



VCA as partners or servants? The effects of information sensitivity and anthropomorphism roles on privacy concerns

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ARTICLE INFO

Keywords:

Information sensitivity
Anthropomorphism roles
Competence-based trust
Integrity-based trust
Privacy concerns

ABSTRACT

Advances in machine learning and natural language processing have driven the growing popularity of virtual conversational agents (VCAs). This anthropomorphic communication approach relies on user information sharing and real-time feedback from VCAs, and has raised privacy concerns while affecting various social interactions and relationships. Previous research on reducing user privacy concerns has mainly focused on user information mining, sensitive user information requests and privacy policies, while little is known about the anthropomorphic roles of partners and servants at the human-machine social hierarchy level. Therefore, this study, based on human-computer interaction (service) anthropomorphism at social level, develops a framework to investigate the impact of information sensitivity and VCAs' anthropomorphic roles, including partner and servant, on users' privacy concerns, as well as the mediating effects of competence- and integrity-based trust. The results show that when highly sensitive information is requested, user privacy concerns are greater for a partner VCA than a servant VCA, and vice-versa. Meanwhile, when a VCA requests highly sensitive information, integrity-based trust mediates the relationship between servant VCAs and privacy concerns, and when a VCA requests low-sensitivity information, competence-based trust mediates the same relationship. These insights provide actionable implications for managers.

1. Introduction

Virtual conversational agents (VCAs) are described as natural language user interfaces that connect data and services via text or voice, allowing users to ask questions or give commands in their everyday language and receive responses or services in a conversational manner (Ponathil et al., 2020). As the need for continuous dialogue and complex task execution becomes more pressing, VCA technology is evolving from understanding language to predicting user intent, and their mode of operation is shifting from a command-and-control focus (I ask, you answer) to continuous dialogue and solving of complex tasks (Aw et al., 2022). The main categories are currently chatbots and conversational artificial intelligences (VCAs). Among them, chatbots are software applications designed to engage in human-like conversations with users through text simulation. They use natural language processing to

understand incoming queries and respond accordingly. Most chatbots are based on logical rules, which means they are trained to answer only a specific set of questions. VCAs, integrate artificial intelligence, natural language processing, and machine learning, to make traditional bots more intelligent and capable of more human-like conversations than traditional chatbots. Conversational AI can provide users with a more personalized experience through smoother, smarter conversations that better interpret human language, and provide more personalized two-way user interaction capabilities to meet the growing expectations of modern customers. At the same time, conversational AI can guess the user's hidden meanings with a high probability and give more accurate suggestions with less information than traditional chatbots. Therefore, the VCAs in this paper fall under the category of conversational AI. The most popular and most exposed VCAs include Apple Siri, Amazon Alexa, Microsoft Cortana, Google Assistant and Samsung Bixby, which help

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<https://doi.org/10.1016/j.techfore.2023.122560>

Received 5 June 2022; Received in revised form 6 February 2023; Accepted 1 April 2023

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users, especially mobile users, perform personalized tasks and services using voice or text commands. These technologies have proven to be effective in reducing the load on the user's processing tasks while increasing the efficiency of task completion during continuous iterative updates (Liang and Huang, 2000; Xu and Wang, 2006a, 2006b). However, while VCAs bring a lot of convenience to people's lives, they collect and store a lot of private user information to improve product performance and meet users' personalization needs, which raises serious privacy concerns (Balapour et al., 2020).

Most previous research on reducing consumer privacy concerns has been along the lines of "by reducing the mining of user information or reducing requests for sensitive user information" (Smith et al., 2011), but access to user privacy information, especially sensitive information, is a prerequisite for product iteration and for providing personalized solutions to customers (Tseng et al., 2022; Xiong and Zuo, 2022). Therefore, the above strategy does not match the trend of VCAs' development (Ameen et al., 2022). There are few studies on how to improve users' perceived security when performing interactive tasks using VCAs from a privacy policy perspective (Guo et al., 2021). However, the effective completion of the interaction task between VCAs and users relies heavily on information sharing by users and real-time feedback from VCAs. Therefore, the reduction of privacy concerns cannot rely on policies alone, and needs to focus on information properties too. In view of this, this paper argues that when VCAs perform tasks, especially personalization tasks, they divide the information they request from users into two categories: high-sensitivity information and low-sensitivity information. Meanwhile, with the development of artificial intelligence technology, anthropomorphism is increasingly used by companies as an effective communication tool for customer service interactions, marketing, finance, education, and health services.

