Understanding adoption of intelligent personal assistants : A parasocial relationship perspective

Abstract

Purpose – The purpose of this paper is to develop a comprehensive research model that can explain customers' continuance intentions to adopt and use intelligent personal assistants.

Design/methodology/approach – This study proposes and validates a new theoretical model that extends the parasocial relationship theory. Partial least squares analysis is employed to test the research model and corresponding hypotheses on data collected from 304 survey samples.

Findings – Interpersonal attraction (task attraction, social attraction, and physical attraction) and security/privacy risk are important factors affecting the adoption of intelligent personal assistants.

Practical implications – To increase current users' satisfaction and continuance intention to use, manufacturers or service providers should focus on developing "human-like" and "professional" assistants based on open development echo-system and form-factor/user interface innovation.

Originality/value – This study is the first empirical attempt to examine user acceptance of intelligent personal assistants, as most of the prior literature has concerned analysis of usage patterns or technical features.

Keywords - Parasocial relationship, Task attraction, Social attraction, Physical attraction, Security/privacy risk, Intelligent Personal Assistant (IPA)

Paper type - Research paper

1. Introduction

In the 2010s, the intelligent personal assistant (IPA) space has been growing rapidly. Most global Information and Communications Technology (ICT) companies are competing fiercely with their own IPA, such as Google's Google Assistant, Amazon's Alexa, Apple's Siri, Microsoft's Cortana, and Samsung's Bixby. These assistants are similar in providing a speech interface for performing simple tasks such as making a phone call, sending a text message, and searching for specific information that the user wants to know (Saad et al., 2016). IPAs, which were mainly installed on mobile devices such as smartphones and tablet PCs, have recently come into the house with their own hardware devices (e.g., Google Home, Amazon Echo/Tab, SK Telecom Nugu). This phenomenon suggests that IPAs are evolving into home assistants to be used by family members for implementing intelligent homes. Through IPAs, users can not only make a dinner reservation, play their favorite music, or check the weather for tomorrow, but also control their home appliances and ensure the safety of their home and family. If IPAs learn an individual's schedule and taste based on AI (artificial intelligence) technology, and can proactively provide customized services without user input, fully automated smart homes will be realized. Augusto and Nugent (2006) argued that AI can improve the functionality of smart homes and experiences for residents.

Because of the obvious value of IPAs to users, recent market research has forecasted that the worldwide IPA market will grow 32.8% a year from 2016 to 2024, and reach a value of US$7.9 billion (TransparencyMarketResearch, 2016). In addition, Gartner (2016) anticipated that 3.3% of global households will have adopted virtual personal assistant-enabled wireless speakers by 2020, and expected that more than one unit or even one per room can be installed by users', due to their ease of use and their natural, intuitive model.

The advantages and positive prospects of IPAs are derived from the possibility that IPA will be similar to actual human assistants. IPA companies are focused on improvement of natural language processing and AI technologies to understand and respond to user requests, and to create IPAs, which communicate with humans, as humans communicate with their colleagues, so that IPAs will be able to make a joke or play games with users. In such a case, people may feel a sense of emotional closeness

with IPAs and gain a sense of a social relationship with them. Human-computer interactions with software agents or avatars can lead to relationship development (Schroeder, 2002, Liu et al., 2011). From a company perspective, it is necessary to carry out an empirical examination of the effects of efforts to enhance user satisfaction by developing a human-likeness in IPAs. To our knowledge, little academic research has been done to examine the issue of a social relationship between the IPA and its user. Thus, we address the following questions to identify the existence of a relationship between users and IPAs, and the impact on user satisfaction and post-adoption behavioral intentions.

(1) Do IPA users have a sense of a social relationship with their IPAs?
(2) Does a sense of a social relationship between the user and the IPA affect user satisfaction with the IPA?
(3) How can the formation of a relationship between the consumer and the IPA be improved to increase satisfaction and ensure continuance of intention to use the IPA?

To determine whether users gain a sense of social relationship with IPAs, we applied the Para-Social Relationship (PSR) theory, which explains the perception of imaginary in interpersonal relationships between people (viewers) and media characters (Turner, 1993). PSR is derived from an emotional affinity that people have with media characters. IPA users may have a sense of intimacy with IPAs through human-like interactions and regard IPAs as friends, which can result in PSR. Prior studies of PSR indicate that the PSR may positively affect user satisfaction with IPAs (Levy, 1979, Kanazawa, 2002). Based on PSR theory, we propose a conceptual framework to identify PSR and its influence on satisfaction and continuance intention to use the IPA.

The paper is structured as follows: in sections 2 and 3, respectively, a review of existing literature on intelligent home assistants and the PSR theory is presented; in section 4, we propose the study's hypotheses and research model; section 5 explains the research methods and presents the statistical results; finally, sections 6 and 7 discuss the results and conclusions of this study.

2. Intelligent personal assistant

An IPA is a software agent that provides professional/administrative, technical, and social assistance to human users by automating and easing many day-to-day activities (Saad et al., 2016,

Santos et al., 2016). As a professional/administrative assistant, IPA can help users in various daily tasks, such as sending text messages, setting alarms, planning schedules, and ordering food). The technical assistance by an IPA includes the performance of complex tasks, such as managing the home automation system by controlling several smart home appliances, or monitoring the status of the user's health by analyzing vital signs from his or her wearable devices. As part of its social assistance function, an IPA can communicate with users the way they do with human friends. Dialogue-enhancing features, which include humorous responses such as jokes, are being added to the repertoire of IPAs.

Technically, all types of IPAs use voice recognition and natural language processing algorithms. At first, an IPA listens and records a user's command through its embedded microphones. Then, the IPA sends this recording over the Internet to a natural language processing server. Finally, this server interprets recorded voices and sends an appropriate response. In recent years, not only voice but also emotion recognition techniques operating by viewing a user's facial expressions have been developed (Knight, 2016).

