An Empirically Grounded Sociotechnical Perspective on Designing Virtual Agents for Older Adults

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ABSTRACT

Autonomous, intelligent virtual agents (IVAs) are increasingly used commercially in essential information spaces such as healthcare. Existing IVA research has focused on microscale interaction patterns, for example those related to the usability of artificial intelligence systems. However, the sociotechnical patterns of users' information practices and their relationship with the design and adoption of IVAs have been largely understudied, especially when it comes to older adults, who stand to benefit greatly from IVAs. Yet, exposing such patterns may more meaningfully relate sociotechnical considerations to users' perceptions and attitudes toward the adoption of emerging technologies such as IVAs. We explore here the feasibility of information models in informing our understanding of how older adults may use and perceive an IVA. To do this, we relate the insights and findings from a case study of health information IVAs to the six stages of the information search process model (ISP). By doing this, we uncover sociotechnical issues pertinent to each stage of the ISP which help to better contextualize (older) users' interaction with intelligent interfaces such as IVAs. Through this, we argue for the potential of information models to inform the design of interactive user interfaces from a sociotechnical approach.

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1. INTRODUCTION

The use of systems powered by artificial intelligence (AI) in essential information spaces such as health and finance has accelerated in growth within commercial spaces. Significant research and engineering advances have recently facilitated this growth. Yet, research in the design of such technologies has focused largely on the technical requirements, and comparatively less so on matters of user comfort, acceptance, and attitudes towards adoption of these systems, especially as influenced by social and cultural contexts. As such, highly functional systems were produced, which at the same time left several classes of people marginalized – in a manner that we are only recently beginning to understand and acknowledge (Browne, 2015; Noble, 2018; Eubanks, 2018).

Older adults are an exemplar of a potential user group that stands to benefit from the many emerging technologies that have been gaining traction due to advances in AI. Digital platforms as interfaced by AI-powered technologies such as virtual assistants and virtual agents offer increased access to essential services such as healthcare when such services are migrated to digital platforms. Yet, at the same time, these transitions risks marginalizing older adults (Norman, 2019; Munteanu et al., 2018). These consequences become amplified by AI applications' increasing ubiquity and availability, which now span mobile devices, internet of things technologies, and smart devices. The potential for group-level and societal harm may pose further challenges in terms of the comfort, acceptance, and attitudes towards the adoption of AI-based technologies, especially by those at risk of being marginalized by such technologies. Yet, the potential benefits of such technologies, especially for many marginalized populations, is great. As such, a path forward may be to not stifle the technical advances of such applications, but to inform their design from the interconnected contexts grounded in societal, cultural, and individual factors (Lee, 2018).

As AI systems grow more sophisticated, they become increasingly coupled with larger information systems which connect into, interplay with, and support users' information behavior at large. This transition in turn influences users' broader socially- and culturally-contextual elements of their lives (Browne, 2015; Noble, 2018; Eubanks, 2018). Thus, it is becoming ever more important for design, research, and development of AI technologies to not only focus on matters of usability and small-scale issues of user experience (in addition, of course, to engineering considerations), but also to consider the greater context in which these systems are being used. In other words, one must continue to study matters of user comfort, acceptance, and attitudes towards adoption of these systems, but do so while also bringing to the forefront the influences of social and cultural contexts.

The most ubiquitous examples of AI-powered systems include intelligent virtual agents (IVAs), which are AI-powered interfaces that use a computer-generated entity (a virtual character) to complete a task. Apple's Siri, Microsoft's Cortana and Amazon's Alexa are examples of virtual agents in the form of virtual assistants that provide real-time information such as weather, sports, traffic, and news. IVAs have recently seen an increase in ubiquity in both mobile and desktop-based interfaces and also as an extension of the means to communicate critical information in commercial or public settings. Such applications include IVAs being used as telehealth or financial advisors, where systems such as health- or finance-related IVAs are complementing or replacing remote (human) specialists. Examples include Woebot (Fitzpatrick, Darcy, & Vierhile, 2017), a virtual therapist used to deliver cognitive behavioral therapy, DocOn (Reuters, 2017), a virtual doctor used to deliver health information, and robo-advisors in the financial industry (BMO, 2018).

Some research on older adults' perceptions of IVAs interplaying with social and cultural factors exists. For example, the work of Vardoulakis et al. (2012) and Esposito et al. (2018) have found that older adults' acceptance of IVAs is related to their social status and familiarity with technology as a whole. However, more progress of this variety has to be made to properly and sufficiently addressed the many contextual, cultural, and especially social aspects at play. These aspects become vital when considering the sociotechnical challenges in AI development as well as incorporating human insights into the development of AI technologies (Turkle, 2017). However, taking such an approach is easier said than done. Numerous properties, such as the complexity of human psychology and the limits of human cognition, make it difficult to fully embrace a sociotechnical approach to design (Norman & Stappers, 2015).

A promising path towards a sociotechnical approach to design may be to draw from information studies to inform the relationship between human information behavior and AI-powered information systems such as IVAs. Information studies draws in a large part from the social sciences (Cronin, 2008) and applies its theories to information systems. Moreover, information studies' applicability in the domains of IVAs and other AI-powered interfaces is reinforced by these technologies' increasing roles as couriers of information to users.

In turn, in this paper we aim to explore the feasibility of one type of information behavior theory, in the form of information models, to inform the sociotechnical approach to the design of user-facing AI systems, especially for marginalized users such as older adults. Information behavior models can provide valuable insight into the processes that users engage in to acquire, manage, process, and understand information. These models have been used extensively in the library and information sciences to explain people's interactions with information but have been underused in HCI research.

Thus, we relate here the results of a case study of older adults' perceptions of IVAs to the Information Search Process (ISP). The ISP is an information model that describes the process of information search, starting from the initiation of the search task to search closure when the desired information is found. We use the ISP to make sense of the experimental results from a sociotechnical perspective. The ISP provided for us an understanding of the complex interplay of socio-technical factors affecting users' interaction, attitudes, and perceptions of an AI system, as well as a more meaningful grounding of design recommendations in these factors. In effect, some conclusions from the study about older adults' perceptions of IVAs could not be drawn prior to the application of the ISP. The example of our case study has shown the value of using information models as a means towards a sociotechnical approach to design in conjunction with the more functional approaches currently used in HCI.

Through this paper, we aim to investigate whether these models can explain users' complex relationships with these systems, and how information models can support the capacity of research and design to more meaningfully engage these relationships and systems. By presenting a critical analysis of and an argument for the theoretical and practical application of information models towards the design of AI-powered systems, we aim to surface evidence to support this methodology proposal.

By taking a systematic approach to design via the use of pre-established information models, researchers, designers, and developers can rely on a conceptual sociotechnical framework that can guide them in designing and developing interactive intelligent systems. This will help with deepening the understanding of the comfort, acceptance, and attitudes towards adoption of AI technologies. In turn, this will help HCI practitioners, user experience designers, AI engineers, information system designers, and critical theory scholars better address issues of the digital divide that are faced by underrepresented users such as older adults, who also stand to benefit from such AI-powered technologies.

1.1. Terms and Definitions

Sociotechnical Approach

The sociotechnical approach to design considers equally the technical, human, social, and organization factors of a product or service in order to deliver better value to end-users and stakeholders (Mumford, 2000). It does this by emphasizing the joint optimization of people (sociological systems) and information communication technologies (technological systems) for improved practical outcomes. A sociotechnical approach posits that technology is not value-neutral and that social values are embedded in design. Sociotechnical approaches to design remain under-studied, and until recently, only timidly explored in a practical way (Baxter & Sommerville, 2011; Norman & Stappers, 2015). We will expand on the definition of the sociotechnical approach in Section 2.4.

Virtual Agent (VA) and Intelligent Virtual Agent (IVA)

Intelligent virtual agents (IVAs) are task-oriented computer-generated entities (virtual characters). More specifically, virtual agents are defined by conferences such as ACM Intelligent Virtual Agents as "*interactive digital characters that exhibit human-like qualities and can communicate with humans and each other using natural human modalities like facial expressions, speech and gesture*" (Pelachaud, 2019). Following from this definition, we use the term Intelligent Virtual Agent (IVA) throughout this paper to denote the type of virtual agents that are capable of actions that are specific to human communication in a programmatic way (typically with the aid of certain capabilities based on artificial intelligence such as natural language processing, emotion recognition, etc.). Examples of IVAs include: SimSensei (DeVault et al., 2014), which is a virtual human interviewer and therapist; Woebot (Fitzpatrick, Darcy, & Vierhile, 2017), which is a virtual cartoon therapist robot; or, Amazon Alexa, which is a commercially successful voice assistant. Design dimensions of intelligent virtual agents include the use (or non-use) of non-verbal body language, the modality of the interface (e.g. voice-only or embodied), and the use of facial expressions.

Sociotechnical Perspective of Intelligent Virtual Agents

A sociotechnical perspective of IVAs aims to study the design IVAs as well as critically analyze their situated use, while accounting for all of a user's technical, human, social, and organization needs. Applying theories from information studies is a means through which a sociotechnical perspective can be taken, as information studies draws in a large part from the social sciences (Cronin, 2008). In the context of this paper, we view IVAs, which have been studied in depth with traditional technologically focused HCI paradigms, as a "technology" component of a larger information system (O'Hara, Watson, & Kavan, 1999). In turn, we posit that empirically grounded theoretical models from information studies can be applied to the design of IVAs in such a context. Thus, we apply a theory from information studies to a case study on IVAs with the goal to demonstrate how to apply concepts from information studies as a bridge between the theory of the sociotechnical approach and the empirical HCI design of systems that use AI.

