Appeared at CUI 2021. Authors' copy. Official publication at: https://dl.acm.org/doi/10.1145/3469595.3469603

VUI Influencers: How the Media Portrays Voice User Interfaces for Older Adults

Jaisie Sin
TAGLab & Faculty of Information, University of Toronto, Canada, js.sin@mail.utoronto.ca

Cosmin Munteanu
TAGlab & Faculty of Information, University of Toronto, Canada, cosmin.munteanu@utoronto.ca

Numrita Ramanand
TAGlab & Faculty of Information, University of Toronto, Canada, numrita.ramanand@mail.utoronto.ca

Yi Rong Tan
TAGlab & Faculty of Information, University of Toronto, Canada, yirong.tan@mail.utoronto.ca

ABSTRACT

Voice User Interfaces (VUIs) such as smart speakers hold promise for older adults (OAs) in terms of usability and convenience. However, their adoption and the extent of their benefits to OAs may be influenced by mass media, as this is a primary source of technology education for OAs. Thus, we aim to obtain a better understanding of how VUIs' value and utility for OAs are portrayed in the media. We conducted a systematic review and thematic analysis of articles published in ten popular digital news outlets that focus on VUIs and older adults. The analysis reveals several design and engineering factors that are portrayed in media as being relevant or encouraging to older adults' adoption of VUIs. Given the media's influence of the consumer adoption of new technologies, this analysis brings to light several sociotechnical aspects that are dominant threads within the media discourse related to VUIs. Through this, we suggest areas of focus for the research and design of VUIs that account for these influencing factors.

CCS CONCEPTS

• **Human-centered computing → Natural language interfaces;** ***HCI design and evaluation methods***

KEYWORDS

Older Adults, Meta-Analysis/Literature Survey, Mass Media, Voice User Interfaces, Sociotechnical

1 Introduction

Voice user interfaces (VUIs) enable users to communicate with devices using voice or speech for input and output. They are becoming an increasingly popular way of interacting with technology [31], and older adults (those 65+) are among the largest growing group of users of VUIs [2]. This may be because VUIs are easier to use for older adults compared to graphical interfaces, which in contrast may pose visual, auditory, physical, and motor-based barriers to interaction [19,55]. As a result, older adults may benefit from the use of VUIs and the addition of VUIs to existing products and services for accessibility [55]. However, the design and adoption of VUIs is not without its challenges, and there is still a gap in understanding of the barriers and drivers of older adults' perceptions of VUIs [45].

Mass media influences users' perceptions, behavior, and adoption with respect to new technologies [52]. Some of this impact is mediated by marketing influences, however the media often also has its own agenda and is a reflection of societal trends. Thus, the media is a proxy for a wider snapshot of factors (including tech industry marketing) that may influence the perceptions of voice user interfaces. In particular, older adults also rely heavily on the media for their knowledge of technology [8], and this relationship can contribute to their adoption (or lack of adoption) of such technologies [23]. As VUIs are an emerging technology that is growing in prevalence in commercial and public spaces and can be of benefit to older adults [51], we wanted

to ask: how are VUIs portrayed within the media discourse, particular with respect to VUI adoption by or suitability for older users?

In other words, our goal with this study is to understand how VUIs are portrayed in media. By focusing on the sociotechnical factor of adoption via media influence, we hope to gain a better understanding of the general factors that influence older adults' adoption of VUIs. As such, we conducted an inductive thematic analysis of articles on VUIs for older adults from ten major news sources. We found that the media sees older adults as a viable target market for VUIs. However, the media discourse also portrays the adoption of VUIs by older adults as dependent on factors of data privacy, trust in institutions behind VUIs, the ability for the VUI to become embedded in older adults' lives, the changes VUIs can bring to them, and trends of the greater VUI market and government policies and practices.

Based on the results, our paper recommends and contributes to a sociotechnical analysis of the media portrayal of VUIs, focused on both the influencing and the critical discourse around the relevance of VUIs to older users. The sociotechnical lens enriches our broad understanding of the multifaceted factors contributing to or affecting the adoption of VUIs by this demographic. This lens has been applied in media theory on emerging technology in the past, such as in understandings of pre-domestication and domestication of technology [18,21,47]. Our study contributes to growing evidence to support the sociotechnical lens to capture the sociotechnical forces at play in terms of factors of non-use, non-participation, adoption [57].

To our knowledge, no other synthesis of the media literature on VUIs has been conducted, especially that related VUI use by older adults. By studying the portrayals of VUIs within media, we will gain a deeper understanding of (older) consumers' perceptions and attitudes towards the adoption of VUI technologies, as these are influenced by such portrayals. In turn, the understanding of the sociotechnical factors portrayed in media will help researchers and designers better understand older users' expectations of VUIs as influenced by the media discourse.

2 Related Work

2.1 Older Adults Perceptions and Use of VUIs

Older adults are seen to potentially benefit a great deal from VUIs [55]. Traditional interfaces such as the mouse-and-keyboard can pose visual, physical, and cognitive challenges for older adults [55]. On the other hand, audio is a preferred modality for people without hearing impairments [55]. Thus, VUIs are believed to serve as a more accessible design to the digital realm, have a low barrier of entry compared to other input methods, and have the potential to be seamlessly incorporated in older adults' lives [26,59]. VUIs can help older adults manage their health [7], navigate the web [48], and develop social skills [4]. Research indicates that older adults perceive VUIs positively [51,59].

Yet, the understanding of these perceptions, especially on the part of older adults, is still preliminary. When it comes to VUIs for use by older adults, many open issues and challenges remain [45]. In particular, we do not yet completely understand the barriers and drivers of older adults' perceptions of VUIs, how VUIs should interact with older adults, and how to personify and anthropomorphize VUI systems designed for older adults' use [45]. There also exists outstanding concerns, such as those articulated by Turkle et al. [53,54], related to empathy with voice and voice-related technologies. Moreover, there is not much computing literature about VUIs on the design of these systems for older adults [51], particularly that involving older adults as participants in studies. Those that exist explore in a large part the application of VUIs in relational artifacts and robots designed for older adults [12,49]. In addition, this literature [51] is notably focused towards older adults' perceptions and benefits according to academic (ACM) literature (rather than on mass media which is our subject of study in this paper). There is a need for a separate analysis of media discourse as mass media has a direct influence on the general population's perceptions of new technologies – this is in comparison with academic literature which typically does not reach consumers of mass-marketed technology.

Our work contributes to the understanding of the barriers and drivers of older adults' perceptions of VUIs. Here, we study the media portrayals of VUIs for use by older adults to understand the factors and drivers of older adults' adoption of VUIs. In future work, we will validate these results in studies with older adult participants to then use to develop design guidelines for VUI design for older adults.

2.2 Media Content Analysis

Content analysis is a well-established research methodology used to understand mass media content. Since the 1950s, content analysis has served as a systematic method to study broad ranges of 'texts' including newspaper articles [28]. By the mid-1980s, content analysis had become a common method taught in research courses in journalism [36]. Operationally, content analysis involves the qualitative coding of texts, with one goal being to focus on the narrative and meaning produced by the words [28]. The "content" in question refers to "words, meanings, pictures, symbols, ideas, themes, or any message that can be communicated" [37] (quoted from [28]).

In our work described in this paper, we conduct content analysis of the text of news articles to find the themes related to how VUI technology for older adults is portrayed by the media.

3 Method

To answer our research question on the portrayal of VUIs within the media discourse, particular with respect to VUI adoption by or suitability for older users, we employed a content analysis of ten major broad media sources. Text-based articles were qualitatively coded and analyzed using inductive thematic analysis by a team of researchers and major themes in the text determined.

3.1 Search Terms & Article Selection

We searched for articles from 10 digital news sources to find articles on the topic of VUIs for older adults. The ten sources were: AARP (aarp.org), USA Today (USAToday.com), New York Times (NYTimes.com), Daily Mail (DailyMail.co.uk), Washington Post (WashingtonPost.com), The Guardian (TheGuardian.com), New York Daily News (NYDailynews.com), Los Angeles Times (LATimes.com), New York Post (NYPost.com), and San Francisco Gate (SFGate.com). The AARP (formerly known as the American Association of Retired Persons, but is now simply known as AARP) is a leading United States-based organization aimed at empowering adults aged 50 and up. It was our primary news source for preliminary analysis as we consider articles on VUI by AARP to be influential for older adults and a valuable subject of study. Notably, AARP is a supporter of VUIs, having three existing Alexa skills for its audience base ("Memory Game", "Now Flash Briefing", and "Raise Your Voice" [1]). The other nine news sources were selected for being the top newspapers by digital traffic according to the Pew Research Center [32]. We used circulation metrics to select media outlets as this was the only object criteria available (as opposed to more subjective criteria such as trustworthiness). We chose not to apply additional filters (such as subjective assessments of writing standards) because our goal was to look at media's influence on the general public (hence including all publications based on the general public's consumption).