"Anthropomorphism" is an interesting phenomenon in the development of human language, which refers to the process of giving human characteristics to non-living objects so that they are perceived as living beings (Qiu and Benbasat, 2009). The VCAs were given an anthropomorphic interface and a humanized virtual agent with a name by their developers. This humanized virtual agent can engage in a natural and fluid dialogue with the user using human voice and emotion, and is perceived to be "smart, friendly, witty, and humorous," thus encouraging the user to communicate more with it. In this scenario, the binary relationship formed between users and VCAs is usually identified as a quasi-social relationship (Chen et al., 2017). On the one hand, anthropomorphic communication can bring consumers closer to the company and make them feel more favorable toward the company. On the other hand, anthropomorphic communication makes consumers treat the company with the same attitude and standards as they do for people, and may generate more skepticism. At the same time, since relationships between people can be classified according to the degree of intimacy as relatives, friends, strangers, enemies, etc., similarly, a wide variety of relationship types can be formed between individuals and VCAs. However, previous research has mostly explored anthropomorphism vs. non-anthropomorphism (Chen et al., 2020; Golossenko et al., 2020), robot vs. human (Mende et al., 2019; Sheehan et al., 2020), human vs. object (Aggarwal and McGill, 2007; Hudson et al., 2016), etc., with less focus on partner vs. servant anthropomorphic roles at the level of human-computer social hierarchy. In existing marketing and messaging practices, the anthropomorphic partner and servant roles of VCAs are increasingly used in practical activities such as branding, product, advertising, and online communication. For example, "Ronald McDonald," as the corporate spokesperson, is called the "McDonald's Chief Happiness Officer" and "children's best friend." "Three Squirrels" always addresses consumers as "masters," making users feel like they are respected. Therefore, this paper focuses on human-computer interaction (service) anthropomorphism at the social level, classifies VCAs into partner and servant anthropomorphisms according to their hierarchical relationship with users, analyzes the impact of their interaction with information sensitivity (high vs. low) on privacy concerns, and explores

the mediation mechanism of the interaction path.

The research contributions focus on the following points. First, this study divides VCAs' anthropomorphic roles into partner and servant, which enriches the research on the effect of VCAs' anthropomorphic roles on privacy concerns. Second, this paper illustrates the impact of different types of VCAs on users' privacy concerns when requesting information of different sensitivities from them. Third, this paper reveals the mechanism of the interaction effect of information sensitivity (high vs. low) and the anthropomorphic role of VCAs (partner vs. servant) on privacy concerns and verifies the mediating role of competence-based trust and integrity-based trust.

2. Theoretical background and literature review

2.1. Information sensitivity

The term "privacy" is commonly found in law, philosophy, psychology, sociology, and information science. However, there is no broad consensus among scholars as to what exactly privacy is. A review of the existing literature reveals five main definitions of privacy, as follows: (1) General privacy as a right. Privacy itself is seen as an intrinsic right, especially as a "right not to be disturbed" (Rubinfeld, 1989); (2) Privacy as a commodity. A commodity-based definition of privacy is one in which users trade their personal information as an intangible asset (Xu and Gupta, 2009). Some scholars consider privacy not only as an important right of individuals (Acquisti et al., 2016), but also as an intermediate or final commodity (Farrell, 2012); (3) General privacy as a state. Privacy can also be seen as a state that enables autonomy – a concept closely related to personality. Westin (1968) defined privacy through four states: solitude, intimacy, anonymity, and retention; (4) General privacy as control of information. One of the most prominent theories on privacy is the personal information control theory. For example, Westin (1968) considers privacy as "selective control of self-access", while Flaherty (1989) explicitly presents the idea of privacy as information control and develops "data protection" as an aspect of privacy. This concept laid the foundation for Fair Information Practice (FIP). Similarly, Acquisti et al. (2016) argues that privacy is not the antithesis of sharing, but rather the control of sharing; (5) Privacy as a collective norm. Shaeffer and Keever (2021) argue that personal data is not valuable in isolation and only becomes more valuable when combined with information about what others do, say, and like. Big data aggregated from personal data are not individual property but should be considered as collective norms. Therefore, they propose to redefine personal data from a collective perspective. The definition of privacy in this paper draws on the fourth definition above. That is, privacy as control of information. In other words, privacy in this paper is information privacy, which is consistent with the discussion of Bélanger and Crossler (2011) and Smith et al. (2011).