1.2. Research Contributions

In this paper, we contribute:

- A sociotechnical perspective on design considerations for IVAs that are to be used by OAs (considerations such as fidelity – video vs. speech-only, or agency – human vs. machine). We provide pragmatic suggestions on the design of IVAs that is informed by empirical results supplemented by this theoretical framework. By viewing the design of IVAs through the lens of theories of information behaviour, we have an additional valuable framework to use when considering the design of IVAs and other AI-based technologies for improved user experience and the better meeting of users' needs. (Sections 3 & 4)

- An analysis on the feasibility of information models to inform the sociotechnical approach, such as the one in the contribution mentioned above, to the design of user-facing AI systems. (Section 5.1)

- A reflection on the generality of the approach of applying information models to design, grounded in our application of ISP to a case study of IVAs for OAs. This includes a discussion of the selection of ISP for such applications (in contrast to other models) (Section 3.2), a reflection on why we consider this model to be appropriate (Sections 3.2 & 5.1), and how this can help frame future HCI research (Section 5.2).

1.3. Outline

In this paper, we present an experimentally-motivated reflection on the use of sociotechnical information models such as the ISP in framing the critical analysis of the design of AI-powered systems (such as IVAs), especially for underrepresented groups such as OAs. For this, we structured the paper as:

- **Section 2:** a synthesis of the literature in which our analysis is grounded, and which informs our considerations of the user and technology space that we selected as a case study.
- **Section 3:** a description of a case study (in the form of an experiment of IVA use by OAs) that helps us show the applicability of models such as the ISP to this space.
- **Section 4:** a discussion of the results of the case study through the lens of the ISP to demonstrate the application of an information model towards the design and evaluation of an AI system.
- **Section 5:** a discussion of the feasibility of the ISP to inform the sociotechnical approach to the design of IVAs, as well as a discussion of the generalizability of the approach of applying information models to the design of AI systems.

2. BACKGROUND AND RELATED WORK

The research discussed in this paper aims to explore how ISP and the study of intelligent virtual agents (IVAs) can be interwoven in order to produce designs that more easily break down adoption barriers particularly for underrepresented users.

For this, we first look at the theoretical background of the Information Search Process (ISP), which is the information model to which the results from the case study are related in order to form new insights. We then discuss the design of IVAs, including providing a background on existing research behind IVAs and telehealth as an example application. Next, we comment on older adults as a user group, their unique characteristics, and existing research that relates IVA and the elderly. Finally, we provide background on what it means to adopt a sociotechnical approach to design.

Grounded in this, we then explore (in the subsequent sections) a case study of IVA adoption factors, interpreted from the lens of the ISP model.

2.1. The Information Search Process (ISP)

Many models try to explain the approach by which humans obtain information. One widely-used model that breaks down the steps of information seeking is the Information Search Process (ISP) (Kulthau 1993, 2004). This model had first been proposed in 1991 (Kulthau, 1991), and over the next ten years developed, empirically verified quantitatively and longitudinally (Wilson, 1999), and received positive feedback, leading to a second edition of a book publication discussing the ISP (Kulthau, 2004). This model approaches information seeking from the users' perspective (Kulthau, 1991). This is as opposed to a systems perspective, which structures retrieval processes in terms of the system's representation of texts and metadata. The ISP factors in users' uncertainty, anxiety, and sense-making (Dervin, 1983) of the encountered information to form a personal point of view of the material. The ISP has been applied to a broad range of spaces where information use is strong, with examples being patrons' use of public libraries, academic research in secondary school education, and within information-based workplace environment such as those of security analysts (Kulthau, 2004). For example, the ISP would explain the several processes involved when conducting a literature review.

The Six Stages of the ISP

The ISP is a theoretical framework to conceptualize the process of information seeking from the user's perspective. It maps the information seeking journey in terms of the affective (feelings), cognitive (thoughts), and physical (actions) elements of the (human user) searcher against six consecutive stages of the process. It is used as a theoretical framework to model.

The stages of the ISP are outlined in Figure 1.

(Figure 1 about here.)

We provide here a detailed background on the ISP model, synthesized from Kuhlthau (2004).

Stage 1: Task Initiation

During the Task Initiation stage, the searcher realizes that they have a gap in knowledge or understanding and recognizes a need for information. This results in feelings of apprehension and uncertainty. Their thoughts concern thinking over the problem, understanding it, and relating the problem to prior experience. Their actions often involve discussing and brainstorming the topic further and avenues to approach the problem. One examples of a search process in the Task Initiation stage is a lawyer's decision to seek background information in order to prepare for an upcoming trial (Kuhlthau, 2004). Another example is the assignment of a group project in a post-secondary virtual learning environment to prepare a report to be presented to the class (Byron & Yong, 2000).

Stage 2: Topic Selection

In the Topic Selection stage, the searcher identifies the general topic to be investigated. Their feelings become optimistic as they gain hope and a readiness to begin the search. Their thoughts are on the deliberations of prospective search topics, weighing them in terms of task requirements, time available, personal interest, and potential information sources. Their actions pertain to conducting a preliminary search for information available and to scan for alternative topics. As time passes, or if selection is delayed or postponed, then feelings of anxiety increases until a selection is made.

Examples of the Topic Selection stage include students' decision on a research paper topic or a lawyer's centering in on the topics relevant to a case in an upcoming trial (Kuhlthau, 2004).

Stage 3: Prefocus Exploration

During the Prefocus Exploration stage, the task is to investigate information on the general topic to gain personal understanding. This stage is characterized by feelings of confusion, uncertainty, and doubt. Searchers may also find the process discouraging and in turn experience a decrease in confidence. Pain points in this stage include difficulties in trying to make sense of information that seem inconsistent or incompatible, processing information that conflicts with previously-held constructs, and expressing information needs to information systems and interfaces. Searchers' thoughts center around becoming sufficiently informed about the topics in order to form a personal point of view. Their actions involve locating information, consuming (e.g. reading) the information, and relating it to what is already known.

Stage 4: Focus Formulation

The Focus Formulation stage is a pivotal stage of the ISP where the searcher forms a focused personal perspective of the topic. They experience an increase in feelings of certainty, confidence, and clarity. Their thoughts are on identifying and selecting appropriate information to form a focused perspective on the topic. Their actions include expressing an awareness of finding meaning among the information and evaluating the information that has been gathered.

Stage 5: Information Collection

During the Information Collection stage, the searcher gathers information on the focused topic. Their feelings of confidence, certainty, and interest in the topic increase as they continue. Their thoughts are centered on further defining, extending, and supporting their information focus. Their actions involve seeking specific information that is relevant to their focused perspective of the topic.

Stage 6: Search Closure

In the Search Closure stage, the searcher completes the search and is ready to summarize, report, or use their findings. The searcher experiences feelings of relief and satisfaction or disappointment, depending on the results of their search. Their thoughts are on a personal synthesis of the topic or problem. Their actions are centered around summarizing the information and taking note of collected information that is redundant or irrelevant.

Applying the ISP Model to Search Processes

The ISP models a pattern of information search behavior that occurs across many spaces. For example, in the case of post-secondary education, undergraduate students undergo the ISP when they are assigned a research paper (Kuhlthau, 2004). Their process includes being given the assignment (Task Initiation), selecting a topic (Topic Selection), learning about the general concepts of the topic (Prefocus Exploration), choosing a specific focus to write about (Focus Formulation), finding information specific to that focus (Information Collection), and writing the paper (Search Closure).

It is also not vital to describe a search process in the exact stages described in the ISP, but merely to recognize that these stages occur. Kuhlthau (2004) describes an example of this through an example of lawyers preparing for an upcoming trial. There, the process is described as the beginning (Task Initiation and Topic Selection) of the process, middle (Prefocus Exploration and Focus Formulation) of the process, and close or end (Information Collection and Search Closure) of the process. In the beginning of the process, lawyers are seeking background information so as to gain new understanding to formulate the issue they are looking for. During the middle of the process, lawyers conduct extensive exploration for related texts. During the close or end of the process, lawyers had a clear sense of the information they are looking for and have a sense of when they have sufficient information. It is also at this stage that they prepare their case for court.

2.2 Intelligent Virtual Agents & Telehealth

Within the context of this paper, we use the term intelligent virtual agents (IVAs) to refer to emerging technologies that employ artificial intelligence and use a computer-generated entity (a virtual character) to complete a task. Examples of IVAs, for instance from a line of virtual therapists, include those embodied by an on-screen animated avatar and which use voice to interact with users (e.g. SimSensei (DeVault et al., 2014)) to ones that use cartoon characters that interact with users by text (e.g. Woebot (Fitzpatrick, Darcy, & Vierhile, 2017). It is not a requirement for intelligent virtual agents to have a visual component (Kim et al, 2018), and as such Amazon Alexa (Purington et al, 2017), Apple's Siri, and Microsoft's Cortana are examples of voice assistants that are also IVAs. Design dimensions of intelligent virtual agents include the use (or non-use) of non-verbal body language, the modality of the interface (e.g. voice-only or embodied), and the use of facial expressions.

Much research exists to evaluate the effect of IVA properties on users' perceptions, such as a IVA's use of nonverbal behavior and gestures (Bickmore et al., 2008; Cafaro et al., 2013), the influences of embodiment (Cassell, 2000; Shamekhi et al., 2018), and the effect of camera angles (Ring et al., 2016). Furthermore, evidence suggests that humans are more comfortable revealing sensitive information to IVAs than real people (DeVault et al., 2014), although more research has to be made on privacy issues related to IVAs (Schulman, Sharma, & Bickmore, 2008).

IVAs can be used in many ways, such as being a display in a public space (Bickmore et al., 2008), as a presentation partner (Trinh, Ring, & Bickmore, 2015), and as a real estate agent (Bickmore & Cassell, 2001). Research has demonstrated the use of IVAs for various healthcare applications such as geriatrics health counselling (Zhang et al., 2015), atrial fibrillation education (Kimani et al., 2016), and patient empowerment (Yin, Ring, & Bickmore, 2012). IVAs have been increasingly used in critical information spaces such as healthcare. One example is Woebot, which is an artificially intelligent "virtual therapist". Woebot has been studied for its feasibility, acceptability, and preliminary efficacy in delivering cognitive behavior therapy to young adults (Fitzpatrick, Darcy, & Vierhile, 2017).

