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Swipe a Screen or Say the Word: Older Adults' Preferences for Information-seeking with Touchscreen and Voice-User Interfaces

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Over a decade ago, the introduction of touchscreens greatly enhanced older adults' access to information online. Today, voice-user interfaces (VUIs) promise a similar revolution. However, relatively little is known about older adults' preferences for using touchscreens versus VUIs to access different kinds of information. In this lab and interview study, older adults used both a touchscreen (tablet) and VUI (smart speaker) to search for various types of information requiring different levels of exploration and judgment. Participants found the VUI generally easy and efficient for obtaining simple information, but they critiqued its value for providing more in-depth information. The touchscreen seemed to offer greater control over accessing information that was of sufficient breadth and in preferred forms or presentations, and which participants felt they could trust. Further, the VUI raised interesting concerns about privacy. These findings suggest that older adults have clear preferences and want to be selective in how they access and use online information. When designing for older adults, focusing solely on efficiency and ease-of-use risks creating simplistic solutions that overlook people's preferences for control over information access and use.

CCS CONCEPTS • Human-centered computing Natural language interfaces; HCI design and evaluation methods; Usability testing; •Hardware → Touch screens; Sound-based input / output; •General and reference → Surveys and overviews •Information systems → Speech / audio search;

Additional Keywords and Phrases: Older adults, Touch interface, Voice user interface, Information seeking, Usability, Privacy, Trust

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1 INTRODUCTION

Over a decade ago, the introduction of touchscreens greatly enhanced older adults' access to information online. Today, voice-user interfaces (VUIs) promise a similar revolution. However, relatively little is known about older adults' preferences for using touchscreens versus VUIs to access information. In this paper, we explore one aspect of the question of how digital interfaces might impede or enable older adults' access to preferred sources of online information, by examining their views on using a VUI and a touchscreen to access information of different kinds.

People who lack adequate access to useful and credible information which they can evaluate and make sense of may miss crucial news and events, fall prey to misinformation, and be less able to pursue activities that enrich their lives. The internet is now the dominant source of information, yet some demographic groups are especially at risk of missing out on appropriate online resources, due to factors like costs of devices and internet access, and differences in ability and confidence in navigating information and communication technologies (ICTs) [11, 76]. Older adults, who represent a rapidly growing portion of the worldwide population [106] are considered to be at risk of digital exclusion [91], including due to ageist stereotyping [53]. Hence, understanding which ICTs best enable older adults to obtain valued information is important.

Human-computer interaction (HCI) researchers have examined how to design ICTs and their interfaces that are appealing to and accessible for older adults, with the aim of improving online access and minimizing digital inequality [5-7, 10, 15, 39-41]. Some of the prior work in this area has focused on identifying and reducing usability barriers for different modes of interface input, including keyboard and mouse [45], touchscreens [55] and more recently VUIs that enable spoken 'conversations' [99]. A basic assumption in much of this work is that if an interface is easy and efficient for older adults to interact with, improved access to digital information will follow. When touchscreen devices became popular earlier this century, researchers suggested they would be easier for older people to use for online and other activities [18, 85]. Compared to earlier modalities, touchscreen devices provided a more direct input method and a lower barrier to entry [18, 22, 32, 85].

However, they were also found to be heavy to hold and sometimes difficult to manipulate. Now there is growing interest in the potential of 'conversational agents' like those in smartphones and smart speakers to provide even easier access to information, because they may overcome some of the usability issues that limit older adults' use of touch interfaces [75]. Yet, for some people and for some information seeking tasks, ease of access and use may not always be a key priority. People use technologies to access and use various kinds of information, and for some information seeking tasks, issues such as trust and reliability of information may become more important than efficiency. In this study, we aimed to gain insight into older adults' views about the value of using touchscreen and VUI interfaces for accessing different kinds of information.

Our study found that, for our participants, VUIs do offer efficiency and ease of use advantages, while having the disadvantages of allowing less control over available online information and over sources they are prepared to trust, of reduced access to a desired breadth and form of online information, and of diminished privacy. Touchscreens, participants felt, have some usability drawbacks, but also offer some key advantages; indeed, our participants strongly favored them for at least some information-seeking tasks. These findings provide a detailed example of how, contrary to ageist stereotypes, older adults can be particularly thoughtful and discriminating in their approach

to obtaining information with ICTs. Designers and researchers should look beyond accessibility to other user-centered considerations when considering how ICTs can empower older people and enrich their lives.

2 BACKGROUND AND PREVIOUS WORK

A shift to new modes of interaction with ICTs is underway. Recent arrivals include smart homes, embodied conversational agents with visual avatars, social robots, and mid-air gesture devices [13, 59, 65, 94]. Virtual assistants in computers and smartphones like Siri and in smart speakers like Google Home and Amazon Alexa are widely used VUIs. The growing popularity of VUIs over the last five years presents new questions for the HCI community, which has begun to examine various aspects of user experience with them. These include perceptions of privacy for accessing sensitive information [24], the effect of an audience on using VUIs in public places [17], children's use of voice interfaces [100], and VUIs in everyday activities like family conversations [75]. Over 3.25 billion 'digital voice assistants' now exist globally, and unit numbers will exceed the world's population by 2023 [101].

However, as some have observed [87], studies at the intersection of VUIs and older adults are limited [92], despite awareness that voice interfaces, which rely on natural speech rather than skilled gestures, may prove easier to use [113]. Research on VUIs often favors younger people and other demographic groups [9, 58, 98]. Sayago et al [87] recently invited HCI researchers to investigate older users' views on talking to voice assistants. They suggested that VUIs may help older people overcome usability problems with cumbersome graphic user interfaces, while noting that VUIs themselves may create user difficulties, such as "knowing what (and how) to say" things when addressing them [87]. More detailed investigations are thus required [87, 99]. To provide context for our study, we highlight why it is important for older adults to be able to access and trust online information, review relevant work on the two selected interfaces (touchscreens and VUIs), and outline the study's aims.

