to share specific symptoms with a provider and wanted the option to connect to a medical professional to provide that information. The HAD skill was changed to offer an option to connect to a doctor to discuss more.

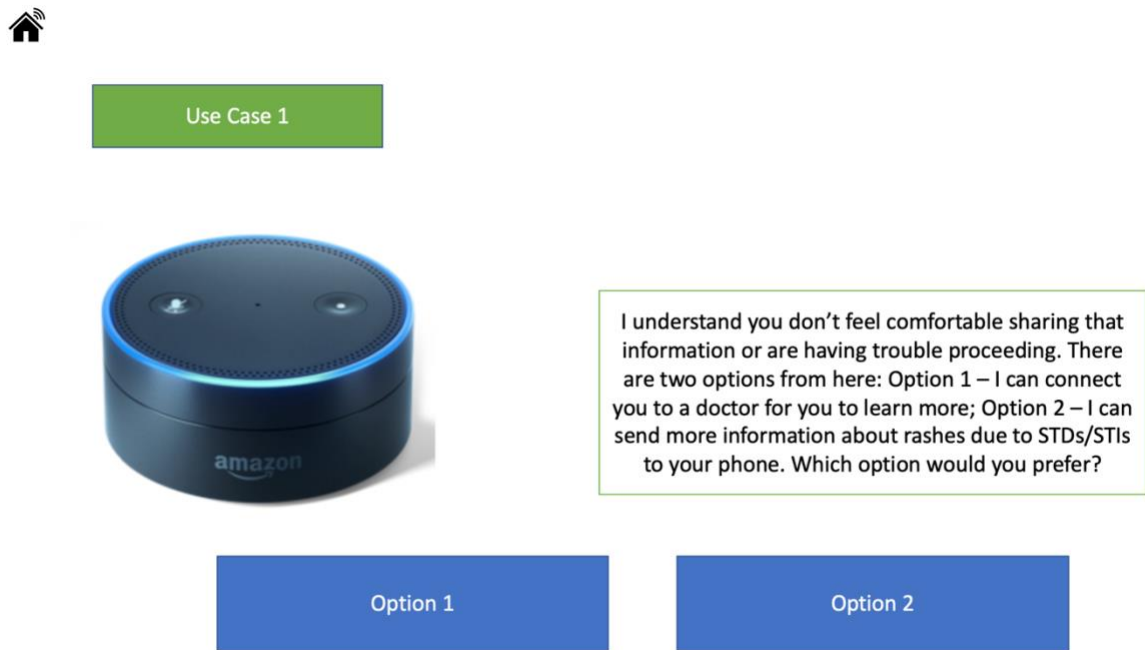
**Illustration 4.6.** Change 5, as seen in the new prototype



*Change 6. Allowing users multiple options based on symptoms*

Users commented during Aim 2 that being asked to get connected to a doctor felt too hasty. Users wanted to have the option to do so at their convenience, not be forced to decide immediately from the voice skill. Two options were provided in the prototype; one option that could connect an individual to a doctor, if desired; and a second option that would send more information to an individual's phone for them to act upon later.

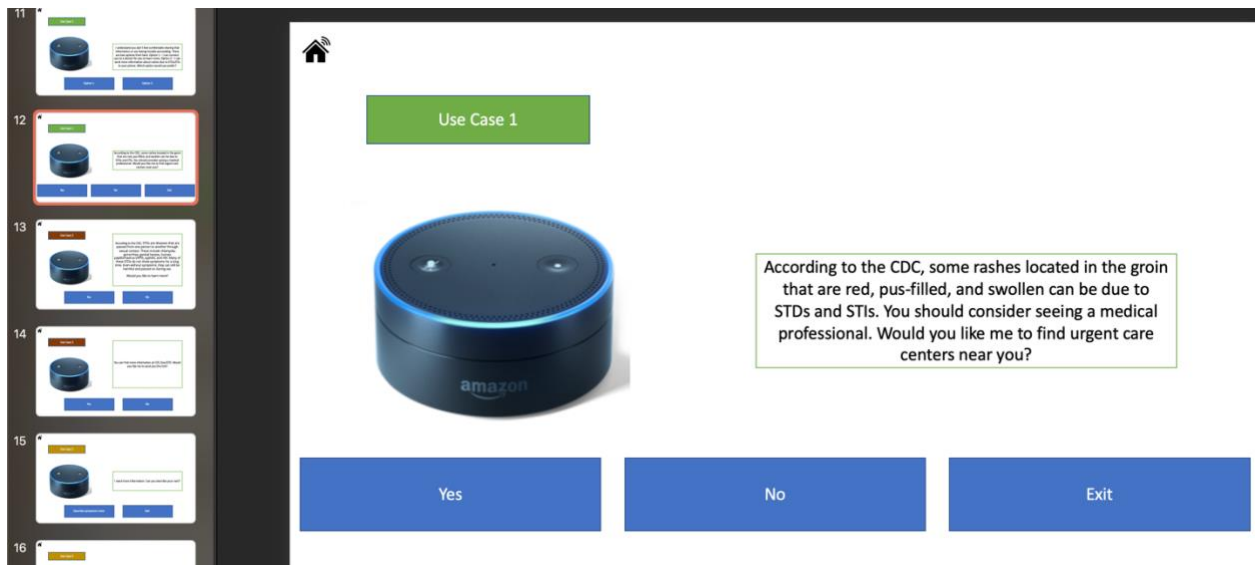
**Illustration 4.7.** Change 6, as seen in the new prototype



*Change 7. A gentle nudge to consider medical attention based on symptoms*

Some users remarked feeling a sense of panic and concern if the HAD is the way they learn they have an STD. The language in the HAD was adjusted so that it requests the user to “consider” seeing a medical professional, based on what the CDC has noted about rashes that could be STDs/STIs. Additionally, users mentioned wanting to be seen quickly, and not wanting to wait, so the health care setting was specific to urgent care facilities.

**Illustration 4.8.** Change 7, as seen in the new prototype



*Change 8. Offering to send more detailed information via a link to a mobile device*

Responding to user feedback that a large amount of information delivered via voice can be hard to remember and act upon, the content for use case 2 was adjusted so that a smaller amount of content was delivered with the HAD skill, and more information was provided via a link that could be accessed at the user's convenience.

**Illustration 4.9.** Change 8, as seen in the new prototype



Use Case 2



You can find more information at [CDC.Gov/STD](https://www.cdc.gov/std/). Would you like me to send you this link?

Yes

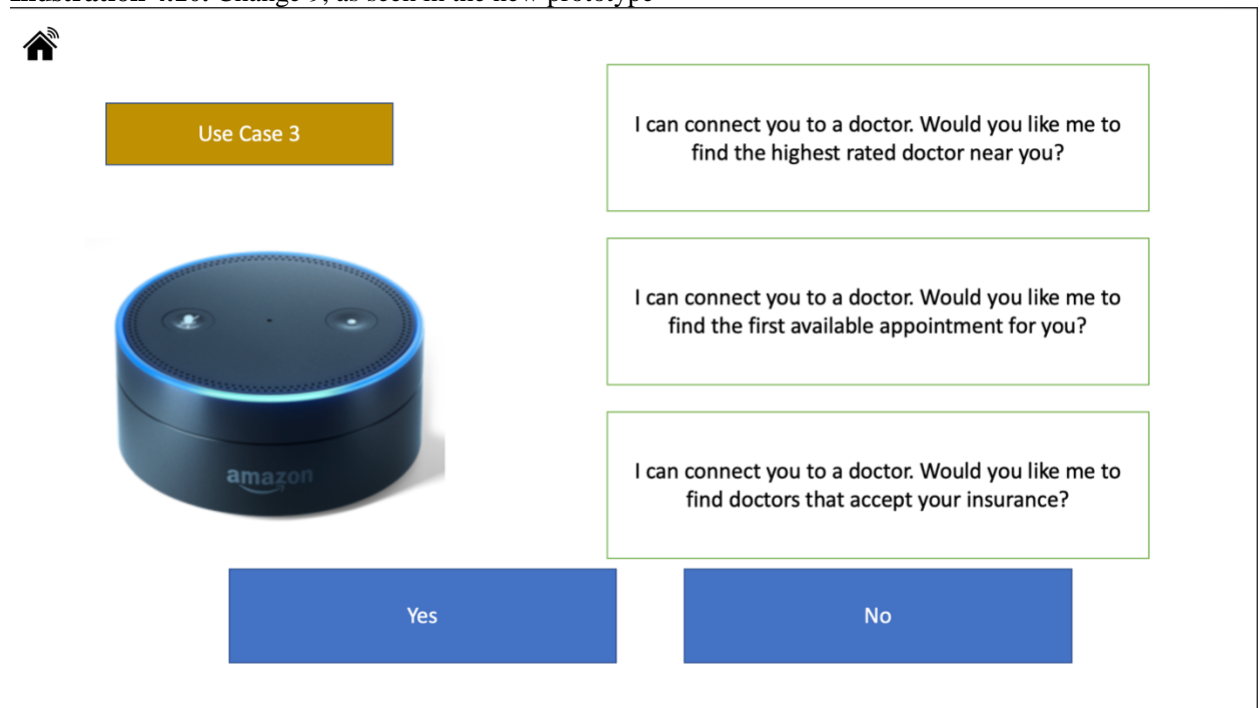
No

*Change 9. Connecting to medical professionals based on multiple criteria*

For those users who were willing to get connected to a doctor via the voice skill, some remarked wanting a way to filter who they could see, and not rely upon Alexa's recommendations. In response to that feedback, use case 3 was adjusted so users could find doctors based on ratings, next available appointment, and acceptance of insurance plans.



**Illustration 4.10.** Change 9, as seen in the new prototype



The changes made in the prototype formed the new iteration of the prototype that was tested in Aim 3.

### Aim 3

In Aim 3, the refined prototype based on feedback from participants in Aim 2 was tested with a new group of participants (n=10), and their reactions captured via IDIs. A total of 32 individuals were screened, with 13 meeting the inclusion criteria. Of the 13 prospective participants, 13 completed background questionnaires and 10 scheduled interviews. All participants who scheduled interviews attended. All background questionnaire data of participants who did not participate in an interview

was excluded. Each session was conducted virtually and lasted 45 minutes. The same questionnaire from Aim 2 was used with a different set of participants. At the end of the IDI, participants were administered the mHealth App Usability Questionnaire (MAUQ) to assess the usability of the voice skill (Zhou, 2019). Data from the IDIs was then analyzed in NVivo, and inductive thematic analysis was conducted to understand the emergent themes by use case.

### *Demographics*

Aim 3 participants (n=10) had a mean age of 24 years old (range of 21 to 26 years; SD = 1.89 years) and were 80% female and 70% White (Table 4.2). 50% of participants had obtained a Master's degree. Nine out of ten participants had owned a HAD for over a year. All participants indicated medical professionals as their primary source of health-related information. Three out of ten participants primarily used the HADs for information-seeking, compared to the remaining seven participants who used them for either entertainment or utility purposes. Six out of ten participants used their HAD more than three times a week. Further demographic information can be found in Table 4.2.

### *In-Depth Interviews*

Each participant reacted to all three use cases in the IDIs, with 8 questions separately for each one (Appendix D). All questions were open-ended with probes. Interviews were recorded and were transcribed either using the auto transcription feature on

Zoom or for interviews conducted on Google Meet, interviews were transcribed manually by the Principal Investigator. Feedback from participants was aggregated and analyzed for each use case, and the feedback from users was used to refine the final prototype by adding/removing features and/or content (Appendix F). Two major themes and six subthemes emerged from the IDIs in Aim 3 (Table 4.7)

•

**Table 4.7.** Aim 3 themes and subthemes.

Aim	Theme/Subtheme	Description
3	Theme 3.1	Sharing visuals to bridge information gap
3	Subtheme 3.1.1	Wanting more than general content
3	Subtheme 3.1.2	Sending more information to screen-based device
3	Subtheme 3.1.3	Allowing for more time to decide to connect to doctor
3	Theme 3.2	Privacy ambivalence
3	Subtheme 3.2.1	Personalizing information experience
3	Subtheme 3.2.2	Gender-specific information

*Theme 3.1: Sharing visuals to build comfort and bridge an information gap*

In each of the three use cases, six out of ten participants mentioned a need for visuals to bridge a gap they had in information, one that a voice search could not address. Particularly when it related to symptoms such as a rash, the need for pictures was important to participant 3.10 to ensure visually that they were not experiencing a medical emergency:

*“I want to see comparison pictures of like what was sent to me so I can...compare what I have to what Alexa sent me. Because if it's something where it doesn't seem that urgent in a way, and it's not an STD, then I'll probably just get cream or something...but if it is something where it is potentially nasty, then I'd have to go the doctor... I can see what's going on”*

For some participants, the need for visuals was driven by the fact that they perceived themselves as visual learners and could not process and appraise information that was non-visual in a rapid manner. One participant noted that *“I’m... a visual person. So I need to see that information, have it written down. Or...somewhere on my phone I can access”*. The difficulty remembering content provided through voice was a main reason behind a desire for visuals for participant 3.8:

*“I’m a visual learner than an audible one, like, someone can say something to me. And I might, she’ll say it one time, I might not be able to remember all the things she said if she’s like, it could be this, this, or this, right. I just would rather be able to type in everything that I have.”*

#### *Subtheme 3.1.1: Wanting more than general content for sexual health*

Nearly all participants expressed wanting more information to be provided within the voice skill. The initial content provided was approximately three sentences from the CDC on what STDs/STIs were, an example, and the dangers of being asymptomatic and still transmitting the disease. While providing this general content was found to be beneficial for all participants, participant 3.6 felt that it was too broad:

*“At this point... I would probably be aware that it’s like, okay, yeah, you can get infected and what not.. but then I would probably go into like, this is exactly what happened. These are... my physical symptoms... So I feel like this is like too broad.”*

Other categories suggested by participants included risk factors, when to see a doctor, other symptoms besides rashes and treatments, with separate categories for each STD/STI. Participant 3.4 felt a more robust information architecture would be beneficial:

*“So I think maybe if they asked, like, Would you like to know about prevention? Or would you like to know more about transmission, or maybe we'd like to know more about like, the best ways to protect yourself, or like different symptoms, something like that, like maybe categorical types of organization of information, but that's just kind of what comes to my head.”*

#### *Subtheme 3.1.2: A desire to send more data to a screen-based device*

For Use Case 2, participants were pleased with an available option to send more general information about STDs/STIs to their phone. They were willing to share their phone number to get that information. Others wanted information on a provider sent to their phone, so they could refer to it visually. When participant 3.6 was asked about being connected to a doctor directly in use case 1, they declined and provided context around the need for visualizing information:

*“So I'm not familiar with the neighborhood, right? If you told me... Broadway and 37th, I would be like, I don't know where that is. So... if you gave me the address, I wouldn't know. But with that information, I can then make... informed decisions. And then...Google search... doctors near me...and that way, I could see a visual map of it.”*

Two other participants preferred receiving visuals when going through the decision to receive medical attention in Use Case 3. The ability to sort and filter was easier for participant 3.6 on a screen-based device, compared to voice search:

*“I'd like to see a visual comparative analysis of like, the pros and cons of like, what my schedule looks like, you know, and like, what the physicians can offer, what their availability is, and what their rating is, you know, then I can make that better informed decision. It's like, a little bit harder when it's just pure audio. For me. Yeah, got it.”*

*Subtheme 3.1.3: Allowing for more time to decide whether to connect to a doctor*

When beginning the information seeking process in use case 3, participants mentioned feeling nervous in this hypothetical scenario. Participant 3.3 expressed wanting medical attention, but only if necessary.