It has been shown that users' privacy decisions are highly scenario-dependent, especially when privacy preferences are uncertain. When users' privacy preferences are uncertain, they usually reduce their perception of risk by looking for external cues and internal controls (Acquisti et al., 2015). Specifically, in this paper, in the face of VCAs integrated with big data, information sensitivity is an important factor that affects users' uncertainty regarding decisions (Wirth et al., 2019). Based on the above analysis, we begin our literature review by discussing various definitions of information sensitivity, the measurement of information sensitivity and the degree to which information sensitivity has been considered from different perspectives (see Table 1).

The results show that there is no precise definition of information sensitivity in previous studies. Among existing definitions, the connotations vary widely, including the degree of concern about a certain type of data (Sheehan and Hoy, 2000), the perceived intimacy of information (Lwin et al., 2007), a cognitive process (Bansal and Gefen, 2010), the potential loss (Mothersbaugh et al., 2012) or negative consequences of information leakage (Wirth et al., 2019), and signals of personal

Table 1
Previous research about information sensitivity.

Definition of perceived information sensitivity	Measurement solely by types of information	Measurement through scale	Information sensitivity for the original owner	Information sensitivity for the co-owner	Author(s) and year of publication
N/A	√	×	√	×	Culnan, 1993
the level of privacy concerns an individual feels for a type of data in a specific situation	√	×	√	×	Sheehan and Hoy, 2000
N/A	√	×	√	×	Malhotra et al., 2004
N/A	×	√	√	×	Xie et al., 2006
the perceived intimacy level of information	√	×	√	×	Lwin et al., 2007
N/A	×	√	√	√	Johnson, 2008
N/A	√	×	√	×	Al-Natour et al., 2009
a cognition process in which a person evaluates health information from the perspective of its possible positive and negative outcomes-and its related disutility of privacy concern	×	√	√	×	Bansal and Gefen, 2010
N/A	√	×	√	×	Smith et al., 2011
the level of discomfort perceived by an individual when disclosing a specific type of information to a website	√	×	√	×	Li et al., 2011
evaluation of potential losses when disclosing information	√	×	√	×	Kehr et al., 2013
N/A	×	√	√	×	Sutanto et al., 2013
personally identifiable be considered	×	√	√	×	Milne et al., 2017
the degree to which a person feels personal information, if shared, can cause harm	×	√	√	×	Markos et al., 2018
N/A	√	×	√	×	Ha et al., 2021
Information sensitivity can be understood as the degree to which a person feels personal information, if shared, can cause harm		√	√	×	This study

identification (Milne et al., 2017). Additionally, when selecting information sensitivity measures, some studies equate information sensitivity directly with the type of information and designate certain categories of information as high (vs. low) sensitivity through intuitive perception. That is, equating information sensitivity with the type of information. They argue that although the type of information may vary across situations and cultures, the perception of certain specific information is consistent, such as financial and medical information (Culnan, 1993; Lwin et al., 2007; Malhotra et al., 2004; Sheehan and Hoy, 2000; Smith et al., 2011). However, other scholars have suggested that users' perception of information sensitivity is highly context-dependent. Therefore, privacy sensitivity needs to be measured according to the specific context of the study to manipulate it more accurately and thus reflect consumers' perceptions of information (Acquisti et al., 2015; Wirth et al., 2019). Meanwhile, previous studies on perceived information sensitivity have mostly taken the perspective of the original owner, and less consideration has been given to the co-owner (Johnson, 2008; Wirth et al., 2019). Finally, users' perceived sensitivity to information has a significant effect on both their privacy concerns and privacy disclosure intentions/behaviors, but this has not been a consistent conclusion in previous studies. Some scholars argue that consumers are usually more hesitant to share information of higher sensitivity in the same scenario (Degirmenci, 2020). This is because they fear that their sensitive information will be leaked or used twice, thus bringing potential risks and losses to them. Adding to this, users are faced with VCAs that are highly integrated with big data analytics technologies and have a much lower sense of control over the disclosed information during their interactions with them (Schomakers et al., 2019; Wirth et al., 2019). However, it has also been shown that consumers' willingness to disclose information and privacy concerns during human-computer interaction can be manipulated (Smith et al., 2011).

