Effects of privacy concerns on connectedness with voice assistants

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ABSTRACT

Today, technology is becoming integral to our everyday lives. We all to some extent feel reliant on our smart devices, especially with the rise of smart devices. The more we interact with these advanced technologies, the more we may feel connected to the devices. Additionally, our expectations of privacy toward the device may change over time. These different factors may affect how we interact with, and approach them. In this project we examine current trends in connectedness and privacy in the context of voice assistants, a subcategory of smart home devices. As well, we provide questionnaires and interview questions that will aid in determining how these factors interact with each other and how they influence users' experiences.

Author Keywords
Smart home devices; Voice assistant; connectedness; privacy.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Today, humans and computers interact in ways which were previously unheard of. These interactions occur with various types of new technology, and for the last decade, the majority of our interactions with computers are made with smart devices, such as smartphones, smart security appliances, and voice assistants. People use such devices on a daily basis; most people carry around a smartphone in their pocket. And, the more we use these devices, the more we may build a relationship with them - a concept referred to as connectedness.

As of recently, new smart technology has emerged in the form of smart home devices. These devices include and are not limited to smart televisions, smart thermostats, smart lights, and voice assistants. What characterizes these devices is that they can replace standard, manual appliances, and offer services which do not depend on user input. For example, a smart humidifier can be set to turn on at 7:00 AM and to turn off at 10:00 PM, and will adjust itself independently according to the humidity levels in the room in which it is located. In addition, many smart home devices offer monitoring through smartphone applications. For example, perhaps in the future everybody will be able to easily track their energy consumption through a smartphone application. Together, the smart home devices can be interconnected through a smart hub, in which a user can access and enable all available smart functionality in their home. Through an app linked to the hub, users can control these functionalities, like turning on specific lights or locking the back door. These devices support the goal of improving the quality of life of its users by automating multiple house tasks seamlessly.

The focus of this paper will be on voice assistants, which have risen in popularity due in part to Amazon Echo and Google Home. These devices are unique in that they can be activated by voice commands. From there, the user can ask the voice assistant to fulfill tasks for them, such as telling them the news of the day or playing music off Spotify, among others. In addition, like the smart hub previously mentioned, voice assistants can be told to interact with other smart home devices, such as smart lights and smart door locks.

As users spend more time with voice assistants, they may feel more connected to them and build relationships that are similar to those between humans and smartphones. The development of these relationships may bring about some important questions. For instance, to what extent are users reliant on their devices? How do these devices influence their social lives? Does using such devices feel as natural as communicating with another human being? Do users build a relationship with their smart device? What does a relationship mean in this context? As we develop relationships with humans, we build trust in them. For example, a human would trust that their best friend would keep their personal information as a secret. Can we expect the same type of relationship between humans and voice assistants? It is worthwhile to investigate whether people perceive smart home devices as a privacy risk. As these technologies develop, more personal information will be required, stored in a database, and tracked. Thus, further questions can be posed. To what extent are users concerned about their privacy? Do privacy concerns affect people's decision of purchasing such devices or limit their relationship with smart home devices? In this study we try to answer such questions. More specifically, we focus on: How do privacy concerns affect users' connectedness with voice assistants such as Amazon Echo and Google Home? Likewise, does connectedness influence users' privacy concerns with the device?

RELATED WORK

To answer our questions, it is necessary to gain knowledge on previous research about human connectedness with technology, as well as the potential privacy concerns regarding smart home devices.

Connectedness

There has been research done to examine the possibility of human connectedness with computers. For instance, according to Bickmore and Picard [1], not only is connectedness important to study, but it is important to determine how to build and manage smart devices such that they are designed to maintain relationships with them. Such connections have the potential to affect users' performance, efficiency, and productivity in a variety of areas such as education, sales and business, and psychotherapy. For example, in the case of business, Gutek et al. [2] showed that one-on-one interaction with a sales representative builds trust and loyalty in the customer easier compared to cases where interaction with the company is at random with different representatives each time. Building a relationship matters in such situations, especially if the company wants to retain its customers. According Bickmore and Picard [1], relationships in general are based on effective socializing and emotions. Therefore, this must be taken into account in designing a device with the ability to connect to its user. Nass et al. [6] suggested that people interact with computers in the same way as they do with human beings if provided appropriate social cues. More importantly, they insist that the personality of the software affects interactions with humans above and beyond the use of natural language processing and artificial intelligence. Thus, personality is crucial when designing software that is meant to connect with it users. Although they brought insightful social implications for technology, long-term connectedness was not considered in this study.