Currently, commercial IPA products are embedded as a separate feature in the OS, such as Apple Siri and Google Now, or downloaded in the form of mobile apps like Amazon Alexa, or installed on dedicated hardware devices such as an Amazon Echo or Google Home. Hardware form-factors of an IPA can be varied, including smartphones/pads/watches, smart speakers, PC/laptops, and robots. Smart speaker IPAs (i.e., a voice-controlled speaker) are the most popular type in the market. They can ask follow-up questions, giving feelings of conversation with users. Many companies have also unveiled robot IPAs with friendly appearances and human-like interaction features. For example, JIBO, which received USD 3.6 million worth of crowdfunding investment, is a personal home robot that is currently under development. It is being designed to recognize the faces and voices of family members, and to have interactive and entertaining functions such as playing games or reading/telling stories to children. The JIBO developer company describes that, "JIBO loves people… he can't wait to talk to you" (www.jibo.com). The humanness and friendliness of IPAs are being emphasized and advertised to consumers, and IPAs are often described as a "digital buddy."

To our knowledge, there is no study that analyzes factors affecting intentions to use IPAs. Only a few studies have investigated user satisfaction with IPAs. Jiang et al. (2015) suggested an automatic method used to assess user satisfaction with IPAs. Kiseleva et al. (2016) investigated differences whether the factors contributing to overall satisfaction with a task differ between different usage scenarios. Sano et al. (2016) built a prediction model of prospective user engagement by using large-scale user logs obtained from a commercial IPA. Capturing real user needs calls for an analysis of the factors affecting user behavior concerning IPAs, especially concerning the human-like characteristics of IPA.

3. Theoretical background

The concept of PSR was introduced by Horton and Wohl (1956) in the context of the analysis of television viewers' responses to media characters. When viewing a media persona through TV, people come to "know such a persona in somewhat the same way they know their close friends: through direct observation and interpretation of his appearance, his gestures and voice, his conversation and conduct in a variety of situations" (Horton and Wohl, 1956, p. 216). Horton and Wohl insisted that viewers establish an "illusion of intimacy" with the remote media character through frequent viewing. Even though the media character appears only on the TV screen, the viewers may respond to the character "similarly to how they feel, think and behave in real-life encounters" (Klimmt et al., 2006, p. 292). Thus, PSR is also expressed as quasi-relationship (Rubin and Step, 2000); it is one-way and less intense comparing with an actual social relationship. (Rubin and McHugh, 1987, Rubin and Step, 2000).

Like a face-to-face relationship, PSR can be enhanced by interpersonal attraction (Rubin and McHugh, 1987, Lee and Kwon, 2013, Rubin and Step, 2000). Interpersonal attraction is defined as "an individual's tendency or predisposition to evaluate another person or the symbol of the person in a positive (or negative) way" (Berscheid and Hatfield, 1978, p. 6). An individual tends to communicate more with another individual who is felt to be more attractive. This increased amount of communication can contribute to an intimate relationship bond between them (Rubin and McHugh,

1987). Interpersonal attraction consists of three dimensions: task attraction, social attraction, and physical attraction (McCroskey and McCain, 1974). Task attraction indicates the ease of working with something; social attraction is based on social or personal liking properties; and physical attraction is attributed to perceived physical appearance.

The notion of PSR has gained empirical support widely in the field of media and communication. Studies have shown that people actually develop and maintain an intimate bond with TV celebrities, or radio hosts (e.g., Rosengren and Windahl, 1971, Levy, 1979, Koenig and Lessan, 1985, Rubin et al., 1985). The research domain of PSR has now been extended to the field of human-computer interaction. As computers such as robots or artificial intelligence come to have human-like interfaces, researchers have investigated the existence of emotional affinity (e.g., feelings of friendship) between people and those computers. PSR may be appropriate to explain emotional closeness to such technology. Studies have suggested that people may perceive human-like computers as a source of emotional communication, which implies a potential companionship between them (Louie et al., 2014, Sproull et al., 1996, Bell et al., 2003). Lee et al. (2006) found that people felt personality in and attraction to socially interactive robots based on their verbal and nonverbal behaviors. Yoo et al. (2016) showed the significant influence of PSR on the learner's psychological processing in deciding to adopt robot assisted learning systems. Lee and Kwon (2013) reported that the personified user interface design of a mobile device was shown to grow PSR of users, which increased user satisfaction with the mobile device and continued use of the device.

The capability of IPAs to understand natural human language is evolving quickly and becoming close to that of a real human personal assistant. When a person is more often interacting with an IPA by talking and issuing voice commands, the relationship between an IPA and its user is expected to be more interactive and socially enjoyable. The intimate relationship would contribute to the continual use of an IPA, similar to how people keep meeting with their friends in close relationship. Therefore, for those interested in promoting IPA usage, it is important to understand the factors that affect the relationship between an IPA and its user. This study hypothesizes that PSR with an IPA is affected by the interpersonal attraction of the IPA. In the proposed research model,

security/privacy risk of an IPA has been incorporated, in consideration of its rising importance due to recent hacking incidents, and it is expected to affect PSR with an IPA. Furthermore, we expect that PSR with an IPA may result in positive relationship outcomes, specifically increased user satisfaction and willingness to continue using the IPA.

4. Research model and hypotheses development

This study proposes a research model based on the above theoretical background (see Figure 1). This research model hypothesizes that interpersonal attraction (task, social, and physical attraction) and security/privacy risk influences users' PSR with an IPA. Users' PSR is expected to increase their satisfaction, which ultimately will affect an IPA continuance intention.

