Self-Disclosure to an IoT Conversational Agent: Effects of Space and User Context on Users’ Willingness to Self-Disclose Personal Information

Ziyang Li 1, Pei-Luen Patrick Rau 1,* and Dinglong Huang 2

1 Department of Industrial Engineering, Tsinghua University, Beijing 100084, China; li-zy14@mails.tsinghua.edu.cn
2 Shenzhen Malong Artificial Intelligence Research Center, Shenzhen 518083, China; dlong@malong.com
* Correspondence: rpl@mail.tsinghua.edu.cn; Tel.: +86-10-6277-6664

Received: 22 March 2019; Accepted: 26 April 2019; Published: 8 May 2019

Abstract: In the era of the Internet of Things (IoT), IoT conversational agents (IoT-CAs) have become the gateways for smart spaces. Users will inevitably self-disclose some types of personal information while interacting with IoT-CAs. In this study, users’ willingness to disclose different types of information to IoT-CAs in two smart spaces (living space and workspace) and two user contexts (one user or two users) was investigated. One living space and one workspace were built for users to experience interactions with IoT-CAs. Subsequently, users’ willingness to self-disclose six types of personal information was measured. Two experiments were separately conducted for a single user (N = 36) and two users (N = 48). The results indicated that users were most willing to disclose information about their tastes and interests and least willing to disclose money information. Users in the living space were willing to disclose more information than those in the workspace, which was mediated by users’ expectations for the reciprocal services of IoT-CAs rather than the awareness of other persons or external factors. Participants had a high private self-awareness in the living space and workspace; their attention was focused on themselves rather than on external factors in smart spaces.

Keywords: IoT-CA; self-disclosure; personal information types; space

1. Introduction

Internet-of-Things conversational agents (IoT-CAs) marketed as smart speakers, such as Amazon Echo and Alibaba Group’s Tmall Genie, are voice-command agents with integrated artificial intelligence and human-like behavior. IoT-CAs embody the underlying concept of virtual assistants and perform various tasks such as controlling IoT devices, setting reminders, and web searching when requested by users. Canalys [1] extrapolated that the number of installed IoT-CAs would approach 100 million by the end of 2018 and will eventually reach 225 million by 2020. Thus, IoT-CAs are a rapidly developing consumer technology, and users are moving into an era of human–IoT-CA interaction.

As the number of interactions between IoT-CAs and users increases, users will increasingly disclose personal information to IoT-CAs for services, e.g., the disclosure of a daily routine to generate a to-do list, eating habits to obtain dining recommendations, and body data for health monitoring. The act of revealing personal information to others is referred to as self-disclosure [2,3]. Users can receive more accurate and personalized services by disclosing personal information. Because of privacy concerns, this self-disclosure might be selective; that is, users may prefer to disclose some types of information to a personalized service while keeping other types of information private. Therefore, understanding a user’s willingness to self-disclose information to IoT-CAs can aid in the provision of personalized services based on their disclosure preferences and privacy concerns.
Given the growing capabilities of IoT-CAs, the ranges of spaces (e.g., living spaces and workspaces) and user contexts (e.g., a single user and multiple users) in which they are used are expanding. Living spaces and workspaces are two typical social spaces in our daily lives. Recent studies have explored the use of IoT-CAs in workspaces [4] and living spaces [5], but no prior study has compared the use of IoT-CAs in these two spaces. Moreover, IoT-CAs can support collaborative use by more than one user by exploiting voice recognition and synthesis technologies. The two-user case is the simplest case of multiple users, which can aid in the understanding of the interaction between multiple users and an IoT-CA. Therefore, the space and user context are important factors in human–IoT-CA interaction.

To the best of our knowledge, no prior studies have investigated the willingness of users to disclose different types of information to an IoT-CA and the effects of the space (living space and workspace) and user context (one user or two users) on their willingness to self-disclose. This study utilized the “Wizard-of-Oz” technique [6] and built artificial smart living spaces and workspaces where one or two users interacted with an IoT-CA. Two laboratory experiments were designed and conducted to understand a user’s willingness to self-disclose to an IoT-CA on the basis of their actual use of it. This study aims to investigate the self-disclosure of one user/two-users to an IoT-CA in both the living space and workplace. The focus of this study was not to compare the differences between one and two users but to understand a user’s willingness to disclose different types of information in the living space and workspace when either one user or two users are interacting with an IoT-CA.

2. Theoretical Background and Research Hypotheses

2.1. Information Types for Self-Disclosure to IoT-CAs

2.1.1. Self-Disclosure to IoT-CAs

Self-disclosure is the process of revealing thoughts, emotions, attitudes, or other personal information to others [7,8]. Social penetration theory [2] asserts that as relationships develop, self-disclosure moves from relatively nonintimate to more intimate levels. Self-disclosure is not limited to human–human interaction. People can engage in self-disclosure in human–computer interaction (HCI). This can be explained by the computers are social actors (CASA) paradigm, in which people respond to computer technologies as social actors, applying interpersonal social rules to their interactions with computers [9,10]. Moon [11] found that users were much more likely to engage in self-disclosure when a text-based computer initiated the disclosure process by disclosing some information about itself first (e.g., the computer’s abilities or configuration) and then followed a socially appropriate sequence of disclosure by gradual escalation from nonintimate to intimate disclosure requests. Li and Rau [12] were the first to use a structured disclosure (i.e., question and answer) procedure, which has been widely used in interpersonal self-disclosure to help people engage in verbal and intimate self-disclosure, with an IoT-CA. They pointed out that people exhibited a close relationship with an IoT-CA when they were engaged in intimate self-disclosure with it.

2.1.2. Privacy and Self-Disclosure Boundaries in Human–IoT-CA Interaction

Supported by artificial intelligence, IoT-CAs can help to personalize services. Specifically, users could receive more personalized services when they disclose more information to a conversational agent [13]. Mennicken et al. [14] showed that it could be beneficial for users and an IoT-CA to “get to know each other” before an IoT-CA exhibits proactive behavior. Furthermore, users would believe that the IoT-CA understood them well and had more confidence in the IoT-CA providing a personalized service when they had previously disclosed personal information (e.g., preferences, habits) to it [12]. In addition, users have privacy concerns if they perceive that too much private information is collected by IoT devices [15]. Bugeja et al. [16] pointed out that privacy concerns had a negative effect on users’ intention to use IoT services. Recently, several IoT-CA providers (e.g., Amazon and Google) have begun to allow users to review and delete their history to address their privacy concerns [17,18].
Therefore, there might be a privacy-disclosure boundary for users when using IoT-CAs. On one hand, more value can be obtained from the agents when more information is disclosed [13]. On the other hand, IoT users do not want to engage in too much self-disclosure in order to protect their information privacy [19]. The results of an online survey of 508 IoT service users (dealing with issues such as mobile payment and intelligent transportation) showed that the perceived benefits provided by IoT services had more effect on users’ intentions to use IoT services, superseding information privacy concerns [20]. However, the “information types” constituting the concerns on information privacy were not defined. More specifically, users may have no problem disclosing some types of personal information for personalized service, whereas they may prefer to keep other types of information private to protect their privacy.