Another emerging application of IVAs in healthcare is as a "Virtual Doctor" (VD). A VD is a virtual representation of a real doctor, and thus can serve as a communication strategy between doctors and their patients. This application is a form of telehealth. Traditional telehealth practice has allowed patients and doctors to connect remotely in real-time (Halpenny, 2014; Huston & Huston, 2000), thus making healthcare and specialized care more accessible. Telemedicine and VDs alike offer multiple potential benefits due to its capability to help its users overcome physical- and time-related barriers. Examples include: 1) making healthcare more accessible for rural clients through reduced time and travel cost; 2) allowing patients to contact remote specialists more easily for more unique care; and, 3) serving as an alternative for patients who are unable to travel. Telemedicine has received positive reception by those who have used such services (Huston & Burton, 1997), and shows promise of being more favorable than in-office visits (Hanson et al., 2017). On the other hand, user perceptions of VDs have yet to be thoroughly studied. Moreover, the sociotechnical aspects of telehealth and, in turn, the design guidelines and principles informed by this approach are largely unexplored.

Yet, the application of user-centered design and evaluation to telehealth applications is not new and contributes to satisfactory clinical outcomes. For example, heuristic evaluation has been shown to improve the usability of telehealth applications (Tang et al., 2006). Participatory design for telehealth technologies has been advocated to factor in users' lives, including those of older adults (Ballegaard, Hansen, & Kyng, 2008). A human factors approach has also been suggested for telehealth applications (Niman et al., 2007).

One example of a VD application is DocOn (Reuters, 2017), which is a mobile app that has been demonstrated to give advice to users about atrial fibrillation. So far, DocOn has been a largely academic project whose focus is on the technical capabilities of 3D computer graphics software to capture the physical appearance of a real doctor to use as a VD. Little investigation has been made into the user perceptions of DocOn or similar software for doctor-patient interaction.

As mentioned in the Introduction, we are focusing on healthcare as a representative domain where information-seeking tasks often play a central (and essential) aspect. From an information theory perspective, similar tasks can be found across several other domains.

2.3 Older Adults & Intelligent Virtual Agents – Factors to Technology Adoption

Older adults (OAs, those of 60 years or older) constitute one of the largest and most rapidly growing user group of interactive technologies such as IVAs. IVAs in particular, being a multimodal interface, hold exciting potential to improve OAs' ability to engage with digital services and platforms in an accessible way and meet their needs (Munteanu & Saleh, 2017). A growing body of research that investigates the use of IVAs by older adults corroborates this, with examples being IVAs as a long-term social companions for older adults (Vardoulakis et al., 2012) or as an exercise coach for older adults (Bickmore et al., 2013).

At the same time, older adults form a user group that faces a "digital divide" which can put them at a disadvantage in society, lower their ability to access relevant and necessary information, and contribute to other issues such as social isolation (Robinson, et al., 2015). This is due to many factors, including diminishing self- confidence, social stigma connected to health- and age-related physical and cognitive decline, and loss of technical proficiency. These create many obstacles to OAs' access and use of technology (Johnson & Finn, 2017; Neves, Amaro, & Fonseca, 2013) and even their representation in digital systems research (Waycott, et al., 2016).

Some work exists that examines the influence of IVA embodiment on OAs' perceptions of the IVA as connected to the IVAs' social behavior (e.g. the work by Looije, Neerincx, & Cnossen (2010) on computer-based personal assistants designed to persuade older adults to effectively adopt daily health self-management practices). However, in contrast, the connection between the interface/interaction design of intelligent IVAs and OAs' personal, social, and cultural aspects remains understudied, especially through the lens of a sociotechnical approach based in information studies. Given the sensitivity of older adults to sociocultural factors (Waycott et al., 2015; Neves & Savago, 2019) and yet at the same time the growing interest in designing IVAs that improve their lives, it becomes increasingly important to integrate socio-cultural factors into design (Munteanu & Saleh, 2017).

2.4 Sociotechnical Approach to Design

The sociotechnical approach to design considers equally the technical, human, social, and organization factors of a product or service in order to deliver better value to end-users and stakeholders (Mumford, 2000). To do this, the sociotechnical approach accounts for the interactions that take place between an information system and the people that use them and whose lives are affected by them. In effect, the sociotechnical approach gives equal weight to the social and technical factors of computer-based systems. The sociotechnical approach has roots in the workplace as that was once the hotspot for computer-systems driven work. However, as technology had begun moving to people's personal lives, such as with the advent of the personal computer in the 1980s (and as early as the 1970s), negotiations between people and the machines they use have become more widespread outside of work. In recent years, the rise of ubiquitous computing has caused technology to become increasingly integrated into people's lives. Furthermore, emerging technologies are moving progressively into critical information spaces like healthcare and finance. These applications of technology have extensive implications for individuals and society at large, for better or worse. Consideration and action upon the sociotechnical aspects of design has never been more important.

Today, the sociotechnical approach serves as an alternative lens for the study, design, and evaluation of a product or service (herein called 'technological outputs') from that which is purely technical. The sociotechnical approach treat groups of individuals and the relevant technological output as actors in an organization or social ecosystem and can be used to reason through conflicts between these two parties even when the output is technically adequate. Furthermore, the sociotechnical approach posits that technological outputs are not value-neutral and that social values are embedded in design. The sociotechnical approach also acknowledges that technological outputs can shape work and societal function, much in the manner that police-body cameras have shaped policy (as elaborated in the next section). Research and analysis through a sociotechnical approach relies heavily on qualitative approaches including longitudinal and ethnographic study. Case studies are often used, and a phenomenological approach taken, however the goal is usually to generalize the findings from one case to broader situations.

More designers, researchers, systems analysts, and engineers alike have been putting more stock into the sociotechnical aspects of design. However, sociotechnical approaches to design remain under-studied and difficult to accomplish (Baxter & Sommerville, 2011; Norman & Stappers, 2015). Yet, the sociotechnical approach offers a valuable critical perspective of such systems for improved design (Waycott et al., 2016). This makes it important to study these systems to inform the factors that lead to positive outcomes of new technologies. This is especially the case with emerging technologies that are steadily becoming a more integral part of people's lives, especially within critical information spaces such as healthcare and finance.

3. MATERIALS AND METHODS

In this paper, we investigate the use of the ISP model to interpret, from a sociotechnical perspective, the interplay between users' information practices and the factors (design considerations) affecting the adoption of intelligent virtual agents. To do this, in this section we first describe a case study of virtual doctors and discuss the results and insights related to information behavior that arose from users' interaction with different embodiments of a IVA. Then, in the next section we will map these results and insights to the ISP and discuss resulting design recommendations for AI-powered systems built for older adult of health information. In doing so, we will have demonstrated the use of an information model (ISP in this case) to inform the analysis and interpretation of an AI-powered system from a sociotechnical lens that applies user insights.

In offering the description of the case study, is important to recognize that our goal in this paper is not to discuss the findings of this study themselves, but rather to demonstrate and discuss the merits of using an information model such as the ISP to reflect on IVA design.

3.1 Case Study: An Experimental Investigation of Virtual Doctors

We conducted a study of a conversational user interface exemplified by the scenario of interacting with a virtual doctor (Sin & Munteanu, 2019). The aim was to see how interface design elements, which in the case of the study were modality (voice vs. video) and agency (human vs. intelligent virtual agent), would impact users' perceptions of the virtual doctor.

The study was designed to collect information about older adults' perceptions of interfaces for digitally-mediated communication between doctors (or their virtual avatars) and patients. This type of information can help designers better understand users' attitudes toward the possible adoption of such systems. We will explore later in the paper how a sociotechnical interpretation of this information can expand this understanding and provide a more meaningful perspective on barriers and pathways to adoption that better capture users information practices, needs, and socio-cultural perspectives.

Four interfaces were used in this study, differing from one another in terms of (1) fidelity of the representation of the doctor (e.g. voice-only vs. embodied); and, (2) the agency of the doctor (e.g. human vs. intelligent virtual agent). Four interfaces (conditions) were used within an experimental investigation. These representations were chosen based on the common types of interactions that current telehealth systems typically offer with an added dimension afforded by the introduction of an intelligent agent. A Wizard-of-Oz (WoZ) method was employed for the interfaces involving an intelligent virtual agent. After trying out each of the four interfaces, older adult participants were interviewed for their thoughts. This procedure is similar in practice with those used in other research studies to date into the effectiveness of IVAs and telehealth applications to date (Bickmore & Schulman, 2007). The interview transcripts were coded and analyzed for themes using inductive thematic analysis.

In this section, we describe the details of the study, following a reporting template commonly used in HCI. However, the study yielded insights about the complicated relationship between IVA design choices and user perceptions, that were richer than what traditional HCI approaches could produce. For this, the subsequent section will present these richer insights through the application of the ISP information model.

Research Goals

We conducted a study with an experimental investigation to investigate the relevance of some of the possible design considerations represented by the combination of conditions descried earlier in this section (voice-only vs embodied; human vs. AI). The connection between virtual doctors (VDs) and traditional telehealth and the potential of VDs to benefit older adults lent themselves to two design considerations for the study to examine as a start:

1) **DC1**: How does **fidelity** (video vs. speech-only) and **agency** (human vs. machine) affect older adults' perceptions of remote health consultations from a sociotechnical perspective, where some of such services may be facilitated by virtual agents?

2) **DC2**: What are the sociotechnical factors and design elements (e.g. anthropomorphic features) that may influence older adults' adoption of virtual

doctors (particularly within health consultations) in terms of **confidence, comfort, and ease of use**?