<Insert Figure 1 about here>

4.1. Task attraction, PSR and satisfaction

Task attraction is relevant to "how easy or worthwhile working with someone would be" (McCroskey and McCain, 1974, p. 6). In this research, task attraction refers to a user's perception of an IPA's ability of completing the given task, and its reliability as a work partner. A user can ask an IPA to perform various tasks such as playing music, making calls, sending and receiving messages, or setting a reminder. When an IPA understands its user's command and returns the appropriate results, his/her trust and reliance on the IPA may increase. This increase in task attraction is expected to facilitate the user-IPA relationship development. Auter and Palmgreen (1992) proposed that viewer's perception of TV anchors' expertise in problem solving affected their PSR. Rubin and McHugh (1987) found that task attraction was one of the motivating factors in the development of a PSR with favorite television personalities.

Task attraction is also expected to impact a user's satisfaction with an IPA. According to Delone and McLean (2003) model, a user's satisfaction concerning information systems is affected by evaluations of quality: information quality (e.g., adaptability, availability, reliability), system quality

(e.g., completeness, ease of understanding, personalization), and service quality (e.g., assurance, empathy, responsiveness). Many studies empirically tested and validated the DeLone and McLean model in the IS field (e.g., Rai et al., 2002, Sedon and Kiew, 1995, Etezadi-Amoli and Farhoomand, 1996, DeLone and Mclean, 2004, Petter and McLean, 2009). From this perspective, as a user evaluates task attraction of an IPA based on its quality in completing tasks, higher task attraction is expected to lead to higher user satisfaction. Lee and Kwon (2013) provided empirical evidence that task attraction of a mobile device significantly affected user satisfaction. Hence, this study hypothesizes:

H1. *Task attraction perceived by a user of an IPA will have a positive influence on his or her PSR with the IPA.*

H2. *Task attraction perceived by a user of an IPA will have a positive influence on his or her satisfaction with the IPA.*

4.2. Social attraction and PSR

Social attraction is a "social or personal liking property" (McCroskey and McCain, 1974, p. 6). In this study, social attraction was operationalized as a user's intention to communicate and make friends with IPAs. Studies have shown the importance of "Humanness" of voice user interface in the context of human-computer interaction. Sproull et al. (1996) reported that people spent more time interacting with a talking face display than interacting with the text display. Tinwell et al. (2011) presented a similar result: people enjoyed the interaction with a talking-face display more than with a text display. IPAs can be socially attractive due to their advantage of humanlike conversational flow. Certain IPAs are able to joke with users to make the conversation more enjoyable. Rubin and McHugh (1987) found that social attraction was the most significant factor affecting the development of PSR. Hence, this study hypothesizes:

H3. *Social attraction perceived by a user of an IPA will have a positive influence on his or her PSR with the IPA.*

4.3. Physical attraction and PSR

Physical attraction is based on "dress and physical features" (McCroskey and McCain, 1974, p. 6). This study defines physical attraction as the physical appearance of an IPA expressed through its user interfaces such as colors, boxes, and menus. Dion et al. (1972) found that people assumed physically attractive individuals would have socially desirable personality traits compared with physically unattractive individuals, which implies that physically attractiveness may have advantages in establishing social relationship. Many studies have shown the importance of products' visual attractiveness to users' emotional affinity with those products. Yang et al. (2016) and Cyr et al. (2006) showed that visual attractiveness positively affected perceived enjoyment. Nanda et al. (2008) reported a positive influence of visual elements of smartphones on users' emotional reactions and preferences for a given product. The physical attraction of an IPA may, therefore, enhance its intimate relationship with its user. This study hypothesizes:

> ***H4***. *Physical attraction perceived by a user of an IPA will have a positive influence on his or her PSR with the IPA.*

4.4. Security/privacy risk and PSR

Security risk is defined as a "circumstance, condition, or event with the potential to cause economic hardship to data or network resources in the form of destruction, disclosure, modification of data, denial of service, and/or fraud, waste, and abuse" (Balta-Ozkan et al., 2013), which also includes the risk of violation of a user's privacy (Yang et al., 2016). This study defines security/privacy risk as users' fear of unauthorized access to IPAs by others, and potential loss from disclosing personal user information to IPAs. Certain IPAs still have a technical limitation in distinguishing between the voices of different individuals (Bong Gi, 2017, Gebhart, 2017). This reveals the risk that someone could hijack IPAs and steal user information. Actual hacking incidents have happened wherein Amazon Echo and Google Home devices heard a voice command from a TV program, not its user, and executed it (Hackett, 2017, Maheshwari, 2017). Security/privacy risk is negatively associated with trusting beliefs (Eastlick et al., 2006, Kim, 2008), which, in turn, increases user reluctance of

interacting with a device (Ba et al., 2003, Gefen et al., 2003) or disclosing personal information (Dinev and Hart, 2006). The less interaction that occurs, the less likely an intimate relationship develops (Berger and Calabrese, 1975). Thus, security/privacy concerns in using an IPA may discourage PSR with the IPA. Hence, this study hypothesizes:

H5. *Security/privacy risk perceived by a user of an IPA will have a negative influence on his or her PSR with the IPA.*

4.5. PSR, satisfaction and continuance intention

Satisfaction refers to "a sense of contentment that arises from an actual experience in relation to an expected experience" (Hernon and Whitman, 2001), and reflects the emotional state of a user – his or her degree of pleasure or delight (Spreng et al., 1996). In this research, PSR with an IPA can be understood as an emotional bonding experience associated with the user's perception of the interpersonal attraction of the IPA. Thus, as the user experiences PSR with an IPA as pleasant, it may lead to satisfaction with the IPA. Lee and Kwon (2013) reported that PSR with a mobile device was positively associated with user satisfaction with that device.