2.1 Older adults, technology use, and information access

Older adults desire opportunities to connect effectively to online services, communities, and sources of information [2]. In 2017, over 40% of American adults over 65 had a smart phone (compared to 18% four years earlier) and 67% reported using the internet [3]. Access to online information is increasingly vital for healthcare, political participation, social engagement, and personal enrichment (including during the Covid-19 pandemic [90]). Yet some older adults can be daunted by the task of accessing online information [51] and may feel challenged by new and emerging ICTs [97]. Such obstacles and the increasing exclusion from these digital benefits fosters and consolidates inter-generational inequity [10, 47, 57, 80, 97].

Although usability, efficiency, and performance influence interface preferences, other factors are important too. Context of use, for instance, can affect user preferences for various digital devices [7, 10, 80]. Rogers et al. observe that the notion of a 'best choice' input device varies with the task in question [84] and the user's conception of that task. For example, interface-related preferences may be shaped by user desires to obtain services or different kinds of knowledge or by the user's circumstances. Using a device in a public place versus at home, for instance, can influence device choice. Furthermore, some (though not all) older adults simply do not trust new ICTs [52]. Distrust of ICTs may relate to such things as: the mechanism of the technology; wider social conditions; individual attitudes to new technology; worries about privacy invasion, 'hacking' and surveillance; and a personal lack of confidence in and understanding of ICTs [51]. Because limited trust may interfere with older adults' full engagement with ICTs

even when they continue using them [51], understanding the reasons individuals have for not trusting various ICTs is important for overcoming obstacles.

2.2 Touchscreen interfaces

Devices like smartphones and tablets are now commonly used by older adults [3]. Touch interfaces are generally considered convenient and easy to use, especially for those lacking experience with ICTs. Compared to mouse and keyboard interfaces, the more direct input route required by touchscreens imposes less cognitive load on users [7, 16, 73, 74]. Touchscreens also decrease user error rates and usability differences that exist between older and younger generations [36]. Nonetheless, despite the spread of touch interfaces, some older adults continue to be frustrated by touchscreens and remain reluctant to learn how to use them [97]. Touchscreens can pose difficulties when touch targets are small, are close together, or are missing the haptic feedback that can guide successful interaction [19, 31, 37, 46, 72, 83]. Touchscreens also require learning unnatural and unfamiliar gestures like swiping, dragging, and zooming [16, 27, 54, 105] and they can create eyestrain and fatigue [38]. Issues such as cognitive impairment [10, 37], short-term memory deficits [83], difficulties of vision [27], and minor motor problems [16, 27, 54, 105] can seriously affect touchscreen use [4]. While not all older adults face these issues, the risks of encountering them increase with age. Thus, newer interfaces that bypass such obstacles promise improved information access. Hence, there is growing interest in the potential value of VUIs for enabling older people to access information.

2.3 Voice-user interfaces (VUIs)

HCI researchers are beginning to explore older adults' experiences of using smart speakers and other VUIs for accessing information. For instance, Pradham et al. [77] studied older adults who were infrequent ICT users and who were asked to trial Amazon Alexa smart speakers at home for several weeks. The study found that "[m]ore than half of the participants reported that the ease of use led them to seek more information online using these devices" (pg 31:2), including information about health, politics, history, celebrities, and food. Participants generally felt this VUI easier to use than computers or smartphones. Some participants also seemed to trust the information received from Alexa—even trusting it more than similar information obtained from friends. In that study, however, participants did not (as they did in our study) use both VUIs and touchscreens to search for the same information. An earlier study by Schlögl et al. [88] found that older people preferred using VUIs to graphic interfaces. Kim and Choudhury found that some older users using smart speakers initially enjoyed their simplicity and convenience and over time became less concerned about unfamiliarity and making errors and even enjoyed a kind of digital companionship [50]. Other research too suggests that older adults are attracted to the simplicity and ease of speech-only interfaces [111].

Nevertheless, VUIs also pose recognized problems. For instance, privacy concerns were notoriously highlighted in 2018 when an Amazon Echo smart speaker secretly recorded and revealed to another party a private conversation held by its users [25]. In some settings, other human voices may interfere with successful VUI interactions [17, 24]. Some people find it more difficult to speak and think than to think and type/touch, and it can be cognitively harder to retain and review spoken information than visual information [93]. Older adults sometimes commit more errors with VUIs [20], particularly when multitasking, and the input of speech can be slow. Speech input is simply not favored by some older people [110]. Despite these known problems, it remains an open question whether the benefits of VUIs outweigh their possible drawbacks for older people.

Recently, there has been interest in more ambitious types of VUIs that act as home assistants and even companions for older adults. Simpson et al [95], for example, tested a "friendly conversational agent" embodied as a potted flower that older adults could talk to and which makes suggestions to them about possible activities. They found that some older people found 'Daisy' (as they named it) approachable and speculated that this VUI device might decrease loneliness. Commercial conversation agents that have a more supportive and companion-like role than do smart speakers are also coming onto the market. For example, ElliQ is a home assistant for older adults that has a moving 'head' and, unlike most smart speakers, proactively makes suggestions and provides information to users [82]. It also has a graphic interface that displays video and websites. These more elaborate VUIs designed for the purpose of providing companionship and assistance to older adults as well as for giving information may be perceived differently by them even when they are used mainly for information seeking tasks [21]. For example, some older adults find these sorts of companionable and proactive devices condescending, while others find them helpful and even delightful [28]. In this study, we focus purely on information seeking with ICTs.