Understanding virtual doctors (VDs) under the perspective of these two design considerations, especially in terms of their sociotechnical components, would:

1) help relate the design of Intelligent Virtual Agents (IVAs) as VDs to existing models of traditional telehealth applications (DC1). For this, we have employed both IVAs and human doctors as options for a remote health consultation. This allows us to better understand the sociotechnical dimensions of such interactions. In turn, this knowledge can inform the design of intelligent virtual agents used in interactions such as remote consultations for older adults; and,

2) help determine criteria that will assist designers in investigating how to make IVAs adoptable by healthcare users, particularly underrepresented groups (DC2).

That is, we planned to investigate how various design choices (such as anthropomorphism) may affect the sociotechnical elements pertaining to IVA adoption by users. Given the lack of prior research on this topic, we had hoped that such an investigation will help frame future studies that will rigorously measure the correlation between such design choices and metrics of user adoption. At the time, we chose to start with two design choices, and study their relevance with respect to user adoption factors.

Participants

The study was conducted in a research lab located in a large metropolitan area. Participants were required to have sufficient commandment of English, enough to be proficient in daily social interactions and to understand and sign the informed consent form. Participants were recruited through distribution on mailing lists of research volunteers. They were scheduled based on their availability to attend the study. Once they were scheduled, participants were given the informed consent form for their review. This allowed them to review the informed consent form prior to attending the study session, where they signed the consent form. Participants were compensated $40 for their participation in the 2-hour study. The study was approved by the university's Research Ethics Board and was deemed low-risk.

Figure 2 shows details of the demographics of the participants (age 60+; two male, three female; average age range 65-69). The rows "Formal Training in Computer-Related Technology Use" and "Approx. Hours Per Week Spent Using Technology" indicate the participants' familiarity with technology, with the majority of them being relatively comfortable with general-purpose digital technology. Participants were not directly queried about their prior knowledge with the given health topics, but several of them had expressed during the interviews some familiarity with some of these topics, as indicated by the third-last row. Participants expressed a range of degree of experience with IVAs, as captured by the second-last row. Finally, many of them have had experience consulting with online health information, but the degree to which they have done so varied, as captured by the last row.

(Figure 2 about here.)

Procedure

We conducted a 2x2 study of different IVA interfaces to see how anthropomorphism might impact older adults' perceptions of IVAs. We compared four different interfaces based on the IVA's fidelity of representation (voice-only vs. embodied) and the agency of the doctor (human vs. intelligent virtual agent), as summarized in Figure 3 and visualized in Figure 4. The Wizard-of-Oz (WoZ) methodology (Kelley, 1983) was used for the VoiceIVA and VideoIVA interfaces. The interfaces were displayed on an ASUS Transformer Book 10.1" tablet.

(Figure 3 about here.)

(Figure 4 about here.)

Five older adult participants (aged 60+; two male, three female) were recruited for the study, which was conducted in a research lab located in a large metropolitan area. Each study session lasted between 1.5 and 2 hours and was conducted with each participant individually. The primary and secondary investigators were located in the study room with the participant, while a "doctor" that played the role of the Wizard for the WoZ configuration was located in a separate room directly across the hall. The participants never met the doctor in person.

Participants were welcomed to the room, the study was explained to them, and the informed consent form was signed. Then, the participants were issued a demographics questionnaire. Next, they were given the scenario for the four options; they were told that they were a patient at a health clinic and that their doctor recommended to them a Virtual Doctor software. They were told that their role in the study was to try each of the four options and comment on their experience with them.

(Figure 5 about here.)

Experimental Design

Then, the participants tried using each of the four interfaces in turn to discuss preassigned health topics with the doctor (Hypertension, Osteoporosis, Shingles, and Type II Diabetes). We selected these four topics due to their general nature and interest to older adults (Vann, 2016). As conversational icebreakers, participants were suggested some leading questions (Figure 5).

Because there was no content connection between the four health topics used in our study, we performed a simple randomization of the order. This was then counterbalanced across the four interface conditions. Although this research was preliminary and exploratory in nature (and thus no hypothesis testing was carried out as there was little prior knowledge in which to ground a hypothesis), it was still important to counterbalance the conditions.

After each interface was tried, participants were asked post-task interview questions about their perceptions towards their comfort, acceptance, and attitudes towards the adoption of each of the respective interfaces. The interview questions asked the participants about whether or not they had additional questions for the doctor in that particular option, their assessment of fit for the option into their own lives, their perception of the particular option in isolation from the other interface options, and their overall thoughts on the option so that they could summarize their views and comment on any additional aspects of the respective interfaces.

After all four interfaces were tried, participants were asked post-session interview questions that compared their experiences based on fidelity and agency. These questions asked participants to compare their experiences between options based on fidelity and agency, comment on their perception of the fit of a virtual doctor in their own lives, and to discuss their experiences with finding healthcare information.

The questions as part of the interview guide are depicted in Figure 6.

(Figure 6 about here.)

An Experimental Investigation

The study was based on the two aforementioned IVA characteristics: (1) fidelity of the representation (e.g. voice-only vs. embodied); and, (2) the agency of the doctor (e.g. human vs. intelligent virtual agent). Thus, the interfaces (as demonstrated in Figure 3) were termed as follows: voice-calling an intelligent virtual agent (VoiceIVA); video-calling an intelligent virtual agent (VideoIVA); voice-calling a person (VoiceDr); and, video-calling a person (VideoDr). The combination of human and voice-calling (top left of the table) is reflective of the most common form of telehealth applications. On the other hand, the commercial trend is to move towards video-calling an intelligent virtual agent (bottom right of the table).

Participants were told in the VoiceDr and VideoDr cases that they were speaking to a human doctor working at a health clinic (named Louise). In these two cases, participants spoke directly to the doctor. On the other hand, participants were told in VoiceIVA and VideoIVA that they were speaking with an intelligent virtual agent representation of the doctor. In these two cases, participants were presented with an automated voice. Screenshots of the interfaces are depicted in Figure 4.

Each study session had the interfaces and tasks presented in different orders. The orders per participant are depicted in Figure 7. The orders were preassigned to try to maximize variation in the order between the participants to help counterbalance against ordering effects.

(Figure 7 about here.)

Apparatus

Research of IVAs have previously used the Wizard-of-Oz (WoZ) methodology (Kelley, 1983), which is a configuration where the artificial intelligence (AI) behind a software system is mimicked by a human operator who is invisible to the participant.

Telemedicine Setup for Doctor. A call was issued to recruit a medical or nursing student to play the role of the "doctor" in the study. The aim was to find someone who had enough knowledge to engage in a dialogue about general health, but could also immediately spot medical problems and then appropriately recommend to the participant to see their primary care provider or a specialist. A nursing student was cast for the role. For the remainder of this paper, the nursing student playing the doctor will simply be referred to as the doctor. During the experiment, the doctor wore a white lab coat and blue medical scrubs to resemble the figure in used in the VideoIVA interface (bottom right screenshot of Figure 4).

Discord, a free Voice-over-Internet Protocol application, was used for communication between the doctor and the participant. Discord has a simplistic and unbranded video-calling user interface and was assumed to be software unfamiliar with the participant cohort (unlike an alternative such as Skype). Discord allows users to communicate via text-based instant messaging, voice-calling, and video-calling.

Wizard-of-Oz (WoZ) Design for Intelligent Virtual Agent. Like previous research on IVAs (Bickmore & Schulman, 2007), we used the Wizard-of-Oz (WoZ) methodology (Kelley, 1983). WoZ is a configuration where the artificial intelligence (AI) behind a software system is mimicked by a human operator who is invisible to the participant. WoZ is a common setup in research studying the usability of interfaces that have AI components. It allows for testing of AI systems without having to invest in the costs of developing them. Our use of WoZ aimed to standardize the experience throughout all of the experimental conditions.

In this study, a WoZ configuration was used to simulate a fully AI-powered IVA system. On the side of the participant (client), a visualized intelligent virtual agent was supplied by Litebody (Bickmore, Schulman, & Shaw, 2009). The visualized character used for the intelligent virtual agent was the default, racially neutral female character of Litebody. For our experiment, we used only one gender of the character throughout all of the conditions. This was chosen to avoid introducing additional confound variables, to reflect the increasingly predominant female distribution of primary care practitioners within our geographical area (Renkas, 2019), as well as for alignment with existing intelligent virtual agent research, such as SimSensei (DeVault et al., 2014).

The AI behind the system was mimicked by a human operator who was invisible to the participant. The human operator in this study was the doctor (nursing student). This was done to help minimize discrepancy between the interactions between the intelligent virtual agent doctor-participant and human doctor-participant. CereProc's CereVoice Engine Software Development Kit was used to generate the voice of the IVA in the VideoIVA and VoiceIVA interfaces (CereProc, n.d.). Out of the CereProc voice library, the specific voice chosen for the intelligent virtual agent was selected for the level of neutrality of its accent within the geographical context of our study.

Validity of the WoZ Configuration. We did not evaluate the convincingness of the intelligent virtual agent in the WoZ configuration of being fully automated. However, we consider this apparatus to be appropriate since none of the participants' observed behaviour, nor their direct interactions with the research team, suggest that they may have perceived the IVA to not be fully automated. In fact, some participants speculated that various aspects the IVA's performance were due to it being automated. For instance, when asked why the participant (P2) was more patient in waiting for the intelligent virtual agent in the study to reply to them, the participant answered:

> "Well, because I knew it wasn't real. I might have less patience with a human, actually. … But I knew it was electronic person. And it had, it had the advantage that the live person might not have. The robot could go searching through databases, whereas the live doctor probably would have to go to the screen and keyboard to find answers, or a physical volume book."

Some participants also reported that their behaviours during the interaction with the IVA were due to their assumption of how the IVA's technical limitations. For example, P5 asked, "So, the robot is limited to these questions, I presume, [by] the way it is programmed" (for which we informed them that there are some programmed responses but that the IVA can also handle off-script queries). We should note that several participants referred to the IVA doctor as a "robot" or "doctor robot" as this was the terminology we used to refer to the IVA doctor during interactions with our participants. We opted for this terminology during our chats with participants as we considered this to be more accessible to them given both generation-specific language and the frequent appearance of terms such as "medical robot" in news media describing non-surgical healthcare robots (Small, 2019).