Jourard’s Self-Disclosure Questionnaire (JSDQ; developed by Jourard and Lasakow [21]) has been the most widely used instrument for measuring one’s capacity for self-disclosure [22,23]. The JSDQ classifies personal information into six types: attitudes and opinions, tastes and interests, work, money, personality, and body. It also measures the amount of information that individuals disclose about these types of information. Jourard and Lasakow [21] found the levels of self-disclosure of different types of information vary from person to person. Specifically, information about tastes and interests (information about one’s interests, e.g., “my favorite reading matter” and “my likes and dislikes in music”) was disclosed the most, and body information (information about one’s physical health and appearance, e.g., “whether or not I have any health problems” and “my past record of illness and treatment”) was disclosed the least. The results of a study by Ma et al. [24] support these results. They noted that information about tastes and interests is not intimate and that participants felt comfortable disclosing it, whereas body information is intimate, which made participants uncomfortable disclosing it. In addition, information about tastes and interests is “high disclosure” information in interpersonal communication (e.g., online social network users often reveal their tastes and interests in books, music, and movies in their profiles or on their “wall” [25]), whereas body information is “low disclosure” information (e.g., people do not want to talk about their physical health to others [26,27]). According to the CASA paradigm, people may apply their self-disclosure preferences during interpersonal self-disclosure in their interactions with IoT-CAs. Thus, we have the following hypothesis:

**Hypothesis 1.** Users are most willing to disclose information about their tastes and interests for better service and are least willing to disclose body information when interacting with IoT-CAs.

2.2. Effects of the Space Type on Self-Disclosure to IoT-CAs

2.2.1. Self-Disclosure in Living Spaces and Workspaces

IoT-CAs are making interactions ubiquitous and are becoming a part of our everyday spaces such as living spaces and workspaces. People in living spaces and workspaces have different emotions and activities, which might affect their willingness to self-disclose to IoT-CAs in these spaces. Winters et al. [28] pointed out that an individual tends to disclose more personal information when they feel safe in a space. Living spaces are safe and private for people, whereas workspaces are spaces to pursue promotions, opportunities, and high performance [29]. Furthermore, the interpersonal relationships in living spaces (close family or friends) are more intimate than those in workspaces (coworkers). People will disclose more personal information to intimate partners than to nonintimate partners [30,31]. People might engage in more self-disclosure with an IoT-CA in a living space than they would in a workspace. Thus, the following hypothesis is proposed:

**Hypothesis 2.** Users in living spaces are willing to disclose more information to IoT-CAs than those in workspaces.
2.2.2. Self-Awareness and Self-Disclosure

The space in which IoT-CA users are located may invoke changes in their self-awareness (either private or public), which could be used to predict their self-disclosure. Self-awareness describes one’s state of attention and can be directed either inward to various aspects of the self (private) or outward to consider external things (public) [32–34]. Heightened private self-awareness is associated with increased attention to physical or emotional states [35] and results in increased self-disclosure [36]. Similarly, Misoch [37] argued that heightened private self-awareness and a lowered feeling of the social presence of other users heighten one’s willingness to disclose personal information and identities in online interpersonal communication. Therefore, people are more willing to disclose more personal information to others when they are more focused on themselves (combined with a lower awareness of outside factors). In a living space, people may focus foremost on themselves, followed by outside factors. In the workspace, people primarily work under pressure and scrutiny and need to pay attention to the social context. Previous studies have shown that making participants identifiable by an audience [38] or accountable for their own behavior can enhance public self-awareness [38–40]. Thus, users experience lower public awareness in the living space compared with the workspace, where users may experience higher public awareness, which results in more self-disclosure. Hence, we have the following final hypothesis:

**Hypothesis 3.** Self-awareness mediates the effect of the space on the self-disclosure of users to IoT-CAs.

2.3. Interactions Between Two Users and an IoT-CA

IoT-CAs support multiuser interaction in a collocated space, which makes the exploration of self-disclosure to IoT-CAs in a context of more than one user a timely topic. Through the combination of multiple far-field microphones and speakers and a tubular design, IoT-CAs support interactions with multiple users from different angles. Furthermore, an update to Google Home in April 2017 provided more multiuser support, allowing Google Home to distinguish up to six people by voice [41]. Recent work has begun to examine the interactions of multiple users with IoT-CAs. Porcheron et al. [5] studied audio data from month-long deployments of Amazon Echo in five households and investigated how their use in the complex social lives of multiple users. McGregor and Tang [4] investigated how an IoT-CA might be used in collaborative work meetings and how multiple users interacted with it. Previous studies have shown that people might have conflicts regarding a routine or methods of using an agent. McCalley et al. [42] pointed out that household members have conflicting priorities when using intelligent agents for household energy conservation—namely, comfort versus financial goals. Brush et al. [43] interviewed smart home households, and one inhabitant complained that he had to change his control rules when his girlfriend moved in because they have different opinions about whether the lights should be on or off when watching television. The two-user context is the simplest multiuser context and can aid in the understanding of multiple users’ use of an IoT-CA. Thus, we have the following research question:

**Research question:** Are the above hypotheses supported when two users are interacting with an IoT-CA?

3. Experiment 1: Interaction Between One User and an IoT-CA

3.1. Method

3.1.1. Design and Participants

In Experiment 1, participants first experienced the functions of an IoT-CA and the process of verbal self-disclosure to it in a living space and workspace. Then, their willingness to self-disclose was measured. The IoT is a new concept for most people; thus, participants should first understand the functionalities of IoT-CAs and experience disclosing personal information to them. Therefore, three
types of IoT-CA functions were designed in this study (type 1: accompany the daily life of users, type 2: help users live a healthy life, and type 3: improve communication between users).

A 3 (function type: types 1–3) × 2 (space: living space and workspace) mixed-design experiment was conducted. The space was designed as a within-subject variable. The function type was designed as a between-subject variable to help understand participants’ experiences of the three function types and avoid their strong reactions to a certain type of function (strongly like or dislike, a type of function resulting in a deviation in the experimental results).

Thirty-six students (18 females) from a university were recruited. Nine of the participants were undergraduate students, and 27 were graduate students. Their average age was 23.89 (standard deviation (SD) = 2.41) years. Each participant was compensated for their time with either a smart socket or the equivalent amount of cash according to their preference. This experiment was approved by the institutional review board at the Institute of Human Factors and Ergonomics at Tsinghua University.

3.1.2. Space and Apparatus

A living space and workspace for one user were built in a university laboratory. The two spaces had the same size (2 m × 1.5 m each) and were separated by partitions. The living space was a mock-up of a small living space in a single-occupancy dormitory, and the workspace was a mock-up of a single seat in a workspace at the university. The two spaces included the same IoT-CA (a Bluetooth speaker) and the same set of IoT devices (a temperature and humidity sensor, smart monitor, smart table lamp, smart cup, smart humidifier, and smart light-emitting diode (LED) light strip). We decorated the spaces to make them more immersive. There was a sofa, a small carpet, a small table (with various household goods), a dog toy, and other items in the living space. There was a chair, a desk (with certain work-related goods), and various other items in the workspace. These spaces might not be accurate reflections of a future living space or workspace, but our goal was to allow participants to interact with an IoT-CA in a smart space to evoke a reaction.