User satisfaction is connected to post-usage intention (Chiu et al., 2007). Technology continuance intention is an important behavior that has been researched in the field of IS. Various studies have shown that the major determinant of the continuance intention was satisfaction (e.g., Bhattacherjee, 2001b, Bhattacherjee, 2001a, Chiu et al., 2007). Therefore, this study hypothesizes:

H6. *A person's PSR with an IPA will have a positive influence on his or her satisfaction with the IPA.*

H7. *A person's satisfaction with an IPA will have a positive influence on his or her continuance intention toward the IPA.*

5. Research method

5.1. Data

An online survey was conducted and validated for two weeks in May 2017, before it was used to test the research model and hypotheses. We used the online labor market Amazon Mechanical Turk (MTurk), which is very popular tool for behavioral research that is used to gather high quality data (Mason and Suri, 2012). Furthermore, results from MTurk are generalizable, because survey participants are demographically varied (Buhrmester et al., 2011). Survey participants consisted of people who had experience in using an IPA. To validate users, we first asked whether they had experience using an IPA. If their answer was affirmative, they were allowed to fill out the usage perception questionnaire. A total of 304 responses were retained for study after responses with missing or erroneous data were removed. Detailed descriptive statistics for the respondents' demographic characteristics are presented in Table 1. The proportion of men who participated in this study was greater than women (62.5% male, 37.5% female), and the majority of respondents (78.1%) were under 35 years of age. Considering that the IPA market is still at an early stage of growth, the skewed gender and age representation of respondents indicates the possibility that respondents will be early adopters. Early adopters tend to be young and educated (Rogers Everett, 1995), and men tend to be more familiar with new technology and IT products/services than women (Pew Research, 2014).

<Insert Table 1 about here>

5.2. Instrument development

The measurement items in this study were developed based on prior studies, and the reliability and validity of these items were checked by applying Cronbach's alpha test and confirmatory factor analysis. Together, the 19 measurement items describe 7 latent constructs: (1) Task attraction, (2) Social attraction, (3) Physical attraction, (4) Security/privacy risk, (5) Parasocial relationship, (6) Satisfaction, and (7) Continuance intention. Table 2 presents the survey items used in this study.

<Insert Table 2 about here>

6. Data analysis and results

6.1. Measurement model

Confirmatory factor analysis was conducted to test the convergent validity of each construct. Table 3 showed the cross-loadings of all items, which loaded highest among their own intended factors rather than other factors. Table 4 summarized the convergent validity of the constructs. Convergent validity was assessed by examining the factor loadings for each item in the measurement model, the significance level for each loading, their reliability, and the average variance extracted (AVE) for each construct. Factor loadings showed that each item reached the minimum requirement whereby a loading must be greater than 0.60 (Anderson and Gerbing, 1988). Cronbach's alphas for all 7 constructs were also above the recommended reliability level (0.70), and the AVE for each construct exceeded 0.50 (Fornell and Larcker, 1981), establishing convergent validity. Discriminant validity is examined by comparing the square root of the AVE for each construct and its correlation values between any two constructs. Table 5 shows that all square roots of the AVEs were greater than the correlation coefficients of the other constructs, demonstrating that all values met these recommendations for discriminant validity (Fornell and Larcker, 1981). The Hetero-Trait Mono-Trait Ratio (HTMT) criterion was also employed to assess discriminant validity. HTMT is an estimate for factor correlation (more precisely, an upper boundary). Monte Carlo simulations show that the HTMT outperforms more traditional measures of discriminant validity (Voorhees et al., 2016). In order to clearly discriminate between two factors, the HTMT should be significantly smaller than the value of 1 (Henseler et al., 2015). As presented in Table 3, HTMT results, except for the ratios between PA and SA, between SAT and TA and between SAT and CONT, are all below the threshold value of 0.85, which warrants discriminant validity (Henseler et al., 2015).

<Insert Table 3 about here>

If the values are higher than 0.85, then we can check confidence intervals to test whether the HTMT statistic is significantly different from the value of 1 (Henseler et al., 2015). A confidence interval containing the value 1 indicates a lack of discriminant validity. Conversely, if the value 1 falls outside the interval's range, this suggests that the two constructs are empirically distinct. We used the bootstrap method to derive a distribution of the HTMT statistic. Table 4 shows that upper confidence intervals are less than 1 in all cases where values of HTMT > 0.85 (Henseler et al., 2015). Thus, the discriminant validity has been verified.

<Insert Table 4 about here>

In addition, Common Method Variance (CMV), which refers to "variance that is attributable to the measurement method rather than to the constructs the measures represent," should be examined when a study uses self-reported data from a survey (Podsakoff et al., 2003, p. 879). This can be tested by employing Harman's single-factor analysis. According to the results of the single-factor test, six factors were found, and the first factor's variance was lower than 50% (43.4%). Thus, from these results it would appear that CMV was not a serious problem (Podsakoff et al., 2003). We also conducted an unmeasured latent marker construct (ULMC) approach (Podsakoff et al., 2003, Chin et al., 2012, Liang et al., 2007). ULMC is a latent variable, which determines the indicators of all the constructs in the model. Results showed that the average substantive variance is 0.788, while the average method based variance is 0.019, which is a small enough magnitude of the method variance. Furthermore, the existence of negative correlations among constructs (Table 7) means that the data of this study are not subject to a CMV problem (Yang et al., 2017).

<Insert Table 5 about here>

<Insert Table 6 about here>

<Insert Table 7 about here>

6.2. Hypotheses testing

This study employed a bootstrapping technique within Smart PLS 3.2.6 that used randomly selected subsamples to generate t-statistics to indicate the significance of model paths. As summarized in Figure 2, all 7 hypotheses were supported. All three attraction constructs (i.e. task attraction, social attraction, and physical attraction) and security/privacy risk significantly affected PSR (H1, β=0.122, t-value=3.172, $p<0.01$; H3, β=0.695, t-value=18.393, $p<0.001$; H4, β=0.072, t-value=2.183, $p<0.05$; H5, β=-0.131, t-value=3.713, $p<0.00$; PSR R^2=0.705). PSR and task attraction were also significant factors influencing satisfaction (H6, β=0.208, t-value=5.079, $p<0.001$; H2, β=0.643, t-value=15.313, $p<0.001$; satisfaction R^2=0.589). Satisfaction was then a significant factor influencing continuance intention, supporting hypothesis H7 and explaining 57.9% of the variance (H7, β=0.761, t-value=26.254, $p<0.001$; continuance intention R^2=0.579).