According to the above analysis, this paper draws on Mothersbaugh et al. (2012) and Wirth et al. (2019) to argue that information sensitivity is the control of access to information or knowledge that might result in the loss of an advantage or level of security if disclosed to others. In addition, we draw on Hui et al. (2007), Sutanto et al. (2013), Milne et al. (2017) and Markos' classification of privacy sensitivity (high vs. low)

and combine it with the research scenario of this paper, inviting subjects to respond anonymously to 24 categories of personal information that VCAs may collect from users, and using hierarchical cluster analysis to classify the different sensitivity levels of the above information, thus providing theoretical and practical guidance for the selection of information sensitivity indicators in this paper. Finally, this study explores the impact of the interaction effect of information sensitivity (high vs. low) and anthropomorphic role (partner vs. servant) on privacy concerns, and further explore the mediating mechanisms of the impact pathways.

2.2. Anthropomorphized roles of VCAs

We reviewed previous studies in terms of anthropomorphic research, constitutive dimensions of anthropomorphism, and anthropomorphic role categories (Table 2).

The results show that, first, previous studies on anthropomorphic characters have addressed multiple subjects, such as nature (Tam, 2015), tourist destinations (Kwak et al., 2020), animals (Kim and Yoon, 2021), machines (Kim and McGill, 2011), advertising (McQuarrie and Phillips, 2011; Puzakova and Kwak, 2021; Touré-Tillery and McGill, 2015), websites (Sivaramakrishnan et al., 2007), time (May and Monga, 2014), money (Zhou et al., 2019), products (Aggarwal and McGill, 2007; F. Chen et al., 2020; Hur et al., 2015), and brands (Aggarwal and McGill, 2012; Fournier and Alvarez, 2012; Golossenko et al., 2020). Among them, the most discussed ones are about product and brand anthropomorphism, while other subjects are less analyzed. The study of anthropomorphism in the field of services is also a topic that has emerged only in recent years (Choi et al., 2021; Croes and Antheunis, 2021; S. Y. Kim et al., 2019; Mende et al., 2019; Schuetzler et al., 2018; Wonseok et al., 2021). Second, in terms of the expression of anthropomorphism, it can be mainly divided into the external/ internal/social level of anthropomorphism. Among them, the external level is the most intuitive as the anthropomorphic image usually makes a product or brand have human facial features or an overall human appearance (Aggarwal and McGill, 2007). However, anthropomorphism in appearance alone does not satisfy the needs of users who are looking for a deeper experience;

Table 2
Previous research about anthropomorphized.

Author(s) and year of publication	Research subjects	Anthropomorphism of the external level	Anthropomorphism of the inner level	Anthropomorphism of the social level	Categories
Aggarwal and McGill, 2007	Products	√	×	×	Human vs. Object
Sivaramakrishnan et al., 2007	Websites	×	×	√	AIA vs. No AIA
Chandler and Schwarz, 2010	Products	√	√	×	Anthropomorphism vs. Object vs. Control
Landwehr et al., 2011	Products	√	×	×	Friendly vs. Aggressive
McQuarrie and Phillips, 2011	Advertisements	×	√	×	Alive vs. Inanimate
Aggarwal and McGill, 2012	Brands	×	√	×	Anthropomorphism vs. Object Partner vs. Servant
Fournier and Alvarez, 2012	Brands	×	×	×	Warmth vs. Competency
Puzakova et al., 2013	Brands	×	√	√	Anthropomorphism vs. Non-anthropomorphized
May and Monga, 2014	Time	×	√	×	Low time Anthropomorphism vs. High time Anthropomorphism
Hur et al., 2015	Products	√	×	×	Anthropomorphized vs. Control (No anthropomorphism)
Kim and Kramer, 2015	Brands	×	√	√	Partner vs. Servant
Tam, 2015	Environmental	×	√	×	Anthropomorphic vs. Non-anthropomorphic
Touré-Tillery and McGill, 2015	Advertisements	×	×	√	Anthropomorphized vs. Human
Hudson et al., 2016	Brands	√	×	×	Human vs. Object
Chen et al., 2017	Brands	×	√	×	Anthropomorphism: yes vs. no
Kwak et al., 2017	Brands	×	×	√	Anthropomorphized vs. Non-anthropomorphized
Mourey et al., 2017	Products	√	×	×	Anthropomorphic vs. Non-anthropomorphic
Puzakova and Kwak, 2017	Brands	×	×	√	Anthropomorphized vs. Non-anthropomorphized
Wen Wan et al., 2017	Products	√	×	×	Anthropomorphism vs. Non-anthropomorphism
Maeng and Aggarwal, 2018	Products	√	×	×	face width-to-height ratio: high or low
Puzakova and Aggarwal, 2018	Brands	×	×	√	Anthropomorphized vs. Non-anthropomorphized
Schuetzler et al., 2018	Service	√	×	√	Embodied vs. Unembodied
Kim et al., 2019	Service	√	√	×	Warmth vs. Competency
Mende et al., 2019	Service	√	√	×	Robot vs. Human
Yuan and Dennis, 2019	Products	√	√	×	Anthropomorphism with visual/auditory features: yes vs. no
Zhou et al., 2019	Money	×	√	×	Anthropomorphism: present vs. control
Chen et al., 2020	Products	×	√	×	Anthropomorphizing vs. not anthropomorphizing
Golossenko et al., 2020	Brands				Anthropomorphized vs. Non-anthropomorphized
Herak et al., 2020	Products	√	√	×	Object vs. Person
Huang et al., 2020	Products	×	×	√	Anthropomorphism vs. Non- Anthropomorphism
Kwak et al., 2020	Tourist destination	×	√	√	Anthropomorphized vs. Non-anthropomorphized
Sheehan et al., 2020	Service	√	√	√	Human vs. chatbot
Choi et al., 2021	Service	√	√	×	Humanoid vs. Non-humanoid
Crolic et al., 2021	Service	√	√	√	Anthropomorphic treatment: higher or lower
Kim and Yoon, 2021	Animal	√	√	×	Anthropomorphism vs. Non- Anthropomorphism
Puzakova and Kwak, 2021	Advertisements	√	√	√	Collective-anthropomorphized vs. Solo anthropomorphized
Weihrauch and Huang, 2021	Products	√	√	√	Human-as-machine vs. Human
Wonseok et al., 2021	Service	×	×	×	Human umpires vs. Humanized robot umpires