The IoT-CAs and IoT devices were controlled by an operator sitting in another laboratory via the “Wizard-of-Oz” technique, which has been widely used in studies in human-computer interaction and the social sciences. When this technique is used, participants interact with a computer system that they believe to be autonomous but is in fact operated by an unseen operator. In this experiment, an operator monitored the participants via a smart monitor in another room and then used the NaturalReader text-to-speech application (www.naturalreaders.com) to generate the IoT-CA’s voice (female voice). The “Wizard-of-Oz” technique was adopted in this study for two reasons: (1) IoT technology and devices were not sufficiently mature to meet the needs of this study, and (2) this technique can help participants experience similar interactive processes.

3.1.3. Tasks

One control task and one question and answer (Q and A) task were designed for the participants. The control task helped participants understand the functions of IoT-CAs. The IoT-CA offered a series of services, and participants gave commands based on their preferences. For instance, the IoT-CA would suggest, “I can change the color of the smart table lamp to green, which will calm you down. What do you think?” or “I can support voice calls. Who do you want to call? Please tell me the phone number.” The IoT-CA controlled the IoT devices according to the participants' instructions.

The Q and A task helped users experience the verbal disclosure of personal information to IoT-CAs. The IoT-CA asked participants their personal information (e.g., habits and preferences) in the living space and workspace separately. The questions for the two spaces were similar; for instance, the IoT-CA would ask “What living habits do you have?” in the living space and “What work habits do you have?” in the workspace. The contents of the two tasks for the three functions of the IoT-CA differed and were selected from common applications of each functionality. Examples of these tasks are provided in Table 1.
Table 1. Examples of the two tasks for the three types of functions.

| Control Task |
|--------------|
| Type 1: Select music to improve your mood; listen to a joke; select the essential oil with the rose fragrance in the humidifier to relax. |
| Type 2: Record water-drinking habits and remember to drink from the smart cup; automatically switch lights according to the user’s actions; record actions and report life habits. |
| Type 3: Choose a company to send your order to; remotely access recorded data of your roommates or colleagues; make voice calls to anyone. |

| Q and A Task (In the Living Space/Workspace) |
|------------------------------------------|
| Type 1: Describe your living space/workspace, the feeling of living/working there, your habits, and things that make you anxious in your living space/workspace |
| Type 2: Habits that are being cultivated or to get rid of in your living space/workspace; how often and what do you think about your living/working habits; the energy-consumption level in your living space/workspace. |
| Type 3: Ways to choose a communication service for your living space/workspace; the person you contact most in your living space/workspace; things you want others to know about you in your living space/workspace. |

3.1.4. Measures

All variables were repeatedly measured via an online questionnaire for both the living space and workspace and participants were guaranteed confidentiality and anonymity.

Self-disclosure: Self-disclosure was measured by the JSDQ, which consists of 60 items—10 items for each of the six types of personal information. Participants responded to each item with a score from 1 = “I will not disclose information about this item,” specifically, “I would not like an IoT-CA to know this information or provide this information related service” to 7 = “I will disclose complete details about the information of this item,” specifically, “I would like an IoT-CA to know this information in full so that it can provide personalized services related to this topic.” The internal consistency of the scale was measured by Cronbach’s $\alpha$, which has been widely used to reflect the scale reliability. Cronbach’s $\alpha$ of this scale was 0.97 (excellent reliability).

Self-awareness: Items about private self-awareness (five items) and public self-awareness (five items) were adapted from the study by Yao and Flanagin [40]. Two items were deleted for poor reliability; one measured public self-awareness (i.e., “I felt that no one cared about me during the study”), and the other measured private self-awareness (i.e., “During the study I was very aware of the way my mind works when I worked through the problem.”). Cronbach’s $\alpha$ was 0.85 for private self-awareness and 0.85 for public self-awareness (good reliability).

User experience: Playfulness and trustworthiness were measured to understand the user experience of the types of functions of an IoT-CA. Playfulness in HCI is related to pleasure and the involvement of users [44–46], and trustworthiness is an important factor in interactions with IoT agents [47,48]. Items about playfulness and trustworthiness were adapted from the studies of Agarwal and Karahanna [49] and Fogg and Tseng [50], respectively. Participants rated the items on a 7-point Likert scale (1 = strongly disagree to 7 = strongly agree). Cronbach’s $\alpha$ for the scale was 0.89 for playfulness and 0.92 for trustworthiness (excellent reliability).

3.1.5. Procedures

The experiment was conducted in a university laboratory and lasted approximately 40 min. The experimental procedure is illustrated in Figure 1. Images of the living space and workspace are shown in Figure 2a,b, respectively. Each participant participated in the experiment alone. Participants were randomly and equally assigned to one of three function-type groups; they experienced the function of an IoT-CA in both the living space and workspace. The sequences of the living space and workspace were counterbalanced. Because the functions in the two spaces were similar, participants completed a control task in the first space in which they were allocated (Participants were told that the IoT devices
and their functions in the two spaces were similar; they would simply engage in the control task in the first space in which they were placed to understand the functions of the IoT-CA. If they had any requests or wanted to control IoT devices in the second space, they could give commands to the IoT-CA.). Upon arrival, participants signed informed consent forms and a general demographics survey. The experimenter gave each participant the following brief instruction: “The purpose of this experiment is to evaluate an intelligent IoT-CA. Imagine that it is your personal IoT-CA and can control all IoT devices in your personal space. Only you can use and control it. Next, you will communicate with it via natural language in the living space and workspace separately. I will leave during your interaction with the IoT-CA, and you just need to make yourself comfortable.”

![Figure 1. Experimental procedure of Experiment 1.](image1)

![Figure 2. Experimental spaces in Experiment 1: (a) living space and (b) workspace.](image2)

The participant was invited to enter a space (living space or workspace), and the experimenter left. The participant interacted with an IoT-CA to complete the control and Q and A tasks. After the participant completed the tasks, the experimenter returned and invited the participant to complete the questionnaire (using an iPad in the living space or a laptop in the workspace). Then, the participant was invited to enter the other space and complete the Q and A task in the absence of the experimenter. After completing the tasks, the participant was again invited to complete the questionnaire. Finally, the participant was asked to evaluate the IoT-CA and was interviewed to obtain their opinions about the functions of IoT-CAs in the living space and workspace.

3.2. Results

3.2.1. Manipulation Checks

Age: The data for the participants’ ages were normally distributed. An analysis of variance (ANOVA) revealed an absence of significant intergroup differences for the participants’ ages ($p = 0.439$).

User experience for three types of functions: The data for the playfulness and trustworthiness were not normally distributed. A Kruskal–Wallis test revealed no significant differences in the playfulness ($p = 0.540$) or trustworthiness ($p = 0.357$) of the participants for the three function-type groups. Overall,
participants had a high playfulness (mean = 5.04, SD = 1.03) in their interaction with the IoT-CA and rated the IoT-CA to have a high trustworthiness (mean = 5.75, SD = 1.00). This revealed that all three types of functions of an IoT-CA were equally appreciated and acceptable by the participants.