2.4 Study Aims

Given the rising popularity of VUIs and interest in their value for older adults, research is needed to better understand how older adults view and regard VUIs. With VUIs being the basis for new devices designed specifically to provide access to information and services for older adults (such as ElliQ), research in this area is particularly warranted. However, although both VUIs and touchscreen interfaces have been explored in the HCI literature, direct comparative evaluations of older people's views on them are lacking (for comparison see [23, 60, 89]), and there is limited understanding of their comparative value for different kinds of information seeking tasks. In this study, therefore, we aimed to obtain a detailed understanding of older adults' views about touchscreens versus VUIs when those two interfaces are considered side-by-side for different kinds of information-seeking tasks. Our research question is: *What are older adults' views about using a VUI and a touchscreen to search for different kinds of information online and what do they see as their advantages and disadvantages?*

3 METHODS

We conducted an interview study with 14 older adults (aged over 65) who used commercially available touchscreen and VUI devices to access different kinds of information in a laboratory setting. Participants completed three information-seeking tasks with each device and discussed them in subsequent one-on-one interviews with a researcher. In this paper, we focus on the reflections participants shared during the interviews. Although participants only interacted with devices for a short time in a laboratory setting, the interviews enabled us to gain an in-depth understanding of participants' views and reasons behind their preferences for touch or voice interfaces when used for information seeking. The study received approval from the University's ethics committee.

3.1 Devices

For the VUI tasks, participants used Google Home, a relatively high performing and popular smart speaker. Smart speakers can use speech recognition software to compute requests. Google Home uses neural networks to self-learn with repeated use , and reportedly has performed well relative to other home assistants by, in one study, answering 68% of queries correctly [35]. It can access various databases [48, 71] and operates hands-free via voice-input from a distance. For the touchscreen tasks, participants used a Samsung Galaxy 10.1-inch tablet, which was widely available at the time of the study. This device was selected over an iPad so that the search platform was the same

across both devices (i.e., Google for both VUI and touchscreen). The size of this device was similar to a standard iPad and large enough that participants would be able to view the search results on the screen.

3.2 Participants

We recruited participants via notices sent to email lists of older adults living in the local community where the study was conducted and who regularly volunteer for research studies at the university. We also used noticeboards in nearby community centers that offer programs for older adults. Fourteen people volunteered for the study and completed a basic background information questionnaire about their demographics and technology experiences (see Table 1). Seven identified as male and seven as female. One participant was in their late 60s; all others were 70-75 (six participants) or over 75 (seven participants). Two had hearing aids and most used glasses, indicating mild aural and vision impairments that may impact on interface use. All 14 were familiar with touchscreen devices, such as tablets and smartphones, whereas only three had used a smart speaker. Accordingly, all participants were given a demonstration and instructed to their satisfaction in how to use the smart speaker by the researcher prior to the prescribed tasks.

Table 1: Participant demographic and technology experience

Group	Participa-nt number	Age	Self-identified sex	Touch-screen Use?	VUI Use?	Glasses	Hearing Aids
A (used tablet first)	P1	70-75	Female	Yes	No	Yes	No
	P2	Above 75	Female	Yes	No	Yes	No
	P3	Above 75	Male	Yes	No	Yes	No
	P4	Above 75	Female	Yes	No	Yes	Yes
	P5	65-69	Female	Yes	Occasional	Yes	No
	P6	Above 75	Male	Yes	Occasional	No	No
	P7	70-75	Male	Yes	No	Yes	No
B (used Google Home first)	P8	Above 75	Female	No	No	Yes	No
	P9	Above 75	Female	Yes	No	Yes	Yes
	P10	Above 75	Male	Yes	No	Yes	No
	P11	70-75	Male	Yes	No	Yes	No
	P12	70-75	Male	No	No	Yes	No
	P13	70-75	Male	Yes	Occasional	Yes	No
	P14	70-75	Female	Yes	No	Yes	No

3.3 Procedure

Participants completed three set tasks using the tablet and Google Home. They were not told to search for information in any particular way but were free to use the devices as they saw fit (for example, visit websites of their choosing). Semi-structured one-on-one interviews were conducted with each participant following task completion.

3.4 Information-Seeking Tasks

To mitigate order effects, participants were divided into two groups: Group A used the touchscreen first, Group B the smart speaker first (Table 1). We used Kim's classification of web searching tasks [49] to develop three scenario-

based tasks. Kim's classification has three search categories of increasing difficulty: a factual task involving searching for straightforward information (e.g., the weather forecast); an interpretive task requiring participants to make some inferences and evaluations while searching for relatively contained answers (e.g., important news of the day); and an exploratory task which is potentially more open-ended and demands greater judgement about the relevance of possible answers (e.g., researching a fictional vacation) [109]. Our goal here was to provide information-seeking tasks of varying levels of difficulty and judgement (Table 2) to see if this affected views about the two interface types.

Table 2: Information-seeking scenarios

Scenario-based tasks spanning three types of information finding activities
Task 1 (Factual): You plan to go out with your friend. Please find out the weather conditions for Melbourne tomorrow and briefly write down any information required to answer this question.
Task 2 (Interpretive): You want to catch up with today's important events. Please find out the important news of the day from Channel 7 TV and briefly write down any information required to answer this question.
Task 3 (Exploratory): You plan to spend Christmas in Iceland. Please find out what the Christmas traditions in Iceland are and briefly write down any information required to answer this question.

3.5 Interviews

We conducted one-on-one semi-structured interviews to capture qualitative data about participants' experiences with the two interfaces. We asked about their preferences for using each device to obtain different kinds of information. The interviews were conducted by the third author, using an interview guide developed by the first three authors. The questions were designed to gain insight into participants' opinions and feelings about the relative benefits and limitations of the two interfaces. Questions included: "What, if anything, did you like about using VUI/touchscreen to accomplish the tasks?"; "Do you perceive any limitations in using the VUI/touchscreen to accomplish the tasks?"; "Which device did you prefer to use for the tasks and why?"; "Do you see a place for using VUI/touchscreen device in your daily life?" All interviews were audio-recorded and transcribed for later analysis.

3.6 Data analysis

We used the thematic analysis method outlined by Braun and Clarke [12]. The third author first identified codes from the transcripts and used them to generate a smaller set of initial key themes. The first three authors then discussed these codes and initial themes. Initial themes included perceived usefulness, speed of access, difficulty remembering spoken information, uncertainty about information sources and quality, privacy, and cybersecurity. Using coding and initial thematic analysis, final themes were generated through an inductive process and were discussed, altered, and refined amongst research team members until agreement was reached. The resulting themes identified participants' perceptions of the benefits and limitations of touchscreen and voice interfaces, their views in comparing the two devices, and key areas of difference between participants' responses.