Of note is the variety in the style and readership of the nine sources; as examples, USA Today is more known for general news and has a right-leaning twist; The New York Times has a readership of higher socioeconomic status; the Washington Post is more left-leaning; and, New York Daily News and New York Post are tabloids. We believe the diversity strengthens the potential of the findings to provide a more holistic picture of the media's portrayals of VUIs for older adults.

We searched on Google (google.com) for articles on each of the 10 news sources by using the following search query:

> site: <website URL address> ("voice user interface" OR "VUI" OR "conversational agent" OR "conversational interface" OR "conversation agent" OR "chatbot" OR "alexa" OR "google home" OR

"siri" OR "cortana" OR "voice assistant" OR "virtual agent" OR "interactive voice response" OR "IVR") AND ("older Adult" OR "senior" OR "aging" OR "ageing" OR "elderly")

This query produced results that mentioned both VUIs and older adults. This search query was designed to parallel the search query used by Stigall et al. in [51], however with search terms modified to match common-use language (e.g. by including commercial VUIs like Alexa).

We used a Google Chrome browser set to "Guest" mode to prevent any side effects from search history. We limited the start date of the articles to September 20, 2018. The aim of selecting such dates as delimiters was to find articles that are both relevant and current would peak starting from the date of significant events related to VUIs, which in this case is the date of the announcement of the 3rd generation of the Amazon Echo Dot. The end date of the articles for AARP was set to February 1, 2020, while the end date of the rest of the articles was set to August 1, 2020. The difference in dates was only due to differences in the dates of the analysis (as we have conducted this sequentially due to the significant human effort required) and were not anticipated to have had much impact on the nature of the results. We limited the article selection to the first five pages of Google search results.

To filter results, we used the process suggested by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [33]. We screened out articles that were not text articles (i.e. some were landing pages or video reports), not on VUIs, or were not about older adults (e.g. false positives of 'seniors' to represent senior designers rather than older adults).

3.2 Data Analysis

We used inductive thematic analysis [9], in particular the Consensual Thematic Analysis approach [20], to code and analyze the selected articles. This technique is used in similar qualitative HCI research [13,14]. Initial coding and clustering of the codes were conducted by two researchers working independently. Once all of the data was coded and initial clusters created, a data session between the two researchers and additional researchers took place. In this session, the researchers closely reviewed the coding and initial themes for each set of articles (corresponding to each news sources) were generated. These themes were further refined by the initial data coders in order to identify overarching, high-level themes among all of the news sources. All researchers had a background in HCI and had experience in conducting qualitative data analyses. In the following section, we present the findings of the analysis in terms of the four themes that emerged.

4 Findings

Based on the filter criteria outlined in Section 2, a total of 98 articles were coded. Figure 1 provides the breakdown of eligible articles sorted by news source. Four major themes were found across the articles and are outlined in this section and summarized in Figure 2.

Source	# of Articles
AARP	43
New York Times	14
Telegraph	10
The Guardian	8
USA Today	6
Daily Mail	5
NY Post	4
Washington Post	4
NY Daily News	2
LA Times	1
SFGate	1

Figure 1. A breakdown of the number of eligible articles evaluated for themes, sorted by news source. A total of 98 articles were coded.

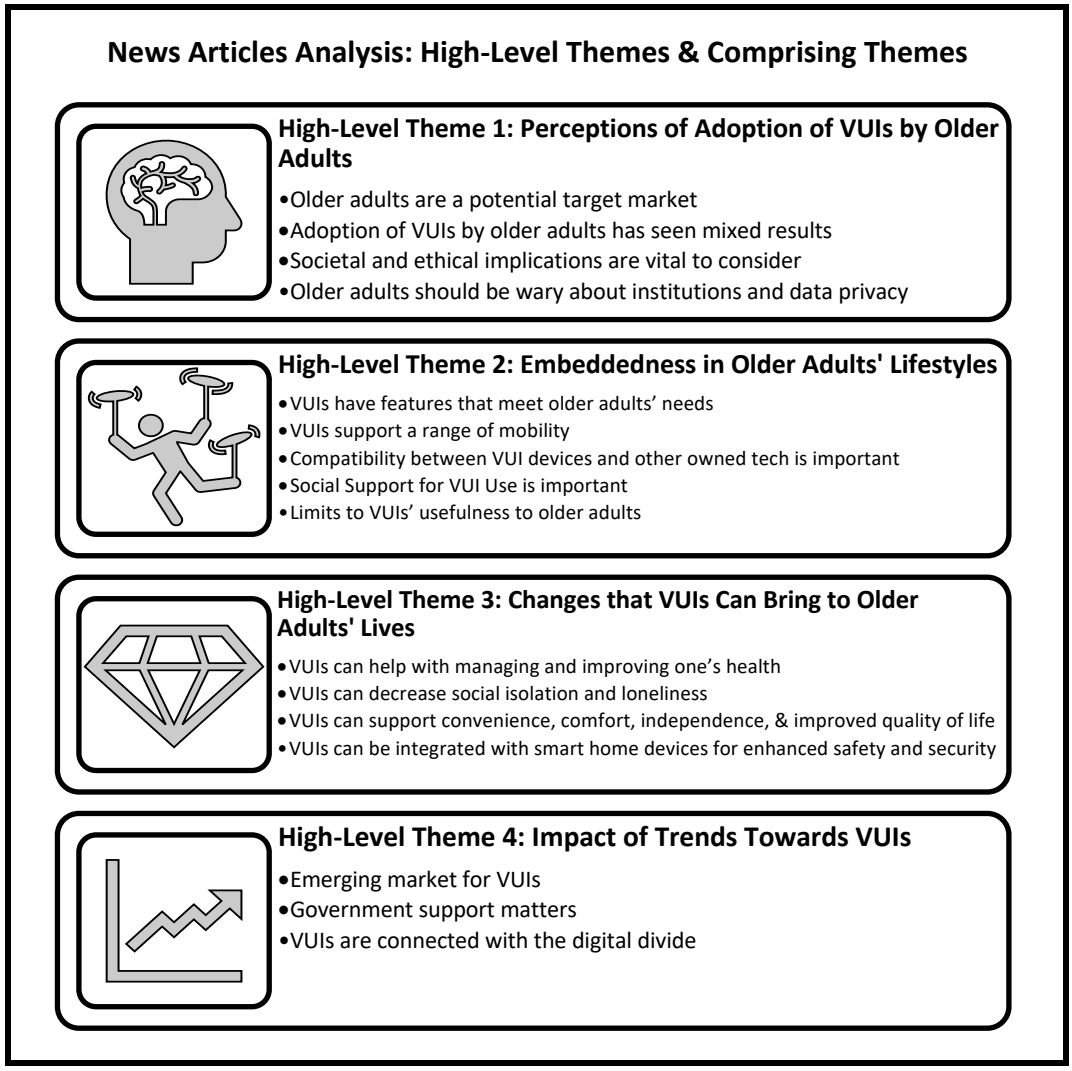

Figure 2. Summary of the themes found across the media articles. Each of these themes are further expanded upon in each subsection of Section 4.

4.1 Perceptions of Adoption of VUIs by Older Adults

The first major theme pertains directly to perceptions of adoption of VUIs by older adults. The media portrays older adults as a potential target market (Section 4.1.1) but that adoption has been mixed (Section 4.1.2) and has been linked (or portrayed as being ought to be linked) to societal and ethical issues (Section 4.1.3), and needs for data privacy and trust in the institutions behind the VUIs (Section 4.1.4).

4.1.1 Older Adults Are a Potential Target Market

Older adults are portrayed by news articles as a target market for VUIs. For example, the Google Home Mini is cited to "make a great gift for grandma, grandpa, or an older aunt or uncle" [15]. Voice is seen as the best modality with which to communicate with older adults and can be a means to bridge gaps in technology literacy [11]. VUI devices are reported to help older adults feel more connected to senior housing communities "by responding to questions like asking what's for lunch, or what activities are available that day" [11]. In particular, it is these digital assistant-related components of VUIs are seen as valuable. For example, Google Assistant is touted as the first choice compared to Siri or Alexa "because Google Assistant

does "know" you and your schedule better than Siri or Alexa, it's usually the first choice for a senior who would benefit from a digital assistant that is better attuned to their individual needs and routines" [15].

News articles have supplemented the claims of the benefits of VUIs by referencing programs that have embedded Alexa in communities of older adults. For example, SFGATE reports that AARP's Social Connectedness Voice-Activated Technology program has given some residents in senior housing communities with Amazon smart speakers [11]. There, "the goal of the program is to determine whether voice activated technology can help older adults fight isolation and loneliness" [11], which is a topic echoed in other news articles with regards to VUIs [40].