3.2.2. Test of Hypotheses

H1: Information type in self-disclosure. The data for self-disclosure (six types of personal information) were normally distributed; therefore, a three-way mixed ANOVA (function type × space × information type) was used to analyze the self-disclosure of users. There was no main effect of the function type on self-disclosure (p = 0.334). This indicates that our experimental manipulation was successful, neither causing strong reactions from participants nor affecting their self-disclosed information types. There was no interaction effect on the function type and information type. The main effect of the information type (i.e., attitudes and opinions, tastes and interests, work, money, personality, and body) was significant (F(5, 165) = 40.85, p < 0.001, η² = 0.28). This finding suggests that participants varied the amount of self-disclosure to an IoT-CA according to the information type. The results of post-hoc tests are listed in descending order of the means in Table 2. Participants were most willing to disclose tastes and interest information and least willing to disclose money information (marginally significantly less than personality information). Body information was not information that participants were least willing to disclose to IoT-CAs, whereas participants were more willing to disclose body information than attitudes and opinions, personality and money information. Therefore, Hypothesis 1 was partially supported in the one-user context.

Table 2. Summary of post-hoc tests for self-disclosure in Experiment 1. SFD: self-disclosure, TA and IN: tastes and interests, AT and OP: attitudes and opinions.

| Information Type | TA and IN | Work | Body | AT and OP | Personality | Money |
|------------------|-----------|------|------|-----------|-------------|-------|
|                   | High SFD  | Medium SFD | Low SFD |
| TA and IN         |           |       |       |           |             |       |
| Work             | <0.001 *** |       |       |           |             |       |
| Body             | <0.001 *** | 0.183 |       |           |             |       |
| AT and OP        | <0.001 *** | 0.023 * | 0.173 |           |             |       |
| Personality      | <0.001 *** | <0.001 *** | <0.001 *** | 0.009 ** |             |       |
| Money            | <0.001 *** | <0.001 *** | <0.001 *** | <0.001 *** | 0.062       |       |
| Mean             | 6.00      | 4.53  | 4.31  | 4.09      | 3.64        | 3.36  |
| SD               | 1.06      | 1.69  | 1.61  | 1.62      | 1.67        | 1.95  |

* p < 0.05, ** p < 0.01, *** p < 0.001.

Moreover, the information types that a single participant disclosed to an IoT-CA can be classified into three levels according to their self-disclosure willingness: high self-disclosure (tastes and interests), medium self-disclosure (work, body, and attitudes and opinions), and low self-disclosure (personality and money). Participants had fewer privacy concerns when their willingness to self-disclose was higher.

H2: Effects of the space on self-disclosure. A three-way mixed ANOVA showed that the main effect of the space on self-disclosure was significant (F(1, 33) = 65.56, p < 0.001, η² = 0.245). There was no interaction effect for the space and information type. Participants in the living space disclosed more information than in the workspace (living space: mean = 5.06 (SD = 1.04); workspace: mean = 3.52 (SD = 1.17)). Therefore, Hypothesis 2 was supported in the one-user context. More specifically, participants in the living space disclosed 44% more information than in the workspace, i.e.,

\[
\text{percentage} = \frac{\text{differences in information in the two spaces}}{\text{information in the workspace}}.
\]

H3: Mediated effect of self-awareness on self-disclosure. The data of private and public self-awareness in the two spaces were normally distributed. The results of t-tests showed that
participants in the workspace and living space had the same level of private self-awareness (living space: mean = 5.19, SD = 1.10; workspace: mean = 4.96, SD = 1.25, \( p = 0.120 \)) and public self-awareness (living space: mean = 2.95, SD = 1.44; workspace: mean = 2.92, SD = 1.28, \( p = 0.847 \)). This indicated that, compared with the workspace, participants did not have higher private self-awareness or lower private self-awareness in the living space. Furthermore, private self-awareness in the living space was not significantly correlated with self-disclosure (\( r = 0.16, p = 0.357 \)) and public self-awareness in the workspace was not significantly correlated with self-disclosure (\( r = 0.06, p = 0.709 \)). Therefore, self-awareness did not mediate the effect of the space on participants’ self-disclosures to IoT-CAs; Hypothesis 3 was not supported in the one-user context.

3.3. Brief Discussion of Experiment 1

In Experiment 1, a manipulation check confirmed that the design of the three function types and two spaces (living and workspace) was successful. Participants were satisfied with the three types of functions, and the two tasks helped them understand the control of an IoT-CA. During the interview, no participants doubted the nature of the IoT-CA and the smart environment, and they all expressed enjoyment in interacting with it in a personal smart space. Consistent with interpersonal communication, participants were most willing to disclose information about their tastes and interests. Conversely, they were least willing to disclose money information (information about their financial and debt situation) rather than body information (information about their physical health and appearance). More specifically, users’ six types of personal information could be classified into three levels: high self-disclosure (tastes and interests), medium self-disclosure (work, body, and attitudes and opinions), and low self-disclosure (personality and money). Consistent with Hypothesis 2, participants in the living space disclosed more information than in the workspace in the one-user context. However, self-awareness did not mediate the effects of the spaces on participants’ self-disclosures to the IoT-CA (Hypothesis 3 was not supported in the one-user context). Participants in the living space and workspace both had high private self-awareness and low public self-awareness.

4. Experiment 2: Interaction Between Two Users and an IoT-CA

4.1. Method

4.1.1. Design and Participants

Experiment 2 examined self-disclosure (information type) and self-awareness when two participants simultaneously interacted with an IoT-CA in the living space or workspace. According to the high playfulness and trustworthiness of the three function types in Experiment 1, participants in Experiment 2 experienced an IoT-CA that had all three types of functions. The space (living space or workspace) was the between-subject independent variable.

Twelve roommate dyads (12 females) and twelve colleague dyads (12 females) from the university were invited to participate in Experiment 2. None of them had participated in Experiment 1. The roommate dyads resided in the same dormitory, and the colleague dyads worked in the same workspace. Participants in the same dyad were the same gender, which helped to eliminate any effects of gender on self-disclosure [51]. Their average age was 23.6 (SD = 2.3) years. Each participant was rewarded with either a smart socket or the equivalent amount of cash for their participation. This experiment was also approved by the institutional review board at the Institute of Human Factors and Ergonomics at Tsinghua University.

4.1.2. Space and Apparatus

The living space and workspace for the dyads were built in a laboratory at the university. The living space was a mock-up of a living room in a two-person dormitory, and the workspace was a mock-up of two seats in the workspace. The area in each space was two times the area of the spaces...
in Experiment 1. The Bluetooth speaker and the set of IoT devices used in Experiment 1 were again used with the “Wizard-of-Oz” technique. The operator and experimenter in Experiment 1 assumed the same responsibilities in Experiment 2.