4 RESULTS

We now report on the key themes identified from the interview analysis. We should note that there were no significant differences in responses between Groups A and B. When comparing their information-seeking

experiences with touchscreen and VUI devices, participants identified and described key differences in relation to: (1) Efficiency and ease of information access; (2) Control over and trust in the information; (3) Breadth and form of information; and (4) Concerns about privacy.

4.1 Issues of efficiency and ease of information access

When asked to describe their experiences in using the VUI to search information in the sessions, participants used words like "quick" and "efficient". Participants sometimes explicitly attributed this efficiency to the input method of speech:

> "It takes less time, you see. The other one I have to type. If I understand how to ask questions—you have to know how to ask questions—then that's [speech] the quickest way of doing it." (P1)

> "I think [the VUI] can help save your time searching for information. Let's say you are going out from point A to point B. Instead of going to the tablet for the direction, you can say, 'Google, can you give me the direction?' So that is good." (P8)

Participants tended to believe that retrieving some kinds of online information simply by talking to the device was fast and saved time, and that speech was a more natural input method than typing. This sentiment applied principally to searching for simpler types of information. Participants felt the VUI would be valuable for accessing basic factual information in a timely way, such as the weather forecast (Task 1) or the expected arrival time of the next bus they might need to catch:

> "For the straight factual questions, like what the weather report is going to be, it's a nice and quick way, you don't have to get into it. For the purely factual things, it [Google Home] would be great, like what time would the tram get to stop 7. You can just get the answers straightaway and there's only one possible answer. It's great to use Google Home to get answers so quickly." (P3)

Participants praised the VUI's usefulness for people with various impairments. Several acknowledged its benefits for people with visual deficits who may not be able to use touchscreens. Others recognized its possible usefulness for other older people and for their own future selves when they imagined acquiring a disability. As one said:

> "If I am bedridden, Google Home would be fantastic. Just to be able to give a command or something from my chair…" (P11)

That participants found speech a fast and efficient method of obtaining information helps confirms previous research [50]. However, there were important caveats to this finding. These concerned voice *input* and voice *output*. Consider voice input first. Participants thought the VUI device was more efficient when the search was for simple information or if the search query contained information such as a keyword. As P3 put it, you can get immediate answers when "there's only one possible answer." But perceptions of efficiency were balanced by the caveat that "you have to know how to ask the questions" (P1). That is, despite the perceived ease and efficiency of the VUI for some tasks, participants found it difficult for other more complex tasks, or tasks where they did not know how to formulate the question in a way that a VUI would understand. For example, they recognized a need to oversimplify speech:

"I think you need to talk simply, ask short questions with Google Home. You can't just say what you want to say, you have to modify what you would normally say. It is not conversational as a normal person." (P11)

"If I talk to you [the interviewer], we can clarify things: 'Are you clear about my question?' But with Google Home, we cannot have a conversation." (P12)

This perceived lack of natural speech communication and ability to quickly clarify meaning meant that the speech modality was sometimes regarded as frustrating and inefficient. Participants felt that there is (usually) no need to 'talk down' to a human to get an intelligible reply, and misunderstandings can be rapidly sorted out with a real person so that the conversation can stay on track and achieve its communicative goals. There were also perceived difficulties related to voice output. In this regard, participants reported difficulty in coping with the speed at which the VUI spoke:

"But Google Home is just too fast, and I barely understand it. For me, for older people, it would be quite difficult…there is too much information, too quickly. My old brain is not processing so well." (P10)

Again, a person can ask another person to slow down or speak more clearly, to take things one point at a time, and so on. This, participants felt, was harder or impossible with the VUI.

However, some participants also expressed frustration with the touchscreen. This dissatisfaction concerned now familiar problems with the usability and convenience of many touchscreens related to letters being too close together and to the need to master required skilled hand gestures:

"The letters on touchscreen are too small and close to each other, I always press the wrong letter, sometimes the one next to it." (P11)

"I notice that sometimes you can enlarge it [i.e. text] but the sentences will be broken. I don't like it at all." (P1)

"It is very difficult for me to type because my finger is not flexible anymore. Whatever I type in, there will be a letter suggestion to it and then I have to re-type. This is a problem with older people." (P2)

In sum, many participants did not experience the tablet as efficient, easy, or enjoyable to use. In this respect, the VUI appeared sometimes to offer advantages from participants' point of view. However, the VUI also raised further problems for participants which have not been well addressed in the HCI literature.

4.2 Control over and trust in information

The second theme we identified was the degree of control users felt they had over the information seeking process and the trust they placed in the information received from respective devices. Many participants voiced serious reservations about the VUI's usefulness with the more exploratory information enquiries. Participants considered the responses from the VUI did not sufficiently answer their questions and felt that they were not able to control

the device to meet their needs and expectations for obtaining this information. For example, reflecting on the Icelandic Christmas traditions search (Task 3), two participants noted:

> "It is doing lots of thinking for me, which I don't like. [My query] was interpreted as 'what do people eat when they sit down at Christmas dinner?' Whereas to me the word 'tradition' means a whole lot of things...It's like having a teacher just telling you the answer. It's like a tradition has just one meaning. [But] there's lots of possibilities. I know that I am talking to a dumb machine." (P7)

> "I quite enjoyed the news [on the VUI] but I was very frustrated about finding the traditions in Iceland. It did keep referring me to something I don't need...I got the sense that it was not receiving the exact question." (P9)

Thus, the VUI did not interpret the question as expected and it failed to give users the information they sought. It was therefore deemed 'unintelligent', especially for the more open-ended question in Task 3. Such lack of control over getting the desired information obtained was perceived as a major drawback of this VUI. In contrast, participants reported having far better and more controllable access to information via the touchscreen, especially when searching for more extensive, less contained information (Tasks 2 and 3). This sense stemmed both from the ability to search and choose from a variety of possible web pages, and from being able to dwell on, pore over, and re-examine online content:

> "With the tablet, I can go back and re-read the news if I think I missed something. I can quickly scan the news and scroll down the headlines and pick what I want to read; whereas with Google Home, I have to wait for it to go through the headlines and it takes time. I find it much easier to scroll through the headlines on the tablet and find what I am interested in, click on that and read it all and go back to something else if I want to." (P12)

Thus, being able to readily select from multiple weblinks enabled users to choose what they wanted to view and also review before forming a final judgement about a matter of interest. In addition to preferring the touchscreen for that reason, participants sometimes distrusted the VUI because they could not see the information's source. Participants felt the touchscreen provided greater clarity and certainty about the information's provenance. For example:

> "I am not sure whether the source, the website is reliable or not. Google Home would tell you what the website is, and I can't change it; whereas using the tablet, I can say this is the website I like, and this is the website I trust." (P13)

> "I am not sure where they get this information from, so probably I would not use Google Home for getting news." (P12)

Moreover, a lack of trust was sometimes present even when the VUI identified the website that the information came from. For example, P12 told us that he consumes a dozen carefully chosen political blogs every day on a screen and could not imagine doing the same with a VUI. Like others, P12 worried about not knowing the source of the information (who or what was providing it); but he also sometimes distrusted information even when he knew who or where it came from because he had doubts about the veracity and worth of information from certain sources

which the VUI had chosen for him. In sum, it was a notable finding that our participants were highly interested in having control over and feeling able to trust information types and sources and that on this score they preferred the touchscreen to the VUI.

4.3 Breadth and form of information

The study's third theme concerned the breadth and the form or manner of presentation of information that participants accessed online from the two devices. This theme emerged especially (but not only) from the contrast between simple factual searching for basic information (Task 1) and more exploratory searching for elaborate, open-ended information (Tasks 2 and 3). Here again, the touchscreen was preferred. Participants judged information to be valuable and useful because it met their needs either in terms of the breadth or extent of the content itself or because of its form or presentation. Information retrieved by the VUI often originated from only a single source (such as a website like Wikipedia or a single news outlet). The VUI's spoken responses, some said, tended to carry less information than the visual modality of a screen allowed.

> "When I was using the tablet to search for Christmas traditions in Iceland, I found the tablet obviously had more information about what to eat and about different dates." (P11)

> "When you are using the tablet, you get pictures and a whole web page which can give you extra explanations." (P8)

Some participants said that the touchscreen enabled them to explore a topic from different angles and permitted access to a greater range of material from different sources. For example, P12, who particularly liked to think and know about political issues, said that he wanted to read conflicting perspectives so that he could deeply understand an issue; he did not think this depth of understanding was possible with the VUI.

The *form* or manner of presentation of the content also mattered to participants. An advantage of touchscreens, as the preceding quote from P8 indicates, is the ability to provide pictures and images. All participants reported that the visual aspect of the touch interface could yield more valuable and useful information than could the VUI. Pictures can also convey information quickly and digestibly. Participants highlighted the useful informational content of pictures and their advantages compared to written text or the spoken word. In fact, some considered visual content valuable even for the simple task of getting the weather forecast (Task 1). As one participant said:

> "The problem I have with [the VUI] is you won't be able to see the wind, the humidity, forecast...I want to have them all in front of me...You know the old saying, 'pictures are worth a thousand words'. You get more information in the visual. The [weather website] I normally use...it automatically gives you seven days weather and it gives icons. Today it might have picture of the sun, tomorrow it might have the pictures of sun and cloud and that needs no explanation." (P6)

Others noted that visual information can reduce mental effort for absorbing information. In contrast, they felt that the VUI's non-visual responses made it harder to recall and digest information:

> "If I want to go backwards and forwards, the aural is not so easy to absorb whereas the visual you can look at it and you can see the words in front of you." (P1)

"I am a visual learner and having something in front of me is really important to my memory." (P6)

The touchscreen, participants declared, made it easier to go back over the information as required, or, as P1 said, to "go backwards and forwards" to enable better digestion of information. Participants could skip ahead to the most useful information, or re-read information that they wanted to retain:

"The information from Google Home was too fast. Maybe I am getting old. Whereas on the tablet, I can go back and read it again if you are missing something…With Google Home you won't be able to remember all the [Christmas] traditions, you can only get 50 or 60% of the possibilities." (P8)

"With the tablet, you can go back and read it. Reading retains more information than hearing. Hearing is easy, reading is a bit harder, but it could retain more. I remember more on the tablet than the Google Home." (P12).

"It would not be very helpful to sit there and listen to Google Home read the whole page; I would get bored quickly, hoping it would come up with something relevant. It is much more difficult to skip ahead and to see what is coming." (P8)

To sum up, participants generally said that the visual element of touchscreens enabled access to and control over information of a kind and a form or presentation that was more detailed, varied, useful, and easier to absorb than that provided by the spoken word. Not only was it true for the participants that pictures are often "worth a thousand words," but visually presented information, whether pictures or text, assisted them in the exploration of more elaborate and nuanced knowledge.

4.4 Concerns about privacy

The relative levels of privacy afforded by the touchscreen and VUI emerged as the fourth and final important theme. We identified two distinct kinds of privacy concern in participants' interview responses. First, participants were concerned about whether their information would be captured by the Google Home device and disclosed intentionally or unintentionally to other parties:

"If Google Home can respond to my voice and turn on my light, it means it now can get lots of data and knows lots of about me. It turns on hacking, you know, cyber safety." (P7)

This voiced apprehension reflects a now commonplace wariness toward Google, Amazon, Facebook, Tik Tok, and other big tech companies and platforms that collect and manipulate user data [58]. Participants expressed concern about the security of personal details and feared that such information could be illegitimately harvested and used without their knowledge or consent.