*“I’d feel concerned here. But also, I would feel like this is inducing panic without needing to. Like STDs aren’t usually life threatening so I’d just wait and schedule an appointment with my GYN vs. an urgent care or hospital. I just feel like this would be directing people to urgent cares and hospitals and driving costs up for everyone in the system.”*

Other participants felt rushed into having to decide whether they should get connected to a medical provider immediately in the voice skill. The perceived hastiness led participants to not use the voice skill to schedule an appointment and exit. Other participants felt that it’s easier to do some more research on phone before connecting to a doctor, with participant 3.8 mentioning they would rather “look up which hospitals and urgent care centers are closest...and find the one with the best reviews... and just call myself”.

*Theme 3.2: Ambivalence towards privacy*

There were varying levels of ambivalence towards privacy – from both a content sharing perspective, and a features perspective. All participants were comfortable with describing their symptoms out loud to a HAD, even if they were unpleasant symptoms related to having unprotected sex. All participants proceeded through use cases 1 and 3 without indicating they were uncomfortable doing so. When other features were discussed, such as getting information texted to a phone, participant

3.10 felt there was no difference in authorizing the voice skill to send more information to their phone, since they already had the information:

*“Alexa is already connected to the phone anyway...with your apps and whatnot. So I feel like it's there's no difference.”*

Half of participants had no privacy concerns with HADs and voice skills. When asked to elaborate, participant 3.1 acknowledged that there are privacy concerns on all their devices, but did not have anything to hide:

*“I feel like it'd be very hypocritical of me to say that I'm extremely nervous about my privacy, because I have a phone, it's always like, every time I will tell my friends about something, I'll see it on Tik Tok, or an Instagram ad. So I can't be super critical about that kind of stuff. But I feel like because these home assistant devices, like are literally picking up cues on like, things that they should say back, I feel like that's kind of like, creepy in a way. But I also... don't really have anything to hide as a college student. So I'm not too worried.”*

Despite being ambivalent towards privacy concerns, participant 3.1 also noted about voice skills that “it’s kind of weird, but I still use them pretty frequently”.

#### *Subtheme 3.2.1: Personalizing the information experience without being invasive*

While the information provided by the prototype in use case 1 and 3 provided recommendations, some participants felt it was not personalized enough, and wanted more information that related to them without being invasive. Some participants were willing to share extra insurance information if it made for a better experience.

Participant 3.10 mentioned that it would be helpful to have a personalized set of providers available that accepted their insurance:

*“I think it'd be helpful because it doesn't tell you that on the internet or anything so like if it's designed to be able... you give them information and then they can tell you which provider... like that's a lot easier to do.”*

When asked about an ideal voice skill, having the ability to scan and process their insurance information to provide a personalized list of providers that are in-network, instead of a general list of all providers was noted:

*“Let's see again. Yeah, if well, if they can put the insurance information in for me that I think that would probably be my addition, because that's a tedious task.” – Participant 3.7*

*Subtheme 3.2.2: Providing information that acknowledges an individual's gender*

In use cases 1 and 3, the medical provider was not specified. Two participants (both women) indicated the importance of being offered a same-gender provider in the prototype, with participant 3.7 indicating that it would be beneficial to use a provider's gender as a filter when selecting a medical provider:

*“I would want to know, like, for me when finding a doctor, if they're male or female, that's important to me. So...if that was a question, or if I could... filter out my doctors to this. So I would want to be like, Okay, can you find the highest rated? You know, female...psychologist or something like I would want to have that option as well.”*

There was also a preference for a gynecologist in the event of a sexual health emergency vs. a general provider or emergency physician for participant 3.10:

*“Like, I would just call the GYN or something, I would have explained it to them, because they're medical professionals. So they would give me more of a solid answer in comparison to the Alexa.”*



### MHealth App Usability Questionnaire (MAUQ)

At the end of the IDI for Aim 3, the MAUQ was verbally administered to all participants (n=10). The results can be found in Table 4.8. Overall, participants agreed that the voice skill was easy to use, and easy to learn to use (average MAUQ scores of 6.5 and 6.3, respectively on a scale of 1 to 7, where 1 was strongly disagree and 7 was strongly agree). Participants had mixed feelings on the use of a voice skill addressing sexual health in a social setting, and it was the lowest scoring item among participants (average score of 4.3 on MAUQ).

**Table 4.8** MAUQ Questionnaire Results

Question	Average Score
1. The voice skill was easy to use.	6.5
2. It was easy for me to learn to use the voice skill.	6.3
3. The navigation was consistent when moving between screens.	6.4
4. The interface of the voice skill allowed me to use all the functions offered by it.	5.6
5. Whenever I made a mistake using the voice skill, I could recover easily and quickly.	5.8
6. I like the interface of the voice skill.	5.6
7. The information in the voice skill was well organized, so I could easily find the information I needed.	6.1
8. The voice skill adequately acknowledged and provided information to let me know the progress of my action.	5.2
9. I feel comfortable using this voice skill in social settings	4.3
10. The amount of time involved in using this voice skill has been fitting for me.	5.6
11. I would use this voice skill again.	6
12. Overall, I am satisfied with this voice skill.	6.1
13. The voice skill would be useful for my health and well-being.	5.8

Overall, the results from the interviews and the MAUQ show a wide variety of benefits and challenges associated with the general information needs and specific sexual health information needs of young adults, and varying perspectives on a voice skill prototyped designed to address those information needs. The implications of these results and suggestions for future research are discussed in the final chapter.

## Chapter 5: Discussion

### Summary

This study sought to explore the perspectives of young adults to understand the depth of their sexual health information needs and whether a user-centric designed HAD can be a suitable alternative for fulfilling those information needs. Using a qualitative approach, IDIs were conducted with 10 young adults meeting the study criteria, and resulted in rich data that led to the development of a voice-based public health application prototype for sexual health information which was then tested and refined based on feedback from 20 different young adults. By using the Theory of Motivated Information Management, the Technology Acceptance Model, and the Design Thinking approach and conducting a series of iterative prototyping phases with the target population, a user-oriented voice skill was created that addressed the information needs and obstacles experienced by this group. The data collected and insights from this study expand the current knowledge base on how young adults interact with public health information and how voice-skills can be best leveraged to facilitate information seeking.

### **Overview of Theoretical Framework**

This study proposed a new theoretical framework bridging the Technology Acceptance Model (TAM) and the Theory of Motivated Information Management (TMIM) (Afifi & Weiner, 2004; Venkatesh & Davis, 2000). An individual's

perception of and attitude towards technology (in this case, HADs) is an outcome expectancy that was not explicitly stated in TMIM, but one that affected the ability of an individual to proceed with their information seeking process. Based on this theory, it was predicted that how young adults perceived HADs (whether positive or negative) had an impact on the information they were willing to provide these devices, how they interacted with them, and how they appraised the information relative to their need.

The TMIM and TAM both provided utility in generating the research questions and the creation of the interview guides for this study. The TMIM's emphasis on the intrapersonal factors occurring when an information gap occurs, helped drive the development of the interview guide in Aim 1, which gathered information on young adults' information needs. The TAM's focus on perceived usefulness and attitudes towards technology, combined with the Design Thinking framework, especially as it related to prototyping, were important in the creation of the interview guides for Aims 2 and 3. Both the TMIM and TAM contributed to the interpretation of the results of the interviews, and contextualized the findings and relevant themes within their respective frameworks.

This study confirmed the proposed theoretical framework and found that young adults' attitudes towards HADs and technology did influence how they interacted with the prototype voice skill and affected how much information they were willing to share with the prototype, thereby affecting the quantity and quality of information

that they were able to receive from the voice skill. Participants who expressed privacy concerns were more guarded about which information they would share with the voice skill (e.g. symptoms of a rash, anything personal about themselves as opposed to general information retrieval from the device). There were fewer concerns with data privacy among those who had favorable perceptions of HADs. Those participants with a more favorable disposition towards HADs and technology were willing to share and receive more information if the tradeoff meant that they could have a more tailored, personalized experience as it related to their sexual health information seeking process (e.g., sharing insurance information with Alexa and having the voice skill track conversations about health over time if they could receive transcripts and identify trends).

### Overview of Findings

#### *Aim 1*

In Aim 1, participants shared their information needs and barriers as it related to sexual health. There were four major themes that emerged from Aim 1: HADs being used primarily as a means of convenience, a preference to use screen-based devices for information seeking, a tradeoff between privacy and functionality, and a desire for HADs to emergency triage users based on their symptoms. This study found that young adults' current usage of HADs focused on convenience-based skills and information, such as setting a timer when cooking, listening to music, turning smart lights on and off, and getting the day's weather forecast. In the context of health,

relevant features that were mentioned as convenient included symptom tracking, symptom evaluation, and being able to connect to emergency services if medically necessary.

Participants highly preferred screen-based devices and entering the study it was the preferred channel for obtaining general information and health information for all participants. Participants noted that a voice skill would need to be efficient and able to deliver content in a manner like their screen-based devices for it to be worth using. Participants also were willing to give up some of their privacy if it resulted in increased functionality in a voice skill. For example, there was a willingness from participants to share insurance information and even have themselves recorded over time if it meant that the voice skill was able to provide some added insights to them. Many participants mentioned concerns around privacy, which affected the type of information they would seek with HADs.

When asked about ideal features/use cases in a voice skill, participants mentioned that in the context of sexual health, wanting a way to understand whether symptoms they are experiencing could be a STD/STI was an important use case that would provide value. Being able to triage symptoms (especially for sexually active young adults) and provide information whether they should seek medical attention was noted as a desired feature in a voice skill.

## *Aim 2*

In Aim 2, participants reacted to the prototype developed based on the data gathered from participants in Aim 1. The prototype had three different use cases – hypothetical scenarios that participants would place themselves in and interact with the skill accordingly. Findings have been divided by use case below.

### *Use Case 1*

In Use Case 1, participants were asked to use the prototype to search for more information regarding unpleasant symptoms experienced after having unprotected sex. Participants were comfortable sharing their symptoms out loud with the voice skill but did want an option where they could indicate they were having difficulty articulating their symptoms (ex. describing a rash). In the event of a misunderstanding or hearing from Alexa that the information was unavailable, participants noted they would disengage with the voice skill quickly and consult a screen-based device instead. When information was provided in response to their hypothetical symptoms, many participants indicated a desire to send more content to a screen-based device so they could review in detail. The TMIM posits that an individual feels anxiety when there is a discrepancy in the information they currently possess and the information that they need, and that they will seek to address that anxiety as soon as possible (Afifi & Weiner, 2006). The need for information quickly (even to the point of, in this case, participants disengaging with the HAD and opting for a screen-based device) aligns with how Afifi & Weiner conceptualized the information gap in TMIM.

### *Use Case 2*

In Use Case 2, participants were asked to search for general sexual health information as it relates to STIs/STDs. In terms of general sexual health information, participants had concerns with the length of content (either too short or too long). When participants felt the information was too long, they were asked about what an appropriate length for a voice response from the voice skill would be. None of the participants were able to give a direct answer on the optimal answer length.

Participants expressed wanting more than general information and being able to get more specific information on a follow-up query with the voice skill. Types of information preferred included an overview of each STD/STI specifically, along with risk factors and treatments. The desire for visuals was mentioned in this use case. The benefit of pictures was to visualize and compare with something they might be experiencing (ex. a rash) so that they could more quickly ascertain whether they needed medical attention. The mixed reactions around the optimal length of content echoes similar findings from Alagha and Helbing (2019) in which they did a comparative analysis of multiple VAs and found that varying lengths of content were delivered by each VA for the same topic. A desire for visuals aligns with the need for rapid information appraisal to reduce the information gap as fast as possible, as discussed in the TMIM (Afifi & Weiner, 2006).

### *Use Case 3*

In Use Case 3, participants were asked to determine whether they needed to use the HAD skill to connect to a medical professional to further discuss their symptoms.

Participants were divided on their reactions to being potentially connected to a medical provider through a voice skill and based their decisions on how they perceived HADs. Some participants expressed feeling a sense of urgency when experiencing uncertainty (in this case, not knowing what their symptoms could be) and wanting to search in a manner that was most comfortable to them (ex. Using Google on a screen-based device). Other participants felt hesitant making complex decisions immediately and wanted some more time to review information before proceeding. Beneficial features mentioned by participants revolved around the ability to sort and filter medical providers. Participants wanted to input more information as it related to their provider to minimize concerns around whether the medical provider would accept their insurance, be in-network, etc. The sense of urgency when experiencing uncertainty aligns well within the context of the TMIM, where an individual seeks to address their gap in knowledge as soon as possible to minimize their anxiety on the subject (Afifi & Weiner, 2006). The hesitation around making complex decisions as it relates to one's health has also been well-documented, and it's possible that feeling pressured to make a decision in the moment like in use case 3 was not a decision users were comfortable with in the moment (Abraham et al., 2011; Kaplan & Frosch, 2005; Moore et al., 2022).