4.1.3. Tasks

One control task and one Q and A task were designed for each dyad in Experiment 2. Before the tasks, the dyad was asked to name the IoT-CA, which would respond when participants called it. This avoids the misinterpretation of communications between participants as commands [52]. During the control task, the IoT-CA offered a series of recommendations, and the dyad was required to give commands to which they both agreed. If the two participants had different commands, the IoT-CA followed the last one. For example, take the case where the IoT-CA said “I can change the color of the smart table lamp to green, which will calm you down. What do you think?” If participant A in the dyad said “Amy, yes” (assuming the name of the agent is Amy) and participant B said “Amy, I like blue,” the color of the lamp would be changed to blue, and the IoT-CA would say, “The color of the smart table lamp has been changed to blue.” During the Q and A task, participants in the dyad were required to answer the IoT-CA’s questions separately. The content of the tasks in Experiment 2 was the sum of the content of the tasks for the three function types in Experiment 1. For example, the content of the control task in Experiment 2 was the sum of the content of the control task for the functions of types 1–3 in Experiment 1 (see Table 1).

4.1.4. Procedures

The experiment lasted approximately 1 h. The dyad members participated in the experiment together, signed consent forms, and filled out general surveys. The following brief introduction was provided by the experimenter: “The purpose of this experiment is to evaluate an intelligent IoT-CA. Imagine that this IoT-CA is in your living space/workspace and can control all IoT devices in your space. All of your roommates/workmates can use and control it. Next, you will interact together with it via natural language. You should control it and communicate with it on the basis of your feelings as a pair.”

Then, the dyad interacted with an IoT-CA to complete the control and Q and A tasks in the absence of the experimenter (photographs of a roommate dyad in the living space and a colleague dyad in the workspace are given in Figure 3a,b, respectively). Afterwards, each participant in the dyad was invited to complete an online questionnaire. The questionnaire was the same as that of Experiment 1. Finally, the dyad was asked to evaluate the IoT-CA and interviewed about their opinions and concerns regarding interaction with the IoT-CA.

![Figure 3](image-url)

**Figure 3.** Example of scenes in Experiment 2: (a) a roommate dyad in the living space and (b) a colleague dyad in the workspace.
4.2. Results

4.2.1. Manipulation Checks

Reliability of the dependent variables: The items deleted in Experiment 1 for poor reliability were deleted again. All of the dependent variables had high reliabilities. Cronbach’s $\alpha$ was 0.97 for self-disclosure, 0.92 for private self-awareness, 0.81 for public self-awareness, 0.92 for playfulness, and 0.95 for trustworthiness.

Age: The participants’ ages were not normally distributed. Wilcoxon rank-sum tests showed that the average age of the colleagues was significantly higher than that of the roommates (colleague: 24.4 (SD = 2.4); roommate: 22.8 (SD = 1.9), W = 182, $p = 0.026$). Three roommate dyads were undergraduate students, and the other nine were graduate students. All colleague dyads were graduate students. Only graduate students are granted a workspace at the university; hence, the ages of the colleague dyads were higher than those of the roommate dyads. There was no significant intergroup difference ($p = 0.117$) in terms of the average length of time of living or working together: 14.8 (SD = 7.9) months for roommates and 10.2 (SD = 9.1) months for colleagues.

User experience. The data of playfulness and trustworthiness were not distributed normally. The results of Wilcoxon rank-sum tests showed that there were no significant differences for playfulness (living space: Mean = 5.54 (SD = 1.07); workspace: Mean = 5.26 (SD = 1.36), $p = 0.549$) and trustworthiness (living space: Mean = 5.45 (SD = 1.37); workspace: Mean = 5.42 (SD = 1.25), $p = 0.584$) in the two spaces. Thus, the participants in different dyad types (roommates and colleagues) felt that interacting with an IoT-CA was playful and that they trusted it.

4.2.2. Test of Hypotheses

H1: Information type in self-disclosure. The data of self-disclosure (six information types) were not normally distributed; thus, nonparametric tests were used for analysis. The results of Friedman’s ANOVA showed that the effect of the types of personal information (i.e., attitudes and opinions, tastes and interests, work, money, personality, and body) was significant ($\chi^2 = 129.72, p < 0.001$). This revealed that the participants in dyads had various levels of self-disclosure according to the information types. The results of post-hoc tests are listed in descending order of the means in Table 3. Of the six information types, participants were most willing to disclose information about tastes and interests and least willing to disclose money information. Therefore, Hypothesis 1 is partially supported in the two-user context.

| Information Type | TA and IN | Work | AT and OP | Body | Personality | Money |
|------------------|-----------|------|-----------|------|-------------|-------|
|                   | High SFD  | Medium-high SFD | Medium-low SFD | Low SFD |
| TA and IN         | <0.001 ***| 0.320 | <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***|
| Work             | <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***|<0.001 ***|
| AT and OP        | 0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***|<0.001 ***|
| Body             | 0.297     | <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***| <0.001 ***|<0.001 ***|
| Personality      | 3.55      | 3.40  | 2.64      | 2.64  | 2.64        | 2.64  | 2.64        | 2.64 |
| Money            | 1.49      | 1.66  | 1.35      | 1.67  | 1.67        | 1.67  | 1.67        | 1.67 |

The information types that users were willing to disclose to an IoT-CA in the two-user context can be classified into four levels: high self-disclosure (tastes and interests), medium-high self-disclosure (work along with attitudes and opinions), medium-low self-disclosure (body and personality), and low self-disclosure (money).
H2: Effects of the spaces on self-disclosure. A Wilcoxon rank-sum test shows that the roommates significantly disclosed more information than the colleagues (living space: mean = 4.49 (SD = 1.23); workspace: mean = 3.52 (SD = 1.05), W = 420, p < 0.01). Thus, Hypothesis 2 was supported in the two-user context. Specifically, participants in the living space disclosed 28% more information than in the workspace.

H3: Mediated effect of self-awareness on self-disclosure. The data of private and public self-awareness were normally distributed. The results of a t-test showed that roommates and colleagues had the same levels of private self-awareness (roommates: mean = 5.02, SD = 1.35; colleagues: mean = 5.24, SD = 1.28, p = 0.557) and public self-awareness (roommates: mean = 3.30, SD = 1.36; colleagues: mean = 3.16, SD = 1.53, p = 0.729). This revealed that, compared with the colleagues, the roommates did not have higher private self-awareness or lower public self-awareness. The roommates’ private self-awareness was not significantly correlated with their self-disclosure (r = 0.31, p = 0.137). Moreover, the colleagues’ public self-awareness was not significantly correlated with their self-disclosure (r = 0.13, p = 0.540). Therefore, Hypothesis 3 was not supported in the two-user context.

4.3. Brief Discussion of Experiment 2

Experiment 2 continued the manipulations of Experiment 1 but extended the experimental spaces to two users. Consistent with the results of Experiment 1, participants were most willing to disclose tastes and interest information and least willing to disclose money information. More specifically, the users’ six types of personal information were classified into four levels: high self-disclosure (tastes and interests), medium-high self-disclosure (work as well as attitudes and opinions), medium-low self-disclosure (body and personality), and low self-disclosure (money). In addition, the results of Experiment 2 provide support for Hypothesis 2 in the two-user context. Participants in the living space (roommates) disclosed more information than did those in the workspace (colleagues). Again, self-awareness did not mediate the effects of the spaces on self-disclosure (Hypothesis 3 was not supported in the two-user context). Participants in the two spaces had high private self-awareness and low public self-awareness.