However, barriers to older adults' adoption of VUIs are portrayed to still exist. So, while there was no comment on the results of the program [11] with regards to the goal, however the authors did comment on the barriers that were found with regards to adoption of VUIs by the older adults. In particular, "the challenge has been that many residents have little experience with smart phones or wireless Internet and have to get past their initial resistance to new technology" [11]. Other articles directed at older adults assert "learning how your new personal assistant likes to be talked to might take a little practice, especially if you have an accent" [41]. To help older adults become comfortable using VUIs, apps for older adults have been made to serve as "guides on how the elderly can use Amazon Alexa" [30]. Advertisements such as the Super Bowl commercial showing an elderly man using Google Assistant to remember his late wife "also helps to make technology seem more approachable [27].

4.1.2 Adoption of VUIs by Older Adults Has Seen Mixed Results

Articles are mixed when it comes to commentary about other's adoption of VUIs. Some articles portray existing VUI use in a positive light, such as one which stated "my new-found friend is Alexa, which sits next to my bed" [69] and other articles which state that VUIs provide real benefit and that "it's more than just the 'cool' factor" [11] and provide advice about regular speakers for people who view smart speakers such as Alexa as "creepy"[70]. Using VUIs is portrayed as being less of a "traumatic experience for many people, especially those who are disabled or not familiar with technology" than searching online [62]. Some remark the positive reception of smart speakers in the greater community, such as an article's commentary on the deployment of Alexa at a senior community that "became an instant hit" [18]. On the other hand, an article was concerned that some people are currently unable to use internet-enabled technologies like VUIs and are concerned about digitization of public services remarks that "digital technologies can be valuable tools to improve public services and reduce health and social inequalities, but should not be adopted as "fashion trends" that leave some people behind" [61].

4.1.3 Societal and Ethical Implications Are Vital to Consider

News articles are skeptical of the societal and ethical considerations of VUIs. They ask ethical questions like "should we make it transparent to people that companion robots are preprogrammed to act this way and do not genuinely have emotions?" [5]. They also contend with whether or not VUIs replace human relationships, with news articles presenting interviewees with the viewpoint that they do not [5]. These articles also remark the evolving definitions of human-robot relationships: "Researcher Astrid Weiss is studying human-robot interactions in Austria and notes the boundaries between human and robot will continue to blur over time. "'We don't know what the concept of friendship will look like with a robot or how the concept of friendship with humans changes,' Weiss says" [5]. Some articles note the limitations of VUIs to comfort people: "Alexa's artificial intelligence-infused heart may be in the right place, but there's only so far it or any AI can go to comfort someone who is alone" [5].

News articles also present design considerations of VUIs when it comes to people in sensitive situations, for example: "Mr. Limp said that Alexa might feel somewhat human to some because of the 'empathy' put into it. 'If you're an adult and you say you're depressed or suicidal,' he said, 'or you're potentially a victim of domestic abuse and you're talking to Alexa in that way, we've talked to experts about what we should do in those situations. Alexa would try to connect you to a suicide hotline or domestic abuse hotlines'" [71].

4.1.4 Older Adults Should Be Wary About Institutions and Data Privacy

Data privacy is portrayed as a topic of concern when it came to VUIs. Data privacy was linked to concerns over the intentions of the institutions behind the VUIs, aims to educate readers about data privacy, and authors of the news articles taking responsibility on helping preserve data privacy when making VUI product recommendations.

News articles displayed a level of caution in terms of privacy when it comes to VUI usage. Some of this occurred through commentary on the state of privacy when it comes to VUIs, for example through a remark that "millions are reluctant to invite the devices and their powerful microphones into their homes out of concern that their conversations are being heard" [72].

Several articles connected data privacy concerns to the institutions behind the VUIs. For example, one article pointed out that "privacy and security issues remain a concern for many in the older age bracket, with Americans over 50 not placing much trust in institutions to keep their personal data safe" [24]. This same rhetoric was repeated in articles around the case of the Amazon Alexa service being used by the United Kingdom's National Health Service to deliver medical advice. For this case, articles mentioned that there were "past concerns about how Alexa-enabled devices handle their users' information" [73] and that "critics demand more specifics on how patient data is protected" [63]. The relationship between data privacy and the institutions behind VUIs was touched upon as well in articles on the use of VUIs in health within other countries, such as the case in South Korea which used a VUI-based system to monitor loneliness in older adults. Here, it was mentioned that "officials are preparing regulations for revised data laws that lawmakers passed in January after months of wrangling. They aim to allow businesses greater freedom in collecting and analyzing anonymous personal data without seeking individual consent" [40]. Overall, the view with privacy when it comes to public health is that "privacy campaigners said that while making it easier for people to access reliable medical advice was a step in the right direction, they were concerned about the partnership and its implications" [39].

Some articles took direct steps educate the reader on the importance of data privacy and on how to protect themselves. For example, one article pointed out the risks involved around data privacy by mentioning that "companies use such information, accurate or not, to determine how much you pay for insurance, what rate you'll get on a home mortgage or whether you'll get a job. So protecting your digital privacy is reasonable" [74]. One article shared historical actions taken on data privacy with VUIs, in that "the human listeners were hired to make transcripts of the recordings to assess and help improve the programs' accuracy. Some of those human listeners are the ones who spilled the beans on Alexa and Google Assistant" [74]. Some articles prompt the reader to consider their trust in the companies behind the VUIs, for example by mentioning "[apps in smart speakers] can be harmless, but you hand over data to the company if you play music through those apps or give them access to your phone's location settings. Consider how much you trust the company with your information" [70]. Other articles mention cases where VUIs were found to listen in or potentially listen in on conversations without a person's knowledge, for example in the case of a VUI being hacked or accidentally activated even from across a room [72]. Some articles directed at older adult audiences were written with the explicit intent of addressing privacy concerns, such as an article by AARP titled "How to Stop Amazon and Google from Listening to Conversations Through Your Smart Speaker" [75].

The climate on data privacy caused some articles to take extra precautions. For example, one article that aimed to give recommendations for smart displays that incorporated VUIs, some for use by older adults, stated, "we reached out to companies about their policies on collecting information from the owners of smart displays, and we did our best to confirm that those policies weren't more invasive than what's standard for the industry" [65].

4.2 Embeddedness in Older Adults' Lifestyles

The second theme pertains to the adoption of VUIs by older adults as linked to the VUIs' ability to become properly embedded in older adults' lives. VUIs are portrayed as meeting the needs of older adults (Section 4.2.1), but that whether or not they can be adopted is relies on a VUI device's support for mobility (or non-

mobility) (Section 4.2.2), the compatibility between the VUI and other devices owned by the older adults (Section 4.2.3), the older adults' access to social support to use the VUI (Section 4.2.4), and limits to VUI devices' usefulness (Section 4.2.5).

4.2.1 VUIs Have Features That Meet Older Adults' Needs

VUIs are noted for their design features which make them fit older adults' needs. One of them is its naturalness as an input. "After all, what's more natural than using your voice?" asked a guide on using Siri on Apple devices [42]. "Voice control is so much easier and more natural for seniors instead of learning how to use a tablet," mentions the coordinator of a project that deployed Amazon Alexa devices assisted living communities [30]. An article on smart speaker features quotes: "'There has never been a more natural way to communicate with technology than using your voice,' says Katherine Prescott, founder and editor of VoiceBrew. 'There's something so magical about these devices, like we're living in the future'" [43]. The ability of smart speakers, such as the Google Home Mini, to distinguish a voice from the crowd was also noted to provide "a truly personalized experience" [44]. Other aspects of input that were mentioned were the ability to ask follow-up questions through features like Alexa's follow-up mode and Google's continued conversations feature [41] and the tactile interaction to "tap to indicate finished speaking, stop talking go finish" when using Siri [42].

The output and feedback are also remarked. Siri's is noted to "answer you back in a humanlike voice" [42]. Guides on setting up and using smart speakers make note of the chime and blue ring indicating activation of Amazon Alexa smart speakers [41]. "LED lights pulse in unison with [a social robot's] voice" is noted as supplemental feedback of voice-based audio output of VUIs [38].

Predictive intelligence capabilities of VUI-enabled personal assistants are noted as another feature that suit older adults' needs. As noted on the guide about using Siri, "Siri learns your routines across your apps and then suggests things that could help make your day better. Ifyou're late for a meeting because you're not at that location yet, it could suggest you send a text to say you're a few minutes behind. Or if you order coffee every day with the same app, Siri might suggest your favorite beverage" [42].

The ability to change the speaking rate of the smart speaker is another positive trait of smart speakers. As noted in an article on this feature, ""There are many people, including myself, who are hard of hearing and the ability to slow Alexa down changes the way we use and understand her,' said Jerry, a 97 year-old customer" [72].