### *Aim 3*

In Aim 3, participants reacted to a new version of the prototype presented in Aim 2. The prototype was refined based on feedback from the participants in Aim 2 and



presented in the context of the same three use cases. Findings have been divided by use case below.

### *Use Case 1*

In Use Case 1, participants approved of the ability to send content to the phone (especially visuals) and be able to refer to them when articulating their symptoms to the voice skill. Additionally, the added functionality of offering the ability to connect to a doctor (accounting for those who did not feel comfortable sharing their symptoms or having difficulty articulating them) was well received. In the event where seeking further medical attention was suggested by the voice skill, participants remarked wanting more time to decide whether to seek medical attention – either by reviewing information on their own more thoroughly, or by seeking information from other channels and then coming back to the voice skill. Like Aim 2, the findings from this use case align well with the constructs of TMIM as it relates to bridging the information gap through a wide array of methods to minimize the anxiety associated with gaps in knowledge when seeking information (Afifi & Weiner, 2006). The hesitancy to select a medical provider was a similar sentiment from Aim 2. The decision to select a medical provider is a complex one, and its possible participants in this study felt there was too much pressure to decide on a provider immediately, instead preferring to take some time to understand their options before moving forward. The need for further research and time to make an informed decision on a healthcare provider has also been well-documented in the literature (Ferrer et al., 2016; Woolf et al., 2005)

### *Use Case 2*

In use case 2, participants searched for general health information related to sexual health. The general content provided was a good introduction according to participants, but participants expressed wanting more specific content related to their sexual health. There was also a desire to have general information sent to their phone for viewing later. Additionally, an individual's perceptions of the HAD affected how comfortable they were with providing information to it. The lack of perceived privacy was a reason driving the use of screen-based devices for health information seeking compared to voice search. Those who had more positive feelings attributed to HADs were more comfortable providing more information to it and found the content to be more reliable. An offering of more sensitive options as it related to a potential health emergency was discussed when asking participants about improvements to the prototype. These findings align directly to the proposed theoretical framework in this study – the attitudes participants had towards the technology (HADs) influenced their outcome expectancies and resulted in the use of alternative information channels.

### *Use Case 3*

In use case 3, participants decided whether they needed medical attention using the voice skill prototype. There was a desire for more personalization around the information experience, with many participants wanting to have a personalized set of providers based on their insurance coverage and location. Other participants mentioned wanting more personalized information relative to their gender – for example, wanting to be offered a same-gender provider, or understanding the specific

effects of STIs/STDs on their gender. Participants mentioned wanting more time to make a complex decision such as connecting to a provider, and despite the changes made from Aim 2, still felt that they would need more information and time to make that decision. The desire for gender-specific care has been well-documented (Guss et al., 2020; Miers, 2002; Regitz-Zagrosek, 2012)

### Discussion

This study helps explore the perspectives of young adults to understand the depth of their sexual health information needs and whether a user-centric designed HAD can be a suitable alternative for fulfilling those information needs. There has long been a desire for focusing on users as it relates to digital products, such as mobile apps, websites, and now HADs (Jungbluth et al., 2018; Tang, 2020; Young, 2022). In recent years, there has been a desire to create these products not with the intention of being first to market, but to be the most relevant and useful product for the end user (Bourgeois-Bougrine, Latorre, & Mourey, 2017). However, special care needs to be taken in finding participants that can represent the end-user, as recruiting is especially difficult for sensitive topics as seen in this study. Recruiting users proved to be more difficult than anticipated, as using traditionally successful mass research platforms such as mTurk and Positly resulted in zero participants completing the entire recruitment process for Aim 1. It is possible that since both platforms required incentives to be provided as tasks were completed (and not at the conclusion of the study) that the less time-consuming tasks that did not require face to face

communication were likely completed for their respective compensations.

Furthermore, the sensitive nature of discussing sexual health could have resulted in hesitancy to have face to face meetings about it.

When considering the impact of COVID-19 on individuals' health seeking behaviors, telehealth became a service viewed more as a necessity than a luxury after the pandemic (Haque, 2021). The telehealth-oriented environment of COVID likely affected individuals' attitudes about online health, information security, and a willingness to engage with technology for health, given the necessity to do so when mass shutdowns were occurring across the country. Recruitment for this study began in early 2022 – two years after the start of the pandemic, and at a point where telehealth services are more mainstream than they were two years before. The findings from this study may have been different had it been conducted prior to March 2020 – with individuals being less likely to be comfortable sharing health information online and engage with technology for health-related purposes.

#### *Privacy Concerns Persist*

In the interviews, participants grappled with the intersection of privacy and functionality, as it related to a voice skill. While some participants were willing to share more information in return for a more relevant user experience, others were not willing to compromise their personal information on a HAD regardless of the potential benefits it could offer. Furthermore, the location and number of devices in a house was a point of concern for participants – those who had roommates or shared a

living space did not see a sexual health voice skill being especially useful for their personal questions.

Privacy remained a concern in Aim 1, with many participants describing the invasive nature of the devices. Concerns based on reports in the media (Knuttsen, 2022) also were mentioned as reasons to not use voice skills extensively. Privacy concerns with HADs have been well-documented in the literature and have been found to have a moderating effect on the usage of HADs (Acosta & Reinhardt, 2022; Cho et al., 2020; Combs, Hazelwood, & Joyce, 2022; McLean, & Osei-Frimpong, 2019). Despite the privacy concerns, participants were still willing to consider using a skill provided it was useful to them. This was an interesting finding, partially due to the privacy concerns, but also due to the sensitivity of sexual health information.

In Use Case 1, participants reacted to discussing their symptoms using voice search to understand how to proceed. Overall, participants were comfortable in sharing their symptoms out loud to a HAD, a finding that goes counter to research conducted on HADs in the context of other sensitive health behaviors such as mental health (Maharjan, Baekgaard, & Bardram, 2019). The inclusion of a reliable source when engaging with health content was also an important theme for Use Case 1. Sources such as the CDC and Mayo Clinic were perceived to be reliable as it related to sexual health content. This is consistent with findings regarding the appraisal of health information for adolescents from Freeman et al. (2020). The importance of the CDC

and Mayo Clinic as strong sources as it relates to online health information appraisal has also been shown to be important to college students by Escoffery et al. (2005).

### *Voice Search Remains Difficult*

Based on the literature, young adults have noted many benefits of HADs in helping streamline the information seeking process (Lopatovska et al., 2018). However, the results from this study noted some drawbacks: participants also expressed their frustration when they could not find information with Alexa, noting that the Alexa interface often misunderstood them, and they felt they had to repeat themselves many times to receive a relevant answer. This finding was aligned with research from Alagha and Helbing (2019) where they evaluated the quality and accuracy of three voice assistants: Siri, Google Assistant, and Alexa. Alexa scored the lowest of the three voice assistants, understanding queries less frequently and using less reliable sources (Alagha & Helbing, 2019). However, Alagha and Helbing's study was focused solely on vaccination information. Our findings confirm their findings about Alexa's drawbacks, but in a sexual health context. Despite their comfort and skill with technology, young adults still expressed that they would have difficulties using voice search on HADs. Difficulties experienced with voice search among young adults was a finding that went counter to characteristics that have defined this population in the literature - being adaptable and able to grasp new technologies quickly (Dimock, 2019).

This study found that the considerations for using a voice skill for health information was predicated on relevance, speed, and convenience. Given the frustrations of some participants with the ability of Alexa to understand them, the room for error when searching for sexual health information on a HAD was low. This was a novel finding in the context of health, as previous studies had focused on the testing of utilitarian benefits of HADs and the impact on usage in general, noting that utilitarian benefits had a direct effect on the usage of the devices (McLean & Osei-Frimpong, 2019). Finally, the desire to use HADs for symptoms-based triage was a new finding not yet discussed in the literature. Generally, providing information about one's health has been viewed with skepticism and hesitation due to privacy concerns by young adults (Cho et al., 2020). This study found that privacy concerns were mitigated if there was a perception that providing information about one's symptoms could help in the case of an emergency. For example, there was a desire to be able to sort by factors such as next open appointment, rating, and wait time (for urgent cases). The features desired by participants in this study are similar to features created for voice skills by Dojchinovski and colleagues (2019). However, Dojchinovski and colleagues created those skills for older adults and caregivers. The findings of this study demonstrate that young adults also desire these features.

### *Beneficial Features*

In terms of beneficial features, participants expressed a desire to have more content options as it related to their symptoms (e.g., If the user mentioned they had a rash, offering more insight than STIs/STDs manifesting as rashes). Initially, content

provided during the use cases consisted of 2-3 sentences from the CDC about STDs/STIs. Participants felt that the length was either too short or too long but could not specifically articulate what the ideal length information provided via a HAD should be. Alagha and Helbing (2020) studied the length of responses from Alexa, Siri, and Google Assistant and found that Alexa's responses were the longest of the three. However, no research to this point has examined what the optimal answer length should be for a HAD voice skill, whether health-related or not.

Another beneficial feature mentioned by participants was to monetize the skill and charge a fixed price to connect the user to a medical professional to discuss any further questions they may have about their sexual health. Monetization has long been a challenge for the Alexa interface, and Amazon recently announced that it will reduce its focus on the Alexa voice assistant division after difficulties in making money from the devices despite having significant market shares in the HAD market (Amadeo, 2022).

Having the ability to send information to a screen-based device was also important. While the desire for more content was an addition that would be made in the prototype (and most voice skills over time), the desire to push sexual health information from a HAD to a screen-based device was a new finding not seen in the literature, one that maximizes the utility of the HAD as a way to triage information and for the screen-based device to serve as a way to more critically appraise the information obtained. Comparing and contrasting a HAD voice skill as an



information seeking channel with more traditional screen-based channels illustrated the preference of this sample to consult screen-based devices when they needed to appraise health information more critically. A beneficial feature for HADs could leverage the best features of HADs and screen-based devices working in tandem: the HAD would serve as the first interaction with information and could send the information to a screen-based device for further examination.

#### *Acknowledging the Sensitive Nature of Sexual Health Information Seeking*

Lastly, accommodating users' concerns about sensitivity was central to the iterative feedback for the prototype. In some of the use case examples, participants did not feel comfortable describing a rash out loud or getting into deep detail about STDs/STIs. The prototype was refined to allow an "exit" opportunity, based on a participant saying that they were uncomfortable sharing information and would prefer to either a) not do so, or b) speak to a medical professional directly about it. There was also an addition of an option for the user to express that they are having difficulty describing their symptoms. By allowing for a more sensitive experience for users, it is possible they will feel more willing to engage with the voice skill and be guided to the information they want.

#### *Digital Health Equity*

The results of this study inform perspectives on digital health equity, particularly as it relates to the ability of HADs to serve as a vital support tool in information seeking

for communities and populations that are historically underrepresented and underprioritized. The approach from this study can be used to identify disparities in information-seeking that occur in different populations. For example, it has been documented in the literature that young adults are more likely than their counterparts to seek health information online, but there remain disparities in information seeking for those in rural populations as well as males in particular age groups (Jackson, Trivedi, & Baur, 2021; Jacobs et al., 2017). Additionally, while this study did not contain a heterogeneous sample of gender and sexual identities (another group with disparate sexual health outcomes), future research could examine how to better understand the health information seeking behaviors for all gender and sexual identities, and how a HAD voice skill can be tailored to best provide the most relevant, timely information as it relates to sexual health. Despite a downtrend in overall usage of HADs, there still exists an opportunity to leverage the main benefits of HAD technology (e.g., the ability of a voice assistant to provide a tailored set of information upon request) with other tools to improve health information seeking in those populations. Another way to improve digital health equity would be to provide the technology directly to patients while anticipating barriers to use, such as a stable internet connection, or a lack of technological literacy and familiarity to set up devices for household use.

### Study Strengths

This study had numerous strengths. First, this study had a broad distribution of young adults in the 18-26 age range. Additionally, the use of in-depth interviews to explore concepts around sexual health and how individuals use a HAD helped uncover insights that could not be collected through a survey or other quantitative instrument, especially given that the extant literature around HADs and sexual health is sparse.

The Design Thinking approach for this study was a strength – by focusing on end user needs and wants and creating a prototype in response to that, an informed prototype was able to be created that already has accounted for the demographic pain points (albeit in a small sample). The testing of particular use cases was also a strength of the study, as it provided the opportunity to test and refine a prototype in a particular situation that an end user could likely encounter in the future. By gathering feedback from two different sets of users that met the study criteria, the voice skill prototype was able to be refined and preliminary architecture in place for future testing.

Lastly, by having participants attend interviews and feedback sessions virtually, this study was able to address some of the discomforts of discussing topics of a sexual nature in person. Additionally, by not asking for personal sexual health information and focusing instead on hypothetical scenarios, this study was able to gather more open, honest feedback from participants without high concerns of recall bias and social desirability bias.

### Limitations

This study did have some limitations. First, as recruitment was a challenge with a sensitive topic such as sexual health, a purposive sample approach was necessary. Snowball sampling methods were used as well, where participants were asked to share information about the study with others who might like to participate, which could have resulted in sample homogeneity, both in demographics as well as responses. Most participants were White or Asian, which may have provided only particular perceptions towards HADs, information seeking, and how they both related to sexual health. In Aim 1, the sample was 70% Asian and in Aim 3 the sample was 70% White. The data gathered on information needs and that informed prototype development could have been biased by the homogeneity of these groups.

Furthermore, this sample was predominantly female, accounting for 63% of the total sample. Therefore, the prototype and understanding of information needs to create the prototype may have also been biased. Additionally, the individuals who participated in this study were different than other people in terms of their comfort sharing their thoughts on a very sensitive topic – something many others might not have agreed to. The level of candor may only apply to a very particular type of individual who may be more proactive in seeking information related to sexual health. The researcher ensured groups did not hit a saturation point in terms of feedback. The sample itself was a younger population that was likely more technologically literate and affluent – all participants were in college or had obtained a graduate degree. Future research could focus on a more even distribution of gender, race, ethnicity, technological

literacy, and affluence (whether by asking household income or limiting the number of participants by educational attainment).