Study Results

Inductive thematic analysis, as developed by Braun & Clarke (Braun & Clarke, 2006), was used to code and analyze the themes from the post-task and post-session interview data. Inductive thematic analysis is a bottom-up approach that generates themes based on the content of the data. The inductive approach focuses on the data and uses it to find patterns without making any assumptions as to what the themes would be. This is in contrast with the deductive approach, which assumes a framework or model when coding. The inductive method makes no presumptions about the data, and the data is what leads to the themes. One of the most common approaches for thematic analysis is developed by Braun & Clarke (2006).

In their paper, Braun & Clarke (2006) describe the use of thematic analysis to analyze qualitative data. They also provide guidelines, potential pitfalls, and advantages and disadvantages for this process. These guidelines were used for the analysis of the interview data. The inductive process employed six steps: familiarization with the data, transcribing and coding the interviews, searching for themes in the codes, reviewing the themes, naming the themes, and writing of the report for the study.

For the coding process, initial codes were generated from the interview transcripts. Since an inductive approach was used, the process of coding was performed without trying to fit the data into any existing frameworks or models. These initial codes were clustered into secondary codes for better categorization and abstraction. Finally, the initial secondary codes were used to identify overarching, high-level themes.

Six high-level themes were identified from the initial themes generated from the codes. Three high-level themes were associated with DC1 and three themes were associated with DC2. DC1 pertained to users' perceptions of the interfaces based on their fidelity and agency. The direct themes from the codes resulted in three high-level overarching themes as described in Figure 8. DC2 related to criteria to make IVAs effectively adopted by older adult healthcare users. The direct themes from the codes resulted into three high-level overarching themes as described in Figure 9.

(Figure 8 about here.)

(Figure 9 about here.)

For this study, of particular interest to us were the voice and video modalities and applying a sociotechnical interpretation to users' perceptions of a IVA that employs these modalities. Thus, when the study was conceived, the expectation was a one-on-one relationship between IVA design choices and user perceptions. However, participants' responses indicated that their preference for the interfaces did not depend strictly on the design elements, but rather on the type of information they were looking for. Namely, participants' responses indicated that:

1. **Older adults seem to prefer using speech-only intelligent virtual agent health interfaces for general healthcare information.** On the doctor's side, participants considered calling an intelligent virtual agent to be the most efficient and effective use of a doctor's time and that this option is better suited for doctors to balance their priorities (P2, P4 – mapped into Theme 4 (Perception of Communication) – see Figure 8). On the patients' side, participants suggested that they would feel less discomfort contacting an intelligent virtual agent for seemingly repetitive, uninformed, or embarrassing questions (P2, P4, P5 – Theme 4 (Perception of Communication), Figure 8). An intelligent virtual agent was also perceived to be advantageous because it could be available at a moments' notice, whereas a call with a human doctor would need to be scheduled (P1, P3, P5 – Theme 4 (Perception of Communication Theme 4), Figure 8). Additionally, the intelligent virtual agent was seen as less distracting since it had minimal characteristics of an identity (e.g. nationality, place of schooling), especially when combined with voice-calling, where the intelligent virtual agent was simply a voice (P1, P4, P5 – Theme 1 (Perceptions of Communication), Figure 8). Thus, the participants indicated that they were most comfortable getting general healthcare information from a voice-only intelligent virtual agent interface among the four options. This finding suggests that speech-only intelligent virtual agent health interfaces may be more naturally perceived as being optimally suitable for the early stages of the

information search process, namely the stages that occur before Focus Formulation.

2. **Video-based human links are preferred for specific, personally pertinent healthcare information.** Specific healthcare information consists of questions that are uniquely applicable for a given patient, such as how they could tell if their condition is due to arthritis or due to osteoporosis (P2 – Themes 4 & 5 (Perception of Communication), Figure 8). Participants considered a human doctor to be better able than an intelligent virtual agent to identify a patients' real question, even if a patient lacked the knowledge to articulate it (P4 – Theme 3 (Perception of Communication), Figure 8). Furthermore, being able to see the doctor's face through video-calling was seen as more personal and conducive to a back-and-forth conversation (P5 – Theme 3 (Perception of Communication), Figure 8). These factors resulted in video-calling a human being the preferred option by participants to gather specific healthcare information. This finding suggests that video-based human links may be more naturally perceived as being optimally suitable for the later stages of the information search process, namely the stages that after Focus Formulation.

These two results indicated that the relationship between design and user perceptions is more complicated than a one-to-one relationship between IVA design choices and user perceptions. Instead, the results suggest that these two elements are related to a third component, which is the users' the information context. Moreover, these study findings suggested an interplay between these design elements and the information context, but which could not be explained by traditional HCI experiment-grounded paradigms. This prompted us to explore ways in which information behavior would factor into design, as we will discuss in the remaining of this paper. It also further suggested the need for a sociotechnical lens to be applied to the design of intelligent virtual agents, especially those used in the information space of healthcare in the form of virtual doctors.

3.2 An ISP Information Model Interpretation for the Design of Intelligent Virtual Agents

To overcome the limitations of HCI-only interpretations of the complex relationship between users' information practices (as informed by socio, cultural, and personal factors), and the design of AI-powered intelligent virtual agents, we turn to information models as a theoretical framework in which to more meaningfully ground the interpretation of the observed relationships. Thus, we investigated the feasibility of employing the models commonly used in information studies to interpret users' information practices when interacting with IVAs and consequently to inform the design of IVAs aimed at supporting underrepresented users.

The goal of applying the ISP information model to the results of the case study are twofold:

1) We use the ISP to frame and explain some of the findings in the case study, in particular those that relate to older adults' interactions with information systems.

2) We use the ISP to speculate on further insights, key takeaways, and design recommendations for the design of IVA technology built for older adults' interactions with health care information.

Rationale and Justification for Using the ISP Model

Several other sociotechnical models exist (Wilson, 1999), such as Wilson's Model of Information Seeking Behavior or Dervin's Sense-Making theory, which have been used as frameworks for the design and study of information systems, such as a computer-system to provide blood donors with information (Dervin, Jacobson, & Nilan, 1982) and the systems used by social workers to communicate and receive information (Wilson, 2005). However, we chose to reflect on the results of the case study against the ISP for four reasons:

1) **Overall model relevance:** The ISP is relevant to information seeking behavior, and in turn is relevant to the study's tasks of seeking health information through the four interfaces.

2) **Supporting components:** A large component of the ISP is the transition from actions concerning relevant but broad information to user-pertinent information, as well as from thoughts concerning ambiguous needs to specific user needs. This mirrors our study's findings of a trend in the responses based on the generality versus personal specificity of sought information.

3) **Capturing broader aspects of users experience:** The ISP comments on aspects of users' affective (feelings) and cognitive (thoughts) elements, which is relevant to our study's design considerations of understanding of older adults' perceptions of virtual doctors (DC1) and their confidence, comfort, and ease of use of these technologies (DC2).

4) **Model origin:** The ISP is based on empirical research and has been empirically validated (Wilson, 1999; Kulthau, 2004).

Although this rationale is specific to the decision of using ISP as a guiding model for the case of information-seeking with IVAs, we hope that the four criteria listed above can serve as a starting point for researchers looking at this or other sociotechnical model to inform their design approaches.

It is important to recognize that the ISP model is not the only, nor necessarily the 'best', information model that represents user information search behavior. That said, the process of gathering information from a source of healthcare information is a large component of the case study and thus the ISP information model offers an appropriate and valuable theoretical framework for analysis of the case study results. In addition, the ISP has been applied previously to health information seeking behavior in the past, such as in the cases of women seeking health information in their everyday life (Warner & Procaccino, 2004) and consumer health information seeking over the internet (Chiu & Wu, 2012). These examples of the application of ISP to health information seeking behaviour reinforce the relevance of ISP to the case study in this paper, and further show

how one may decide if this or other models are relevant to their design or interaction context.

We mapped the relevant insights from the case study to the ISP model. This way, we use the ISP to make sense of our findings and generate new insights, and we also illustrate how information models can be applied to take a sociotechnical approach to design. The results of this mapping and sociotechnical interpretation, as well as key takeaways and recommendations are discussed in the next section.

4. RESULTS & DISCUSSION

The immediate results that had been generated in the context of the case study indicated an interplay between design elements and the users' information context. In the following subsections, we detailed the interpretation of the experimental investigation using the six stages of the ISP model. By producing user behavior insights and design recommendations through the lens of the ISP, we aim to:

1) answer our two design considerations of understanding, from a sociotechnical perspective, older adults' perceptions of virtual doctors (DC1) and their confidence, comfort, and ease of use of these technologies (DC2) in order to understand the attitudes towards adoption of IVAs; and,

2) demonstrate how insights can be mapped onto the ISP model in order to determine key takeaways and design recommendations for the design of AI systems.

4.1 Connecting ISP and Case Study Results

In the following subsections, we use the case study results to discuss the design components that would factor into users' perceptions of an intelligent virtual agent doctor at each stage of the ISP.

Figure 10 derives from Figure 1 (which illustrated the six stages of the ISP) in that it maps the six stages of the ISP against the affective (feelings), cognitive (thoughts), and physical (actions) elements of the user. In addition, Figure 10 also includes one row that lists the sociotechnical components that, as suggested by the results of the case study, should be factored into the design of IVAs during the respective ISP stage.

(Figure 10 about here.)

Stage 1: Task Initiation

The ISP suggests that a lack of knowledge is the trigger for a user to commence an information search. In the context of this study, the task was initiated by our request for the participants to ask the doctor for information related to the respective health topic. In the context of any practical use of a IVA system, there may not be an explicit request from another party which would trigger the user to initiate a search for information. Thus, the role IVAs play in the initiation of the information search task remains an open question. Yet, understanding this role is relevant because it is a key stage of the ISP. Incorporating Task Initiation functionality to a IVA system may increase the perceived usefulness of the IVA, with perceived usefulness being an aspect that has been shown to be a large component of users' ultimate adoption of a new system (Venkatesh & Bala, 2008).