5. General Discussion

5.1. Self-Disclosure of Information to IoT-CAs

Previous studies examining the use of IoT devices or IoT-CAs have tended to focus on the question of how to protect the information privacy of IoT users. However, only a few have distinguished information that users are willing and unwilling to disclose. It is inevitable that users will disclose their personal information in their interactions with IoT-CAs. The privacy and self-disclosure boundaries in these interactions should be defined by the users themselves on the basis of their user experience.

The results of this study suggest that users were most willing to disclose information related to tastes and interests, which is in accordance with previous research on interpersonal face-to-face [21] and online [24] self-disclosure. This result can be explained in two respects. On the one hand, the information about tastes and interests can help IoT-CAs learn users’ preferences (e.g., eating habits, leisure hobbies, and tastes in clothing) and provide them with personalized services [13]. Compared with other information types, users might think that the information about tastes and interests can make it easier to obtain rewarding feedback. On the other hand, social penetration theory argues that the intimacy of self-disclosure increases during the acquaintance process [2]; in the earliest stage of a relationship, the information disclosed between prospective partners is superficial (e.g., favorite foods, hobbies, and interests). In this study, users and IoT-CAs were in the initial stages of relationship development (i.e., users just started to use the IoT-CA and are becoming familiar with it); thus, the information that users were willing to disclose is also the shallowest.

In contrast to earlier findings on interpersonal self-disclosure that determined that people were least willing to disclose body information to others, users were least willing to disclose money
information to an IoT-CA. This finding is consistent with current market situations in that users are reluctant to use IoT-CAs to buy things [53]. Researchers at Statista (an online market research portal) [54] pointed out that the top reasons that users do not adopt IoT-CAs for shopping are their concerns about providing payment and money-related information security. Users disclosed information for “fair” social exchanges [55], such as others’ self-disclosure or material and emotional support. The disclosure of personal money information to IoT-CAs might do more harm (i.e., leaking personal financial information) than good (e.g., convenient shopping). Furthermore, when users disclose money information to human beings, they are usually seeking financial support or investment advice from others; users might not believe that IoT-CAs currently have the social capital or intelligence to provide financial support and advice. However, in terms of users’ self-disclosure of body information, various IoT devices have been recently developed and applied for health care and monitoring [56,57]. Users’ body information is being collected and effectively used for the detection of personal conditions and future disease prevention. Therefore, users would like to disclose body-related information to IoT-CAs for personalized health care.

5.2. Self-Disclosure in Different Spaces and User Contexts

Users were willing to disclose more information in the living space than in the workspace (one-user context: 44% more information; two-user context: 28% more information). However, this high self-disclosure was not mediated by a heightened private self-awareness. The private self-awareness of participants was significantly higher than their public self-awareness in both Experiment 1 (living space: t(35) = 7.12, p < 0.001; workspace: t(35) = 7.32, p < 0.001) and Experiment 2 (living space: t(23) = 4.99, p < 0.001; workspace t(23) = 4.77, p < 0.001). This finding reveals that a user’s attention is directed toward themselves (e.g., physical or emotional states) rather than external factors (e.g., contextual factors and other people) regardless of the space (living space or workspace) and user context (e.g., one user or two users) when interacting with an IoT-CA. This finding supports the ideas that the IoT (ubiquitous computing) brings computers into our world and frees people to shift awareness back to themselves and their everyday life [58,59]. IoT-CAs can enable people to return to an awareness of and focus on themselves and their life rather than other external factors.

The higher level of information disclosure in the living space than the workspace can be explained by self-disclosure reciprocity. Self-disclosure reciprocity in social interactions refers to a situation in which one person reveals personal information to the other partner, and the other will disclose something or behave in a manner that is responsive to the initial disclosure’s content in return [60,61]. Self-disclosure reciprocity can be explained by the norm of reciprocity [62] and social exchange theory [63]; people attempt to maintain equality in their relationships or behaviors, and the violation of this makes them uncomfortable. In interacting with IoT-CAs, users sought reciprocity. The opinions about the IoT-CAs in the two spaces showed that participants had more expectations for the IoT-CA in the living space than in the office. In Experiment 1, participants (30 out of 36 participants) argued that the IoT-CA in the living space should provide more diverse services (e.g., chatting, help with cooking, housework, reminding the user to exercise and sleep, and providing energy consumption information), whereas the IoT-CA in the workspace did not need to provide many services (27 out of 36 participants). Therefore, self-disclosure reciprocity can exist in human–IoT-CA interaction.

5.3. Limitations and Implications

This study has several limitations. First, all participants were sampled from a university; therefore, the results of this study must be interpreted with caution. In addition, this study built artificial smart spaces (a living space and workspace). Although the participants did not doubt the authenticity of the IoT-CAs and smart spaces and were satisfied with the layouts of these spaces, further studies among a broader user sample in real smart spaces are needed to further validate our results. Despite these limitations, this study is the first—to the best of our knowledge—to measure users’ willingness
to disclose different types of information that is based on the actual experience of interacting with IoT-CAs and considers the effects of spaces and user context. The key implications are as follows.

The first implication concerns the collection of user data and the services provided by IoT-CAs. The results of this study suggest that a company’s collection of user information can be divided into three levels according to the user’s willingness to self-disclose: high self-disclosure (tastes and interests), medium self-disclosure (work, attitudes and opinions, body, and personality), and low self-disclosure (money). Therefore, it is a good start to collect high self-disclosure information in the early stages of use—tastes and interests—and provide personalized taste- and interest-related services that will not cause privacy concerns. Then, the company could gradually collect medium self-disclosure information and provide related services; this would help deepen users’ closeness to IoT-CAs and increase their confidence and patience with services [12]. After a period of time, high self-disclosure information could be collected for money-related services (e.g., shopping) according to users’ needs. Companies should exercise caution when adding money-related services to an IoT-CA because they could give users a strong sense of privacy violation. Therefore, as a new product, it might not be a good idea to promote money-related services during the early marketing or use stages of IoT-CAs.

The second implication is that users expect reciprocity in their interactions with IoT-CAs. Users were willing to disclose more information to an IoT-CA in the living space, but they also expected the IoT-CA to provide more diverse and personalized services in this space. IoT designers could design services for IoT-CAs in the living space and take advantage of users’ disclosed information to provide personalized and appropriate services. This is a lucrative new market because rewarded self-disclosure is more likely to be continued compared with unrewarded self-disclosure [64]. If users receive satisfactory service after self-disclosure, they might more actively engage in more self-disclosure with an IoT-CA. This would form a benign use cycle in human–IoT-CA interaction.

6. Conclusions and Plans for Future Research

This study examined users’ willingness to self-disclose different types of personal information to an IoT-CA in different smart spaces (a living space and workspace) and user contexts (one user or two users). The results found that users were most willing to disclose information related to tastes and interests to help an IoT-CA learn their preferences and then provide personalized services. Users were least willing to disclose money information to an IoT-CA owing to their concerns related to information security. Moreover, users were willing to disclose more information in the living space than in the workspace (one-user context: 44% more information; two-user context: 28% more information). However, high self-disclosure in the living space was mediated by users’ expectations for reciprocal services; users had more expectations of services provided by the IoT-CA in the living space than in the office. When interacting with an IoT-CA, users had high private self-awareness and low public self-awareness. Thus, IoT-CAs can help direct users’ attention to themselves and their life rather than external factors. In future research, users’ actual use behaviors in a real smart space could be collected, and users’ self-disclosure behaviors could be analyzed (e.g., amount and intimacy of disclosed information) during a period such as a week or a month. Further, the effects of users’ self-disclosure to an IoT-CA on further human–IoT-CA interaction, such as users’ trust of IoT-CAs and collaborative task completion, could be investigated.

