A Preliminary Investigation of the Role of Anthropomorphism in Designing Telehealth Bots for Older Adults

Jaisie Sin
University of Toronto, TAGlab and University of Toronto, Faculty of Information
Toronto, ON, Canada
js.sin@mail.utoronto.ca

Cosmin Munteanu
University of Toronto, TAGlab and University of Toronto Mississauga, ICCIT
Toronto, ON, Canada
cosmin@taglab.ca

ABSTRACT

Autonomous virtual agents (VAs) are increasingly used commercially in critical information spaces such as healthcare. Existing VA research has focused on microscale interaction patterns such as usability and artificial intelligence. However, the macroscale patterns of users' information practices and their relationship with the design and adoption of VAs have been largely understudied, especially when it comes to older adults (OAs), who stand to benefit greatly from VAs. We conducted a preliminary investigation to understand the role design elements, such as anthropomorphic aspects of VAs, play in OAs' perception of VAs and in OAs' preferences for VAs' participation within their health information practices. Some unexpected findings indicate that the fidelity of anthropomorphic features influences perception in ways that are dependent on the context of the information tasks. This suggests that research on improving the design and increasing the adoption of VAs should factor the interplay between fidelity of VA representation and information context.

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KEYWORDS

ACM proceedings; Older Adults; Empirical study that tells us about how people use a system; Health – Wellbeing; Embodied Interaction

1 INTRODUCTION

Virtual agents (VAs) are emerging technologies that employ artificial intelligence. They use a computer-generated entity (a virtual character) to complete a task. Due to advances in artificial intelligence and computer graphics machinery, VAs have been increasingly used in critical information spaces such as healthcare, with recent examples being the "virtual therapist" Woebot [10] and the "virtual doctor" DocOn [15]. However, users' perceptions of VAs have been understudied. This is especially the case with regards to potentially digitally-marginalized users, such as older adults (OAs), who stand to benefit from such technologies, and these users' trust, comfort [9], and acceptance of VAs. We do not know, for example, the effect of anthropomorphic design choices, such as fidelity of representation of a person face-to-face (e.g. voice-only vs. embodied) on OA's perceptions of the VA. We also do not know how well VAs are accepted or trusted by OAs, especially when comparing the newer fully-automated VAs to traditional models of telemedicine [11] with humans. Yet, such factors can play a role in OA's adoption of VAs. Thus, we conducted preliminary research into Virtual Doctors (VDs) to determine whether possible design choices, such as a VA's type, form, or level of anthropomorphism, are relevant to OAs' perceptions and subsequent adoption of VAs.

2 BACKGROUND AND RELATED WORK

Telemedicine allows patients and doctors to connect remotely in real-time, thus making healthcare and specialized care more accessible. The application of user-centred design and evaluation to telemedicine is not new and contributes to satisfactory clinical outcomes. For example, participatory design for telemedicine technologies has been advocated to factor in users' lives, including those of older adults [1]. A human factors approach has also been suggested for telemedicine [14]. However, the sociotechnical aspects of telemedicine and, in turn, the design guidelines and principles informed by this approach are largely unexplored.

Much research exists to evaluate the effect of VA properties on users' perceptions, such as a VA's use of nonverbal behaviour and gestures [3], the influences of embodiment [7], and the effect of camera angles [16]. VAs can be used in many ways, such as being a display in a public space [3], as a presentation partner [17], and as a real estate agent [2]. Research has demonstrated the use of VAs for various healthcare applications such as geriatrics health counselling [19], atrial fibrillation education [13], and patient empowerment [18]. However, the use of VAs to represent a real doctor, such as in DocOn [15], is only a recently emerging development.

3 EXPERIMENTAL INVESTIGATION

3.1 Research Goals

We conducted a quasi-experiment to investigate the relevance of some of the possible design considerations (DC). For this preliminary study, we focused on the question: **what is the role of the anthropometric features of fidelity (video vs. speech-only) and agency (virtual agent**

Table 1: Summary of the 2x2 Design resulting in four conditions in the study. The combination of human and voice-calling (top left of the table) is reflective of the most common form of telemedicine. On the other hand, the commercial trend is moving towards video-calling a robot (bottom right of the table).