We conducted a mediation analysis to confirm the intermediating role of the satisfaction variable between PSR and continuance intention. Following the procedure proposed by Nitzl et al. (2016), the analysis was performed using 5,000 bootstrap re-samples. The mediating effect was significant and the 95% bias-corrected confidence intervals (CIs) did not include zero, which confirms the mediating role of the satisfaction variable (Nitzl et al., 2016).

<Insert Table 8 about here>

<Insert Figure 2 about here>

7. Discussion

The objective of this paper was to develop a comprehensive research model that can explain customers' behavioral intentions to adopt and use IPAs. For this purpose, this study employed the PSR theory and enhanced it by incorporating not only interpersonal attraction (i.e. task attraction, social attraction, and physical attraction) but also a risk factor (i.e. security/privacy risk). Several findings derive from this research. As expected, satisfaction had a significant influence on continuance intention, which is consistent with many previous studies (Bhattacherjee, 2001a,

Bhattacherjee, 2001b, Thong et al., 2006, Chiu et al., 2007, Yu et al., 2013). This study also confirmed that PSR and task attraction were positively related to user satisfaction. The strong effect of task attraction on satisfaction aligns with the traditional perspective of the utility value of an IT product (Rubin and Step, 2000, Lee and Kwon, 2013). Practitioners must focus on task attraction of IPAs for improved user satisfaction. Voice recognition for IPAs is still imperfect as there is sometimes difficulty in understanding user requests. Development of natural language process technology should, therefore, be prioritized. In the same way, machine learning technologies, which learn the frequent requests and patterns of users is also beneficial in recognizing and responding to user requests more accurately. Sensors and cameras will be added to IPAs to collect contextual information such as temperature, or to distinguish between visitors and residents when providing more situation relevant information to users. Among the three components constituting the interpersonal attraction concept, social attraction was shown to have a much stronger effect on PSR than task attraction and physical attraction. This result indicates that it is critical to make user interfaces intimate like a "human" friend, based on natural language processing technology, talking-face displays, and human-like robot form factors for enhancing PSR with IPAs. Lee and Kwon (2013) reported a similar result showing a very strong tie between social presence, which measured users' perceived sense of sociability and human warmth in the interface of mobile devices, and PSR with mobile devices (social presence→PSR: β=0.728). There are two potential reasons for a slight relationship between physical attraction and PSR. First, the survey respondents were more familiar with software application-style IPAs on mobile devices than device-type IPAs that have a physical appearance, because the diffusion rate of device-type IPAs is still low. Second, most of the current device-type IPAs are cylindrical speakers, so users cannot be aware of the importance of design differentiation.

In addition, security/privacy risk, reflecting the users' perceived concern about IPAs, negatively affected PSR. This result is consistent with previous research. Easwara Moorthy and Vu (2015) reported that IPA users were more cautious disclosing private information than nonprivate information, and emphasized privacy concerns as one of the major reasons for not using IPAs.

Therefore, to increase consumers' intent to use IPAs continuously, it is important not only to increase their attractiveness, but also to reduce their risk of security/privacy invasion.

8. Conclusions

This study makes several contributions to existing theory. To begin, this is the first empirical academic study to examine user acceptance of IPAs with consideration of the social characteristics attributed to IPAs. Previous studies addressed privacy issues of IPAs (Easwara Moorthy and Vu, 2015), or technical architecture (Chen et al., 2016, Dernoncourt et al., 2017). Mindmeld (2016) reported IPA usage patterns such as usage time, frequency of use, purpose of use, and satisfaction; however, this work was limited to a descriptive survey report. We expect the social aspect of IPA will be highlighted in future studies because IPAs will resemble humans more, as AI technology advances. Second, to our knowledge, no research has been conducted to test the role of PSR in the context of IPAs. This study demonstrated that PSR plays an important role in post-adoption satisfaction and continued usage of IPAs, Therefore, PSR is a powerful theory for anticipating the behavioral intentions of users in the context of human-intelligent computer interaction. Third, this study verified the robustness of the proposed model by introducing new antecedents reflecting risk-related attributes, which has not been investigated in prior PSR research. The empirical results showed that the extended research model had good explanatory power, with an R^2 value of 58.9% for satisfaction and an R^2 value of 57.9% for continuance intention. This implies that this new research model creates a useful framework and theoretical basis to explain IPAs, and shows that the application of traditional theories is appropriate to reflect the attributes of this new technology. Yang and Lee (2017) argued that it is necessary to select a base theory carefully and extend the theory to fit the research context, as most technology acceptance theories have limitations.