Author Contributions: Conceptualization, Z.L., P.-L.P.R. and D.H.; data curation, Z.L.; formal analysis, Z.L.; funding acquisition, P.-L.P.R.; investigation, Z.L.; methodology, Z.L. and P.-L.P.R.; project administration, Z.L. and P.-L.P.R.; resources, Z.L., P.-L.P.R. and D.H.; software, Z.L. and D.H.; supervision, P.-L.P.R.; validation, Z.L. and D.H.; visualization, D.H.; writing—original draft, Z.L.; writing—review and editing, Z.L. and P.-L.P.R.

Funding: This research was funded by the National Natural Science Foundation of China, grant number 71661167006.

Acknowledgments: Thanks to all the participants in this study. We would like to thank Editage (www.editage.com) for English language editing.

Conflicts of Interest: The authors declare no conflict of interest.
References

1. Canalys Newsroom-Smart Speaker Installed Base to Hit 100 Million by end of 2018. Available online: https://www.canalys.com/newsroom/smart-speaker-installed-base-to-hit-100-million-by-end-of-2018 (accessed on 21 August 2018).
2. Altman, I.; Taylor, D.A. Social Penetration: The Development of Interpersonal Relationships; Holt, Rinehart and Winston: New York, NY, USA, 1973.
3. Tolstedt, B.E.; Stokes, J.P. Self-disclosure, intimacy, and the depenetration process. *J. Personal. Soc. Psychol.* **1984**, *46*, 84–90. [CrossRef]
4. McGregor, M.; Tang, J.C. More to Meetings: Challenges in Using Speech-Based Technology to Support Meetings. In Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing, Portland, OR, USA, 25 February–1 March 2017; ACM; pp. 2208–2220.
5. Porcheron, M.; Fischer, J.E.; Reeves, S.; Sharples, S. Voice Interfaces in Everyday Life. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems, New York, NY, USA, 21–26 April 2018; ACM; p. 640.
6. Hanington, B.; Martin, B. *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*; Rockport Publishers: Beverly, MA, USA, 2012.
7. Greene, K.; Derlega, V.J.; Mathews, A. Self-disclosure in personal relationships. In *Cambridge Handbook of Personal Relationships*; Vangelisti, A., Perlman, D., Eds.; Cambridge University Press: Cambridge, UK, 2006; pp. 1268–1328.
8. Pearce, W.B.; Sharp, S.M. Self-disclosing communication. *J. Commun.* **1973**, *23*, 409–425. [CrossRef]
9. Nass, C.; Brave, S. *Wired for Speech: How Voice Activates and Advances the Human–Computer Relationship*; MIT Press: Cambridge, MA, USA, 2005.
10. Moon, Y. Intimate exchanges: Using computers to elicit self-disclosure from consumers. *J. Consum. Res.* **2000**, *26*, 323–339. [CrossRef]
11. Li, Z.; Rau, P.-L.P. Effects of Self-Disclosure on Attributions in Human–IoT Conversational Agent Interaction. *Interact. Comput.* **2019**, *7*, 2728–2742. [CrossRef]
12. Saaffarizadeh, K.; Boodraj, M.; Alashoor, T.M. *Conversational Assistants: Investigating Privacy Concerns, Trust, and Self-Disclosure*; Association for Information Systems (AIS): Atlanta, GA, USA, 2017.
13. Menningen, S.; Zihler, O.; Juldaschewa, F.; Molnar, V.; Aggeler, D.; Huang, E.M. It’s like living with a friendly stranger: Perceptions of personality traits in a smart home. In Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing, Heidelberg, Germany, 12–16 September 2016; ACM; pp. 120–131.
14. Ziegeldorf, J.H.; Morchon, O.G.; Wehrle, K. Privacy in the Internet of Things: Threats and challenges. *Secur. Commun. Netw.* **2014**, *7*, 2728–2742. [CrossRef]
15. Bradley, T. How Amazon Echo Users Can Control Privacy. Available online: https://www.forbes.com/sites/tonybradley/2017/01/05/alexa-is-listening-but-amazon-values-privacy-and-gives-you-control/ (accessed on 23 August 2018).
16. Sicari, S.; Rizzardi, A.; Greico, L.A.; Coen-Porisini, A. Security, privacy and trust in Internet of Things: The road ahead. *Comput. Netw.* **2015**, *76*, 146–164. [CrossRef]
17. Hsu, C.-L.; Lin, J.C.-C. An empirical examination of consumer adoption of Internet of Things services: Network externalities and concern for information privacy perspectives. *Comput. Hum. Behav.* **2016**, *62*, 516–527. [CrossRef]
18. Jourard, S.M.; Lasakow, P. Some factors in self-disclosure. *J. Abnorm. Soc. Psychol.* **1958**, *56*, 91–98. [CrossRef]
22. Zane, N.; Ku, H. Effects of ethnic match, gender match, acculturation, cultural identity, and face concern on self-disclosure in counseling for Asian Americans. *Asian Am. J. Psychol.*, 2014, 5, 66–74. [CrossRef]

23. Schwartz, A.L.; Galliher, R.V.; Domenech Rodriguez, M.M. Self-disclosure in Latinos’ intercultural and intracultural friendships and acquaintanceships: Links with collectivism, ethnic identity, and acculturation. *C. Diviors. Ethn. Minor. Psychol.*, 2011, 17, 116–121. [CrossRef]

24. Ma, X.; Hancock, J.; Naaman, M. Anonymity, intimacy and self-disclosure in social media. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, San Jose, CA, USA, 7–12 May 2016; ACM; pp. 3857–3869.

25. Krasnova, H.; Kolesnikova, E.; Guenther, O. “It won’t happen to me!”: Self-disclosure in online social networks. In *Proceedings of the 15th Americas Conference on Information Systems*, San Francisco, CA, USA, 6–9 August 2009; p. 343.

26. Benson, A.; Lambert, V.; Gallagher, P.; Shahwan, A.; Austin, J.K. “I don’t want them to look at me and think of my illness, I just want them to look at me and see me”: Child perspectives on the challenges associated with disclosing an epilepsy diagnosis to others. *Epilepsy Behav.*, 2015, 53, 83–91. [CrossRef]

27. Imber-Black, E. Will talking about it make it worse? Facilitating family conversations in the context of chronic and life-shortening illness. *J. Fam. Nurs.*, 2014, 20, 151–163. [CrossRef] [PubMed]

28. Winters, C.; Taylor, P.; Luther, K. Safe space: Examining the Effect of Interview Location on Self-Disclosure. Available online: http://eprints.lancs.ac.uk/125965/ (accessed on 28 April 2018).