In contrast to this current 'hot topic' fear about privacy loss, the second privacy concern was more 'localized' in nature. Participants worried about being overheard when talking to the VUI even at home, and that others might thereby obtain personal information about them. Indeed, this worry tended to turn some people off using VUI devices altogether. Here is an example of this sentiment from one participant:

> "Google Home is not private…others around me will know what I am doing and if I am going to use Google Home to report my schedule then everyone would know my schedule. I prefer to read it quietly myself." (P6)

Although this VUI was designed to be used in the private space of the user's home—hence the name 'Google Home'—others, like voice-based technologies in smartphones, can be and are used in public places. Moreover, even in the home environment, users may desire privacy from household members when searching online. For example, a user may simply want to search for birthday or holiday gifts for other household members without them knowing. As discussed further below, however, there are other, darker reasons for users to be wary about privacy when searching for online information in the home, such as when living with controlling or abusive partners or family members [63].

5 DISCUSSION

In this study, we investigated older adults' views toward two different interface types which they used to obtain information that required varying levels of exploration and judgment. The interviews provide insights into what participants thought about two common interfaces. The results suggest that participants were discerning in their attitudes towards ICTs, with clear individual preferences regarding the manner of obtaining information.

Participants reported that the two interface modalities provided differential benefits related to efficiency and ease of use. For some participants, the touch-screen device was difficult to use because of the small screen size and the need for fine motor skills. For others, the VUI presented usability challenges such as providing information too quickly or not responding as expected to some commands and questions. However, these observations, while backing up previous findings in the literature, do not provide the full picture of how people responded to the two interface modalities examined in this study. Importantly, participants' reflections extended beyond concerns about usability and accessibility [52] when they considered how useful the different devices would be. They considered the value the different modalities provided for supporting preferred ways of using online information and reflected on how well they could evaluate the trustworthiness of different information sources accessed via a smart speaker or a touchscreen device for different kinds of information. In this section, we discuss implications of these findings for a fuller understanding older adults' views and preferences regarding preferred interfaces and information access and control (5.1), privacy (5.2), and trust (5.3).

5.1 Preferred interfaces and information access and control

As has been noted, speech is often considered a relatively quick and easy interaction modality, which is one of the reasons VUIs are ostensibly valuable for their accessibility for older adults. However, a key limitation of VUIs highlighted by our study and some previous HCI research [29] is the frustration that can occur when users have to ask the right questions in the right ways to obtain the desired information As Myers et al [68] put it, "even the most current VUIs regularly cause frustration for their users."

A well-known YouTube video that clearly illustrates this issue is home footage captured by family members showing an older woman with a strong Italian accent trying to talk to Google Home in a conversational style that is natural to her and finding that, frustratingly, she is not always recognized by the device [1, 70]. The interaction causes amusement for her family and has delighted YouTube audiences, but the video clearly highlights a key challenge that needs to be considered when designing VUIs, especially for older users. Because human speech is

highly varied, VUIs must be effective at responding to different kinds of conversational input [9]. Sayago and other scholars call this the conversational user experience [66, 67, 87]. While there are notable efforts to improve the conversational user experience—for example, the natural conversation framework, described by Moore [66]—questions remain as to whether older users have been included in conversational datasets that inform the performance of conversational agents [87]. Nevertheless, improvements in artificial intelligence such as in deep learning and neural networks [56] that render VUI experiences increasingly naturalistic, conversational, efficient, and less frustrating compared to current incarnations [8, 96] may be beneficial for all users.

Improving the conversational user experience becomes even more important when VUIs are designed to be used as virtual assistants for older adults. As noted earlier, virtual assistant devices are being developed for the explicit purpose of supporting older people by providing them with information, reminders, and access to services [21]. Furthermore, commonly available VUI devices, such as smart speakers, are sometimes viewed as potential companions and assistants for older adults [76]. However, if older adults, especially those who are isolated and vulnerable, come to rely on such devices for accessing information and services, then it is necessary that the VUIs be designed to respond appropriately to all conversational input. Having reliable access to information is, for various reasons, crucial.

At the same time, relying on digital devices alone raises ethical questions, especially when the interfaces are designed to mimic human interaction but fall short of being able to respond in an appropriate way. A disturbing case that vividly illustrates this issue was reported by Buzzfeed during the height of the COVID-19 crisis: a woman who died of coronavirus asked her Amazon Echo device for help to manage her pain in the midst of her suffering [69]. While this is an extreme example, it does highlight the risks involved in relying on VUIs for assistance and information access. Creating or encouraging such reliance is an ethical issue, connected with, for example, responsibilities of safety and beneficence regarding digital technologies.

In our study, participants used the VUI device in a lab environment to conduct three information-seeking tasks requested by the research team. We note that this was not a naturalistic study of user engagement with the devices; hence, we need to be cautious in drawing insights from our findings about the conversational user experience and the ethics of using VUIs for virtual assistance and companionship [50]. We also stress that questions about these issues need to be investigated through longer-term field deployments of the technology. Nevertheless, our participants' reflections suggest that they have distinctive views on the potential value of VUIs, especially smart speakers, for the longer term. For example, participants saw the smart speaker as somewhat efficient, for some kinds of tasks, but also as somewhat frustrating and not always useful. They voiced reluctance, therefore, to consider using such devices in their own homes.

Participants expressed notable preferences for information presented in a way that allowed them to skip ahead, go back, review, pore over, digest, etc.—they preferred the touchscreen in this sense. Information presented visually seemed to give them a greater sense of being better informed and achieving a better understanding. They felt that this type of control often outweighed the fact that it could take longer to access information with the touchscreen than the VUI. Images and pictures ("worth a thousand words," as one participant said) can give rich information while reducing cognitive load. Cognitive load is a particular problem for some older users who are developing mild cognitive deficits [103] and it can be created by the presentation of too much information that strains working memory [43]. Some participants even preferred pictures or icons for simple factual information like the weather forecast, perhaps because images can be absorbed very quickly and with minimal mental effort. As one participant noted, while "hearing is easy" there may be more value in being able to see the information, view accompanying

images, and read the text carefully with the aim of better grasping and retaining the content. Positive views towards visual information are not always linked to impairments: some people simply prefer this way of absorbing information.