In Bickmore and Picard's [1] study, an interactive embodied conversational agent was designed for use on home computers that incorporated a wide range of naturalistic coverbal behaviour, including hand gestures, posture shifts, and facial animation. It also included the widest range of verbal and nonverbal behaviours yet developed for relationship-building and emotional support. 101 people were studied using this program for a six-week period and the evaluation study of the exercise advisor system demonstrated that people will readily engage in relational dialogue with a software agent, and that this can have positive impacts on users' perceived relationship with the agent. Additionally, they showed that users preferred relational agents, with the ability to show emotion and build a relationship, in comparison to non-relational agents. The users even had more trust for the relational agent, just as if it were human.

There are many studies suggesting the development of relationships with software agents, but does it extend to smart home devices? Lee, Kwon, Lee, and Kim [4] defined

connectedness in two different ways. First, inner social connectedness increases with interactions between humans and smart home devices in their house. Second, outer social connectedness increases with interactions between humans and smart home devices in other people's houses. They found that the user's perceived social support increases with both types of connectedness. An even more interesting result from this study is that this perceived social support from smart home devices increases the user's companionship with the device, which is important to develop a friendship with the device. All the previous studies combined suggest that humans have the capacity to form relationships with their smart home devices, and that these relationships are similar to those with other humans.
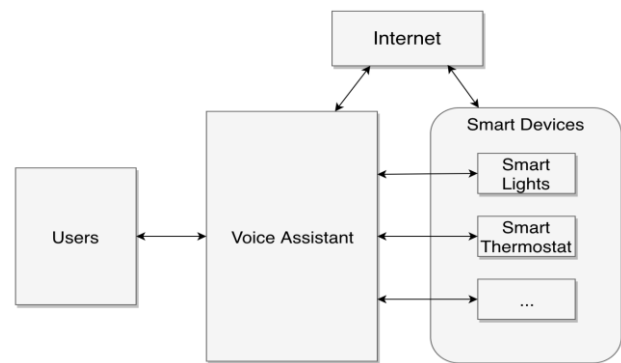

Figure 1: The relationship between users and voice assistants, as well as voice assistants and other smart home devices. All smart devices are connected to the internet

Privacy

Although people may be able to build a relationship with a smart home device, they may not fully trust it enough regarding their privacy. Homes are considered private environment, and with the introduction of a smart device, suddenly personal information, such as habits of the inhabitants, as well as information about the house and its layout become the knowledge of the device. Martin [5] examined people's expectation of privacy on online platforms Facebook and email to analyze whether these expectations depends on the platform being used, on the novelty of the device, or whether age difference is influencing privacy expectations. She made multiple conclusions: First, privacy expectations depend on the novelty of the technology. So, given that smart home devices are a novel form of technology, users may be more concerned with their privacy. Second, participants in her study had higher privacy expectations for email in comparison to Facebook, since email is similar to communicating in a private room. This could be extended to smart home devices because houses are considered private environments. Finally, she observed that privacy expectations change over time. Thus, it may be possible that once smart home devices are no longer novel, the perception that these devices may pose a risk to user privacy may diminish over time.

It is also important to consider that there exist real risks to privacy when owning a smart home device. Since smart devices are connected to the internet, the user's privacy is at risk by anyone who gains access to the device. Figure 1 shows the relationship between users and voice assistants, as well as between voice assistants and other smart home devices. As we can see, all smart home devices are connected to the Internet, which increases the risk of privacy invasion. Jacobsson, Bengt, and Carlsson [3] gathered 32 possible risks in a smart home automation system. Based on the probability of occurrence and the potential impact, 9 were considered low-risk, 19 were considered moderate-risk, and 4 were considered high-risk. The most severe ones involved the security of the API used by apps regulating the smart devices, password selection for the in-house gateway, social engineering attacks, and privacy threats through gamification. Thus, human factors are more likely to contribute to privacy invasion, as well as the security of the APIs used by the devices.

METHODS

The goal of our research is to examine the relationship between users' connectedness with smart home devices and how it relates to privacy concerns. Specifically, we have chosen questionnaires and interviews as means of collecting qualitative data to conduct throughout our research.

Questionnaires

Questionnaires present a convenient method for gaining qualitative information from respondents as it can be done online and save them a lot of time as a result. Furthermore, it is useful to gather attitudinal data, such as their opinions and feelings about the devices. The Likert and rating scales included in the questionnaire will allow respondents to choose an option that best supports their opinion without them needing to be specific. This will provide a quick and efficient way for the researchers to access data pertaining to certain demographics and respondent characteristics - making it easier to draw possible conclusions from large numbers.

Interviews

While questionnaires are useful to gain a broad set of qualitative data, we will conduct interviews to gather detailed accounts of how voice assistants affect their lives. As we are studying the relationship between privacy and connectedness with smart voice assistants, we believe interviews would be a better mean of discovering previous and current privacy concerns, as well as the development of their connectedness with the device. Some advantages of interviews for qualitative studies are that they allow for asking open ended questions and giving the respondent the chance to share their story and elaborate on matters that may be difficult or impossible to answer through questionnaires. It is also an appropriate way to discover how respondents feel and think about particular matters that cannot not be expressed through a Likert scale response.