Stage 2: Topic Selection

The ISP describes the topic selection stage as one of optimism as the user begins their search for relevant information. Options for information sources are weighed based on the users' needs and resources. The variant of information being sought at this stage, which is general in nature, suggests that an intelligent virtual agent doctor is optimal for this stage. This is backed by the comments from participants in the study, who mentioned that they could see themselves using voice IVAs as their preliminary means of healthcare research. As P5 put it, "I would use several of them. […] Probably a voice-call robot to sort of get you up to speed. And then a video-call person to go in deeper."

In particular, a voice-only (rather than a video-based) intelligent virtual agent interface may be further suited for this stage as well. The participants had expressed that the voice-only interface meant that they could focus on the desired information. The rationale was that the intelligent virtual agent has diminished presence of identity (e.g. nationality, place of schooling), especially when combined with voice-calling, when the intelligent virtual agent was simply a voice (P1, P4, P5). In line with this, participants also expressed that they liked not having to see a face when talking to an intelligent virtual agent. As P5 mentioned, "As […] I just demonstrated (referring to Google Assistant, a VoiceIVA application), it's a voice. That's all. So you're not distracted by the person or the robot."

An intelligent virtual agent doctor has advantages over human doctors in terms of time and availability of access that may contribute to its usefulness at the Topic Selection stage. In our study, the participants expressed concerns for the human doctor's time and compensation. For example, as P4 stated, "because that's a service [the doctor] just gave to me. She should be reimbursed. And is that a good use of a doctor's time? Whereas the same information can come from that robot, is the question." An intelligent virtual agent doctor can be always-on, so as might be easily expected, users may be more comfortable consulting an intelligent virtual agent doctor during the topic selection stage, where (according to the ISP) their thoughts on the search are more ambiguous.

The advantages of an intelligent virtual agent-based interface aside, it may be too ambitious to believe that a IVA would be the only source of health care information users may consult. Participants mentioned that they consult multiple sources of healthcare information during their information search. Examples of sources include "Online. Friends. Colleagues" (P5). The reason for consulting multiple sources was a matter of bias. Each source of information "may have a different solution or a different angle" (P5), so it was important to "take it with a grain of salt and you have to weigh what's the best for you" (P5). Participants also reported desires to keep to their existing means of finding healthcare information even if a real IVA-based system were to be released. As P4 put it, “I don't think I would use it myself because if I was interested in finding out what osteoporosis was I’d go online and look it up”. P4 also added later on, “If I really want to see a doctor, there is a doctor I can see. If I really want information, there's so many places that I can get it, is this a better way of getting it?” (P4).

This behavior raises the issue of the credibility of the information provided by alternative sources as another element of system adoption. As P5 noted, “and then you have to look at the sources given, whether it looks like a credible source, whether it’s someone’s blog, whether it’s a doctor’s name I know”. It was important to “take everything with a grain of salt” (P5). Yet, participants reported that “people in general don't really look up the background of the knowledge of information they are getting. Because it’s extra work, basically” (P4). Participants also indicated the concern that “lot of people don't differentiate. It’s not that they're not looking, they just don't differentiate” (P4). In the case of health information, desperation was cited as a reason to fall for non-credible sources. “It’s like going to Mexico to get a cure for Cancer. […] if you are desperate, you might go to that website” (P4).

That said, many participants expressed that it was important for patients to filter the healthcare information they come across. As P3 remarked, “there is so much available on the net these days. They call it Doctor Google, right? And if you have any problem you can just Google it. A lot of the time you have to filter the information, so maybe you…I would say it’s just a matter of getting used to it. So if you can filter the information and then have someone to talk to and ask questions.” The filtering would be based on the perceived credibility of the healthcare. Several participants indicated that it was important to them that the options came from a credible source. As P5 noted, “and then you have to look at the sources given, whether it looks like a credible source, whether it’s someone’s blog, whether it’s a doctor’s name I know”. It was important to “take everything with a grain of salt” (P5).

Overall, an intelligent virtual agent doctor interface, and in particular, a voice-only based one, may be optimal for the Topic Selection stage due to it being less distracting and its wide availability. However, when designing the human-facing interface for such a system, one should accept that the IVA may not be the only source of information that which the user may consult during their information search. Designers should also pay attention to issues of credibility and that even information from the IVA system may be disregarded in favor of non-credible sources due to reasons such as personal desperation.

Stage 3: Prefocus Exploration

The ISP describes the Prefocus Exploration stage as a rougher stage of the process for users. Here, the users contend with confusion, frustration, and doubt as they progress through challenges in processing the information they found and interacting with the various information systems they come across. The degree of the pain points suggests that there is plenty of opportunity for AI-powered IVAs to be designed for a positive user experience.

An IVA provides feelings of comfort in that it is non-judgmental and is open to repeated questions, which may help to prevent or alleviate some of the feelings of stress from this stage of the process. “So, with the robot, if the information given by a robot and a real person are exactly the same, you might want to go to the robot, because you can go back and ask for the question to be repeated” (P5). The intelligent virtual agent seemed like an entity that could be used without the participant feeling like a bother or needlessly using up anyone’s time. As P2 mentioned: “It’s the reverse of my comments on the telephone. There’s no sense of interruption. The robot is there dealing in communication with me. It’s not dealing with several, I’m assuming, that because the robot can be replicated, you can have several. And each one is dealing with a different patient. Not waiting in turn unless they’re all busy. […] So I’m not interrupting a session, and the doctor’s not interrupting any of my business.” P1 had similar opinions when they said, “And from a perspective of… if I forgot to say something, I’ll call that robot back. And I don’t have to care about the robot’s not going to be, “Oh god, you already asked me the first time, you’re wasting my time now.” […] I could go through something with the robot from home and then hang up or whatever. And then go, “Ah! Damn, I forgot this and that”. I’d be straight back in there no problem. You know. I’d have no feeling of, you know, “oh I’m bothering this person”.” As P1 put it, “it cut through -- that the robot hasn’t had a bad day, the robot isn’t going to be thinking, you know, your own doctor, my GP, is going to be thinking, ‘well you’ve asked me four questions, I don’t want to answer another one. I’m sure I’ve got someone in the waiting room. Go away.’ You know, there’s none of that, right?” (P5).

Designing with the intent to give the user a sense of anonymity may also be beneficial in terms of user comfort and adoption of IVA technology. “With the robot, there’s a degree of anonymity” (P5). The effects of this is more pronounced when speaking with a human doctor. P1 commented, “If it’s face to face […] is it more responsibility? I don’t know,” indicating that the sense of connection was inversely proportional to the degree of audiovisual information that was conveyed by that particular interface option. When P1 was introduced to the option of voice-calling a person, he questioned in his mind “will [the doctor] be able to see me?” and he mentally thought “oh, okay” when the investigator confirmed that the doctor would not be able to see him. In other words, he felt a sense of relief that the doctor was not able to see them in VideoDr. The remarks of P4, who had experience providing information herself to students as a guidance counsellor, offered a possible explanation for this. In her words, “Again, [VoiceDr] could be more relaxing for some people because you don't see the person […] Someone may be asking a lot of questions and not seeing the person is sometimes better because you don't see they’re going “Oh my God”, they're asking me these questions.” In the same vein, voice-calling an intelligent virtual agent may offer users a greater sense of anonymity and thus contribute more to a feeling of comfort during the Prefocus Exploration stage.

The Prefocus Exploration stage also shares with the Topic Selection stage a number of common issues to consider in the design of a IVA system. As the user is still searching for relatively broad information, a voice-call interface may continue to better enable them to focus on the information they are seeking. During this stage, it may also be expected that the IVA would only be one of many health information sources and that the credibility of the system may not be as important to the user at this point.

In all, paying attention to the issues of freedom from judgement, openness to question repetition, and anonymity, may contribute to better comfort with the IVA at this stage, and improved acceptance and attitudes towards the adoption of the IVA system as a solution for the overall ISP process. The findings from the study suggest that an intelligent virtual agent doctor would best help searchers navigate and cope with the feelings of confusion, uncertainty, and doubt that arise in the Topic Selection stage. These findings indicate that an AI-based interface, especially one that uses primarily the voice interface, would be of benefit to users in the Topic Selection stage, where the focus is on the searcher's goal of forming a personal perspective on a topic, without being distracted by any irrelevant details. Still, at this stage it cannot be expected that the IVA will be the only source of information for this stage of the process, where searchers cast their net wide to form a perspective on a topic.

Stage 4: Focus Formulation

The ISP describes this stage as a moment of clarity in which users form a focused perspective on their topic. They become able to search for information that is personally relevant. The study design focused on general questions and did not explicitly ask for participants to relate the general health topic to themselves. Yet, some participants had provided comments that suggested that the shift in general to specific information is relevant. In the context of the study, an intelligent virtual agent-based interface was seen to be capable of providing general information, for example for broad information on osteoporosis. However, in the study, humans were still seen to be better suited to provide information that was pertinent to the specific user; such questions could include whether a users' set of symptoms is due to arthritis or due to osteoporosis (P2). It remains an open question how an intelligent virtual agent-based AI system may be better designed to help users perceive them as better able to help users pivot from relevant but general information to specific and pertinent information.

Stage 5: Information Collection

The ISP describes this stage of the process as one of focus, where the user gains a sense of direction and confidence and seeks specific information that is pertinent to themselves. In the context of the study, numerous elements of a video-based human doctor system seemed to make it the preferred interface for this stage of the process. All of the elements worked towards helping older adults more comfortably ask focused and specific questions that were pertinent to themselves. One example of such a question, as mentioned in section 4.4, was how one could tell if a pain in their joints is due to arthritis or due to osteoporosis (P2). Such a question implies that the searcher already has background knowledge to form a focused perspective of the topic and thus can ask questions that are more personally relevant – this indicates that the searcher is likely at an Information Collection stage.