This study used a small sample size across three aims ( $n = 10$  for each phase of the study). While the sample may be small, the depth of responses was rich and varied. The lack of member checking – a technique that takes ideas and results of a research study and presents it back to participants to determine whether they agree with it – was a limitation in this study that affected the methodological rigor. Furthermore, the prototype tested went through 2 rounds of feedback, although in a typical Design Thinking approach there can be more feedback iterations. In future studies, the prototype can undergo more iterative feedback sessions with a larger sample to continuously refine the prototype ahead of development.

Lastly, the prototype was a low-fidelity version in PowerPoint; the results could vary when structuring the prototype using the Alexa interface. Additionally, the prototype was not structured in a way that the voice prompts were read out loud, which could also affect the reliability of the results found. However, this was an exploratory study that was focused on optimal design from a content perspective. Future research will take the prototype and code in Alexa's console to generate a true voice skill for beta testing.

### Implications for the field

The findings from this study have several implications for public health practice. This study leveraged Design Thinking for a relatively new technology in HADs to improve the sexual health information seeking process for young adults through a prototype voice skill. The Design Thinking process can be leveraged in practice to create relevant voice skills for any population of interest, for any content that could be beneficial if distributed through a HAD. Furthermore, the approach to creating a voice skill is relevant for payers (ex. Insurance companies) and providers looking to better engage with their members and improve health outcomes without having constant in-person touchpoints.

The results of this study also inform the emerging literature base on the use of HADs in public health as purveyors of both general and specific information. This study examined the information seeking process for sexual health information in young adults, the results of which could be used to inform public health practitioners' approaches to creating sexual health awareness programs from a content and setting perspective. Public health practitioners operating in local health departments or public health intervention programs could also focus on creating relevant voice skills to better engage with populations of interest, especially in areas that have had historically poor health outcomes (e.g., mental health conditions, seasonal vaccine uptake). The content for the voice skill could also be expanded to include more sexual health information outside of STIs/STDs. Lastly, from a technological perspective, this study is the first study known to the author to conduct usability testing of a

prototype voice skill for public health. The results of this study could provide a methodology to design and evaluate voice skills for public health.

### *Policy Implications*

Numerous policy implications exist for the use of HADs when obtaining health information. Many participants noted concerns about privacy, whether it was feeling that they were listened to by the HAD or their search history not being concealed from others. The recent emergence of advanced AI in the form of ChatGPT has significant implications for conducting this type of research in the future (van Breugel & van der Schaar, 2023). There exist concerns around whether AI is becoming too advanced, and whether it should be limited in its ability to ingest information used in recommendations. It is possible that this study may have had even more difficulties in recruitment had the news of ChatGPT been more widespread during the study period. Furthermore, it is likely that the research findings from this study would be different were it conducted in a post-ChatGPT world, especially as it relates to the utility of “outdated” algorithms such as those in HADs. As developers of these voice skills begin to think about privacy concerns, it will be important to enact policies that protect individuals’ data privacy and offer them the ability to obtain any data being stored or kept by the developers for research purposes.

Payers can also consider enacting equitable policies to ensure that voice-based services, such as HADs, are available to individuals who would most benefit from

them, and that HAD voice skills are not exacerbating existing disparities. HADs may address a population that already has higher levels of technological literacy and resource availability compared to others. One equitable approach could be subsidies through insurance plans, provided that the end-user meets a particular level of engagement with the voice skill (e.g., a payer would pay for 100% of the cost of a HAD (~\$40 value) if the member uses the payer's voice skill at least twice a week for six months). This approach has previously been conducted with the Apple Watch in the Medicare population successfully (Farr, 2019).

### *Future Research*

This study identified multiple areas of focus that would warrant future research to examine further. First, the use of the DT framework for creating voice skills in public health was the first known application in public health to the Principal Investigator's knowledge. Future research could follow the same DT framework and apply it to the creation of other public health voice skills. The use of the TMIM and TAM were both valuable in this study, as they helped contextualize both the structure of the research and the findings. Future research should consider leveraging the TMIM and TAM to build empathetic, user-oriented digital products that can address information gaps in public health. Additionally, while this study examined sexual health information seeking behaviors and how HADs could facilitate that process, future research could examine other sensitive, stigmatized health behaviors, such as mental health conditions. Other feedback from this study revolved around perceptions and concerns about privacy. Future studies could examine the brand perceptions associated with



privacy (e.g., the perception that screen-based browsers have a higher level of privacy than HADs; the tradeoff between privacy and functionality with voice skills, but also other digital products). Lastly, this study examined young adults between the ages of 18 and 26. Future research should consider studying older adults and their information seeking processes, and whether HADs can help facilitate their information needs.

### Conclusion

STI/STD incidence and prevalence among young adults remain at record levels, despite years of research and interventions focused in this area. Despite a plethora of resources, there remains an information gap for young adults seeking to obtain information on sexual health in a manner that is private and judgement-free. HADs and voice skills offer a unique way to address those information needs but remains an understudied area. The application of the Design Thinking approach to design, prototype, and evaluate a voice skill designed to facilitate sexual health information seeking in this study offers a new way to think about engaging with younger populations by rethinking the information seeking process. By further studying young adults' engagement with HADs and voice skills, we can develop content and features in the technology that can better improve the information seeking process, which will hopefully reduce the incidence and prevalence of STIs/STDs among this group.

## Appendices

### **Appendix A. Screener Questionnaire for on-campus participants (to be done via Qualtrics for all aims)**

Thank you for your interest in this study of Home Assistant Devices, such as Alexa, for health information seeking. The purpose of this questionnaire is to see if you match the criteria we have for study participants. Please answer the following questions as honestly as possible.

A “Home Assistant Device” is a handsfree speaker that can be controlled with your voice. They can connect to voice-controlled virtual assistants, like Alexa Voice Service, or Siri, to play music, make calls, send and receive messages, provide information, news, sports scores, tell the weather, and more. I am interested in how young adults like yourself use these devices for sexual health information seeking.

Name:

1. How old are you in years?
  - a. If not between 18 to 26 years, thank them for their time)
2. Are you aware of what a Home Assistant Device is?
  - a. If not, thank them for their time
3. Do you currently own a Home Assistant Device?
4. Which type of Home Assistant Device do you own?
  - a. If not an Amazon Echo suite product, Google Home, or Apple HomePod, thank them for their time.
5. Have you ever used a Home Assistant Device to search for information using a voice command?
  - a. If not, thank them for their time
6. Have you ever used the Internet to search for health-related information?
  - a. If not, thank them for their time
7. Are you comfortable talking about sexual health information seeking?
  - a. Yes
    - No, dismiss

**This concludes our screening questionnaire. Thank you for your time. Based on the questions you’ve answered, you’re eligible for our study. In terms of next steps, I’ll be reaching out to schedule some time to schedule a video call with you and also emailing you a background questionnaire to complete prior to our time together. As a reminder, you will be compensated for your time that you**

**participate in the study and participation will be fully voluntary, with the option to withdraw at any time.**

**Appendix B: Background Questionnaire to be emailed to all participants prior to completion of study activities**

**Thank you for choosing to participate in this study on Home Assistant Devices (HADs) and health information seeking. Prior to your session, please complete the questionnaire below. There will be some multiple-choice questions, and some questions requiring a typed in response. Please answer the following questions as honestly as possible.**

1. What is your gender?
  - a. ☐ Male
  - b. ☐ Female
  - c. ☐ Transgender
  - d. ☐ Non-binary
  - e. ☐ Genderqueer
  - f. ☐ My gender is not reflected here
2. What is your race?
  - a. ☐ White
  - b. ☐ Black or African-American
  - c. ☐ American Indian or Alaskan Native
  - d. ☐ Asian
  - e. ☐ Native Hawaiian or Pacific Islander
  - f. ☐ My race is not reflected here
3. Are you Hispanic/Latino/Latina/Latinx?
  - a. ☐ Yes
  - b. ☐ No
4. What is your age?
5. What is your highest level of education?
  - a. ☐ High School/ GED
  - b. ☐ Some college
  - c. ☐ Community college degree (A.A.)
  - d. ☐ 4-year college/university
  - e. ☐ Masters Degree (MS, MBA, MPH, etc.)
  - f. ☐ Doctorate (PhD, MD, JD, etc.)
6. Which of the following HADs do you own OR use?
  - a. ☐ Amazon Echo
  - b. ☐ Amazon Echo Show
  - c. ☐ Amazon Echo Dot
  - d. ☐ Google Home

- e. ☐ Google Home Mini
- f. ☐ Apple HomePod
- g. ☐ Other: \_\_\_\_\_

7. Have you ever looked for information about health or medical topics from any source?
  - a. Yes = continue
  - b. No =continue
  
8. Based on the results of your most recent search for information about health or medical topics, how much do you agree or disagree with each of the following statements?.....
  - a. It took a lot of effort to get the information you needed.....
    - i. Strongly Agree = Low or medium Health Information Seeking (HIS)
    - ii. Somewhat Agree = Low or medium Health Information Seeking (HIS)
    - iii. Somewhat Disagree = High Health Information Seeking (HIS)
    - iv. Strongly Disagree = High Health Information Seeking (HIS)
  
  - b. You felt frustrated during your search for the information.....
    - i. Strongly Agree = Low or medium Health Information Seeking (HIS)
    - ii. Somewhat Agree = Low or medium Health Information Seeking (HIS)
    - iii. Somewhat Disagree = High Health Information Seeking (HIS)
    - iv. Strongly Disagree = High Health Information Seeking (HIS)
  
  - c. The information you found was hard to understand.....
    - i. Strongly Agree = Low or medium Health Information Seeking (HIS)
    - ii. Somewhat Agree = Low or medium Health Information Seeking (HIS)
    - iii. Somewhat Disagree = High Health Information Seeking (HIS)
    - iv. Strongly Disagree = High Health Information Seeking (HIS)

**Please answer the questions below:**

*Home Assistant Devices*

1. How frequently do you use Home Assistant Devices?
  - a. ☐ Less than 1 time a month
  - b. ☐ 1-3 times a month
  - c. ☐ 1-2 times a week
  - d. ☐ More than 3 times a week
  
2. How do you use Home Assistant Devices?

- a. ☐ Leisure ()
  - b. ☐ Entertainment ()
  - c. ☐ Information ()
  - d. ☐ Smart Home ()
  - e. ☐ Other: \_\_\_\_\_
3. How long have you been using Home Assistant Devices?
- a. ☐ Less than one month
  - b. ☐ 1 – 6 months
  - c. ☐ 6 – 12 months
  - d. ☐ Over 12 months
4. What are your most frequently performed tasks on Home Assistant Devices?
- a. ☐ – Utility (setting alarms, timers, smart home functions)
  - b. ☐ – Searching for information (Asking questions)
  - c. ☐ – Entertainment (Playing games, listening to music)
  - d. ☐ - Other: \_\_\_\_\_

*Information Seeking Behaviors*

1. How do you primarily seek information when it's related to your health?
- a. ☐ Through friends and family
  - b. ☐ Through printed sources (books, magazines, newspaper)
  - c. ☐ Through the internet (phone, computer)
  - d. ☐ Other: Please specify: \_\_\_\_\_
2. How do you find health information about sexual health related questions?
- a. ☐ Through friends and family
  - b. ☐ Through printed sources (books, magazines, newspaper)
  - c. ☐ Through the internet (phone, computer)
  - d. ☐ Other: Please specify: \_\_\_\_\_
3. When you think about who or what you rely on for answering questions about your health, which source do you trust the most?
- a. ☐ Friends
  - b. ☐ Family members
  - c. ☐ Medical professionals
  - d. ☐ Information found on the internet
  - e. ☐ Information found in print sources
  - f. ☐ Other: Please specify: \_\_\_\_\_
4. Which information source would best help you to make an informed decision about your health?
- a. ☐ Friends
  - b. ☐ Family members
  - c. ☐ Information found in print sources
  - d. ☐ Information found on the internet

- e. ☐ Medical professionals
- f. ☐ Other: Please specify: \_\_\_\_\_

## **Appendix C. Aim 1 Interview Guide**

### **Home Assistant Devices and Information Seeking Behavior Interview Guide**

\*Note: Ensure participant chooses a pseudonym prior to beginning the interview.

Introduction [not recorded]: Hello and thank you for joining today. My name is Junaed Siddiqui and I'm a PhD candidate at the University of Maryland, College Park in the School of Public Health, Department of Behavioral and Community Health. The purpose of today's interview is to learn about your experiences and thoughts about Home Assistant Devices and how you search for health information generally and sexual health information specifically with and without these devices.

#### **\*INFORMED CONSENT REVIEW AND CONFIRMATION HERE\***

I would like to record this conversation to make sure I don't miss anything you say. Do I have your permission? This is just an informal conversation with no right or wrong answers to any of the questions I will ask. I am interested in sexual health information and will ask you questions about that. You do not have to answer any questions you're uncomfortable with and we can stop the interview any time.

#### **\*RECORDING START\***

Introduction

#### *Preferences in a Home Assistant Device Voice Skill*

1. What features are least helpful for you when using a Home Assistant Device skill?
2. What benefits do you feel that a Home Assistant Device provides?
3. What do you think you would not use a Home Assistant Device for?

#### *Information Seeking*

1. How do you normally search for sexual health information?
2. What sources do you consult when looking to learn more?
3. How do you find or get health information about recreational drugs, alcohol, and sexual health?
4. When searching for health information, what methods do you use (Ex. Google search, talking to friends, posting online, etc.)?
  - a. If you use the internet to obtain sexual health information, where do you normally start your search? A search engine, specific website, healthcare center website, social media, blogs, forums, or something else?
5. How do you decide which sources to use when searching for information regarding your health?
  - a. What about for sexual health?



6. How do you feel when you are searching for health information?
  - a. When you are unable to find something?
  - b. When you have trouble articulating what you're looking for?
7. What features would be most beneficial in a voice skill for Home Assistant Devices designed for sexual health information needs?
8. What would be a “dealbreaker” for you to not use a Home Assistant Device for sexual health information needs?