4.2.2 VUI Support a Range of Mobility

New articles often cited the ability for a VUI to be available on-the-go is one of the factors connected to the adoption of VUIs. Articles intended to help shoppers decide on VUI-based products for older loved ones mention the portability of the VUI. For example, these articles remark that "Sonos Move is the perfect smart speaker for someone who's always on the go" and "Siri lives on your iPhone (and/or other Apple devices) and is better equipped for mobility while Alexa lives in your home or apartment, usually in an Echo product, and is typically more fully integrated into your home" [15].

Some VUI devices are noted for their fixed locations. For example, an article in the Guardian notes that "Alexa devices – like Portals and Nest Hubs – are always plugged into the mains, so grandma never has to think about recharging them" [66].

4.2.3 Compatibility Between VUI Devices And Other Owned Tech is Important

The fit of VUI devices to an older adults' existing technology ecosystem was often mentioned as a topic for consideration. This takes two forms: one in which other technologies motivate the adoption of VUIs, and another in which VUIs motivate the adoption of other technology. In terms of the former, VUIs are a gateway to other technology services such as one's email, calendar, and music (such as Apple Music and Spotify) [2]. In terms of the latter, VUIs are often mentioned in connection with smart home technologies. An article on "Best Tech Gifts for Older Parents" remark "if your parents use Alexa, Google Assistant, or Siri, this [Honeywell Home Lyric T5] smart thermostat is compatible with all of those platforms" [64]. Other devices that have been mentioned for their inclusion of VUIs include home security systems [68,76], vacuum cleaners

[76], electric outlets [76], and faucets [3]. It has been mentioned that VUIs "can serve as a standalone device that streams music and answers questions or it can be the hub that serves as the command center for every other smart device that you own" [15]. The compatibility between smart speakers and smart home ecosystems is termed in the articles as "interoperability" [3].

4.2.4 Social Support for VUI Use is Important

The need for social support in order to help an older adult set up a VUI is seen as a burden. An article titled "So You Bought Someone a Gadget. Here's How Not to Become Their Tech Support," notes "but while it seems easy enough to throw a $50 gadget into your cart and order away, for some people that's where the problems start. Loved ones, whether a family member or a best friend, often expect you to set up the device for them and give you a call when there's even the slightest problem. Suddenly, what was supposed to be a nice gift and sentiment ends up becoming your next headache, or worse, a long-distance project" [77]. This article mentions that Amazon provides how-to videos on how to set up Echo devices, however it does not remark the effectiveness of this approach when it comes to helping older adults set up their devices.

4.2.5 Limits to VUIs' Usefulness to Older Adults

There are some limitations to the capacity of current VUI devices to become fully embedded in older adults' lives. In the case of comparisons between various VUI-based products, these include the need to charge the device and their sound quality [66]. Due to limitations in voice-recognition that or comprehension capabilities, "the truth is that Alexa, Siri and Google Assistant are pretty dumb" [2].

Tests of a virtual talking dog at an assisted living community was reported to reveal the importance of culturally-sensitive tech support. As noted in the article that reported on this product [15]:

> "The remote caregivers tasked with interacting with users' questions and comments over an Internet connection were based in the Philippines, causing technical and cultural problems […] "And because the remote caregivers were in the Philippines, they didn't always understand certain references. Like, they didn't know what Walgreens was." Sometimes, the technology failed for a reason all too familiar to computer users everywhere: lack of tech support."

Some of the limitations of VUIs may be due to the older adults not being an intentional target population for these devices. As noted by an article in the Washington Post, "you won't see Apple say "senior citizen" in ads — yet suddenly, grandmothers and abuelas, not to mention opas and yeyes, are thinking about getting [an Apple watch]" [16] which uses Siri as one of its interface elements.

The limitations need to be addressed to properly "address people's needs, especially when it comes to aging in place" and avoid the "'the box problem,' something that research scientist Chaiwoo Lee of the MIT AgeLab has encountered among older adults in particular. 'We [often] see when we go to people's homes to do interviews and do studies that there are a lot of boxes,' which either contain products that never were opened or gadgets that people tried but ultimately abandoned, says Lee" [3].

4.3 Changes That VUIs Can Bring To Older Adults' Lives

The third theme pertains to the adoption of VUIs by older adults as linked to the benefits and transformations that VUIs can bring to their lives. The media portrays VUIs as potential solutions towards improved health (Section 4.3.1), decreased social isolation and loneliness (Section 4.3.2), improved convenience and independence (Section 4.3.3), and enhanced safety and security (Section 4.3.4).

4.3.1 VUIs Can Help With Managing And Improving One's Health

VUIs are seen as a means to help older adults manage their mental and physical health. In an example involving dementia, Amazon Alexa "reminds [the older adult, who is also the author of the article] to take [their] evening medication as all the rest are taken in the morning" [69].

In addition, news articles mention the use of Amazon Alexa by the United Kingdom's National Health Service to provide medical information to users [39]. It has been noted that this "will be especially useful for senior citizens, blind people and others who find it hard to access the internet while also easing pressure on

doctors" [39]. As noted in another article, "the health service hopes patients asking Alexa for health advice will ease pressure on the NHS, with Amazon's algorithm using information from the NHS website to provide answers to questions such as: 'Alexa, how do I treat a migraine?'; 'Alexa, what are the symptoms of flu?'; and 'Alexa what are the symptoms of chickenpox?'" [62]. The use of VUI devices as an outlet for health service has been reported to have been "highly successful in improving customer experiences and cutting costs" [63] but articles question the motivations of the companies designing the VUIs. "What precisely are its ambitions? Can we trust it with our sensitive health data? And are its commercial imperatives compatible with the core values of the NHS, or do they threaten its very existence?" [63].

4.3.2 VUIs Can Decrease Social Isolation and Loneliness

VUIs are portrayed as potential aids to decrease social isolation and loneliness in older adults. Some of this is in the form of bonding with the virtual agent of the VUI device. Talking with a smart speaker has been stated to help combat loneliness [3]. "They might not have all their mobility, they might be a little elderly and they find companionship with Alexa," noted an article about Empathetic Alexas [71]. "While robots still aren't prancing around most living rooms, beyond the occasional Roomba, we are increasingly forming some kind of bond with the AI's in our smart speakers, phones and other devices – yes, Alexa, Google Assistant and Siri," as noted in an article in USA Today on using voice assistants to help with loneliness [5]. This companionship is compared to that of a dog or a cat – "think high-tech variation of a service animal, absent the responsibilities that come with feeding and caring for a pet" [5]. However, it has been asserted that AI cannot fully replace human relationships [5]. "It seems like a pipe dream to suggest that a machine-based solution, no matter what human traits it picks up or how chatty it gets, can properly fill the void when relationships end or loved ones pass on" [5].

It has been suggested that this void be addressed by having the VUI help with reminiscence. As reported by an article on Google's Super Bowl 2020 commercial, "we can outsource our most precious moments to voice assistants so that memories are kept in a cloud, where they are always accessible when we want them" [10]. Here, VUIs were demonstrated to "[capture] how technology and the internet can help us feel a little less lonely" [50].

Other articles discuss the ways that VUIs can help older adults stay connected. Some of it is through predictive intelligence, for example, "if you're late for a meeting because you're not at that location yet, [Siri] could suggest you send a text to say you're a few minutes behind" [42]. VUIs that incorporate a display are hailed for keeping family connected with one another, with Echo Show's "drop-in" feature cited as helpful for reaching elderly relatives [25,43,65,67]. The use of a smart speaker to make phone calls is also mentioned in articles directed at older adults to help them stay socially connected [2].

4.3.3 VUIs Can Support Convenience, Comfort, Independence, and Quality of Life

VUIs are portrayed as helping older adults live more comfortable, convenient, and independent lives without inconveniencing others.

VUIs are demonstrated to give "an immediate response and they can always ask multiple times if they have trouble with comprehension or cognition" [11]. They are also remarked to be particularly useful for those who experience barriers accessing the internet through traditional means [73]. VUIs are praised for their help related to memory issues, for example to "eliminate senior moments. You can ask smart speakers to remember details you tend to forget or rarely have to recall. Just tell Google or Alexa to keep track of, say, where you stashed your homeowner's policy or what your son's shoe size is" [43].

Some articles view the benefits of VUIs in connection with their use in smart homes. For example, an article listing the benefits of voice-enabled devices like smart outlet plugs notes that "the following collection of devices may not be essential for all people aging in place, but they could help someone live more independently and accomplish everyday tasks many people take for granted, such as turning lights on and off, turning fans and space heaters on and off, and monitoring appliances" [68]. Other uses for smart speakers including monitoring and changing the status of lights [43,66].

Some of the benefits of VUIs related to smart home use are listed in connection to predictive intelligence; for example, one article reports that "when Alexa believes it has detected a regular pattern, such as turning off a television set before bed, the voice assistant will remind owners if they forget to do it, and offer to fix the problem" [60].