From the practitioner's perspective, this study provides several useful insights for managers who control the development and distribution of IPAs. To increase the adoption of IPAs, manufacturers should focus on developing "human-like" and "professional" assistants, in consideration of the important role of PSR and task attraction for enhancing customers' satisfaction

and prolonged usage. R&D should continuously strive to realize AI technology advances so that IPAs can better recognize the user's voice and speak naturally like a person. Mindmeld (2016)'s survey revealed that IPA users wish that their IPAs would perform better by better understanding the word they are saying (44% of respondents), speaking more naturally (28%), giving them the appropriate results they ask for (27%), and so on. Building an open development ecosystem is also very important. Collaboration with third-party companies or individual developers is essential in this field, as manufacturers are unable to independently develop applications that support the specific tasks of various industries. In fact, IPA makers such as Google, Amazon, and Microsoft recently provided third parties their SDK (Software Development Kit), and tried to enhance their products' capabilities and spread their voice recognition technology. In the future, if a large ecosystem is created in which related companies cooperate, interoperability between IPAs will be achieved such that users could receive the same level of personalized services anytime and anywhere. It is also necessary to enhance IPA device design and its user interface to enhance physical attraction. For instance, Amazon is known to be developing an IPA with a display that goes beyond the cylindrical speaker form, which it intends to release within the year 2017 (TechCrunch, 2017, TheVerge, 2016). This attempt can be interpreted to indicate that Amazon is continuously trying to increase the physical appeal and ease of use of its IPA through form factor and user interface innovation. Softbank's Pepper, which is a representative commercial humanoid robot with human-like shape and facial expression, is widely used not only for personal but also for business use, replacing human labor. Security/privacy related issues are inevitable problems with the proliferation of devices and services based on artificial intelligence. In particular, as data analysis has been conducted on the central Cloud systems, consumers are increasingly concerned about the leakage of personal information through their online applications. Therefore, IPA manufacturers and service operators should focus more on investments to strengthen security technologies and establish strong internal policies in order to prevent information leakage generated by consumers. In the case of Amazon, the company rejected the request of police for a murder suspect's voice information stored in an Amazon Echo, claiming

protection of customer privacy. Further, corporate communication units should make appropriate promotion programs for enhancing trust levels of customers.

This study has limitations that future research may address, although the findings of this study nevertheless provide meaningful insights into the adoption of IPAs. First, key findings of this research are based only on data from users in the United States. In order to ensure generalizability, a future study should attempt to gather data from an ethnically and geographically diverse group. Second, individual differences among the survey respondents were not examined in this study. Future studies could extend and refine the findings by investigating the moderating effects of individual differences such as gender and age. Lastly, in future studies, a significant difference in the antecedents' influence on behavioral intention between current and potential users may be found. However, although this study has some limitations, this study contributes to a more systematic understanding of IPA adoption. In this regard, it is hoped that this study will help to build a foundation for future research on related topics.

Author Biography

Heetae Yang is an associate research fellow in Science and Technology Policy Institute(STEPI) of South Korea. He received his PhD in business studies from Graduate School of Innovation and Technology Management at Korea Advanced Institute of Science and Technology (KAIST). His research interests include user adoption of new high-tech products and online services, disruptive business model and corporate strategy. His papers have appeared in Telematics & Informatics, Information Systems and e-Business Management, and Industrial Management and Data Systems.

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Table 1 Characteristics of the respondents

Characteristics	Respondents (n=304) Number	Percentage
Gender		
Male	190	62.5
Female	114	37.5
Age		
18-24	55	18.1%
25-30	113	37.2%
31-35	64	21.1%
36-40	30	9.9%
41-50	21	6.9%
50+	21	6.9%
Education		
Less than high school	15	4.9%
College or university	222	73.0%
Advanced degree	67	22.1%
Monthly Income($)		
Less than 1,000	54	17.8%
1,000~2,000	60	19.7%
2,000~3,000	68	22.4%
3,000~4,000	41	13.5%
4,000~5,000	29	9.5%
5,000 +	52	17.1%
Occupation		
Blue collar	29	9.5%
White collar	79	26.0%
Professional	121	39.8%
Student	34	11.2%
Home maker	20	6.6%
Other	21	6.9%

Table 2 Survey items used in this study

Construct	Item No.	Measurement items	References
Task Attraction	TA1	My intelligent personal assistant is useful for my task.	Lee and Kwon (2013)
	TA2	I would recommend my intelligent personal assistant as a work partner.	
	TA3	I could rely on my intelligent personal assistant to get the job done.	
Social Attraction	SA1	I think my intelligent personal assistant could be a friend of mine.	McCroskey et al. (2006)
	SA2	I would like to have a friendly chat with my intelligent personal assistant.	
	SA3	My intelligent personal assistant would be pleasant to be with.	
Physical Attraction	PA1	My intelligent personal assistant has an attractive interface (i.e., colors, boxes, menus, etc.).	McCroskey et al. (2006)
	PA2	I find my intelligent personal assistant attractive visually.	
	PA3	My intelligent personal assistant looks appealing.	

Security/Privacy Risk	PR1	I am worried to my intelligent personal assistant because other people or organizations may be able to access my AI device.	Yang et al. (2017)
	PR2	There will be much potential loss associated with disclosing personal information to my intelligent personal assistant.	
Parasocial Relationship	PARA1	I feel like I am seeing my favorite friend when I see my intelligent personal assistant.	Lee and Kwon (2013)
	PARA2	My intelligent personal assistant makes me feel comfortable, as if I am with family.	
Satisfaction	SAT1	I am very pleased with my intelligent personal assistant.	Lee and Kwon (2013)
	SAT2	I feel relieved that my intelligent personal assistant meets my needs.	
	SAT3	I feel delighted with my intelligent personal assistant.	
	SAT4	Overall, I am very satisfied with my intelligent personal assistant.	
Continuance intention	CONT1	I will frequently use my intelligent personal assistant in the future.	Bhattacherjee (2001)
	CONT2	I intend to continue using my intelligent personal assistant rather than discontinue its use.	
	CONT3	I will use my intelligent personal assistant on a regular basis in the future.	

Table 3 Hetero-Trait Mono-Trait Ratio

	TA	SA	PA	PR	PARA	SAT
SA	0.539					
PA	0.509	0.445				
PR	0.112	0.300	0.175			
PARA	0.558	**0.930**	0.475	0.385		
SAT	**0.861**	0.563	0.556	0.084	0.593	
CONT	0.833	0.422	0.484	0.062	0.453	**0.880**

Note 1: TA=Task attraction; SA=Social attraction; PA=Physical attraction; PR=Security/Privacy concern; PARA=Parasocial relationship; SAT=Satisfaction; CONT=Continuance intention
Note 2: The results marked in bold indicate HTMT > 0.85.