Agency of Doctor	Fidelity of Representation	
	Voice-calling	**Video-calling**
Human	Voice-calling a Person (VoiceDr)	Video-calling a Person (VideoDr)
Robot	Voice-calling a Robot (VoiceVA)	Video-calling a Robot (VideoVA)

Figure 1: Interface for voice-calling a robot (VoiceVA) & voice-calling a person (VoiceDr). In VoiceVA, participants were presented with a robotic voice powered by CereVoice Engine Software Development Kit [8]. In VoiceDr, participants heard the voice of the doctor (played by a nursing student).

vs remote human) on older adults' perceptions of virtual doctors? We speculated that understanding VDs in this perspective would 1) help relate the design of VAs for VDs to existing models of traditional telemedicine; and, 2) determine criteria that will assist designers in investigating how to make VAs adoptable by healthcare users.

In other words, we planned to investigate how various design choices (such as anthropomorphism) may affect adoption by users. Given the lack of prior research on this topic, we hoped that such an investigation will help frame future studies that will rigorously measure the correlation between such design choices and metrics of user adoption. For now, we are proposing to start with two design choices, and study their relevance with respect to user adoption factors.

3.2 Experimental Design

The study used a mixed-methods, quasi-experimental design combined with observations. Since this research study had very little prior work in VDs to draw from, we conducted a small-scale exploratory study first. This study was based on the two aforementioned VA characteristics: (1) fidelity of the representation (e.g. voice-only vs. embodied); and, (2) the agency of the doctor (e.g. human vs. machine/robot). The combinations of these characteristics resulted in the four interfaces, which are summarized in Table 1 and depicted in Figures 1 to 3. The Wizard-of-Oz (WoZ) methodology [12] was used for the VoiceVA and VideoVA interfaces.

Five older adult participants (age 60+; two male, three female) were recruited for the study, which was conducted in a research lab located in a large metropolitan area. Participants were asked to try each of the four interfaces one at a time. Each interface was tested in turn with the task of discussing with the doctor a certain health topic, such as Hypertension, Osteoporosis, Shingles, and Type II Diabetes, as illustrated in Table 2. As conversational icebreakers, participants were suggested some leading questions, for example, "How can I prevent Shingles?". The order of presentation of the interfaces and the order of the health topics chosen for the tasks were counterbalanced between participants. Although this research was preliminary and exploratory in nature (and thus no hypothesis testing was carried out as there was little prior knowledge in which to ground a hypothesis), it was still important to counterbalance the conditions.

Participants completed post-task questionnaires and post-task interviews about their perceptions, confidence, comfort, and adoption of the respective interfaces. However, the results of the questionnaires have not been used to support the findings in this paper due to the small sample size. Participants also completed a post-session interview, which asked them to compare their experiences between options based on fidelity and agency, comment on their perception of the fit of a virtual doctor in their own lives, and to discuss their experiences with finding healthcare information.

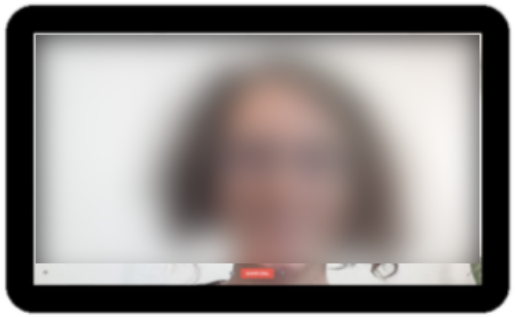

Figure 2: Interface for voice-calling a person (VideoDr). In this condition, participants were told they were speaking directly to the doctor (played by a nursing student).

Figure 3: Interface for video-calling a robot (VideoVA). Litebody [5] and CereProc's CereVoice Engine Software Development Kit [8] provided the visual and audio for the AI, respectively.

4 RESULTS AND DISCUSSION

The post-task and post-session interview data were coded and analyzed for themes. As the study was preliminary, inductive thematic analysis, as developed by Braun & Clarke [6], was used. Design factors, as outlined in the following sections, related to each design consideration were determined based on analysis of the high-level themes and their composite subthemes.