The benefits of the convenience are portrayed as coming with some drawbacks. The ability for voice assistants to "seamlessly handle daily chores and tasks" are reported to be "as long as you're comfortable with such cozy digital relationships" [2]. Other articles highlight that convenience benefits are only guaranteed within the particular platform's ecosystem, for example by mentioning that "one of the reasons Amazon and Google are vying to be your go-to home assistant is because the brand you choose pretty much locks you into that company's products and services" [25]. Such articles also bring up the data concerns by stating that "each company is also selling the content that plays on those devices" [25].

VUIs are also portrayed as enabling older adults to maintain independence while aging at home [3,78]. The VUIs are presented as potential "fully functional digital butlers" [2] and that "robots can facilitate strong relationships between people […] as well as provide the tools and social support to help seniors live independent lives" [79]. These digital butlers can help older adults with tasks such as scheduling deliveries of groceries and medicine through shopping services such as Amazon [78,80]. As stated by the news articles, "with voice recognition, one doesn't have to have visual or manual dexterity" to order. That helps the recipient maintain independence" [78].

VUIs are positioned as helping older adults address health concerns on their own, for example through virtual caregivers that use Alexa [22]. Other articles discuss independence in relation to using VUIs to operate smart devices aimed at maintaining safety in the home [3] or personal comfort, such as "if you're about to be pulled over by the police and want video evidence of the encounter, you might say, 'I'm getting pulled over,' which then enables the front-facing camera, starts recording a video and sends it someone in your Contacts list" [42].

The fact that VUIs can allow caregivers peace-of-mind has also been mentioned as one of the factors enabling independence, as indicated by an article that mentions "if adult children can be reassured that their parents are OK and immediately be alerted if they're not, they'll feel better about Mom and Dad living independently at home" [22].

4.3.4 VUIs can be integrated with smart home devices for enhanced safety and security

VUIs have been mentioned in connection with smart home devices across several news articles for purposes related to personal safety and security. One purpose is as a safety request mechanism. In connection to fall-recovery, an article mentions that voice input "makes [voice-activated systems] a good fit for seniors. People with dexterity issues or vision problems can benefit from them because it's easier to speak a request than it is to dial a phone or read a printed schedule" [11]. VUIs are also said to support older adults in sending "help" requests and substituting as alert buttons that would be difficult to press in the case of arthritis [11].

An article that discusses the benefits empathy in smart speakers for older adults also remarks the capacity of smart speakers to help address depression or suicidal tendencies: "If you're an adult and you say you're depressed or suicidal," he said, "or you're potentially a victim of domestic abuse and you're talking to Alexa in that way, we've talked to experts about what we should do in those situations. Alexa would try to connect you to a suicide hotline or domestic abuse hotlines."" [71].

Finally, in a discussion about the benefits of Alexa, an author living with dementia mentions "My daughters can now "track" me, so I'll often get a text when I'm somewhere asking if I'm supposed to be there" [69], however this feature was not mentioned by name.

4.4 Impact of Trends Towards VUIs

The fourth theme pertains to the adoption of VUIs by older adults as linked to greater trends in the market (Section 4.4.1), government policies (Section 4.4.2), and the digital divide (Section 4.4.3).

4.4.1 Emerging Market for VUIs

Several articles touched upon the greater context of the VUI market that drives their use for and by older adults. The problems that they outline to be addressed include that "an estimated 1.2million frail or elderly people are not receiving the help they need – with underfunded care homes facing staffing shortages" [80]. Articles connect such issues with the characteristics that make the aging population a fit within the target market users for VUI-based services. One of these is limits in digital literacy. An Alexa-based health advice system developed by the United Kingdom's National Health Service is said to "be especially useful for senior citizens, blind people and others who find it hard to access the internet while also easing pressure on doctors" [39]. In addition, older adults are portrayed as being willing to actively try to address their needs, such as a case where "senior citizens pay $17 an hour, $10 of which goes to students, and members of Humana's Medicare Advantage insurance plan can have 10 hours a week covered as part of a trial program" for a service connecting older adults to children as conversation partners [38]. There was no equivalent recurring billing program mentioned in relationship with VUIs with any of the articles, however social robots such as ElliQ are portrayed as sought after options [38].

The market for VUIs is sometimes portrayed as linked to smart home technologies. Smart homes incorporating Amazon Alexa mention design features like attached private suites "meant for elderly parents coming to live with their children or post-college 'boomerang' children coming home to live with mom and dad" [58], indicating the extent at which ecosystems involving VUIs are meant to include older adults in their userbase. That said, the same articles mentioning these benefits for older adult users also mention that such homes are not yet "must-haves" [58].

Support of VUIs by external brands is also noted. For example, one article notes that "On Google Home, where the term 'skills' is replaced by 'actions,' Estée Lauder has one for personalized beauty advice and Disney has some games for children" [29].

Articles also note the active research being conducted to improve VUIs for older adults' use [80]. For example, an article noted that "'Often you'll hear elderly people trying to use Alexa - Amazon Echo's voice assistant - and getting frustrated and eventually giving up because she keeps asking users who may have slow or interrupted speech to repeat themselves […] With this [an Amazon Echo for the elderly] project we've been able to spend two years really getting to know how elderly people live and develop a device that can get to know its users incredibly quickly' […] We've spent time learning about these issues, what future users keep telling us is we need to make technology adapt to them and not the other way round'" [6]. Other articles mirror these sentiments; for example an article on Amazon Alexa's newly implemented feature to change its talking speed writes:

> "'Some of our hard of hearing and older customers shared how they love talking to Alexa and how she has become a companion but sometimes they would like her to slow down so they can better understand her responses.
>
> 'On the other hand, some of our customers who are blind or low vision are used to consuming audio content and want to be able to listen more quickly.
>
> 'We're thrilled to introduce this feature to help customers further personalise their interactions with Alexa, and adapt the experience to best fit their individual needs" [72].

4.4.2 Government Support Matters

VUIs were mentioned several times in connection with the provision of government funded services and support. One of these was in relation to public transportation. An audio-based navigation app for the government transit service in Washington, D.C. is compared to Siri and Alexa [35]. As quoted by the article on the introduction of this app, "'This service addresses the challenge that seniors and customers with disabilities . . . have locating a Metrobus stop and knowing when their desired bus will arrive,' said James Hamre, Metro's director of bus planning. 'By addressing this challenge, we empower our customers with disabilities to more fully use Metrobus for their travel needs'" [35]. This app was said to be "'revolutionary' for the region's commuters with disabilities — particularly those who are blind or vision-impaired" [35].

Another area demonstrating the use of VUIs to supplement existing government-supported services is in healthcare, with the use of Alexa by the United Kingdom's National Health Service being said to "be especially useful for senior citizens, blind people and others who find it hard to access the internet while also easing pressure on doctors" [39]. Here, Alexa is described as being capable of responding to users "with the authority of an organization once described as "the closest thing the English have to a religion": the country's National Health Service" [73]. Meanwhile, in South Korea, businesses are being allowed increasing access to personal information for purposes related to telemedicine. This has led to the creation of voice-enabled smart speakers that "has reduced human contact in welfare services while still providing governments with a tool to prevent elderly residents from dying alone" [40]. These apps portrayed in a positive light with a desire for more features, as demonstrated by a quote in these articles: "'It's nice to have something to talk to,' said Lee Chang-geun, an 89-year-old who has lived alone in his small apartment since his wife died three years ago. "But I wish they developed an Aria function for opening doors. What good is a distress signal if I die while emergency workers try to force open my door?" [40].

4.4.3 VUIs are Connected with the Digital Divide

Some articles touched upon issues of the digital divide on the implementation of VUI-based programs. For example, cost has been cited as a barrier to VUI-enabled robots designed to help address loneliness [5]. Further articles that mention the inclusion of VUI-based devices for the provision of digitally-mediated life services also point out the gaps:

> "It's also vital to ensure digital improvements benefit vulnerable groups, and there should be a range of ways to access public services, rather than simply switching to digital-by-default, agreed the panel. In 2018 there were still 5.3 million adults in the UK who were digitally excluded because they lack internet access or have low levels of digital literacy, including people from low-income groups, the elderly, and those living in rural communities. […] "We shouldn't ask how to digitise public services," said Ed Poyntz-Wright, account delivery lead for DXC. "Instead, we should ask how we can use digital technologies to improve services."" [61].

Guides on various tablet-based options for connecting with older adult family members high cost as a possible barrier for purchasing one product option despite it having VUI capabilities [66].