### *Technology*

1. How do you use your internet connected devices (ex. Phone, tablet, computer, etc.) when searching for information currently?
2. How would you use technology when you're looking for something you already have an idea about?
3. What is your level of confidence with your ability to use technology? How does this impact your ability to look for information?
4. What technologies do you use when searching for information that's familiar vs. unfamiliar?
5. What concerns do you have with particular technologies that could stop you from seeking information using it, even though it may be more useful than other ones?
6. How would you use technology when you are unsure of something you need information on?
7. What is your comfort level with technology and using it to search for information?

Thank you so much for taking the time to talk to me today. After I meet with other participants, I will look at the themes of what people have said over the course of our meetings. If it's okay with you, I can get back in touch and share those compiled results. You can also reach out to me via phone or email, both of which are in the consent form.

### **\*RECORDING END\***

- **Provide compensation and have them sign acknowledge receipt.**
- **Upload audio recording file to a safe location on UMD Box. Do not delete until the UMD Zoom audio transcription feature has been obtained and validated by someone from the research team.**

## **Appendix D. Aim 2 and 3 Interview Guide**

### **Home Assistant Devices and Information Seeking Behavior Interview Guide**

\*Note: Ensure participant chooses a pseudonym prior to beginning the interview.

Introduction [not recorded]: Hello and thank you for joining today. My name is Junaed Siddiqui and I'm a PhD candidate at the University of Maryland, College Park in the School of Public Health, Department of Behavioral and Community Health. The purpose of today's interview is to learn about your experiences and thoughts about Home Assistant Devices and how you search for health information generally and sexual health information specifically with and without these devices.

#### **\*\* INFORMED CONSENT PROCESS HERE\*\***

I would like to record this conversation to make sure I don't miss anything you say. Do I have your permission? This is just an informal conversation with no right or wrong answers to any of the questions I will ask. I am interested in sexual health information and will ask you questions about that. You do not have to answer any questions you're uncomfortable with and we can stop the interview any time.

#### **\*RECORDING START\***

#### **Introduction and Warm Up**

Before we look at the prototype, I'd like to learn more about your thoughts regarding Home Assistant Devices.

#### **Information Seeking**

What are your thoughts about Home Assistant Devices?

Do you have any concerns about using Home Assistant Devices?

#### **Starting Iteration Session**

Okay, we can start looking at things now. I'll share my screen and a prototype voice skill here. We will be walking through this prototype in the context of three hypothetical scenarios. I will not be asking you about any personal information but will ask that you answer the questions from the perspective of someone in this scenario.

Okay, now we're ready to start a feedback session. The goal of this session is to get your open, honest feedback on the prototype being presented here. What I will be doing is taking notes on your feedback, asking some probing questions, and getting an understanding of how you like the prototype. I will take the feedback from this session and others, and provide a redesigned prototype, and we will meet again and repeat this process.

\*Have user walk through prototype\*

*Prototyping*

- *What works well for this prototype?*
- *What are limitations of this prototype?*
- *How can this prototype be improved?*
- *How can this prototype use other functionality?*

*Testing*

- *Can you tell me why you did \_\_\_\_?*
- *Walk me through why you chose \_\_\_\_.*
- *What were you deciding here?*
- *How do you feel about the design here? Functionality?*

Thank you so much for taking the time to talk to me today. After I meet with other participants, I will look at the themes of what people have said over the course of our meetings. If it's okay with you, I can get back in touch and share those compiled results. You can also reach out to me via phone or email, both of which are in the consent form. The last part of this will be taking a short survey.

**\*RECORDING END\***

**1. Provide compensation and have them sign acknowledge receipt.  
Upload audio recording file to a safe location on UMD Box. Do not delete until the UMD Zoom audio transcription feature has been obtained and validated by someone from the research team.**

## Appendix E: Aim 2 Prototype


# Alexa Voice Skill Wireframe

1



2







Alexa, what should I do if I have a rash?

Alexa, what is a STD/STI?

Alexa, what are the risks of having unprotected sex?

3





Alexa, tell me more about STDs/STIs

Alexa, are there any available appointments nearby?

Alexa, is there someone I can talk to more about this?





Alexa, tell me more about STIs/STDs

Alexa, how do I treat my rash?

Alexa, how are STIs/STDs treated?

5





Alexa, how do I know I have a STD/STI?

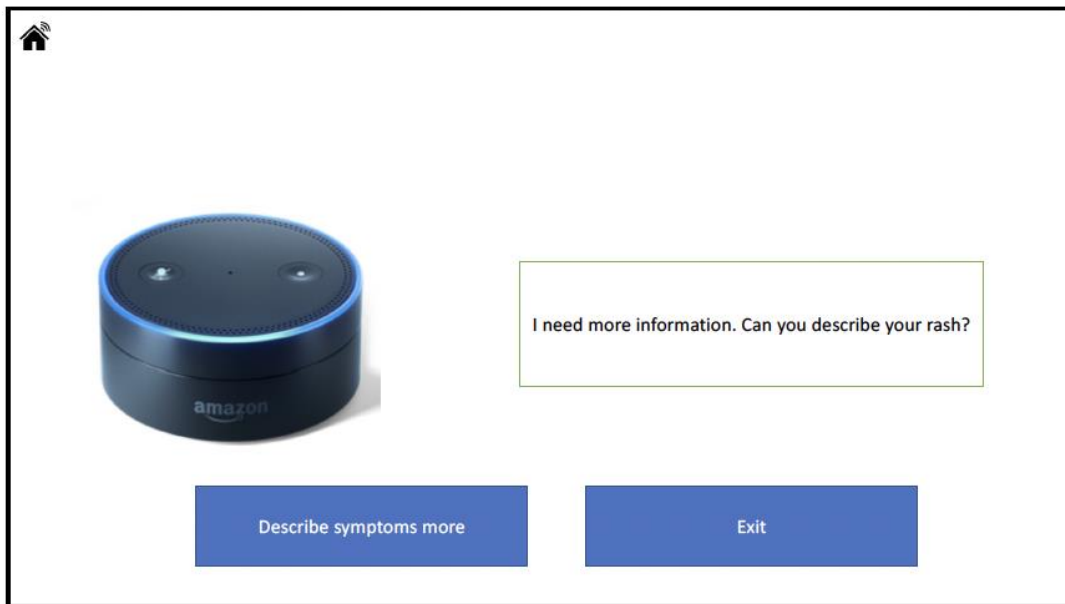
Alexa,

Alexa,


6


# Alexa Responses

7




8






According to the CDC, STDs are diseases that are passed from one person to another through sexual contact. These include chlamydia, gonorrhea, genital herpes, human papillomavirus (HPV), syphilis, and HIV. Many of these STDs do not show symptoms for a long time. Even without symptoms, they can still be harmful and passed on during sex.

9







According to the CDC, Sexual risk behaviors place youth at risk for HIV infection, other STDs, and unintended pregnancy

10







According to the CDC, Half of the 20 million new STDs reported each year were among young people aged 15 to 24.

11






According to the CDC

According to Mayo Clinic,

STDs/STIs are....





Tell me more about your symptoms

Do you want me to connect you to a doctor? There are X available appointments in your area

I'm sorry, I can't answer that

13





I'm sorry, I can't answer that

14



15

## Appendix F: Aim 3 Prototype

# Alexa Voice Skill Wireframe

1



 Use Case 1




Alexa, I have a rash. Could it be a STD?

Alexa, do I need medical attention for my rash?

Alexa, can you tell me more about my rash?

3

 Use Case 1: first set of responses



My rash is in my groin.

I don't feel comfortable sharing that information.


The rash is hard to explain. What else can I do?


4



5



 Use Case 3



Alexa, do I need to schedule an appointment for my rash?

Alexa, schedule me an appointment for my rash.

7

 Use Case 3



My rash is red/swollen/has pus.


I'd rather discuss this with a doctor.

# Alexa Responses

9







Use Case 1




I understand you don't feel comfortable sharing that information or are having trouble proceeding. There are two options from here: Option 1 – I can connect you to a doctor for you to learn more; Option 2 – I can send more information about rashes due to STDs/STIs to your phone. Which option would you prefer?


Option 1

Option 2

11



Use Case 1




According to the CDC, some rashes located in the groin that are red, pus-filled, and swollen can be due to STDs and STIs. You should consider seeing a medical professional. Would you like me to find urgent care centers near you?


Yes

No

Exit



Use Case 2




According to the CDC, STDs are diseases that are passed from one person to another through sexual contact. These include chlamydia, gonorrhea, genital herpes, human papillomavirus (HPV), syphilis, and HIV. Many of these STDs do not show symptoms for a long time. Even without symptoms, they can still be harmful and passed on during sex.

Would you like to learn more?

Yes

No

13



Use Case 2



You can find more information at [CDC.Gov/STD](https://www.cdc.gov/std/). Would you like me to send you this link?

Yes

No

14



15



16



17

**Appendix G: mHealth App Usability Questionnaire (adapted from Zhou et al., 2019)**

#	Statements	N/A	1	2	3	4	5	6	7
1.	The app was easy to use.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
2.	It was easy for me to learn to use the app.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
3.	The navigation was consistent when moving between screens.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
4.	The interface of the app allowed me to use all the functions (such as entering information, responding to reminders, viewing information) offered by the app.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
5.	Whenever I made a mistake using the app, I could recover easily and quickly.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
6.	I like the interface of the app.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
7.	The information in the app was well organized, so I could easily find the information I needed.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
8.	The app adequately acknowledged and provided information to let me know the progress of my action.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
9.	I feel comfortable using this app in social settings.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
10.	The amount of time involved in using this app has been fitting for me.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
11.	I would use this app again.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
12.	Overall, I am satisfied with this app.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE
13.	The app would be useful for my health and well-being.	<input type="checkbox"/>	DISAGREE	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	AGREE

## Appendix H: IRB Approval Letter

---



1204 Marie Mount Hall  
College Park, MD 20742-5125  
TEL 301.405.4212  
FAX 301.314.1475  
irb@umd.edu  
www.umresearch.umd.edu/IRB

DATE: January 3, 2023

TO: Junaed Siddiqui, MS  
FROM: University of Maryland College Park (UMCP) IRB

PROJECT TITLE: [1982188-1] An Exploration of the Feasibility of Home Assistant Device voice skills as a means of disseminating sexual health information for young adults

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS  
DECISION DATE: January 3, 2023

REVIEW CATEGORY: Exemption category #45CFR46.104(d)(2)(ii)

Thank you for your submission of New Project materials for this project. The University of Maryland College Park (UMCP) IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact the IRB Office at 301-405-4212 or [irb@umd.edu](mailto:irb@umd.edu). Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Maryland College Park (UMCP) IRB's records.

## Appendix I: Informed Consent Form



Initials: \_\_\_\_\_ Date: \_\_\_\_\_

/

### Institutional Review Board

1204 Marie Mount Hall • 7814 Regents Drive • College Park, MD 20742 • 301-405-4212 • [irb@umd.edu](mailto:irb@umd.edu)

### CONSENT TO PARTICIPATE

<b>Project Title</b>	<i>An Exploration of the Feasibility of Home Assistant Device voice skills as a means of disseminating sexual health information for young adults</i>
<b>Purpose of the Study</b>	<i>This research is being conducted by <b>Junaed A. Siddiqui, MS</b> at the University of Maryland, College Park. We are inviting you to participate in this research project because you currently own or are aware of the Amazon Alexa suite of Home Assistant Devices, are between the ages of 18 and 26, have used the internet to search for information about your health, speak English, and live in the United States. The purpose of this research project is to understand whether the use of home assistant devices for health information is feasible and/or acceptable, and whether there exist any barriers to their use.</i>
<b>Procedures</b>	<i>This study involves answering some basic questions about yourself and how you look for information via an online questionnaire that takes 15-minutes to complete and participating in a 30-minute virtual interview to test a basic prototype for a Home Assistant Device. Questions asked during the video discussion will relate to preferences for a Home Assistant Device skill (ex. "Which of these options is most helpful?"), information seeking (ex. "How did you decide which option to choose?"), and technology in general (ex. "Does this prototype make sense to you intuitively?") The reaction sessions will be audio and screen recorded via Google Meet or Zoom. You will be asked to be recorded and if not, the researcher will take notes on the reaction sessions and your answers to the questions.</i>
<b>Compensation</b>	<p><i>Upon completion of the questionnaire and reaction session, you will receive \$30.00 in a VISA gift card. Your name will not be linked to the questionnaire.</i></p> <p><i>If you will earn \$100 or more as a research participant in this study, you must provide your name, address and SSN to receive compensation.</i></p> <p><i>If you do not earn over \$100 only your name and address will be collected to receive compensation.</i></p>
<b>Potential Risks and Discomforts</b>	<i>There may be some risks from participating in this research study. Some questions about sexual health and searching for information about your sexual health may be distressing. This study will mitigate that risk by asking questions about hypothetical scenarios and will not have to have to reflect your personal experiences. You do not have to answer any question that makes you uncomfortable and may withdraw at any time. Any risks to breach of confidentiality will be mitigated by ensuring all data <u>will be only be</u> accessible to the Principal Investigator, and will be only stored on a cloud secure storage location managed by the University of Maryland.</i>
<b>Potential Benefits</b>	<i>There are no direct benefits from participating in this research. This research is not designed to help you personally, but the results may help the investigator learn more about the reasons people will/will not use home assistant devices for health information. We hope that, in the future, other people might benefit from this study through improved understanding.</i>



<b>Confidentiality</b>	<p>Your data will be protected to the greatest extent possible to prevent a breach in confidentiality. To minimize risk, your name will not be included on any collected data. Each survey will be coded. Only the investigator will have access to survey data. Electronic data will be kept on a password protected computer accessible only to the Principal Investigator. Data will be retained for a period of 2 years from the interview date to provide opportunity to publish aggregated results from the data. After the 2-year period, the recordings will be destroyed – all versions and copies of the recordings will be deleted from the PIs UMD Box account. Identifiers will be deleted 90 days after acceptance of this dissertation by the University.</p> <p>If we write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.</p>
<b>Right to Withdraw and Questions</b>	<p>Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify. If you are a faculty member, staff or student at the University of Maryland, your grades, standing or employability at the University of Maryland will not be positively or negatively affected by your decision to participate or not participate in this study.</p> <p>If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the investigator:</p> <p style="text-align: center;"><b>Junaed A. Siddiqui, MS</b>  <b>University of Maryland College Park, School of Public Health</b>  <b>Department of Behavioral and Community Health</b>  <b>1234 SPH Building</b>  <b>College Park, MD 20742</b>  <b>Junaed1@umd.edu</b>  <b>443-722-2507</b></p>
<b>Participant Rights</b>	<p>If you have questions about your rights as a research participant or wish to report a research-related injury, please contact:</p> <p style="text-align: center;"><b>University of Maryland College Park</b>  <b>Institutional Review Board Office</b>  <b>1204 Marie Mount Hall</b>  <b>College Park, Maryland, 20742</b>  <b>E-mail: <a href="mailto:irb@umd.edu">irb@umd.edu</a></b>  <b>Telephone: 301-405-0678</b></p> <p>This research has been reviewed according to the University of Maryland, College Park IRB procedures for research involving human subjects.</p> <p>For more information regarding participant rights, please visit:  <a href="https://research.umd.edu/research-resources/research-compliance/institutional-review-board-irb/research-participants">https://research.umd.edu/research-resources/research-compliance/institutional-review-board-irb/research-participants</a>.</p>
<b>Statement of</b>	By clicking yes below, you confirm that you are at least 18 years of age; you have read



Initials: \_\_\_\_\_ Date: \_\_\_\_\_

<b>Consent</b>	<i>this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in this research study. You are free to print/save a copy of this consent form.</i>
----------------	--

## Appendix J: Study Flyer

### AMAZON ALEXA STUDY

Come interact with a novel voice skill for Home Assistant Devices!