4.1 Factors Related to the Effect of Fidelity and Agency on OA Perceptions of VDs

There appears to be a connection between the fidelity and agency of the doctor and the type of information that older adult users preferred receiving from the doctor. Participants' responses suggest that:

1) **Older adults seem to prefer using speech-only robot health interfaces for general healthcare information.** On the doctor's side, participants considered calling a robot to be the most efficient and effective use of a doctor's time and that this option is better suited for doctors to balance their priorities (P2, P4). On the patients' side, participants suggested that they would feel less discomfort contacting a robot for seemingly repetitive, uninformed, or embarrassing questions (P2, P4, P5). A robot was also perceived to be advantageous because it could be available at a moments' notice, whereas a call with a human doctor would need to be scheduled (P1, P3, P5). Additionally, the robot was seen as less distracting since it had minimal characteristics of an identity (e.g. nationality, place of schooling), especially when combined with voice-calling, where the robot was simply a voice (P1, P4, P5). Thus, the participants indicated that they were most comfortable getting general healthcare information from a voice-only robot interface among the four options.
2) **Video-based human links were preferred for specific healthcare information.** Specific healthcare information consist of questions that are uniquely applicable for a given patient, such as how they could tell if their condition is due to arthritis or due to osteoporosis (P2). Participants considered a human doctor to be better able than a robot to identify a patients' real question, even if a patient lacked the knowledge to articulate it (P4). Furthermore, being able to see the doctor's face through video-calling was seen as more personal and conducive to a back-and-forth conversation (P5). These factors resulted in video-calling a human being the preferred option by participants to gather specific healthcare information.

4.2 General Factors' and Design Elements' Influence on OA Perceptions of VDs

Analysis of the high-level themes and their composite subthemes suggest three considerations that can be made to increase users perceptions of comfort of VDs and to adopt them. Based on this preliminary evidence, we speculate that VDs should:

1) **Complement older adults' visits to their doctors.** It is very difficult for an OA to be comfortable with the idea of a VD completely replacing a doctor (P2, P4). There are also technical and legal limitations to a VDs' ability to cover all of the healthcare needs of a patient (P5). If a patient suspects that their time is better served visiting a doctor who can meet more

Table 2: Examples of leading questions for the four health topics discussed during the main part of the experiment (Hypertension, Osteoporosis, Shingles, Type II Diabetes). <health condition> refers to one of: "Hypertension", "Osteoporosis", "Shingles", and "Type 2 Diabetes". Each participant engaged with all the topics across the experiment, with topics randomized and counter-balanced over the combinations of experimental conditions described in Table 1.

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

of their healthcare needs with greater efficiency than a VD, then they would not consult a VD (P4). As a result, we suggest that VDs be designed to have a distinct role and function from doctors that the VDs do well in order to maximize chances of adoption by OAs.

2) **Align with older adults' existing practices for gathering healthcare information.** Participants have indicated that they normally consult multiple sources of healthcare information, weigh each of them for credibility, bias, and relevancy, before going to the doctor with specific questions (P3, P4, P5). This suggests a particular workflow from general information to specific information (P3). We suggest that VDs be designed with this workflow in mind, whether it is with the entire workflow in mind or only part. For instance, a VD can be designed to be one of the initial multiple sources of healthcare information users can consult. Alternatively, VDs can be designed to help patients in their later process of asking doctors specific questions, such as by providing example questions or providing advice on how to best ask questions of their doctor to get the information they need.
3) **Have a perceived value as compared to currently available alternatives.** Participants have indicated three ways that their existing attitudes of healthcare and technology may influence their willingness to use a VD. They have demonstrated that they prefer to see their own doctor rather than just any doctor (P2, P3, P4). This suggests that VDs may have an increased rate of adoption if they leveraged existing relationships between patients and their doctors. Secondly, participants have indicated that they may be less inclined to use a VD if it does not perform at the standard of existing alternatives, such as WebMD, such as by not providing enough relevant information (P4). This indicates that VD designs should consider competing products that also provide healthcare information when designing for increased adoption. Lastly, participants had stated that their previous experience with VAs impacted their willingness to use a VD that had a similar interface (P1, P4, P5). This suggests that VD designs can consider existing technologies that OAs use and their characteristics to best design VAs for older adults.

5 CONCLUSION & FUTURE WORK

This paper presents preliminary research into how design choices influence the role VAs have within OAs' health information practices. The results suggest a connection between VA design choices, OAs' perceptions of VAs, and the OAs' information context. This study thus opens the door for future research in which specific hypotheses about how virtual agents' anthropomorphism influences OA's adoption of VDs can be statistically tested. Our own next step in this line of research is to conduct a more comprehensive study that engages participants in a more personal level to further explore some of the concepts revealed here, such as the influence of the personal applicability of information to OAs' perceptions of VAs. We also intend to explore the impact of VAs and VA design on OAs' perceptions of these technologies in other critical information spaces, such as the fields of law and finance, where VAs are also emerging as technological tools used to provide critical services to consumers including OAs.