5 A Discussion of Sociotechnical Factors that (Should) Influence VUI Design

In the previous section, we conducted an inductive thematic analysis of news articles to understand the media's portrayal of VUIs when it comes to older adults. We did this with the goal of understanding factors of adoption of VUIs by older adults. Towards this end, each of the four themes reveals one an aspect of VUIs' adoption by older adults, as follows:

1. **Perceptions of Adoption of VUIs by Older Adults:** VUIs are a potential target market that has seen mixed results when it comes to adoption. When considering whether or not to adopt VUIs, it is important to consider societal and ethical issues, as well as data privacy trust in the institutions behind the VUIs.
2. **Embeddedness in Older Adults' Lifestyles:** VUIs have features that meet older adults' needs and can support a range of mobility. However, the fit of VUIs in older adults' lives is reliant on the compatibility of the VUI to other devices they own and use and the older adults' access to social support. Still, there may be some limits to the usefulness of VUIs to older adults.
3. **Changes that VUIs Can Bring to Older Adults' Lives:** VUIs can be very useful to older adults in terms of improving health, decreasing social isolation and loneliness, and supporting a convenient, independent, safe, and secure life.
4. **Impact of Trends towards VUIs:** There is an emerging market for VUIs that is helping drive forward the adoption of VUIs by older adults. This is further pushed by changes in government policies and

practices that advocate for the use of VUIs. However, the digital divide is still a factor when it comes to VUIs.

The objective of our analysis was to understand the media's portrayals of VUIs for older adults, to which these four themes address. That said, our results suggest some implications when it comes to further research of adoption of VUIs by older adults. Specifically, the results suggest further value of the sociotechnical approach for this research of VUIs for older adults.

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 [34]. It does this by accounting for the interactions between information systems and the people who use and are affected by these systems. The sociotechnical approach began as an attempt to understand people with the information systems in workplaces, and today 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. Given that popular media (such as news) is one of the many facets at the intersection of society and technology, our analysis of the media discourse of VUIs as relevant to older adults adds a deeper understanding of some of the facets that sociotechnical design can factor in. Examples of sociotechnical systems include specially designed software applications (the "technical") in care organizations (the "social) [56] and software applications ("technical") used in the home setting ("social") [57]. The sociotechnical approach in HCI sees to a variety of methods that aimed to understand technology in the social context [56].

The use of sociotechnical methods has risen in part from an increase in concern over the sociotechnical impact of technological systems on older adults and over older adults' adoption of the very technology designed for their use [56,57]. Sociotechnical-oriented methods aim to understand how existing and novel technologies are and can be used in people's everyday lives as well as validate a concept or a prototype [46]. It aims to do this in a way that is improved in ecological validity from that of the standard experimental approach [17].

Technology use by older adults has been found in previous research to be sociotechnical [57]. In particular, older adults' non-participation with technology is sociotechnical and relies on personal, social, and technological contexts of the older adults [57]. In their paper, [57] Waycott et al. presented a contextual framework that factors in these contexts to inform the evaluation of non-participation in research of sociotechnical interventions. These contexts included: 1) personal circumstances and preferences; 2) social contexts of physical space, family circumstances, and norms or social activity; and 3) previous interactions with technology and greater contexts of digital exclusion.

Here, we use this framework [57] as a means to communicate and show the sociotechnical aspects and considerations of our findings. We took each of the themes and mapped them onto the three contexts of personal, social, and technological axes. In Figure 3, we present questions that reflect these three contexts in relation to each high-level theme. Interestingly, all four themes can be mapped to a context in the sociotechnical framework. The fit of the findings to the framework not only motivates a sociotechnical approach to the study and design of VUIs, but also indicates further directions for sociotechnical-based approaches to the research of VUIs for older adults.

High-Level Theme	Examples of Personal, Social, and Technological Contexts
Perceptions of Adoption of VUIs by Older Adults	• **Personal:** Do I trust the institutions behind VUIs? • **Social:** What are the societal and ethical issues others consider? • **Technological:** Do I trust the VUI device to keep my data safe?
Embeddedness in Older Adults' Lifestyles	• **Personal:** Does the VUI device support my level of mobility? • **Social:** Does the VUI device fit my space? • **Technological:** Is the VUI device interoperable with my other devices?
Changes that VUIs Can Bring to Older Adults' Lives	• **Personal:** Does the VUI help me maintain or improve my health? • **Social:** Can the VUI improve my relationships with others? • **Technological:** Can the VUI be integrated with other technology to benefit my health and safety?
Impact of Trends towards VUIs	• **Personal:** Can VUIs help me connect to my healthcare providers? • **Social:** What does the government say about VUIs? • **Technological:** Can I access VUIs at all?

Figure 3. An outline of each high-level theme in terms of the contexts of a framework for the sociotechnical approach to technology design and evaluation.

6 Limitations

This paper identifies common characteristics that the media portray about VUIs for older adults. That said, it is important to note that all of the news outlets that were sourced were based in the Western world. As such, the claims made in this paper can only be applied to the western context, the countries of which share similar socioeconomic structures. The findings do not necessarily speak to an international context.

7 Conclusion

In this paper, we investigated the characteristics of VUI for use by older adults as portrayed by mass media. We did this by conducting an inductive thematic analysis of news articles from media sources influential for older adults and the top newspapers by digital traffic. Through this, we were able to draw conclusions about the media portrayal of VUIs with respect to adoption by and suitability for older adults.

While our overarching goal is to investigate the factors that influence VUI adoption among older adults, our goal with this study is to understand how VUIs are portrayed to begin with. Thus, we investigated the themes within media discourse of VUIs for older adults. Specifically, we found that the media depicts older adults as a viable target market for VUIs but that their adoption of VUIs is dependent on factors of data privacy, trust in institutions behind VUIs, the ability for the VUI to become embedded in older adults' lives, the changes VUIs can bring to them, and trends of the greater VUI market and government policies and practices.

These results contribute to our goal of understanding factors of adoption (or lack of adoption) of VUIs. News articles reflect the views of society along with further propagating them. Thus, by analyzing media portrayals of VUIs for older adults, we can gain a better understanding of the factors that may influence older adults' adoption of VUIs. This knowledge is also useful for shedding light on the competing forces for adoption of VUIs, which is a technology that has been increasingly used commercially and in public settings. Our work also supports further sociotechnical-based work on the study and design of VUIs, especially those for older adults.

The key takeaway of this paper is an understanding of the messages about VUIs that are being passed on by the media and the existence of further evidence to support a sociotechnical lens to approaching the study of adoption of VUIs by older adults. We plan to expand this work with further comparisons of these themes with those in VUI literature, such as those revealed in the work by Stigall et al. [51] (and perhaps other studies beyond simply that in ACM literature). Previous work has not emphasized as strongly the sociotechnical

approach to the study of VUIs, and so in addition we wish to apply this valuable lens to further study of existing work. The aim will be to gain an increased breadth and depth of understanding of the factors of adoption of VUIs, to better understand the barriers that exist for the adoption of VUIs, and to better understand how to improve the design of VUIs. Future work will also include consulting older adults through in-depth interviews of their perceptions of these themes to further validate the results presented in this paper.

REFERENCES

[1] AARP. 2019. Amazon Echo Dot Getting Started Guide. Retrieved from https://www.aarp.org/content/dam/aarp/about_aarp/voice/echo-dot/amazon-echo-getting-started-guide9.26.19.pdf

[2] AARP. 2019. How to Use a Voice Assistant to Help with Daily Tasks. Retrieved from https://www.aarp.org/home-family/personal-technology/info-2019/voice-commands-smart-speakers.html

[3] Sarah Elizabeth Adler. New Smart Home Devices Make Household Upkeep Easier. *AARP*. Retrieved February 21, 2021 from http://www.aarp.org/home-family/personal-technology/info-2020/future-smart-home-devices.html

[4] Mohammad Rafayet Ali, Kimberly Van Orden, Kimberly Parkhurst, Shuyang Liu, Viet-Duy Nguyen, Paul Duberstein, and M. Ehsan Hoque. 2018. Aging and Engaging: A Social Conversational Skills Training Program for Older Adults. In *23rd International Conference on Intelligent User Interfaces*, 55–66. https://doi.org/10.1145/3172944.3172958

[5] Edward C. Baig. Hey, Alexa: Can a robot with AI or your voice assistant help you feel less lonely? *USA TODAY*. Retrieved February 21, 2021 from https://www.usatoday.com/story/tech/2019/11/08/alexa-google-assistant-ai-robots-become-substitute-friends/4057885002/

[6] Victoria Bell. 2018. "Amazon Echo for the elderly" uses AI to track people's movements. *Mail Online*. Retrieved February 22, 2021 from https://www.dailymail.co.uk/sciencetech/article-6397441/Amazon-Echo-elderly-uses-AI-track-peoples-movements.html

[7] Timothy W. Bickmore, Lisa Caruso, and Kerri Clough-Gorr. 2005. Acceptance and usability of a relational agent interface by urban older adults. In *CHI '05 extended abstracts on Human factors in computing systems - CHI '05*, 1212. https://doi.org/10.1145/1056808.1056879

[8] Vanessa Boothroyd. 2014. Older Adults' Perceptions Of Online Risk. Carleton University, Ottawa, Ontario. https://doi.org/10.22215/etd/2014-10240