therefore, anthropomorphic characters that focus on the internal level have emerged. For internal level anthropomorphic roles, brand personality is an important component, which can be expressed as anthropomorphic emotions that can be perceived by users (Marin et al., 2006). Later, with the rapid development of social media and natural

language processing, social virtual assistants focusing on interactive communication gradually became popular. This social anthropomorphism allows for a dialogue with the consumer in the tone of a virtual character, which can create a better social connection with the user and enhance the sense of social relationship, and it can also improve the

perceived helpfulness of anthropomorphic products (Schweitzer et al., 2019). In addition, Nass et al. (1997) indicated that developers adding female voices to electronic devices can make people feel weak, while using male voices can make users feel more persuasive and influential. These ideas were entertained to further support personalization efforts in the design and building of subsequent versions of intelligent agents and systems (Xu and Wang, 2006a, 2006b).

Combined with Table 2, it can be concluded that previous studies have discussed more anthropomorphic roles at the exogenous and intrinsic levels, while paying relatively little attention to anthropomorphism at the social level. Finally, an analysis of the classification of anthropomorphic roles reveals that existing studies mostly classify them as anthropomorphic and nonanthropomorphic, robot and human or humanoid (vs. nonhumanoid), but focus less on partner-type and servant-type anthropomorphic roles at the human-machine social hierarchy level. To assist users' decision-making practices, VCAs are frequently designed by developers as various types of virtual personas to create a psychological distance between the VCA and the users. For example, Newman (2014) also discusses how Apple Siri provides social support to users and becomes an autistic boy's "best friend forever."³ of an autistic boy. These applications of anthropomorphizing in practice provide support for the argument that users reflect anthropomorphized versus objectified VCAs differently for different roles or characteristics. In this paper, we focus on human-computer interaction (service) anthropomorphism at the social level, and classify VCAs into partner anthropomorphism and servant anthropomorphism according to the hierarchical relationship between them and users. In terms of concept, the term "partner" has been used in past studies to refer to the coproducer of benefit. The relationship between partners is equal, and the synonyms are "co-worker" and "teammate." The term "servant" refers to the outsourced provider of the benefit, a person who has a low status, is at the disposal of the master, has no personal freedom and economic rights, and performs odd jobs. In modern society, "servant" more often refers to a nanny, maid, assistant, etc., who is economically dependent on the employer, but has a certain freedom in other areas (Aggarwal and McGill, 2012; Kim and Kramer, 2015).