At this stage, the participant is more receptive to and desiring of contact with a human doctor for the personal connection factor. A video-calling interface, where the participant could see the doctor's face, was seen as more personal and conducive to a back-and-forth conversation (P5). The process is further enabled by a human doctor's perceived ability to be better able than an intelligent virtual agent to identify a patients' real question, even if a patient lacked the knowledge to articulate it (P4). This observation may contribute to the human's role in the Collection stage to help the searcher extend their knowledge in the search focus.

The greater the amount of information that could be passed via the interface option seemed to increase the perceived possibility of uses for the respective option. For example, a voice-call intelligent virtual agent interface seemed to all participants like it was strictly for information. In contrast, a video-call intelligent virtual agent interface was seen as an option that could be used for diagnosis, simply due to its addition of a camera. As P1 stated, "like with a robotic doctor, […] the idea that you can take a picture of it, […] say some kind of little sunspot, or something, you know, you could clip, clip-" These comments may indicate that personally pertinent questions call for an increased bandwidth of information flow, and thus a video-based interface would be preferred for the Information Collection stage of the ISP.

Overall, increasing the degree of personal connection expressed and the number of information channels or modalities used in the IVA system may be optimal for the Information Collection stage. Thus, this stage may be where an increase in video-based elements such as embodiment and camera functionality would have the most potential, as they can best facilitate the users' search for pertinent information.

Stage 6: Search Closure

According to the ISP, the Search Closure stage is characterized by feelings of relief or disappointment, depending on the results of the user's search. Their tasks are centered around forming a personal synthesis or report on the topic. In the case of the study, due to practical considerations given the context and our participants, the study was designed to conclude after one round of questions. Although some participants expressed interest in continuing the interaction through additional follow-up questions (P2 and P3), the study protocol did not anticipate the need for this. Thus, no conclusion about Search Closure can be drawn from the study.

That said, the ISP helps raise questions about what may be the IVA's role in helping users understand and synthesize information that they have obtained at the end of their search. This may be an important question, especially in the context of understanding important information such as that in health and financial domains.

5. IMPLICATIONS

5.1. Feasibility of the ISP to Inform the Sociotechnical Approach to the Design of IVAs for OAs

In this paper, we apply an information model as a practical sociotechnical approach to inform design. To do this, in Section 4, we have provided an interpretation of the experimental investigation using the six stages of the ISP model. In turn, we are able to identify the sociotechnical considerations for IVA design per stage of the users' information search process. This comparison also prompts questions about "how one might better understand a users' information context to lead to the design of IVAs that have a higher level of user adoption?" It also prompts questions that asks what types of interfaces are best for each stage of the ISP, as well as questions that are more specific to the types of interfaces that were explored in this study. For example, one could ask "how might we better design voice-based IVA interfaces to facilitate the Selection and Exploration stages of the Information Search Process?" Another question could be "how might we better design IVA interfaces or human-based video interactions to better facilitate the Collection stages of the Information Search Process?" In turn, this analysis will pave the way for further research of sociotechnical elements of older adults' interactions with IVA technology for information. This will help in the discovery of new opportunities for IVA technology and its design to improve older adults' search experience, and thus their comfort, acceptance, and attitudes towards the adoption of such technologies.

The ISP is also particularly useful in that it has potential for industry application. Not only does it have an extended period and degree of development and verification, but it resembles tools used in typical user experience design industry practices, namely, in the manner of customer journey or experience maps (Kalbach, 2016). In an experience map, stages of a users' interactions with a product or a service are mapped against their thoughts, feelings, and actions – much like in the case of the ISP. As a tool that shares format and function, the ISP has potential to be a practical and useful framework for industry practice in addition to academic study of AI-powered information systems.

By performing the analysis in Section 4, we also demonstrate how information models such as the ISP can be used towards the better understanding of the design considerations of AI-powered systems. That said, it is important to recognize that the ISP is not the only nor the absolute best information model to be applied to this situation. The value in the ISP being used is the particular insights it sheds on the findings in a case study such as the one described in this paper. The process of deciding which information model to apply to a case is an art in itself, and is outside the scope of this paper.

5.2. Generalizability of the Approach of Applying Information Models to the Design of AI Systems

In this paper, we investigated the applicability of the ISP to a case study of OAs' perceptions of IVAs based on the design considerations of fidelity (video vs. speech-only) and agency (human vs. machine). Through this, we were able to draw conclusions from the findings of the study that could not be drawn prior to application of the ISP, when we were solely using the more functional approaches currently used in HCI.

In our instance, we have related the findings of an experimental investigation on the topic of healthcare to a single information model as an illustrative application of IVAs for OAs. Our research is framed in the broader context of IVAs as intelligent anthropomorphic interfaces that are often discussed, especially in the commercial technology space, as a prime candidate for technology that is beneficial to OAs (with telehealth as an example). However, our research is not limited to the healthcare domain or telehealth as an application. In particular, the healthcare example, especially as we have used it in our experiment (as a general topic question-answering, as opposed to a medical consultation resulting in a medical diagnostic), was representative of an information-seeking task. As such, we consider that our findings can be extended to other information-seeking tasks where IVAs are being used, such as in financial advising or the provision of practical information. By understanding how the information models can be used to frame design, our findings are not limited to a specific domain, but are moreso defined by the approach taken.

Models such as the ISP are intended to be used in a critical sense and to help frame the understanding of how people interact with a system. While there are no formal (empirical) methods to verify the correctness of a certain model, the interpretivist approach we took in our research provides an example of how such models may be validated. In particular, by reflecting on the empirical results from our experiment through the lenses of the ISP, we were able to show how the elements of the ISP explain the behavior and relationship between participants and the IVA. This indicates that the ISP can be used as a sociotechnical framework to inform the study of AI-powered systems such as IVAs from an information behavior perspective. We suggest that future HCI research could incorporate models such as the ISP in more formative stages of the design process, in the form of a guiding or reflective framework (instead of an interpretative framework used post-design).

6. CONCLUSION

In this paper, we have argued, justified, and brought to light evidence in support of information models being applied as a sociotechnical approach to improve the design of AI-based systems. When the experimental investigation in the case study was conceived, the expectation was for there to be a one-on-one relationship between IVA design choices and user perceptions. However, it was discovered that the relationship is more complicated and there is an interplay between IVA design choices, user perceptions of IVAs, and the users' information context. This relationship between design elements and user information context could not be so richly explained by traditional HCI paradigms; however, not only can this relationship be explained through models of information behavior, but these models can more meaningfully inform (from a sociotechnical perspective) the design and further investigation of IVAs.

By taking this approach to exploring the interplay between these models and technology, we may become better equipped to relate this promising technology to societal needs, contexts, and barriers. The information models mentioned in this paper have been applied previously to web technologies and to information systems even before the web technologies became so prevalent. These models have much potential to provide a richer understanding of the relationship between humans and society. Our own next step is to seek out more participants for a larger, more comprehensive study to formalize the use of this model. This will include more strongly connecting the ISP-based interpretations to a more traditional HCI experimental approach. We also intend to explore the influence of IVA design on older adults' perceptions of these technologies in other critical information spaces such as the fields of legal and financial assistance, where

IVAs are also emerging as digital alternatives to traditional forms of these critical information services.

Designers and developers of AI-based systems such as intelligent virtual agents have much to learn from theorists of the past and those of other disciplines such as critical theory. As an example that is within the same disciplinary space, contemporary voice-based AI-agent designers have been rediscovering concepts and design principles that were already learned 15 years prior from the design work on interactive voice response systems (Pearl, 2016). Then, as a reflection on perspectives grounded in sociotechnical disciplines, designers and developers have also yet to fully recognize that unpredictable software can have negative implications and still experience challenges developing software in an ethically responsible manner. This problem is exemplified by the critical analysis of the ill-considered launch of Microsoft’s AI agent Tay (Wolf, Miller & Grodzinsky, 2017).

Despite the best intentions of designers and builders of technology, they often inadvertently ignore or dismiss the work and knowledge of others who study the impact of those technologies in different contexts (e.g. critical theory of the sociotechnical approach). Factoring in information behavior models, such as the ISP, into design is one way of better contextualizing the interactions between users and intelligent systems and bridging together design practices and sociotechnical and critical theory.

Figure 1. Schematic of the affective (feelings), cognitive (thoughts), and physical (actions) elements of the information searcher mapped against the six stages of the Information Search Process (ISP). Image source: Figure 4.2 in Kuhlthau (2004).

Stages	Task Initiation	Topic Selection	Prefocus Exploration	Focus Formulation	Information Collection	Search Closure
Feelings	uncertainty	optimism	confusion, frustration, doubt	clarity	sense of direction/ confidence	relief
Thoughts		ambiguity -			▶ specificity	
				- ▶ Increase interest		
Actions		Seeking relevant information		- - - - - - - - - - - ▶	seeking pertinent information	

Figure 2. Demographics of the participants in the study.