[9] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3, 2: 77–101. https://doi.org/10.1191/1478088706qp063oa

[10] Dalvin Brown. "Hey Google, show me photos": Google presents emotional "Loretta" Super Bowl commercial. *USA TODAY*. Retrieved February 21, 2021 from https://www.usatoday.com/story/tech/2020/02/02/google-super-bowl-2020-ad-loretta-show-me-photos/4642142002/

[11] Jan Burns. 2019. Voice-activated technology can help you live better. *SFGATE*. Retrieved February 21, 2021 from https://www.sfgate.com/news/article/Voice-activated-technology-can-help-you-live-13619613.php

[12] Wan-Ling Chang, Selma Šabanovic, and Lesa Huber. 2013. Use of seal-like robot PARO in sensory group therapy for older adults with dementia. In *2013 8th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 101–102. https://doi.org/10.1109/HRI.2013.6483521

[13] Leigh Clark, Cosmin Munteanu, Vincent Wade, Benjamin R. Cowan, Nadia Pantidi, Orla Cooney, Philip Doyle, Diego Garaialde, Justin Edwards, Brendan Spillane, Emer Gilmartin, and Christine Murad. 2019. What Makes a Good Conversation?: Challenges in Designing Truly Conversational Agents. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19*, 1–12. https://doi.org/10.1145/3290605.3300705

[14] Benjamin R. Cowan, Nadia Pantidi, David Coyle, Kellie Morrissey, Peter Clarke, Sara Al-Shehri, David Earley, and Natasha Bandeira. 2017. "What can I help you with?": infrequent users' experiences of intelligent personal assistants. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services*, 1–12. https://doi.org/10.1145/3098279.3098539

[15] Allen Foster. Which smart home product you should get your grandma, child, and everyone in between. *nydailynews.com*. Retrieved February 21, 2021 from https://www.nydailynews.com/consumer-reviews/sns-bestreviews-holiday-smart-home-gift-guide-20191213-hrjvcruwofhfrpjyhmtpd7hfwi-story.html
[16] Geoffrey A. Fowler. Review | The Apple Watch faces its toughest challenge yet: Grandma and Grandpa. *Washington Post*. Retrieved February 21, 2021 from https://www.washingtonpost.com/technology/2018/10/03/apple-watch-faces-its-toughest-challenge-yet-grandma/
[17] Darren Gergle and Desney S. Tan. 2014. Experimental Research in HCI. In *Ways of Knowing in HCI*, Judith S. Olson and Wendy A. Kellogg (eds.). Springer New York, New York, NY, 191–227. https://doi.org/10.1007/978-1-4939-0378-8_9
[18] Leslie Haddon. 2017. Domestication and Mobile Telephony. In *Machines that become Us* (1st ed.), Katz James E. (ed.). Routledge, 43–55. https://doi.org/10.4324/9780203786826-4
[19] Wan He, Daniel Goodkind, and Paul Kowal. International Population Reports. 175.
[20] Clara E. Hill, Barbara J. Thompson, and Elizabeth Nutt Williams. 1997. A Guide to Conducting Consensual Qualitative Research. *The Counseling Psychologist* 25, 4: 517–572. https://doi.org/10.1177/0011000097254001
[21] Eric Hirsch and Roger Silverstone. 2003. *Consuming Technologies: Media and Information in Domestic Spaces*. Routledge.
[22] Christina Ianzito. New Home Monitoring Devices Offer Help to Caregivers. *AARP*. Retrieved February 22, 2021 from http://www.aarp.org/caregiving/home-care/info-2020/ces-caregiving-products.html
[23] Jaeheung Yoo, Youngseong Yoon, and Munkee Choi. 2010. Importance of positive reputation for Smartphone adoption. In *2010 International Conference on Information and Communication Technology Convergence (ICTC)*, 314–318. https://doi.org/10.1109/ICTC.2010.5674690
[24] Brittne Nelson Kakulla. 2019 Tech Trends and the 50+. *AARP*. https://doi.org/10.26419/res.00269.001
[25] Caroline Knorr. Perspective | What parents need to know before buying Google Home or Amazon Echo. *Washington Post*. Retrieved February 21, 2021 from https://www.washingtonpost.com/lifestyle/2018/12/14/what-parents-need-know-before-buying-google-home-or-amazon-echo/
[26] Jarosław Kowalski, Anna Jaskulska, Kinga Skorupska, Katarzyna Abramczuk, Cezary Biele, Wiesław Kopeć, and Krzysztof Marasek. 2019. Older Adults and Voice Interaction: A Pilot Study with Google Home. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, 1–6. https://doi.org/10.1145/3290607.3312973
[27] Tamar Lapin. 2020. Super Bowl commercials 2020: Experts grade the leaked ads. *New York Post*. Retrieved February 21, 2021 from https://nypost.com/2020/02/02/super-bowl-commercials-2020-experts-grade-the-leaked-ads/
[28] Jim Macnamara. Media content analysis: Its uses; benefits and best practice methodology. 23.
[29] Sapna Maheshwari. 2018. Marketing Through Smart Speakers? Brands Don't Need to Be Asked Twice. *The New York Times*. Retrieved February 22, 2021 from https://www.nytimes.com/2018/12/02/business/media/marketing-voice-speakers.html
[30] Tom McNichol. 2019. 10,000 baby boomers turn 65 in the US every day – can Silicon Valley help with "happier ageing"? *the Guardian*. Retrieved February 21, 2021 from http://www.theguardian.com/technology/2019/sep/03/senior-citizens-apps-tech-devices
[31] Michael McTear, Zoraida Callejas, and David Griol. 2016. *The Conversational Interface. Talking to Smart Devices*. Springer.
[32] Amy Mitchell and Dana Page. State of the News Media 2015.
[33] David Moher, Alessandro Liberati, Jennifer Tetzlaff, and Douglas G. Altman. 2010. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery* 8, 5: 336–341. https://doi.org/10.1016/j.ijsu.2010.02.007
[34] Enid Mumford. 2000. A Socio-Technical Approach to Systems Design. *Requirements Engineering* 5, 2: 125–133. https://doi.org/10.1007/PL00010345
[35] Hannah Natanson. Metro to launch new app and website to help riders with disabilities navigate rail and bus. *Washington Post*. Retrieved February 22, 2021 from https://www.washingtonpost.com/local/trafficandcommuting/metro-to-launch-new-app-and-website-