REFERENCES

[1] S. A. Ballegaard, T. R. Hansen, and M. Kyng (2008, April). Healthcare in everyday life: designing healthcare services for daily life. *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1807-1816). ACM.

[2] T. Bickmore, and J. Cassell (2001, March). Relational agents: a model and implementation of building user trust. In Proceedings of the SIGCHI conference on Human factors in computing systems (pp. 396-403). ACM.

[3] T. W. Bickmore, L. Pfeifer, D. Schulman, S. Perera, C. Senanayake, and I. Nazmi (2008, April). Public displays of affect: deploying relational agents in public spaces. In *CHI'08 Extended Abstracts on Human Factors in Computing Systems* (pp. 3297-3302). ACM.

[4] T. Bickmore, and D. Schulman (2007, April). Practical approaches to comforting users with relational agents. In *CHI'07 extended abstracts on Human factors in computing systems* (pp. 2291-2296). ACM.

[5] T. Bickmore, D. Schulman, and G. Shaw (2009, September). DTask and LiteBody: Open source, Standards-Based tools for building Web-Deployed embodied conversational agents. In *International Workshop on Intelligent Virtual Agents* (pp. 425-431). Springer, Berlin, Heidelberg.

[6] V. Braun, and V. Clarke (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

[7] J. Cassell (Ed.). (2000). *Embodied conversational agents*. MIT press.

[8] CereProc Text-to-Speech. (n.d.). Retrieved from https://www.cereproc.com/en/products/sdk

[9] M. Dornisch (2013). The digital divide in classrooms: Teacher technology comfort and evaluations. *Computers in the Schools*, *30*(3), 210-228.

[10] K. K. Fitzpatrick, A. Darcy, and M. Vierhile (2017). Delivering cognitive behavior therapy to young adults with symptoms of depression and anxiety using a fully automated conversational agent (Woebot): a randomized controlled trial. *JMIR mental health*, *4*(2). In *Proceedings of the 2014 international conference on Autonomous agents and multi- agent systems* (pp. 1061-1068). International Foundation for Autonomous Agents and Multiagent Systems.

[11] R. Halpenny (2014). *Telehealth/Telemedicine: e-Enabling our Health System.* Interior Health. Retrieved November 16, 2018, from: https://www.ubcm.ca/assets/Convention/2014/Presentations/Monday~Sessions/Improving~Health~for~Remote~and~Rural~Communities/RobertHalpenny.pdf

[12] J. F. Kelley (1983, December). An empirical methodology for writing user-friendly natural language computer applications. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 193-196). ACM.

[13] E. Kimani, T. Bickmore, H. Trinh, L. Ring, M. K. Paasche-Orlow, and J. W. Magnani (2016, September). A Smartphone-Based Virtual Agent for Atrial Fibrillation Education and Counseling. In *International Conference on Intelligent Virtual Agents* (pp. 120-127). Springer International Publishing.

[14] B. V. Niman, A. Rodríguez-Ascaso, S. Brown, and T. Sund (2007). User experience design guidelines for telecare (e-health) services. *interactions*, *14*(5), 36-40.

[15] Reuters. (2017, May 09). *The virtual doctor will see you now.* Retrieved August 20, 2017, from https://www.reuters.com/video/2017/05/09/the-virtual-doctor-will-see-you-now?videoId=371645018&videoChannel=13974

[16] L. Ring, D. Utami, S. Olafsson, and T. Bickmore (2016). Increasing Engagement with Virtual Agents Using Automatic Camera Motion. *Intelligent Virtual Agents Lecture Notes in Computer Science*, 29-39. doi:10.1007/978-3-319-47665-0_3

[17] H. Trinh, L. Ring, and T. Bickmore (2015, April). Dynamicduo: co-presenting with virtual agents. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1739-1748). ACM.

[18] L. Yin, L. Ring, and T. Bickmore (2012, May). Using an interactive visual novel to promote patient empowerment through engagement. *In Proceedings of the International Conference on the Foundations of Digital Games* (pp. 41-48). ACM.

[19] Z. Zhang, H. Trinh, Q. Chen, and T. Bickmore (2015, August). Adapting a Geriatrics Health Counseling Virtual Agent for the Chinese Culture. *In International Conference on Intelligent Virtual Agents* (pp. 275-278). Springer International Publishing.