29. Nguyen, P.D.; Dang, C.X.; Nguyen, L.D. Would better earning, work environment, and promotion opportunities increase employee performance? An investigation in state and other sectors in Vietnam. *Public Organ. Rev.*, 2015, 15, 565–579. [CrossRef]

30. Derlega, V.J. *Communication, Intimacy, and Close Relationships*; Elsevier: Amsterdam, The Netherlands, 2013.

31. Morton, T.L. Intimacy and reciprocity of exchange: A comparison of spouses and strangers. *J. Personal. Soc. Psychol.*, 1978, 36, 72–81. [CrossRef]

32. Buss, A. *Psychological Dimensions of the Self*; Sage Publications, Inc.: Thousand Oaks, CA, USA, 2001.

33. Duval, S.; Wicklund, R.A. *A Theory of Objective Self Awareness*; Academic Press: Oxford, UK, 1972.

34. Fenigstein, A.; Scheier, M.F.; Buss, A.H. Public and private self-consciousness: Assessment and theory. *J. Consult. Clin. Psychol.*, 1975, 43, 522–528. [CrossRef]

35. Scheier, M.F. Self-awareness, self-consciousness, and angry aggression. *J. Personal.* 1976, 44, 627–644. [CrossRef]

36. Kalin, L.R.; Schuldt, W.J. Effects of self-awareness on self-disclosure. *Psychol. Rep.*, 1991, 69, 289–290. [CrossRef]

37. Misoch, S. Stranger on the internet: Online self-disclosure and the role of visual anonymity. *Comput. Hum. Behav.*, 2015, 48, 535–541. [CrossRef]

38. Carver, C.S.; Scheier, M.F. *Attention and Self-Regulation: A Control-Theory Approach to Human Behavior*; Springer Science and Business Media: New York, NY, USA, 2012.

39. Prentice-Dunn, S.; Rogers, R.W. Effects of public and private self-awareness on deindividuation and aggression. *J. Person. Soc. Psychol.*, 1982, 43, 503–513. [CrossRef]

40. Yao, M.Z.; Flanagan, A.J. A self-awareness approach to computer-mediated communication. *Comput. Hum. Behav.*, 2006, 22, 518–544. [CrossRef]

41. Noda, K. Google Home: Smart speaker as environmental control unit. *Disabil. Rehabil. Assist. Technol.*, 2018, 13, 674–675. [CrossRef] [PubMed]

42. McCalley, L.T.; Midden, C.J.H.; Haagdorens, K. Computing systems for household energy conservation: Consumer response and social ecological considerations. In *Proceedings of the CHI 2005 Workshop on Social Implications of Ubiquitous Computing*, Tokyo, Japan, 11–14 September 2005.

43. Brush, A.J.; Lee, B.; Mahajan, R.; Agarwal, S.; Sarouj, S.; Dixon, C. Home automation in the wild: Challenges and opportunities. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Vancouver, BC, Canada, 7–12 May 2011; ACM; pp. 2115–2124.

44. Webster, J.; Martocchio, J.J. Microcomputer playfulness: Development of a measure with workplace implications. *MIS Q.*, 1992, 16, 201–226. [CrossRef]

45. Webster, J.; Trevino, L.K.; Ryan, L. The dimensionality and correlates of flow in human-computer interactions. *Comput. Hum. Behav.*, 1994, 9, 411–426. [CrossRef]

46. Starbuck, W.H.; Webster, J. When is play productive? *Account. Manag. Inf. Technol.*, 1991, 1, 71–90.
47. Agarwal, Y.; Dey, A.K. Toward Building a Safe, Secure, and Easy-to-Use Internet of Things Infrastructure. *Computer* 2016, 49, 88–91. [CrossRef]

48. De Graaf, M.M.; Allouch, S.B.; Klamer, T. Sharing a life with Harvey: Exploring the acceptance of and relationship-building with a social robot. *Comput. Hum. Behav.* 2015, 43, 1–14. [CrossRef]

49. Agarwal, R.; Karahanna, E. Time flies when you’re having fun: Cognitive absorption and beliefs about information technology usage. *MIS Q.* 2000, 24, 665–694. [CrossRef]

50. Fogg, B.J.; Tseng, H. The elements of computer credibility. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Pittsburgh, PA, USA, 15–20 May 1999; ACM; pp. 80–87.

51. Morgan, B.S. Intimacy of disclosure topics and sex differences in self-disclosure. *Sex Roles* 1976, 2, 161–166. [CrossRef]

52. Koskela, T.; Väänänen-Vainio-Mattila, K. Evolution towards smart home environments: Empirical evaluation of three user interfaces. *Pers. Ubiquitous Comput.* 2004, 8, 234–240. [CrossRef]

53. Peraz, S. 32% of U.S. Consumers Now Own a Smart Speaker, up from 28% at Start of Year; TechCrunch: New York, NY, USA, 2018.

54. Infographic: Alexa. I Don’t Trust You to Be My Shopping Assistant. Available online: https://www.statista.com/chart/13831/reasons-against-shopping-with-smart-speakers/ (accessed on 28 October 2018).

55. Hamid, P.N. Self-monitoring, locus of control, and social encounters of Chinese and New Zealand students. *J. Cr. C. Psychol.* 1994, 25, 353–368. [CrossRef]

56. Zhong, R.; Rau, P.-L.P.; Yan, X. Application of smart bracelet to monitor frailty-related gait parameters of older Chinese adults: A preliminary study. *Geriatr. Gerontol. Int.* 2018, 18, 1366–1371. [CrossRef] [PubMed]

57. Darshan, K.R.; Anandakumar, K.K. A comprehensive review on usage of Internet of Things (IoT) in healthcare system. In Proceedings of the IEEE 2015 International Conference on Emerging Research in Electronics, Computer Science and Technology (ICERECT), Mandya, India, 17–19 December 2015; pp. 132–136.

58. Galloway, A. Intimations of everyday life: Ubiquitous computing and the city. *C. Stud.* 2004, 18, 384–408. [CrossRef]

59. Weiser, M. The computer for the 21st century. *Mob. Comput. Commun. Rev.* 1999, 3, 3–11. [CrossRef]

60. Dindia, K. A comparison of several statistical tests of reciprocity of self-disclosure. *Commun. Res.* 1988, 15, 726–752. [CrossRef]

61. Jourard, S.M. *The Transparent Self*; Van Nostrand Reinhold: New York, NY, USA, 1971; pp. 133–152.

62. Gouldner, A.W. The norm of reciprocity: A preliminary statement. *Am. Social. Rev.* 1960, 25, 161–178. [CrossRef]

63. Archer, R.L. Role of personality and the social situation. In *Self-Disclosure: Origins, Patterns, and Implications of Openness in Interpersonal Relationships*; Chelune, G.J., Ed.; Jossey-Bass: San Francisco, CA, USA, 1979; pp. 28–58.

64. Sprecher, S.; Treger, S.; Wondra, J.D.; Hilaire, N.; Wallpe, K. Taking turns: Reciprocal self-disclosure promotes liking in initial interactions. *J. Exp. Soc. Psychol.* 2013, 49, 860–866. [CrossRef]

© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).