Table 4 Distribution of HTMT statistic

	Original sample	Sample mean	Bias	2.5%	97.5%
PARA→ CONT	0.453	0.453	0.000	0.340	0.552
PA → CONT	0.484	0.486	0.002	0.357	0.605
PA → PARA	0.475	0.475	0.000	0.361	0.583
PR → CONT	0.062	0.104	0.042	0.017	0.076
PR → PARA	0.385	0.386	0.000	0.241	0.519
PR →PA	0.175	0.189	0.014	0.092	0.278
SAT → CONT	**0.880**	0.880	0.000	0.810	0.940
SAT → PARA	0.593	0.593	0.000	0.501	0.675
SAT → PA	0.556	0.559	0.003	0.427	0.662
SAT → Privacy	0.084	0.118	0.034	0.033	0.114
SA→ CONT	0.422	0.421	-0.001	0.299	0.531
SA→ PARA	**0.930**	0.931	0.001	0.887	0.970
SA → PA	0.445	0.445	0.000	0.323	0.563
SA→ Privacy	0.300	0.303	0.003	0.172	0.437
SA → SAT	0.563	0.563	0.000	0.468	0.652
TA → CONT	0.833	0.833	0.000	0.746	0.905

TA → PARA	0.558	0.558	0.000	0.454	0.648
TA → PA	0.509	0.512	0.002	0.366	0.629
TA → Privacy	0.112	0.136	0.024	0.041	0.171
TA → SAT	**0.861**	0.860	0.000	0.785	0.920
TA → SA_	0.539	0.538	0.000	0.422	0.639

Note 1: TA=Task attraction; SA=Social attraction; PA=Physical attraction; PR=Security/Privacy concern; PARA=Parasocial relationship; SAT=Satisfaction; CONT=Continuance intention
Note 2: The results marked in bold indicate HTMT > 0.85.

Table 5 Construct cross-loadings

	TA	SA	PA	PR	PARA	SAT	CONT
TA1	**0.755**	0.203	0.286	0.049	0.226	0.525	0.570
TA2	**0.900**	0.513	0.414	-0.095	0.501	0.661	0.606
TA3	**0.916**	0.469	0.390	-0.103	0.500	0.618	0.609
SA1	0.458	**0.905**	0.334	-0.280	0.776	0.439	0.285
SA2	0.403	**0.904**	0.324	-0.231	0.717	0.424	0.342
SA3	0.435	**0.885**	0.366	-0.247	0.709	0.483	0.356
PA1	0.396	0.334	**0.877**	-0.171	0.388	0.438	0.407
PA2	0.370	0.321	**0.895**	-0.147	0.347	0.392	0.311
PA3	0.341	0.330	**0.817**	-0.071	0.317	0.411	0.336
PR1	-0.092	-0.323	-0.191	**0.960**	-0.381	-0.098	0.017
PR2	-0.009	-0.117	-0.033	**0.808**	-0.181	-0.098	0.020
PARA1	-0.184	-0.239	-0.192	0.335	**0.941**	-0.114	-0.169
PARA2	-0.178	-0.227	-0.176	0.403	**0.947**	-0.121	-0.149
SAT1	0.670	0.438	0.406	-0.072	0.457	**0.881**	0.652
SAT2	0.599	0.400	0.348	-0.027	0.408	**0.842**	0.669
SAT3	0.662	0.530	0.493	-0.123	0.581	**0.876**	0.648
SAT4	0.661	0.365	0.416	-0.003	0.383	**0.877**	0.676
CONT1	0.625	0.338	0.407	0.005	0.377	0.693	**0.880**
CONT2	0.545	0.239	0.251	0.094	0.214	0.605	**0.820**
CONT3	0.618	0.362	0.397	-0.039	0.424	0.680	**0.903**

Table 6 Validity of constructs

Construct	Items	Factor loading	Std. error	t-value	AVE (>0.5)	Composite Reliability(>0.6)	Cronbach's alpha(>0.7)
Task Attraction	TA1	0.755	0.036	20.954	0.739	0.894	0.824
	TA2	0.900	0.012	77.594			
	TA3	0.916	0.010	96.285			
Social Attraction	SA1	0.905	0.012	75.771	0.807	0.926	0.880
	SA2	0.904	0.012	73.080			
	SA3	0.885	0.018	50.252			
Physical Attraction	PA1	0.877	0.017	51.094	0.746	0.898	0.829
	PA2	0.895	0.017	53.535			
	PA3	0.817	0.032	25.246			
Security/Privacy Risk	PR1	0.960	0.014	69.558	0.787	0.880	0.758
	PR2	0.808	0.054	14.911			
Parasocial Relationship	PARA1	0.941	0.007	126.004	0.891	0.943	0.878
	PARA2	0.947	0.006	158.689			
Satisfaction	SAT1	0.881	0.018	50.068	0.755	0.925	0.892
	SAT2	0.842	0.025	34.223			
	SAT3	0.876	0.015	59.154			
	SAT4	0.877	0.019	45.816			
Continuance	CONT1	0.880	0.019	45.196	0.754	0.902	0.836

intention	CONT2	0.820	0.029	28.600
	CONT3	0.903	0.014	63.691

Table 7 Correlations of the constructs and square root of AVE

	TA	SA	PA	PR	PARA	SAT	CONT
TA	**0.860**						
SA	0.482	**0.898**					
PA	0.429	0.380	**0.864**				
PR	-0.072	-0.282	-0.154	**0.887**			
PARA	0.497	0.818	0.408	-0.337	**0.944**		
SAT	0.746	0.499	0.480	-0.065	0.527	**0.869**	
CONT	0.688	0.363	0.409	0.020	0.395	0.761	**0.868**