#### An exploration of the information-seeking process using Home Assistant Devices

This study is being conducted to better understand the information seeking preferences of young adults when engaging with Home Assistant Devices (ex. Google Home, Amazon Echo, Apple HomePod). The study will involve completing a 15-minute background questionnaire and a 30-minute interview about your reactions to a prototype voice skill designed to address sexual health concerns.

Participants will receive:

- \$30.00 upon completion of the questionnaire and reaction session



#### Location

- One 30-minute interview conducted via Zoom/Google Meet

#### Are you eligible?

- Between the ages of 18 and 26
- Speak English
- Have used the Internet to search for health information
- Currently own OR are aware of an Alexa Home Assistant Device (HAD)
- Live in the United States
- Have NOT participated in the previous HAD study by the PI

**If you're unsure if you meet the requirements, call or email a member of the study team:**

- Junaed Siddiqui, MS, CPH
- Principal Investigator
- University of Maryland School of Public Health
- Junaed1@umd.edu
- ###-##-####

## Glossary

*Device Interaction:* Any voice-activation of the developed public health skill, measured by back-end analytics via Amazon platform.

*Voice Path:* The specific series of voice-commands given by the user to the device, measured by back-end analytics via Amazon platform. This is one of the main components of usability testing.

*User Experience:* This term is used to represent how the user perceives the entire interaction time with the skill, including processing, comprehension, and ease of use. It is a core concept measured and observed in the field of human-computer interaction. Measured via survey

*Home Assistant Device:* This term refers to a device with artificial intelligence capabilities that can receive audio data as voice input from a user and provide audio data as voice output, responding to the user via spoken language. The program driving the user interface can access databases which stores information of activation commands, tasks, activity types, device descriptions, device categories, and device location. Using a series of algorithms, machine learning models, and natural language processing capabilities, the device's response can be accompanied with a device interaction and/or the results of an internet search to process the user's request. Google was the first organization to coin the term "Home Assistant Device" in their patent application, although it is now used ubiquitously to represent devices made by other companies such as Amazon and Apple.  
(<https://patents.google.com/patent/US9747083B1/en>)

*Skill:* This refers to a voice experience specific to the Amazon interface, and only used for Amazon Alexa-enabled devices. For the purposes of this dissertation, we used Amazon Echo devices only, and thus this term refers to the custom voice experience that was designed during this process. Skills are programmed through the JSON language and leverage Amazon's automatic speech recognition and natural language understanding to let people use their voices naturally to interact with content, services, and devices. (<https://developer.amazon.com/en-US/alexa/alexa-skills-kit>)

*End-User:* The person using the product or skill.

*User Centered Design:* This term refers to an iterative design process in which designers focus on the users and their needs in each phase of the design process. Design teams generally involve users throughout the design process via a variety of research and design techniques, to create the most highly usable and effective products for the user. Also referred to as *Human-Centered Design*.  
(<https://www.interaction-design.org/literature/topics/user-centered-design>).

*Internet of Things:* This term refers to the suite of technologies and applications that equip devices to generate and transmit information to each other, allowing them to

“talk” to each other via the Internet.

([https://www2.deloitte.com/insights/us/en/focus/internet-of-things/technical-primer.html?icid=dcom\\_promo\\_featured|us;en](https://www2.deloitte.com/insights/us/en/focus/internet-of-things/technical-primer.html?icid=dcom_promo_featured|us;en))

*Artificial Intelligence:* This term (AI for short) is commonly referred to as the lifecycle of information transmission, starting from an agent that receives information from the environment, undergoes an internal decision/analysis process (leveraging complex programming concepts to approximate human behavior), and outputs the information to assist in performing an action. (Russell and Norvig, 1995). Home Assistant Devices leverage AI to interact with users in their environment and return intelligent responses.

*Usability Testing:* Usability testing refers to the evaluation process of a product by testing it with a representative group of users. Typically, users will be given a task to complete, while researchers monitor their interaction with the product by watching, listening, and note taking. The goal of usability testing is to identify any issues with the effectiveness of the product from a user perspective and try to rectify those problems to improve user satisfaction. (<https://www.usability.gov/how-to-and-tools/methods/usability-testing.html>)

## Bibliography

- Abookire, S., Plover, C., Frasso, R., & Ku, B. (2020). Health Design Thinking: an innovative approach in public health to defining problems and finding solutions. *Frontiers in Public Health*, 8, 459.
- Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M., & Steggles, P. (1999). Towards a better understanding of context and context-awareness. In *Handheld and Ubiquitous Computing: First International Symposium, HUC'99 Karlsruhe, Germany, September 27–29, 1999 Proceedings 1* (pp. 304-307). Springer Berlin Heidelberg.
- Abraham, J., Sick, B., Anderson, J., Berg, A., Dehmer, C., & Tufano, A. (2011). Selecting a provider: what factors influence patients' decision making? *Journal of Healthcare Management*, 56(2), 99-116.
- Ackard, DM, Neumark-Sztainer, D. (2001). Health care information sources for adolescents: age and gender differences on use, concerns, and needs. *Journal of Adolescent Health*, 29, 170-176.
- Acosta, L. H., & Reinhardt, D. (2022). A survey on privacy issues and solutions for Voice-controlled Digital Assistants. *Pervasive and Mobile Computing*, 80, 101523.
- Afifi, W. A., & Weiner, J. L. (2004). Toward a theory of motivated information management. *Communication Theory*, 14, 167–190. doi: <http://10.1111/j.1468-2885.2004.tb00310.x>.
- Afifi, W. A., & Weiner, J. L. (2006). Seeking information about sexual health: Applying the theory of motivated information management. *Human Communication Research*, 32(1), 35-57.

- Alagha, E., & Helbing, R. (2019). Evaluating the quality of voice assistants' responses to consumer health questions about vaccines: an exploratory comparison of Alexa, Google Assistant, and Siri. *BMJ Health & Care Informatics* 26: e100075.
- Amadeo, R. (2022, November 21). *Amazon Alexa is a "colossal failure," On pace to lose \$10 billion this year. Amazon Alexa is a "colossal failure," on pace to lose \$10 billion this year.* <https://arstechnica.com/gadgets/2022/11/amazon-alexa-is-a-colossal-failure-on-pace-to-lose-10-billion-this-year/>
- Ammari, T., Kaye, J., Tsai, J. Y., & Bentley, F. (2019). Music, Search, and IoT: How People (Really) Use Voice Assistants. *ACM Transactions on Computer-Humam Interaction.*, 26(3), 17-1.
- Anderson, M., & Jiang, J. (2018). Teens, social media & technology 2018. *Pew Research Center*, 31, 1673-1689.
- Basch, C. H., MacLean, S. A., Romero, R. A., & Ethan, D. (2018). Health information seeking behavior among college students. *Journal of Community Health*, 43(6), 1094-1099.
- Bernstein A (2015). The Evolution of Design Thinking. *Harvard Business Review.*;93(9).
- Berwick, D. (2003). Disseminating Innovations in Health Care. *Journal of the American Medical Association* .289(15):1969–1975. doi: <http://10.1001/jama.289.15.1969>.
- Bias, R. G., & Mayhew, D. J. (Eds.). (2005). *Cost-justifying usability: An update for the Internet age*. Elsevier.
- Biddinika, M. K., Syamsiro, M., Novianti, S., Nakhshiniev, B., Aziz, M., & Takahashi, F. (2019). Dissemination of technology information through YouTube: a case of renewable energy technology. *Telkomnika*, 17(3), 1526-1538.

- Bonsch, A., Vierjahn, T., Shapiro, A., & Kuhlen, T. (2017). Turning anonymous members of a multiagent system into individuals. *Virtual Humans and Crowds for Immersive Environments*, 1-4.
- Borzekowski, D. L., & Rickert, V. I. (2001). Adolescent cybersurfing for health information: a new resource that crosses barriers. *Archives of Pediatrics & Adolescent Medicine*, 155(7), 813-817.
- Bourgeois-Bougrine, S., Latorre, S., & Mourey, F. (2017). Facilitating Innovation Through Design Thinking and Prospective Ergonomics. In *12th European Conference on Innovation and Entrepreneurship ECIE 2017*, 100.
- Bresnahan, T. F., Davis, J. P., & Yin, P. L. (2014). *Economic value creation in mobile applications*. In *The changing frontier: Rethinking Science and Innovation Policy*, 233-286. University of Chicago Press.
- Brin, D. J. (2022, November 2). *50% of U.S. Consumers Use Voice Search Daily: 2022 survey*. UpCity. <https://upcity.com/experts/consumers-and-voice-search-study/>
- Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6).
- Brown, T., & Wyatt, J. (2010). *Design thinking for social innovation (SSIR)*  
[http://www.ssire.view.org/articles/entry/design\\_thinking\\_for\\_social\\_innovation./](http://www.ssire.view.org/articles/entry/design_thinking_for_social_innovation./)
- Brownson, R., Eyler, A., Harris, J. Moore, J., & Tabak, R. (2018). Research full report: getting the word out: new approaches for disseminating public health science. *Journal of Public Health Management and Practice*, 24(2), 102.
- Buhi, E., Daley, E., Fuhrmann, H., & Smith, S. (2009). An observational study of how young people search for online sexual health information. *Journal of American cCollege hHealth*, 58(2), 101-111.

- Canbek, N., & Mutlu, M. (2016). On the track of artificial intelligence: Learning with intelligent personal assistants. *Journal of Human Sciences*, 13(1), 592-601.
- Carroll, C., Nidever, M., Chiodo, C., Pathipati, J., & Lin, A. (2017). Robin: Enabling independence for individuals with cognitive disabilities using voice assistive technology. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems* (pp. 46-53). New York NY: ACM.
- Chesson, H., Spicknall, I., Bingham, A., Brisson, M., Eppink, S., Farnham, P., Kreisel, K., Kumar, S., Laprise, J., Peterman, T., Roberts, H., & Gift, T (2021). The Estimated Direct Lifetime Medical Costs of Sexually Transmitted Infections Acquired in the United States in 2018, *Sexually Transmitted Diseases*, 48(4), 215-221.doi: <http://doi.org/10.1097/OLQ.0000000000001380>
- Cho, E. (2019). Hey Google, can I ask you something in private? *In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, pp. 1-9.
- Cho, E., Sundar, S., Abdullah, S., & Motalebi, N. (2020). Will deleting history make Alexa more trustworthy? effects of privacy and content customization on user experience of smart speakers. *In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (pp. 1-13).
- Choi, B. (2005). Peer Reviewed: Twelve Essentials of Science-based Policy. *Preventing Chronic Disease*, 2(4).
- Choi, B., Orlova, A., Marsh, M., Issa, N., & Morrison, H. (2004). Two information dissemination approaches for public health decision makers: encyclopaedia and fire alarm. *Journal of Epidemiology & Community Health*, 58(8), 634-634.



- Chung, H., Iorga, M., Voas, J., & Lee, S. (2017). Alexa, can I trust you? *Computer*, 50(9), 100-104.
- Clauser, G. (2017, February 10). *What is alexa? what is the amazon echo, and should you get one?* TheWirecutter. Com.
- Clay, R. (2020, March 19). *Conducting Research During the COVID-19 Pandemic*.  
<https://www.apa.org/news/apa/2020/conducting-research-covid-19>
- Cohen, P., Cheyer, A., Horvitz, E., Kaliouby, R., & Whittaker, S. (2016). On the future of personal assistants. *In Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems (CHI'16)*, 1032- 1037.
- Combs, M., Hazelwood, C., & Joyce, R. (2022). Are you listening? –an observational wake word privacy study. *Organizational Cybersecurity Journal: Practice, Process and People*, 2(2), 113-123.
- Conti, G., & Sobiesk, E (2007). An honest man has nothing to fear: User perceptions on web-based information disclosure. *In Proceedings of the Symposium on Usable Privacy and Security (SOUPS)*, 2007. DOI <http://10.1145/1280680.1280695>
- Coumau, J., Furuhashi, H., & Sarrazin, H. (n.d.). *A smart home is where the bot is*.  
<https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/a-smart-home-is-where-the-bot-is>
- Coyne, S., Padilla-Walker, L., & Howard, E. (2013). Emerging in a digital world: A decade review of media use, effects, and gratifications in emerging adulthood. *Emerging Adulthood*, 1(2), 125-137.
- Creswell, J. (2013). *Qualitative inquiry and research design: Choosing among five approaches.*: Sage publications.