We have emphasized the importance of older people having access to valued information. Valued information is important not only because it matters for survival, health, and basic wellbeing, but also because it can enrich people's lives. For example, it can allow them to pursue hobbies and passions, deepen their knowledge, and maintain their relationships. Older adults in this study felt that their ability to access information that they both trusted and wanted depended on having some control over the devices such that they could, for instance, readily scroll through and visit multiple preferred websites to obtain more content and, importantly, a range of viewpoints or perspectives. This was less important for certain activities (such as getting the weather) than it was for others (such as getting important news). This finding exemplifies Rogers et al.'s point that the value of a device can vary with the task and the user's needs and interests [84]. We could remember here, for example, P12's desire to immerse himself in varied and contrasting political perspectives to achieve what he considered to be a substantial breadth and depth of understanding on matters that require nuance and critical thinking. For this participant, pursuing this enriching activity could only be attained when he could access various and contrasting viewpoints from numerous sources that he considered reliable. This illustrates how older people, like others, often want to go well beyond acquiring basic or surface knowledge or information when using ICTs.

5.2 Preferred interfaces and trust

When reflecting on how they evaluated the information that the two devices provided, participants often spoke of or alluded to trust. The notion of trust has different applications in HCI and related research [26, 34, 81]. As Edwards and Sanubari [34] recently noted in discussing conversational user interfaces (CUI), it is important that we differentiate between different aspects of trust. For example, trust can refer to the technical dependability and safety of a device, to privacy concerns [26, 30], or to a feeling of rapport with a machine which resembles rapport with a person [26, 44]. Trust, as Knowles and Hanson [51] observe, can also refer to older people's lack of confidence in using ICTs. According to this latter variety of trust, older people attribute a lack of self-confidence in using ICTs to a lack of trust in the machine.

While these are important meanings of trust in HCI, our participants were specifically concerned about whether they could trust the informational content itself as retrieved and presented by ICTs. Although it stemmed from this content delivered to them, such (dis)trust effectively extended to the devices that provided the content [58]. Thus, participants tended sometimes to regard the VUI as less trustworthy than the touchscreen because they were unsure of the provided information's provenance or doubted the reliability of the source which the VUI device had 'chosen' to give them. In their paradigmatic forms, the notions of trust and trustworthiness, as philosophers of trust note [64], are interpersonal: we typically regard other human beings as trustworthy, or not. For example, we regard some people as honest, well-informed, and possessing good judgment about information, and other people as less honest and prone to giving inaccurate, biased, or relatively worthless information—and for many different reasons. Accordingly, we may know who we are prepared to trust when seeking knowledge and information, and the specific people we trust may vary with the specific type of information sought. Scholars have, of course, recognized that forms of trust extend also to technology [61]. In our study, participants evoked a kind of trust and distrust in ICTs that have the agency to select and provide different types of information that seekers of knowledge do or do not

have faith in [9]. They regarded the ICT's they used as trustworthy in some ways and not in others, and found differences in trustworthiness between the two interfaces.

Because older adults' preferences regarding information and trust are, as with many other groups of people, nuanced and discriminating, VUIs may benefit from having more customization options for users to tailor experience to needs. For example, while not used in the tasks in this study, Google allows Google Home users to select the sources of their news. This could potentially mitigate people's concerns about trusting the information shared by a VUI. Further, as some others suggest [77], VUIs might signal to users relevant data about the provenance of the information. Our study provides a context for further studies into issues like trust and ICTs. For example, studies could be conducted in real-life settings with older adults who are given the opportunity to trial and directly compare touch and voice-based interfaces for seeking information that is important to them outside of the lab. Studies conducted in homes and aged care settings may also shed more light in how different interface modalities are related to other key factors, such as different forms of control and privacy.

5.3 Preferred interfaces and privacy

Participants had strong preferences for touch input and visual display over speech input and output that related to privacy. It is worthwhile reflecting on this theme since privacy is a major human need. Privacy concerns in this study included but went beyond familiar anxieties (which are perhaps informed by notorious cases like the Amazon Echo privacy lapse [25] about hacking, surveillance, and data security). Privacy scholars classically distinguish between public and private spaces [107]. Moorthy and Vu [33] found that, in comparison to the use of keyboards in public, users have concerns about speaking aloud to voice assistants in public spaces, especially when what is said is considered private information. In the present case, users may be worried about drawing public attention and having strangers learn about their private lives [33]. However, a variation on this theme which emerged from this study was that the privacy concerns some older adults have about VUIs extend into that most private of spaces: the home or residence [77].

Notably, the VUI device we used in this study is designed for use in the home environment. Reflections on privacy concerns, therefore, may not apply so much to strangers who can eavesdrop, but to concerns about people's partners, family members, or housemates overhearing or actively listening. The need to speak aloud is inherent to VUI devices, and for some people this is problematic. Trajkova and Martin-Hammond [102] observe that some older VUI users worry about invading the shared space of others within the home when they speak aloud. In this study, however, the concerns were more about users losing their own privacy. It is easy to appreciate that like any other group older people might want to keep some things to themselves, even when the information is not acutely personal. Some people are simply shy about speaking in front of others [77]. The revelation even of relatively non-sensitive material or activities may distress some people. Obviously, exposure of more personal business, such one's political views, relationships, or sex life, can cause still more embarrassment, shame, and hurt. People may also be concerned that the exposure of some information and activities may harm them in various ways, such as when information can be used against them by an unfriendly eavesdropper.

Moreover, the need for keeping particularly intimate parts of our lives off-limits to others, even sometimes to our nearest and dearest, is a widespread and substantial human need [62]. Philosophers like James Rachels, for example, have argued that privacy is a distinctive human requirement insofar as it is a precondition of developing and maintaining various social relationships [78]. As Rachels explains, we typically put on various masks in our dealings with different people. Thus, we behave very differently with our friends and our casual acquaintances.