PARTICIPANTS

Although voice assistants have increased in popularity as of recently, it is not easy to find people who own them. Thus, to gather participants, we will use convenience sampling. Our participants will be comprised of adults over the age of 18, regardless of gender, who are employed full-time, and who have acquired the voice assistant within the last six months. With this limit on when they acquired the device, we can assure that their privacy concerns have not diminished over time. As well, it ensures that they can remember their attitudes toward the device before and after acquiring it. We will gather at least ten participants - however, we will add more participants if it allows us to gain a greater variation of results. If we cannot gather enough participants for our study, we will indirectly observe related subreddits and online product reviews to gather additional experiences.

PROCEDURE

The participants will first fill out a consent form, which will enable them to access the questionnaire or take part in the interview. The questionnaire will be presented online through Google Forms, and the participants will have ten minutes to fill it out. They will be instructed to fill out the form and submit it when it is done. The participants will finish their task individually to avoid any external influences in their answers. Regarding the interviews, they will be conducted by telephone call or by person depending on the participant's availability. Each interview should not take longer than 15 minutes. They will be instructed to answer each question in as much detail as possible. Additionally, to avoid future confusion when analyzing the data, the researcher will ask the participant to elaborate on their answers if necessary.

TIMELINE

Below is a table indicating the timeline of this project:

Phase	Gathering data via questionnaires	Analyzing	Interview	Final Analysis
Date	Feb 5 - Feb 12	Feb13-20	Feb17-20	Feb20-25

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Appendix

Questionnaire

1. What is your age in years? (Circle the option that applies)

18-22	23-27	28-35	35-50	51+

2. Who do you share your living environment with, if any? (Circle all options that apply)

a.   Family
b.   Significant other
c.   Spouse
d.   Friends/Roommates
e.   Other: _____

3. What smart-home voice assistant device do you currently own?

a.   Amazon Echo
b.   Google Home
c.   Apple HomePod
d.   Other: _____

4. How often do you use your device? (Circle the option that applies)

Not at all	Sometimes	Often	Very Often

5. On a scale of 1-10, to what extent do you use your smart device's features? (With 1 being "not at all" and 10 being "using its features to its full capabilities")

6. Do you think about your privacy when using the device's features? (Circle the option that applies)

Not at all	Sometimes	Often	Very Often

7. I am concerned about my privacy when using the device's features. (Circle the option that applies)

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree

8. Since acquiring the device, has any change occurred in the amount of time you spend with your families and friends?

Significant decrease in time spent with family	Decrease in time spent with family	No notable changes	Increase in time spent with family	Significant increase in time spent with family

9. On a scale of 1-10, how connected do you feel with your device? (With 1 being "not connected at all" and 10 being "completely connected")

10. I find the device difficult or challenging to use (Circle the option that applies)

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree

11. I feel safe when using the device (Circle the option that applies)

Completely Satisfied	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Very Dissatisfied	Completely Dissatisfied

12. I have been satisfied with the device since I acquired it (Circle the option that applies)

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree

13. My hobbies have changed since I acquired the device (Circle the option that applies)

Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree

Interview

1. What is your age?

2. Who do you live with?

3. What voice assistant device do you own and what led you to acquiring it?

4. When did you acquire the device?

5. How often do you use your device in a day?

6. Would you say you use your device's functionality to its fullest? What is your favourite feature?

7. Do you find it difficult to use the device? What is the most irritating feature if any?

8. When you interact with your voice assistant, does it feel like you're interacting with a human?

9. Do you have any semblance of connectedness with the device?

10. Do you feel safe when using the device?

11. Has privacy ever been a concern since acquiring the device?

12. Do any of your privacy concerns affect what information you share with your device?

13. Since the acquirement of the device, has there been a significant change in your prior hobbies or social life?

14. Are you satisfied with the device?

Consent Form: Questionnaire/Interview

I hereby consent to participate in a research study conducted by Gabriel Bussieres, Maryam Fallah and Taha Zulfiqar as part of a Spring 2018 semester project for CSC428, Human-Computer-Interaction, a course offered by the Department of Computer Science at the University of Toronto. I agree to participate in this study the purpose of which is to gain insight on how much of factor does privacy concerns have on smart-device connectedness.

I understand that:

● The study involves answering questions truthfully from the questionnaire/interview.

● The risks incurred by participating are your answers being analysed and recorded by the research team.

● I will receive no compensation for my participation.

● I am free to withdraw at any time during the study without any explanation or penalty.

● All materials and results will be kept confidential, and that my name and any identifying or identified information will not be associated with the data.

● I can contact the course lecturer, Velian Pandeliev (vpandeli@cs.utoronto.ca) with any questions or concerns.

PARTICIPANT
Name (please print) _____
Signature _____
Date: _____

INVESTIGATOR(s)
Name _____
Signature _____