to-help-riders-with-disabilities-navigate-rail-and-bus/2019/07/14/14adeed4-a242-11e9-bd56-eac6bb02d01d_story.html
[36] Kimberly A. Neuendorf. 2017. *The Content Analysis Guidebook*. SAGE Publications, Inc, 2455 Teller Road, Thousand Oaks California 91320. https://doi.org/10.4135/9781071802878
[37] William Neuman. 2014. Social Research Methods: qualitative and quantitative approaches.
[38] Annie Palmer. 2019. Senior citizens fight loneliness via robots and "grandchildren" app. *Mail Online*. Retrieved February 21, 2021 from https://www.dailymail.co.uk/sciencetech/article-6744487/Senior-citizens-fight-loneliness-talking-robots-demand-grandchildren-app.html
[39] Associated Press. 2019. Dr. Alexa: Amazon's Alexa will soon provide health advice in the UK. *New York Post*. Retrieved February 21, 2021 from https://nypost.com/2019/07/10/dr-alexa-amazons-alexa-will-soon-provide-health-advice-in-the-uk/
[40] Associated Press. 2020. AI monitoring elderly in South Korea for signs of 'loneliness or insecurity.' *New York Post*. Retrieved February 21, 2021 from https://nypost.com/2020/06/01/in-virus-hit-south-korea-ai-monitors-lonely-elders/
[41] Marc Saltzman. Guide to Set Up Your Voice Assistant Smart Speakers. *AARP*. Retrieved February 21, 2021 from http://www.aarp.org/home-family/personal-technology/info-2019/smart-speakers-set-up-instructions.html
[42] Marc Saltzman. How to Use Siri on Your Apple Device for Any Task. *AARP*. Retrieved February 21, 2021 from http://www.aarp.org/home-family/personal-technology/info-2019/how-to-use-siri.html
[43] Marc Saltzman. What Is a Smart Speaker? – Features, Uses and More. *AARP*. Retrieved February 21, 2021 from http://www.aarp.org/home-family/personal-technology/info-2019/smart-speaker-uses.html
[44] Marc Saltzman. Comparison of the Top Smart Speakers for Your Home. *AARP*. Retrieved February 21, 2021 from http://www.aarp.org/home-family/personal-technology/info-2019/types-of-smart-speakers.html
[45] Sergio Sayago, Barbara Barbosa Neves, and Benjamin R Cowan. 2019. Voice assistants and older people: some open issues. In *Proceedings of the 1st International Conference on Conversational User Interfaces - CUI '19*, 1–3. https://doi.org/10.1145/3342775.3342803
[46] Katie A. Siek, Gillian R. Hayes, Mark W. Newman, and John C. Tang. 2014. Field Deployments: Knowing from Using in Context. In *Ways of Knowing in HCI*, Judith S. Olson and Wendy A. Kellogg (eds.). Springer New York, New York, NY, 119–142. https://doi.org/10.1007/978-1-4939-0378-8_6
[47] Roger Silverstone. 1994. *Television and Everyday Life*.
[48] Anjeli Singh. 2009. The Potential Benefits of Multi-modal Social Interaction on the Web for Senior Users. Retrieved from https://doi.org/10.5555/2038836. 2038856
[49] Cory-Ann Smarr, Tracy L. Mitzner, Jenay M. Beer, Akanksha Prakash, Tiffany L. Chen, Charles C. Kemp, and Wendy A. Rogers. 2014. Domestic Robots for Older Adults: Attitudes, Preferences, and Potential. *International Journal of Social Robotics* 6, 2: 229–247. https://doi.org/10.1007/s12369-013-0220-0
[50] Hannah Sparks. 2020. Google's Super Bowl 2020 commercial will make you cry. *New York Post*. Retrieved February 21, 2021 from https://nypost.com/2020/01/28/googles-super-bowl-2020-commercial-will-make-you-cry/
[51] Brodrick Stigall, Jenny Waycott, Steven Baker, and Kelly Caine. 2019. Older Adults' Perception and Use of Voice User Interfaces: A Preliminary Review of the Computing Literature. In *Proceedings of the 31st Australian Conference on Human-Computer-Interaction*, 423–427. https://doi.org/10.1145/3369457.3369506
[52] David Strang and Sarah A. Soule. 1998. Diffusion in Organizations and Social Movements: From Hybrid Corn to Poison Pills. *Annual Review of Sociology* 24, 1: 265–290. https://doi.org/10.1146/annurev.soc.24.1.265
[53] Sherry Turkle. 2007. Authenticity in the age of digital companions. *Interaction Studies* 8, 3: 501–517. https://doi.org/10.1075/is.8.3.11tur
[54] Sherry Turkle, Will Taggart, Cory D. Kidd, and Olivia Dasté. 2006. Relational artifacts with children and elders: the complexities of cybercompanionship. *Connection Science* 18, 4: 347–361. https://doi.org/10.1080/09540090600868912
[55] Michel Vacher, Sybille Caffiau, François Portet, Brigitte Meillon, Camille Roux, Elena Elias, Benjamin Lecouteux, and Pedro Chahuara. 2015. Evaluation of a Context-Aware Voice Interface for Ambient Assisted Living: Qualitative User Study vs. Quantitative System Evaluation. *ACM Transactions on Accessible Computing* 7, 2: 1–36. https://doi.org/10.1145/2738047

[56] Jenny Waycott, Amee Morgans, Sonja Pedell, Elizabeth Ozanne, Frank Vetere, Lars Kulik, and Hilary Davis. 2015. Ethics in Evaluating a Sociotechnical Intervention With Socially Isolated Older Adults. *Qualitative Health Research* 25, 11: 1518–1528. https://doi.org/10.1177/1049732315570136
[57] Jenny Waycott, Frank Vetere, Sonja Pedell, Amee Morgans, Elizabeth Ozanne, and Lars Kulik. 2016. Not For Me: Older Adults Choosing Not to Participate in a Social Isolation Intervention. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, 745–757. https://doi.org/10.1145/2858036.2858458
[58] Elizabeth Weise. Amazon's Alexa will be built into all new homes from Lennar. *USA TODAY*. Retrieved February 22, 2021 from https://www.usatoday.com/story/tech/news/2018/05/09/amazons-alexa-built-into-all-new-homes-lennar/584004002/
[59] Randall Ziman and Greg Walsh. 2018. Factors Affecting Seniors' Perceptions of Voice-enabled User Interfaces. In *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 1–6. https://doi.org/10.1145/3170427.3188575
[60] 2018. Amazon's Alexa knows what you forgot and can guess what you're thinking. *the Guardian*. Retrieved February 22, 2021 from http://www.theguardian.com/technology/2018/sep/20/alexa-amazon-hunches-artificial-intelligence
[61] 2019. The challenge to ensure digital public services leave no one behind. *the Guardian*. Retrieved February 22, 2021 from http://www.theguardian.com/society/2019/mar/05/challenge-ensure-digital-public-services-leave-no-one-behind
[62] 2019. NHS teams up with Amazon to bring Alexa to patients. *the Guardian*. Retrieved February 21, 2021 from http://www.theguardian.com/society/2019/jul/10/nhs-teams-up-with-amazon-to-bring-alexa-to-patients
[63] 2019. Does Amazon have answers for the future of the NHS? *the Guardian*. Retrieved February 21, 2021 from http://www.theguardian.com/technology/2019/aug/24/alexa-nhs-future-amazon-artificial-intelligence-healthcare
[64] 2019. 12 Tech Gifts for Digitally Disinclined Parents. *The New York Times*. Retrieved February 21, 2021 from https://www.nytimes.com/wirecutter/gifts/best-tech-gifts-for-parents/
[65] 2019. The Best Smart Display for Amazon Alexa and Google Assistant. *The New York Times*. Retrieved February 21, 2021 from https://www.nytimes.com/wirecutter/reviews/best-smart-display-for-amazon-alexa-and-google-assistant/
[66] 2020. What's the best tablet for video calling grandma? *the Guardian*. Retrieved February 21, 2021 from http://www.theguardian.com/technology/askjack/2020/mar/26/what-is-the-best-tablet-for-video-calling-grandma
[67] 2020. Amazon's Echo Show Makes It Easy to Keep Family Together While Social Distancing. *Wirecutter: Reviews for the Real World*. Retrieved February 21, 2021 from https://www.nytimes.com/wirecutter/blog/amazon-echo-show-social-distancing/
[68] 2020. The Best Smart Home Devices to Help Seniors Age in Place. *The New York Times*. Retrieved February 21, 2021 from https://www.nytimes.com/wirecutter/reviews/smart-home-for-seniors/
[69] Facing life with dementia and discovering a positive path | Dementia | The Guardian. Retrieved February 21, 2021 from https://www.theguardian.com/lifeandstyle/2019/sep/14/facing-life-with-dementia-and-discovering-a-positive-path
[70] An S.O.S. for Listening at Home - The New York Times. Retrieved February 22, 2021 from https://www.nytimes.com/2020/06/05/technology/home-speakers.html
[71] Amazon Bets on an Empathetic Alexa - The New York Times. Retrieved February 21, 2021 from https://www.nytimes.com/2019/03/03/business/amazon-alexa-david-limp.html
[72] Alexa, hurry up! Amazon now lets you change the talking speed of the smart speaker | Daily Mail Online. Retrieved February 21, 2021 from https://www.dailymail.co.uk/sciencetech/article-7341435/Alexa-hurry-Amazon-lets-change-talking-speed-smart-speaker.html
[73] Alexa Now Gives U.K. Users N.H.S. Medical Advice - The New York Times. Retrieved February 22, 2021 from https://www.nytimes.com/2019/07/10/world/europe/alexa-nhs-amazon-privacy.html
[74] Protecting Your Privacy When Using a Voice Assistant. Retrieved February 22, 2021 from https://www.aarp.org/home-family/personal-technology/info-2019/voice-assistants-privacy-settings.html
[75] Stop Amazon and Google Smart Speakers from Listening. *AARP*. Retrieved February 22, 2021 from http://www.aarp.org/about-aarp/voice/raise-your-voice/enable-privacy-settings-on-a-smart-speaker.html

[76] 20 things from Best Buy that make aging in place easier. Retrieved February 21, 2021 from https://www.usatoday.com/story/tech/reviewedcom/2020/06/25/20-things-best-buy-make-aging-place-easier/112013022/
[77] So You Bought Someone a Gadget. Here's How Not to Become Their Tech Support. - The New York Times. Retrieved February 21, 2021 from https://www.nytimes.com/2020/03/19/smarter-living/so-you-bought-someone-a-gadget-heres-how-not-to-become-their-tech-support.html
[78] Aging at Home is Easier Thanks to Technology. Retrieved February 22, 2021 from https://www.aarp.org/caregiving/home-care/info-2018/technology-helps-aging-at-home.html
[79] How Robot Caregivers Will Help an Aging U.S. Population. Retrieved February 22, 2021 from https://www.aarp.org/caregiving/home-care/info-2018/new-wave-of-caregiving-technology.html
[80] Robots capable of caring for the elderly are being developed in £34m government project | Daily Mail Online. Retrieved February 22, 2021 from https://www.dailymail.co.uk/sciencetech/article-7615563/Robots-capable-caring-elderly-developed-34m-government-project.html