Consider the way we can be less formal and more open with those we know well and trust. If privacy disappeared, we would be forced either to effectively behave towards our friends as we behave towards our acquaintances, or the converse. Such a situation would undermine the conditions for one or other of those relationships, and most of us would regard this outcome as a great loss. This, thinks Rachels, is the essential reason behind the distinctive value of privacy. We could add that the absence of privacy appears most pernicious when it interferes with the intimate relationships that we hold most dear.

In addition to these considerations, the feeling of being watched is, past a certain point, profoundly inhibiting of the spontaneous and natural behavior that is essential for personal authenticity. Most of us feel we cannot 'be ourselves' when we are being listened to or watched and when we have no control over others' access to our body, activities, behavior, and thoughts. Many older people already suffer from a degree of privacy intrusion, such as when they are in aged care or rely upon frequent caregiver support. These individuals may also depend heavily on ICTs for many important activities and interests. Given the importance of the interests that are at stake here, it is crucial that older people enjoy an area of privacy that allows them to achieve and sustain those basic human goods. As our findings suggest, interface type may have a role to play in upholding these goods for some older people.

We also want to draw attention to the possibility of even more disturbing scenarios related to privacy loss. For example, a person may need to search for information secretly when they are coping with intimate partner abuse [63]. Intimate partner abuse is a complex and profoundly harmful phenomenon. During the "physical control" phase of the intimate partner abuse cycle, the abuser may physically control and monitors the survivors' technology use [63]. Clearly, using a VUI could make searching for resources about domestic violence or leaving an abusive partner even more difficult if an abusive partner is within earshot. For older users there may be additional concerns about other family members, such as adult children, overhearing information searches. Abuse of older people instigated by family is a growing concern worldwide [86], but this has not, to our knowledge, been the topic of HCI research to date. Elder abuse, which is a complex phenomenon and can be psychological, verbal, sexual, or physical, is also of increasing concern in aged care [79]. While it is beyond our scope to examine this issue further, the fact that some participants recognized privacy as a barrier for using VUIs demonstrates a need for more research into why older users may prefer to keep what they say to a VUI device private from a range of other people.

6 LIMITATIONS

A key limitation of our study is that it involved one-off interactions with the devices in a lab setting. A one-off lab study provides limited information about user views and long-term adoption since technology preferences can change over time. Nevertheless, this study enabled us to gain insight into participants' views about the two interface modalities for different kinds of information seeking tasks and to identify issues that warrant further investigation in longer-term field deployment studies. We also recognize that the small sample size of this study. Qualitative research routinely involves sample sizes of 14 participants [14]. This can make it difficult to generalize findings to the experiences of other older adults, but there is still value in obtaining people's individual views and experiences. Another key limitation relates to participants' comparative familiarity with the two devices. While all participants had used tablets, only three had occasionally used a smart speaker (note that our study was conducted in a place where smart speakers have not been universally adopted), and, even though we instructed participants in how to use the smart speaker, this study involved only one session. With more comparable levels of use and reduced novelty, older adults may experience fewer frustrations with the smart speaker than they did in this study [50].

Meanwhile, smart speakers have continued to evolve. Some of the participants' concerns, therefore, may have been addressed in subsequent updates. For example, Google Home can now give more detailed information about weather, including seven-day forecasts. Additionally, Google home now combines some of the benefits of a VUI and touchscreen together when it sends 'more information' to the users' specified device after a search. Some recent research is exploring how accessory speech input might make it easier for users to navigate webpages [112]. Other research suggests that older people may sometimes view interfaces that convert text into speech as helpful when reading [42]. Yet despite the potential of both speech input and output, many of the reasons that our participants gave for their preferences will still be relevant to designers of future VUIs and to some existing ones. Our study adds to the overall body of HCI work examining VUIs by bringing to it the perspective of older adults which was virtually absent until recently [87]. Finally, an interview study cannot answer certain questions like user error rates and usability of respective devices: that requires separate investigation.

7 CONCLUSION

It is vital that citizens of all ages can connect effectively and safely with online information. Interface design plays a role in equitable access to digital knowledge, and this study identified a range of relevant benefits and limitations of both VUIs and touchscreens. Overall, while older adult participants enjoyed aspects of the VUI device and found it efficient and convenient for simple tasks, they generally preferred touchscreens for getting the breadth of content they wanted and in a form that they preferred and had control over, so that they could achieve the kind of understanding and knowledge they sought.

Our study provides an example of the way in which older people are thoughtful and selective when using ICTs to obtain different kinds of information. Older people, we found, sometimes view ease of use and efficiency as peripheral to having control over information sources, maintaining the ability to evaluate the information provided, and enjoying the level of privacy desired. This lesson is no mere platitude. As Knowles et al argue [53], society suffers from an ever-present tendency to ageism, such as by entertaining stereotypes, pathologizing the aging process, and underappreciating the wisdom and life experience that older people bring to ICT use [104, 108].

While a primary (and worthwhile) aim of technology designers and researchers has been to remove accessibility barriers for older users, our study suggests that this aim can fall short of supporting information-seeking experiences that older adults value. These insights contribute to a growing body of HCI research that conceptualizes older adults as diverse and discerning technology users for whom new technologies should be designed to add value, rather than simply to compensate for perceived impairments and limitations [104]. Such knowledge has real-world importance for a more fully user-centered approach to the design of ICTs for older people.

Researchers might consider building on and extending this study in various ways. For example, they could explore older adults' use of VUIs that also have screens (such as Google Next Hub or Alexa Echo Show) as opposed to smart speakers that lack them. Furthermore, future research could examine how older adults use VUIs and touch interfaces in home rather than in lab settings, and over an extended period. Such work would help to further illuminate interface-related issues, including privacy, trust, control, and efficiency, for older adults who wish to seek online information.

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