- Creswell, J. (2015). *30 essential skills for the qualitative researcher*. Sage publications.
- Crosswaite, C., & Curtice, L. (1994). Disseminating research results-the challenge of bridging the gap between health research and health action. *Health Promotion International* 9(4), 289–296, <https://doi-org.proxy-um.researchport.umd.edu/10.1093/heapro/9.4.289>
- Crouch, M., & McKenzie, H. (2006). The logic of small samples in interview-based qualitative research. *Social Science Information*, 45(4), 483-499.
- Cunningham J., Godinho A., Kushnir, V. (2017) Can Amazon's Mechanical Turk be used to recruit participants for internet intervention trials? A pilot study involving a randomized controlled trial of a brief online intervention for hazardous alcohol use. *Internet Interventions* 10:12-16. doi: <http://doi.org/10.1016/j.invent.2017.08.005>.
- Cunningham, J., Godinho, A., & Kushnir, V. (2017). Using Mechanical Turk to recruit participants for internet intervention research: experience from recruitment for four trials targeting hazardous alcohol consumption. *BMC Medical Research Methodology*, 17(1), 156. <https://doi.org/10.1186/s12874-017-0440-3>
- Czibula, G., Guran, A., Czibukla, I., & Cojocar, G. (2009). IPA- An Intelligent Personal Assistant Agent for Task Performance Support. In: *Proceedings of the 5th IEEE International Conference on Intelligent Computer Communication and Processing*, pp. 31-34.
- De Castro, P., Marsili, D., Poltronieri, E., & Calderón, C. A. (2012). Dissemination of public health information: key tools utilised by the NECOBELAC network in Europe and Latin America. *Health Information and Libraries Journal*, 29(2), 119–130. <http://doi.org/10.1111/j.1471-1842.2012.00977.x>

- Decker, M. , Gutmann-Gonzalez, A., Price, M., Romero, J., Sheoran, B., & Yarger, J. (2020). Evaluating the effectiveness of an intervention integrating technology and in-person sexual health education for adolescents (In the Know): protocol for a cluster randomized controlled trial. *Journal of Medical Internet Research Protocols*, 9(8), e18060.
- DeMers, J. (2015, January 29). *Communication in Text, Voice, Video or In-Person?*  
<https://www.inc.com/jayson-demers/communication-in-2015-text-voice-video-or-in-person.html>
- Denning, T., Kohno, T., & Levy, H. (2013). Computer security and the modern home. *Communications of the Association for Computing Machinery*, 56(1): 94, doi <http://doi.org/10.1145/2398356.2398377>.
- Denning, T., Matsuzek, C., Koscher, K., Smith, J., Kohno, T. (2009). A spotlight on security and privacy risks with future household robots: Attacks and lessons. *In Proceedings of the International Conference on Ubiquitous Computing (UbiComp)*, doi <http://doi.org/10.1145/1620545.1620564>.
- Design thinking*. (n.d.). IDEO U. <https://www.ideo.com/pages/design-thinking>
- Digital Health Technology Vision 2017: Technology for People* (pp. 1-24, Rep.). (2017). Accenture Consulting. doi: <http://doi.org/10.1097/OLQ.0000000000001368>
- Dojchinovski, D., Ilievski, A., & Gusev, M. (2019). Interactive home healthcare system with integrated voice assistant. *In 42nd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO)* (pp. 284-288). IEEE.

- Dunn, J. (2016, November 4) *We put Siri, Alexa, Google Assistant, and Cortana through a marathon of tests to see who's winning the virtual assistant race – here's what we found.* <http://www.businessinsider.com/siri-vs-google-assistant-cortanaalexa-2016-11>
- Elliot, V. (2018). Thinking about the coding process in qualitative data analysis. *The Qualitative Report*, 23(11), 2850-2861. Retrieved from
- Eng, T. (2001). *The e-Health landscape: A terrain map of emerging information and communication technologies in health and health care*. Princeton, NJ: The Robert Wood Johnson Foundation, 2001.
- Ericsson, K., & Simon, H. (1984). *Protocol analysis: Verbal reports as data*. The MIT Press.
- Escoffery, C., Miner, K. R., Adame, D., Butler, S., McCormick, L., & Mendell, E. (2005). Internet use for health information among college students. *Journal of American College Health*, 53(4), 183-188.
- Farr, C. (2019, October 7). *Private medicare plan devoted health says it is the first to cover Apple Watch as a benefit.* <https://www.cnbc.com/2019/10/07/devoted-medicare-advantage-plan-covering-apple-watch-as-a-benefit.html>
- Fernandes, E., Jung, J., & Prakash, A. (2016). Security analysis of emerging smart home applications. *In Proceedings of the IEEE Symposium on Security and Privacy (S&P)*,. DOI: <http://doi.org/10.1109/SP.2016.44>.
- Ferrer, R., Klein, W., Lerner, J., Reyna, V. and Keltner, D. (2016). Emotions and health decision making. *Behavioral Economics and Public Health*, pp.101-132.
- Ficco, M., & Russo, S. (2009). A Hybrid Positioning System for Technology-Independent Location-Aware Computing Software: *Practice and Experience* 39, 1095-1125.
- Flick, O. (2009). *An Introduction to Qualitative Research*: Sage Publications.

- Fox, S., & Duggan, M. (2013, January 15). *Health online 2013*.  
<http://www.pewinternet.org/2013/01/15/health-online-2013/>.
- Freeman, J., Caldwell, P., & Scott, K. (2020). The role of trust when adolescents search for and appraise online health information. *The Journal of Pediatrics* 221, 215-223.
- Freeman, J., Caldwell, P., Bennett, P., & Scott, K. (2018). How adolescents search for and appraise online health information: A systematic review. *The Journal of Pediatrics* 195: 244-255.
- Ghosh, A., Chakraborty, D., & Law, A. (2018). Artificial intelligence in Internet of things. *CAAI Transactions on Intelligence Technology*, 3(4), 208-218.
- Gibbons, S. (2016, July 31). *Design Thinking 101*. Nielsen Norman Group.  
<https://www.nngroup.com/articles/design-thinking/>.
- Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.
- Glanz, K., Rimer, B. K., & Viswanath, K. (2015). *Health behavior: Theory, Research, and Practice*. John Wiley & Sons.
- Graus, D., Bennett, P., White R., & Horvitz, E. (2016) Analyzing and predicting task reminders. *Proceedings of the 2016 conference on User Modeling Adaptation and Personalization (UMAP '16)* (pp. 7–15). New York: ACM.
- Gray, N., Klein, J., Noyce, P. (2005). Information-seeking behavior in adolescence: the place of the Internet. *Social Science & Medicine* 60(7): 1467-1478.
- Griol, D., Molina, J., & Callejas, Z. (2017). Incorporating android conversational agents in m-learning apps. *Expert Systems* 34(4). doi: <http://doi.org/10.1111/exsy.12156>.

- Guest, G., Bunce, A., & Johnson, L. (2006). How Many Interviews Are Enough? An experiment with data saturation and variability. *Field Methods*, 18(1), 59–82.doi: <https://doi.org/10.1177/1525822X05279903>
- Guss, C.E., Eiduson, R., Khan, A., Dumont, O., Forman, S.F. and Gordon, A.R. (2020). “It'd Be Great to Have the Options There”: A Mixed-Methods study of gender identity questions on clinic forms in a primary care setting. *Journal of Adolescent Health*, 67(4), pp.590-596.
- Hall, A., Mayer, T., Wuggetzer, I., & Childs, P. R. N. (2013). Future aircraft cabins and design thinking: optimisation vs. win-win scenarios. *Propulsion and Power Research*, 2(2), 85-95.
- Haque, S. N. (2021). Telehealth beyond COVID-19. *Psychiatric Services*, 72(1), 100-103.
- Hassoon, A., Schrack, J., Naiman, D., Lansey, D., Baig, Y., Stearns, V., Celentano, D., Martin, S., & Appel, L. (2018). Increasing physical activity amongst overweight and obese cancer survivors using an Alexa-Based intelligent agent for patient coaching: Protocol for the Physical Activity by Technology Help (PATH) trial. *JMIR Research Protocols* 7(2): e27.
- Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2017). Code saturation versus meaning saturation: how many interviews are enough? *Qualitative Health Research*, 27(4), 591–608. doi: <https://doi.org/10.1177/1049732316665344>
- Herner, S. (1959). The information-gathering habits of American medical scientists. *Journal of Medical Education* 58, 236.

- Holden, H., & Rada, R. (2011). Understanding the influence of perceived usability and technology self-efficacy on teachers' technology acceptance. *Journal of Research on Technology in Education* 43(4), 343-367.
- Huang, T. T., Aitken, J., Ferris, E., & Cohen, N. (2018). Design thinking to improve implementation of public health interventions: an exploratory case study on enhancing park use. *Design for Health*, 2(2), 236-252.
- Jääskeläinen, R. (2010). Think-aloud protocol. *Handbook of translation studies*, 1, 371-374.
- Jacobs, W., Amuta, A., & Jeon, K. (2017). Health information seeking in the digital age: An analysis of health information seeking behavior among US adults. *Cogent Social Sciences* 3(1), 1302785.
- Jayasundara, C. (2021). Sexual health information seeking behaviour of adolescents and their satisfaction with the information outcome: An application of the theory of motivated information management. *The Journal of Academic Librarianship* 47(5), 102383.
- Joshi, S.V., Stubbe, D., Li, S.T.T., & Hilty, D. (2019). The Use of Technology by Youth: Implications for Psychiatric Educators. *Academic Psychiatry* 43, 101–109. doi: <https://doi-org.proxy-um.researchport.umd.edu/10.1007/s40596-018-1007-2>
- Jungbluth, J., Krieger, R., Gerke, W., & Plapper, P. (2018). Combining virtual and robot assistants-a case study about integrating amazon's Alexa as a voice interface in robotics. *In Robotix-Academy Conference for Industrial Robotics (RACIR)*, 5.
- Moar, J., & Escherich, M. (2021, February 8). *Voice Assistant Market – Key Statistics 2018*; <https://www.juniperresearch.com/researchstore/operators-providers/voice-assistants-market-research-report?ch=voice%20search>

- Kachur, R., McFarlane, M., Habel, M., Friedman, A., Ford, J., Kinsey, J., & Hogben, M. (2013). STD information seeking, communication and testing among american youth: exploring exposure to the national Get Yourself Tested (GYT) campaign. *Journal of Adolescent Health, 52*(2), S7.
- Kaplan, R. M., & Frosch, D. L. (2005). Decision making in medicine and health care. *Annual Review Of Clinical Psychology, 1*, 525-556.
- Kamal, S., Shafiq, M., & Kakria, P. (2020). Investigating acceptance of telemedicine services through an extended technology acceptance model (TAM). *Technology in Society 60*, 101212.
- Kelley, T., & Kelley, D. (2013). Creative confidence: Unleashing the creative potential within us all. Danvers (MA): Crown Publications.
- Kerner, J., Rimer, B., & Emmons, K. (2005). Introduction to the special section on dissemination: dissemination research and research dissemination: how can we close the gap? *Health Psychology, 24*(5), 443–446. doi: <https://doi.org/10.1037/0278-6133.24.5.443>
- Khurana, D., Koli, A., Khatter, K., & Singh, S. (2023). Natural language processing: state of the art, current trends and challenges. *Multimedia Tools & Applications 82*, 3713–3744. doi: <https://doi.org/10.1007/s11042-022-13428-4>
- Knote, R.; Janson, A.; Eigenbrod, L. & Söllner, M. (2018): The what and how of smart personal assistants: principles and application domains for IS Research. *Multikonferenz Wirtschaftsinformatik (MKWI)*.



- Knuttson, K. (2022, December 13). *Alexa is listening: Make these important privacy tweaks on your Amazon Echo Device now*. <https://www.foxnews.com/tech/alexa-is-listening-make-these-important-privacy-tweaks-your-amazon-echo-device-now>
- Kreisel, K. M., Spicknall, I. H., Gargano, J. W., Lewis, F. M., Lewis, R. M., Markowitz, L. E., Roberts, H., Johnson, A., Song, R., St. Cyr, S., Weston, E., Torrone, E., & Weinstock, H. S. (2021). Sexually transmitted infections among US women and men: prevalence and incidence estimates, 2018. *Sexually transmitted diseases*, 48(4), 208-214.
- Ku, B., & Lupton, E. (2020). *Health Design Thinking: Creating products and services for better health*. MIT Press.
- Kumar, S., Chesson, H., & Gift, T. (2021). Estimating the direct medical costs and productivity loss of outpatient chlamydia and gonorrhea treatment. *Sexually Transmitted Diseases* 48(2) e18-e21 doi: <http://doi.org/10.1097/OLQ.0000000000001240>
- Kwon, M., Jung, M., & Knepper, R. (2016). Human expectations of social robots. *In Proceedings the Eleventh ACM/IEEE International Conference on Human Robot Interaction*, 463-464.
- Lau, J., Zimmerman, B., & Schaub, F. (2018). Alexa, are you listening? Privacy perceptions, concerns and privacy-seeking behaviors with smart speakers. *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW), 1-31.
- Lazim, C., Ismail, N., & Tazilah, M. (2021). Application of technology acceptance model (TAM) towards online learning during covid-19 pandemic: Accounting students perspective. *International Journal of Business Economics & Law* 24, 13-20.