Table 8 Mediation test

Mediator	Mediated path	Original sample	Sample mean	Standard deviation	*t*-value	Significance ($p < 0.05$)	95% CIs (Bias-corrected)
SAT	PARA → CNT	0.158	0.158	0.031	5.025	Yes	[0.097, 0.220]

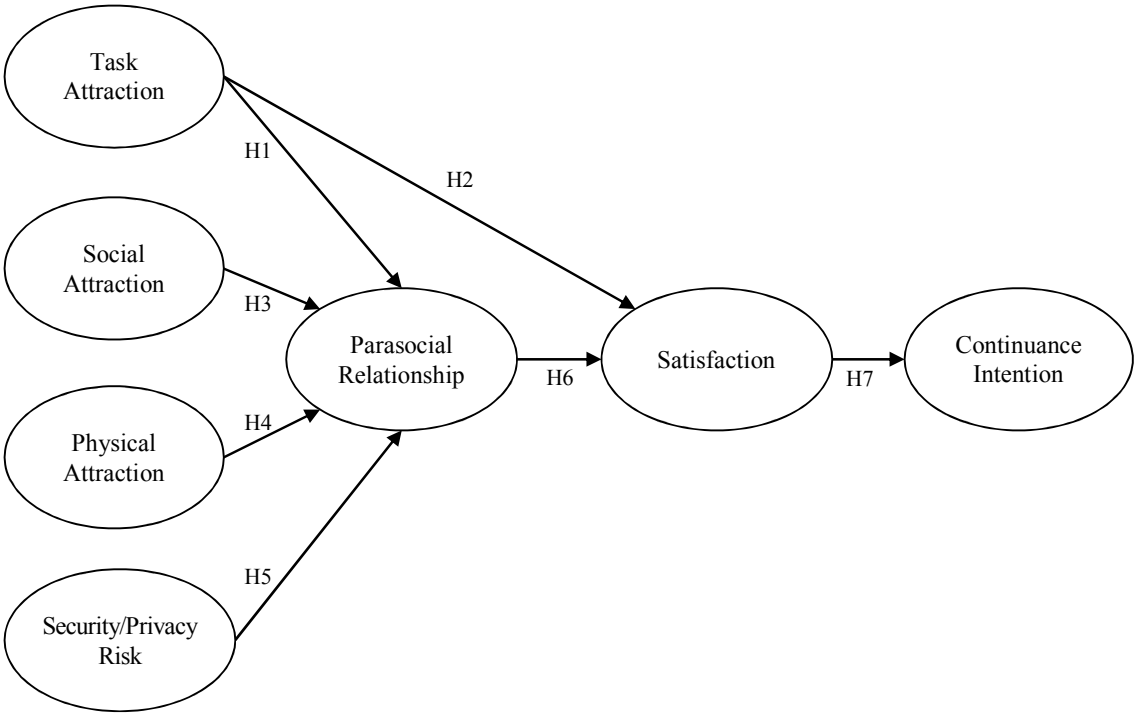

Figure 1 Research model

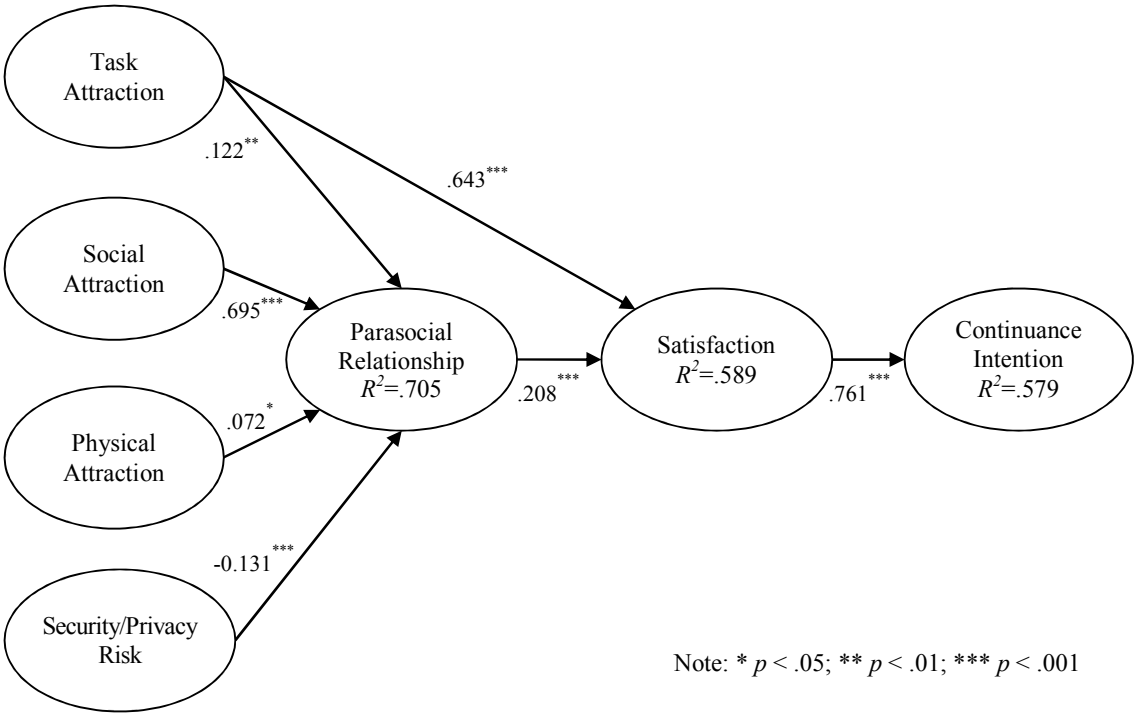

Figure 2 PLS results of the structural model