	Participant				
	P1	**P2**	**P3**	**P4**	**P5**
Age Range	60-64	70-74	60-64	65-69	70-74
Gender	Male	Male	Female	Female	Female
Marital Status	Single	Divorced	Married	Married	Married
Level of Education	Secondary	Post-Graduate	Post-Secondary	Post-Graduate	University
Medical Training/Experience	First Aid	None	None	None	None
Formal Training in Computer-Related Technology Use	None	Taught computers at community college	None, self-taught Word and Excel	Trained to use TDSB information systems	None, self-taught
Approx. Hours Per Week Spent Using Technology	3.5	35-56	15	15	28
Occupation/Occupation Prior to Retirement	Unemployed, Concierge / Security	Retired, Teacher / Instructor at a Community College	Retired, Commercial Banker	Semi-Retired, Teacher / Guidance Counsellor	Retired, Waste Management Specialist
Prior Knowledge with:					
Hypertension	None indicated	None	None indicated	Some	Some
Osteoporosis	None indicated	None	Has Diagnosis	Familiar	None indicated
Shingles	Some	None indicated	Not Familiar	Familiar	None indicated
Type 2 Diabetes	Some	Some	Familiar	Familiar	Some
Prior Experiences with IVAs	No experience but may have heard about intelligent virtual agents through social media. Knows about Siri.	Familiar with IVAs but never used them before.	Basic commands with Siri, e.g. asking for directions	Microsoft Office Assistant (Clippy); interactive voice response with banks; has used Siri	Uses Google Assistant; has used Siri (on previous phone)
Prior Experiences with Online Health Information	None indicated.	Occasionally; has used Mayoclinic before.	Not often; checks Mayoclinic.	Has looked online; checks reputable sources, e.g. national charities	Has looked online; searches online with husband; checks reputable sources, e.g. doctors' blogs; also checks forums and Facebook.

Figure 3. Summary of the 2x2 Design resulting in four conditions in the study. The combination of human and voice-calling (top left of the table) is reflective of the most common form of telehealth applications. On the other hand, the commercial trend is moving towards video-calling an intelligent virtual agent (bottom right of the table).

Agency of Doctor	Fidelity of Representation	
	Voice-calling	**Video-calling**
Human	Voice-calling a Person (VoiceDr)	Video-calling a Person (VideoDr)
Machine	Voice-calling an intelligent virtual agent (VoiceIVA)	Video-calling an intelligent virtual agent (VideoIVA)

Figure 4. Screenshots of the four IVA interfaces. For privacy reasons we have edited the screenshot to obscure the face of the human doctor in this image; of course, during the experiment participants interacted with an unobscured video connection to the human doctor.

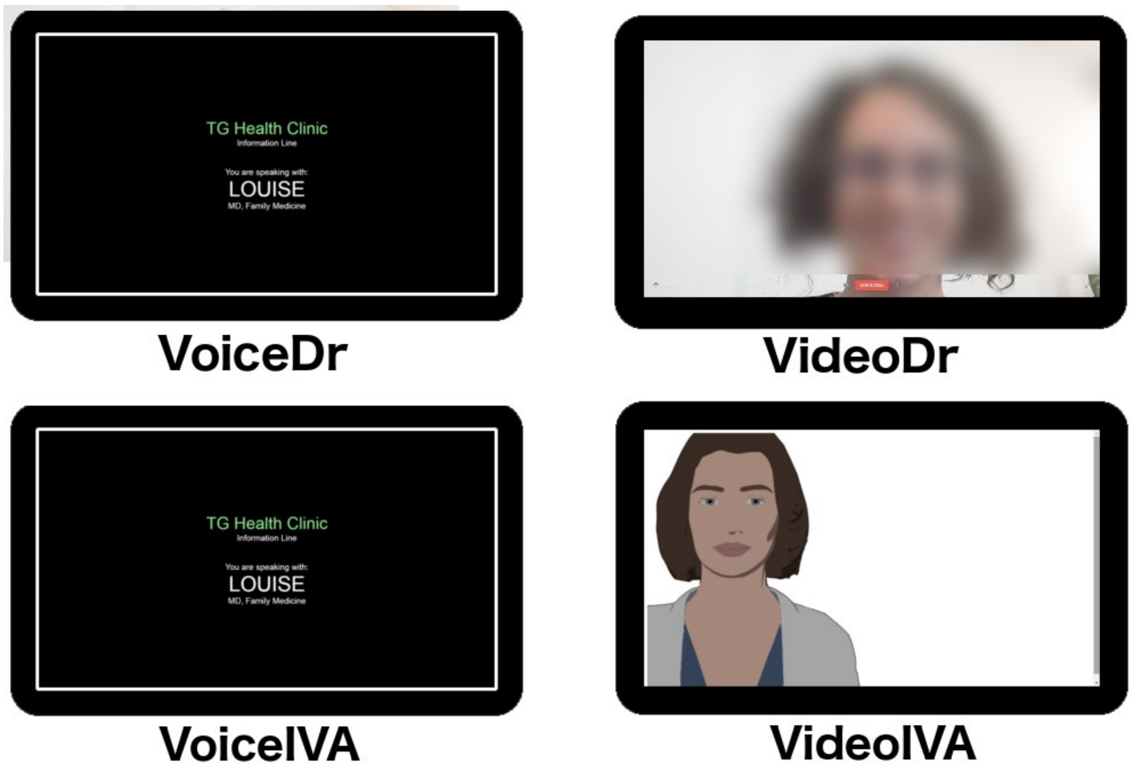

Figure 5. Examples of questions for the four health topics discussed during the main part of the experiment (Hypertension, Osteoporosis, Shingles, Type II Diabetes). <health condition> refers to one of: “Hypertension”, “Osteoporosis”, “Shingles”, and “Type 2 Diabetes”. Each participant engaged with all the topics across the experiment, with topics randomized and counter-balanced over the combinations of experimental conditions described in Figure 3.

1. What is <health condition>?
2. What causes <health condition>?
3. How would I know if I have <health condition>?
4. How is <health condition> diagnosed?
5. What happens if I don’t treat my <health condition>?
6. Can you cure <health condition>?
7. How do I prevent <health condition>?
8. What should I do if I think I have <health condition>?

Figure 6. Questions forming the interview guide for the study described in this paper.

Questions asked after trying each interface:

1. Was there anything else you would have liked to ask this doctor that you didn't get a chance to?

For the following questions, please be honest; please don't feel the need to impress us.

2. Have you ever used anything like this option before, whether in a healthcare setting or not? Please describe.
3. Do you have anything you liked about this option?
4. Do you have anything you didn't like about this option?
5. Is this option easy or difficult to use (in theory)?
6. What would you like to see changed to improve this option?
7. How much would you like to continue using this option in your own life?
8. Do you see this option fitting in your own life? If so, where and how?
9. What are your overall thoughts on this option?

Questions asked after all four interfaces were tried:

1. What are your thoughts on voice-calling vs. video-calling?
   a. When talking with a robot?
   b. When talking with a person?
2. What are your thoughts on talking with a robot vs. talking with a person?
   a. When talking with a robot?
   b. When talking with a person?
3. If you have the four options to choose from to get healthcare information, which of these options you choose, if any? Does it depend on the situation?

Figure 7. Order of the conditions of the five participants. Under the "Task" headings, H means "Hypertension", O means "Osteoporosis", S means "Shingles", and D means "Type II Diabetes".

			Option #			
			1	**2**	**3**	**4**
Participant	**1**	**Option**	VoiceIVA	VideoIVA	VoiceDr	VideoDr
		Task	H	O	S	D
	2	**Option**	VideoDr	VoiceDr	VideoIVA	VoiceIVA
		Task	H	O	S	D
	3	**Option**	VoiceDr	VoiceIVA	VideoDr	VideoIVA
		Task	D	O	S	H
	4	**Option**	VideoIVA	VideoDr	VoiceIVA	VoiceDr
		Task	S	D	O	H
	5	**Option**	VideoIVA	VoiceDr	VideoDr	VoiceIVA
		Task	S	D	O	H

Figure 8. Summary of the themes related to DC1, which pertained to users' perceptions of the interfaces based on their fidelity and agency.

High-level Themes & Description	Themes
Perception of Communication: Pertains to perceptions of the options stemming from attitudes of communication.	• Options with less identity feel less biased, more factual, and less distracting. • Options and degree of information conveyed relate to social responsibility • Participants consider humans to be better at conversations than intelligent virtual agents • People choose options that are the most efficient and cause the least interference to themselves and the other users • Intelligent virtual agents give more general information, people give more specific information
User Experience Design: Pertains to perceptions of the options that can be altered by designing for a user experience.	• Intelligent virtual agents are better if it is not too similar to a real person • Nonverbal behaviors in video-calling affect comfort • Having face triggers more personal conversations • Need to provide a clear mental representation when talking with intelligent virtual agents
Technical Considerations: Pertains to impressions that relate primarily to technical qualities of the agent apparatus (e.g. audio/visual quality).	• Sync between audio and visual can make/break experience • Limitations that break conversations can break experience • There is a desire for further functionality to be included

Figure 9. Summary of the themes related to DC2, which pertained to criteria to make IVAs effectively adopted by older adult healthcare users.

High-level Themes & Description	Themes
Making Options Worth Using: Pertains to making the options worthwhile for older adults to use.	• Making options accessible • Making options not redundant
Relation of Healthcare Information to the User: Pertains to the influence of users' status quo for interacting with healthcare information.	• General information first by myself, then to doctor for specifics • Multiple sources of healthcare information are consulted to maximize credibility and minimize bias
Influence of Present Attitudes on Acceptance: Pertains to the influence of existing technologies that are similar to the interfaces used in the study on the attitudes towards acceptance.	• Prior connection/impression with communicator • Attitudes towards alternative/existing options • Attitudes towards similar interfaces

Figure 10. The ISP schematic, with a list of the sociotechnical components that, as suggested by the results of the case study, should be factored into the design of IVAs during the respective ISP stage. Diagram modified from Figure 3.2 in Kuhlthau (2004).

Stages	Task Initiation	Topic Selection	Prefocus Exploration	Focus Formulation	Information Collection	Search Closure
Feelings	uncertainty	optimism	confusion, frustration, doubt	clarity	sense of direction/ confidence	relief
Thoughts		ambiguity -			► specificity	
				- - - - - - - - - - - - - - - - - - - ► Increase interest		
Actions		Seeking relevant information - - - - - - - - - -			► seeking pertinent information	
IVA Sociotechnical Elements	Role of IVA in initiating search	Level of distraction, system availability, alternative sources of information, credibility	Freedom from judgement, openness to question repetition, alternative sources of information, credibility	Role of IVA in helping form a focused perspective	Personal connection, information bandwidth	Role of IVA in understanding and synthesizing information

NOTES

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