- Lee, Y., Kozar, K., & Larsen, K. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems* 12(1), 50.
- Legris, P., Ingham, J., & Colletette, P. (2003). Why do people use information technology? A critical review of the technology acceptance model. *Information & management* 40(3), 191-204.
- Leichliter, J., Copen, C., Dittus, P (2017). Confidentiality Issues and Use of Sexually Transmitted Disease Services Among Sexually Experienced Persons Aged 15–25 Years — United States, 2013–2015. *MMWR Morbidity Mortality Weekly Report* 2017; 66:237–241. DOI: <http://dx.doi.org/10.15585/mmwr.mm6609a1>
- Link, B., & Phelan, J. (1995). Social conditions as fundamental causes of disease. *Journal of Health and Social Behavior*, 80-94.
- Lis, J. (2022, September 16). *How big is the voice assistant market?* <https://www.insiderintelligence.com/content/how-big-voice-assistant-market>
- Lomas, J. (1990). Finding audiences, changing beliefs: the structure of research use in Canadian health policy. *Journal of Health Politics and Policy Law* 15, 525–42.
- Lopatovska, I., Rink, K., Knight, I., Raines, K., Cosenza, K., Williams, H., Sorsche, P., Hirsch, D., Li, Q., & Martinez, A. (2018). Talk to me: Exploring user interactions with the Amazon Alexa. *Journal of Librarianship and Information Science* 51(4), 984-997.
- López, G., Quesada, L., & Guerrero, L. A. (2017). Alexa vs. Siri vs. Cortana vs. Google Assistant: a comparison of speech-based natural user interfaces. *In International Conference on Applied Human Factors and Ergonomics*, 241-250.

- Luger, E., & Sellen, A. (2016) Like having a really bad PA: The gulf between user expectation and experience of conversational agents. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, 5286–5297.
- Lyon, A. R., & Koerner, K. (2016). User-centered design for psychosocial intervention development and implementation. *Clinical Psychology: Science and Practice*, 23(2), 180-200.
- MacFadyen J. S. (2014). Design thinking. *Holistic nursing practice*, 28(1), 3–5.  
<https://doi.org/10.1097/HNP.0000000000000008>
- Malbon, K. M., Ojong, T., & Nucci-Sack, A. (2012). Access to sexual health education and care for adolescents: Using technology. *Journal of Adolescent Health*, 50(2), S24-S25.
- Mantel, M. (1994). A basic framework for cost-justifying usability engineering. *Cost-Justifying Usability*, 9.
- Marangunic, N., & Granic, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society* 14(1), 81-95.
- Mayhew, D. J. (1999). The usability engineering lifecycle. In *CHI'99 Extended Abstracts on Human Factors in Computing Systems*, 147-148.
- McLean, G., & Osei-Frimpong, K. (2019). Hey Alexa... examine the variables influencing the use of artificial intelligent in-home voice assistants. *Computers in Human Behavior* (99), 28-37.
- Miers, M. (2002). Developing an understanding of gender sensitive care: exploring concepts and knowledge. *Journal of Advanced Nursing*, 40(1), 69-77.

- Miles, M., Huberman, A., & Saldaña, J. (2014). Qualitative data analysis: A methods sourcebook.
- Moore, R., Purvis, R.S., Hallgren, E., Reece, S., Padilla-Ramos, A., Gurel-Headley, M., Hall, S. and McElfish, P.A. (2022). “I am hesitant to visit the doctor unless absolutely necessary”: A qualitative study of delayed care, avoidance of care, and telehealth experiences during the COVID-19 pandemic. *Medicine*, 101(32).
- Nass, C., Moon, Y., & Carney, P. (1999). Are people polite to computers? Responses to computer-based interviewing systems. *Journal of Applied Social Psychology* 29(5): 1093-1109.
- Nass, C., Moon, Y., Fogg, B., Reeves, B., & Dryer, C (1995). Can computer personalities be human personalities? *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '95)*, 228-229
- Nass, C., Steuer, J., & Tauber, E. R. (1994). Computers are social actors. *In Proceedings of the SIGCHI conference on Human Factors in Computing Systems* ,72-78. ACM.
- Nehls, K., Smith, B., & Schneider, H. (2015). “Video-Conferencing Interviews in Qualitative Research” *Enhancing Qualitative and Mixed Methods Research with Technology*. Pp. 140-157. doi: <http://doi.org/10.4018/978-11-4666-6493-7.ch006>
- Newman, L. (2016, December). *The botnet that broke the Internet isn't going away*.<https://www.wired.com/2016/12/botnetbroke-internet-isnt-going-away/>.
- Nielsen J. (1993). *Usability Engineering*. Academic Press.: .
- Nielsen, N. (2000, March 18). *Why You Only Need to Test with 5 Users*. Nielsen Norman Group. <https://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/>.

- Norman, D. (2013). *The design of everyday things: Revised and expanded edition*. Basic Books.
- Norouzi, N., Bruder, G., Belna, B., Mutter, S., Turgut, D., & Welch, G. (2019). A Systematic Review of the convergence of Augmented Reality, Intelligent Virtual Agents, and the Internet of Things. *In Artificial Intelligence in IoT*, 1-24.
- Office of Disease Prevention and Health Promotion. (n.d.). *Social determinants of health. Healthy People 2030*. U.S. Department of Health and Human Services.  
<https://health.gov/healthypeople/objectives-and-data/social-determinants-health>
- Ohannessian, C. M., Vannucci, A., Flannery, K. M., & Khan, S. (2017). Social media use and substance use during emerging adulthood. *Emerging Adulthood*, 5(5), 364-370.
- Olson, K. E., O'Brien, M. A., Rogers, W. A., & Charness, N. (2011). Diffusion of Technology: Frequency of Use for Younger and Older Adults. *Ageing International*, 36(1), 123–145. <https://doi.org/10.1007/s12126-010-9077-9>
- Patterson, S. P., Hilton, S., Flowers, P., & McDaid, L. M. (2019). What are the barriers and challenges faced by adolescents when searching for sexual health information on the internet? Implications for policy and practice from a qualitative study. *Sexually Transmitted Infections*, 95(6), 462-467.
- Plattner, H. (2010). *An introduction to design thinking PROCESS GUIDE*. <https://dschool-old.stanford.edu/sandbox/groups/designresources/wiki/36873/attachments/74b3d/MoDeGuideBOOTCAMP2010L.pdf>
- Porcheron, M., Fischer, J. E., & Sharples, S. (2017). "Do animals have accents?": Talking with agents in multi-party conversation. *Proceedings of the 2017 ACM Conference on*

- Computer Supported Cooperative Work and Social Computing - CSCW '17*, 207-219.  
doi: <http://doi.org/10.1145/2998181.2998298>
- Porcheron, M., Fischer, J., McGregor, M., Brown, B., Luger, E., Candello, H., & O'Hara, K. (2017). Talking with Conversational Agents in Collaborative Action. *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, 431-436. doi: <http://doi.org/10.1145/3022198.3022666>
- Powell, J. A., Darvell, M., & Gray, J. A. (2003). The doctor, the patient and the world-wide web: how the internet is changing healthcare. *Journal of the Royal Society of Medicine*, 96(2), 74–76. doi: <https://doi.org/10.1177/014107680309600206>
- Punch, K. (2014). *Introduction to social research (3rd ed.)*. London, UK: SAGE.
- Purington, A., Taft, J., Sannon, S., Bazarova, N., & Taylor, S. Alexa is my new BFF: In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems- CHI EA '17*, 2853-2859.
- QSR International. (n.d.) NVivo for Mac. <https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/support-services/nvivo-downloads>.
- Radovic, A., McCarty, C. A., Katzman, K., & Richardson, L. P. (2018). Adolescents' perspectives on using technology for health: Qualitative study. *JMIR Pediatrics and Parenting*, 1(1), e8677.
- Raffaelli, M., Bogenschneider, K., & Flood, M. (1998). Parent-teen communication about sexual topics. *Journal of Family Issues* 19: 315-333.
- Regitz-Zagrosek, V. (2012). Sex and gender differences in health: Science & Society Series on Sex and Science. *EMBO Reports*, 13(7), 596-603.

- Rains, S. (2008). Health at high speed: Broadband internet access, health communication, and the digital divide. *Communication Research*, 35, 283-297.
- Ranney, M. L., Choo, E. K., Spirito, A., & Mello, M. J. (2013). Adolescents' preference for technology-based emergency department behavioral interventions: does it depend on risky behaviors?. *Pediatric Emergency Care*, 29(4), 475-481.
- Roberts, J. P., Fisher, T. R., Trowbridge, M. J., & Bent, C. (2016). A design thinking framework for healthcare management and innovation. *Healthcare* 4 (1): 11–14.
- Ronen, E., O'Flynn, C., Shamir, A., & Weingarten, A. (2016). IoT goes nuclear: Creating a ZigBee chain reaction. Cryptology ePrint Archive, Report 2016/1047  
<http://eprint.iacr.org/2016/1047>.
- Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the health belief model. *Health Education Quarterly*, 15(2), 175-183.
- Russell, S., & Norvig, P. (2003). *Artificial Intelligence: A modern approach*. Prentice Hall, New Jersey.
- Sandhu, J. (2013). *PopTech: Measure early, measure often: rapid, real-time feedback in design for social innovation*. PopTech (Made to Measure: The New Science of Impact). [http://poptech.org/e3\\_jaspal\\_sandhu](http://poptech.org/e3_jaspal_sandhu)
- Schamber, L. (2000). Time-line interviews and inductive content analysis: their effectiveness for exploring cognitive behaviors. *Journal of the American society for Information Science*, 51(8), 734-744.
- Schank, R. C. (2014). *Conceptual information processing* (Vol. 3). Elsevier.

- Scholten, H., & Granic, I. (2019). Use of the principles of design thinking to address limitations of digital mental health interventions for youth. *Journal of Medical Internet Research*, 21(1), e11528.
- Sciuto, A., Saini, A., Forlizzi, J., & Hong, J. I. (2018). " Hey Alexa, What's Up?" A Mixed-Methods Studies of In-Home Conversational Agent Usage. *In Proceedings of the 2018 Designing Interactive Systems Conference*, 857-868.
- Selkie, E. M., Benson, M., & Moreno, M. (2011). Adolescents' views regarding uses of social networking websites and text messaging for adolescent sexual health education. *American Journal of Health Education*, 42(4), 205-212.
- Selwyn, N. (2009). *The digital native—myth and reality*. Emerald Group Publishing Limited.
- Sexually transmitted diseases (stds)*. (2019, October 29).  
<https://www.mayoclinic.org/diseases-conditions/sexually-transmitted-diseases-stds/symptoms-causes/syc-20351240>
- Sexually Transmitted Infections - Healthy People 2030* | *health.gov*. (n.d.). Healthy People 2030. <https://health.gov/healthypeople/objectives-and-data/browse-objectives/sexually-transmitted-infections>
- Sexually transmitted infections (STIs)*. (2019, June 14). World Health Organization.  
[https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-\(stis\)](https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(stis))
- Shim B. S. (2011). Current concepts in bacterial sexually transmitted diseases. *Korean Journal of Urology*, 52(9), 589–597. doi: <https://doi.org/10.4111/kju.2011.52.9.589>
- Simon, H. A. (1981). *The sciences of the Artificial*. Massachusetts Institute of Technology.



- Skinner, H., Biscope, S., Poland, B., & Goldberg, E. (2003). How adolescents use technology for health information: implications for health professionals from focus group studies. *Journal of Medical Internet Research* 5(4): e32.
- Strauss, A. (1998). *Qualitative analysis for social scientists*. New York: Cambridge University Press.
- Tang, Y. (2020). Promoting user advocacy through design thinking in the age of automated writing. *In Proceedings of the 38th ACM International Conference on Design of Communication*, 1-6.
- Thakur, A., Soklaridis, S., Crawford, A., Mulsant, B., & Sockalingam, S. (2021). Using Rapid Design Thinking to Overcome COVID-19 Challenges in Medical Education. *Academic Medicine: Journal of the Association of American Medical Colleges*, 96(1), 56–61. <https://doi.org/10.1097/ACM.00000000000003718>
- Tonsaker, T., Bartlett, G., & Trpkov, C. (2014). Health information on the Internet: gold mine or minefield? *Canadian Family Physician Medecin de Famille Canadien*, 60(5), 407–408.
- Tsevat, D., Wiesenfeld, H., Parks, C., & Peipert, J. (2017). Sexually transmitted diseases and infertility. *American Journal of Obstetrics and Gynecology*, 216(1), 1–9. doi: <https://doi.org/10.1016/j.ajog.2016.08.008>
- van Breugel, B., & van der Schaar, M. (2023). Beyond Privacy: Navigating the Opportunities and Challenges of Synthetic Data. *arXiv preprint arXiv:2304.03722*.
- Von Rosen, A., & von Rosen, F., Tinnemann, P., Muller-Riemenschneider, F. (2017). Sexual health and the internet: cross-sectional study of online preferences among adolescents. *Journal of Medical Internet Research* 19(11), e379.

- Vtyurina, A., Savenkov, D., Agichtein, E., & Clarke, C. L. (2017). Exploring conversational search with humans, assistants, and wizards. *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems - CHI EA '17*, 2187-2193. ACM Press. doi: <http://doi.org/10.1145/3027063.3053175>
- Weinstock, H., Kreisel, K., Spicknall, I., Chesson, H., Miller, W. (2021). STI prevalence, incidence and costs in the United States, *Sexually Transmitted Diseases* 48(4), 207.:
- Williams, M., & Moser, T. (2019). The art of coding and thematic exploration in qualitative research. *International Management Review* 15(1), 45-55.
- Wu, D., Taly, A., Shankar, A., & Boneh, D. (2016). Privacy, discovery, and authentication for the Internet of Things. *In Proceedings of the European Symposium on Research in Computer Security (ESORICS)*, 301–319. doi: [http://doi.org/10.1007/978-3-319-45741-3\\_16](http://doi.org/10.1007/978-3-319-45741-3_16).
- Yi, Y. J. (2018). Sexual health information-seeking behavior on a social media site: Predictors of best answer selection. *Online Information Review* 42(6), 880-897.
- Young, T., Pang, J., & Ferguson, M. (2022). Hearing from you: Design thinking in audiological research. *American Journal of Audiology*, 31(3S), 1003-1012.
- Zeng, E., Mare, S., & Roesner, F. (2017). End user security and privacy concerns with smart homes. *In Proceedings of the 13th Symposium on Usable Privacy and Security (SOUPS)*.
- Zhou, L., Bao, J., Setiawan, M., Saptono, A., Parmanto, B. (2019). The mHealth App Usability Questionnaire (MAUQ): Development and Validation Study. *JMIR MHealth and UHealth* 7(4): e11500.