In terms of interest relations, in a partnership, partners are coproducers of interests, they work together on an activity and share the results, and their interests are relatively independent (Aggarwal and McGill, 2012). Although both partners cooperate for a common goal, when it comes to the distribution of benefits, there may be a competitive relationship, and there may even be actions that undermine the relationship for the sake of personal benefit. In the master-servant relationship, on the other hand, the servant is the creator of the master's or employer's interests, and it is controlled as well as possessed by the master. The relationship between master and servant is one of subordination and dependence in terms of interest. The servant's remuneration comes from the master and is determined by the master, and only when the master benefits does the servant receive the corresponding benefit (Fournier and Alvarez, 2012). Therefore, to some extent, the master and the servant are considered as a "community of interests", and the relationship between the two parties takes the form of "all gains and losses" (Srinivas, 1995). In terms of social status, Gruenfeld et al. (2008) argue that the relationship between two entities often involves different social classes. For example, one individual is equal to the other, or one individual can control the other (Gruenfeld et al., 2008). The former refers to a partnership, while the latter refers to a master-servant relationship. VCAs, as partners, gain equality by co-creating benefits with consumers. However, the master-servant relationship is like the model of the relationship between a high power person and a low power person (Rucker et al., 2012). The servant is low status and low power, and the master believes that he or she naturally possesses and controls his or her servant (Srinivas, 1995). In terms of the interaction model between the anthropomorphic persona and the user, consumers tend to behave in the opposite way to their favorite servant brand. That is, to leave matter in the hands of the favorite servant brand with confidence. If consumers do

not like the servant brand, they display behavior consistent with that brand and say "I can do these things without you" (Aggarwal and McGill, 2012; Kim and Kramer, 2015).

Therefore, this paper considers partner anthropomorphism to mean that users and VCAs are equal and independent of each other in terms of status. They are co-producers, working together on a task and sharing the results. However, when it comes to a conflict of interest, there may be competition or even betrayal. Servant anthropomorphism denotes a master-servant relationship between the user and the VCAs; the VCAs are the user's servants and are controlled and possessed by them, and they are a close community of interest. Accordingly, no matter the circumstance, the servant VCAs will not betray the user.

2.3. Competence and integrity-based trust

In the virtual environment of human-computer interaction, trust is the most important relationship between the user and the product, and it guarantees an excellent interaction task performance (McKnight et al., 1998). According to Rousseau et al. (1998), trust is a psychological state comprising the intention to accept vulnerability based on positive expectations of the intentions or behaviors of another. That is, trust is composed of beliefs and intentions. On this basis, McKnight et al. (1998) divided trust into two aspects: trusting intention and trusting beliefs. The former is the consumer's confidence that a subject such as a product, brand, or machine can accomplish an interactive task from a technical level and is referred to as competence-based trust; the latter is the user's perception that a subject has moral qualities such as integrity, benevolence, and honesty and is referred to as integrity-based trust (Kim et al., 2004). Gefen and Straub (2004) and Connelly et al. (2018) propose that competency-based trust can also be understood as the willingness of users to achieve a certain goal by relying on more recognized partners whom they have confidence in. In this process, the user trusts that the other party can solve a certain type of problem and that the two are independent and equal partners. Integrity-based trust is more oriented toward the assessment of moral quality. It can be understood as trusting subjects in that they will not violate the agency relationship between them for personal gain, much less betray each other. In this paper, previous research has verified that disclosing information of different sensitivities (high vs. low) triggers different levels of privacy concerns for users, and different types of intelligent virtual assistants (partners vs. servants) also bring different interaction experiences to users. Based on this, we draw on previous classifications of trust, that is, competence- and integrity-based trust to explore the mediating mechanisms through which the interaction of information sensitivity and anthropomorphic roles of VCAs affects users' privacy concerns.

3. Hypothesis development and research model

Advances in machine learning and Natural Language Processing (NLP) are driving the rapid spread of VCAs, which rely on their superior learning capabilities and rapid feedback mechanisms to have a profound impact on individual cognition, interpersonal interactions, trust relationships, and potential social structures (Yu et al., 2020; Xiao and Kumar, 2021). Many retail stores have introduced VCAs into their workflows to make customer engagement more interesting and engaging. In the field of information management and marketing, previous research has focused on machine anthropomorphism (e.g., robots, drones, and smart devices) and brand/product anthropomorphism (Golossenko et al., 2020; Kwak et al., 2017; Lee et al., 2021; MacInnis and Folkes, 2017; Puzakova and Kwak, 2017; Sheehan et al., 2020). Aggarwal and McGill (2007) found that anthropomorphism enhances consumers' perceived fluency, which in turn helps to improve consumers' perceived attitudes toward brands and products, thereby enabling a significant increase in their perceived competence. Furthermore, 'the most prominent role of the introduction of anthropomorphism into brands and products lies in the establishment of a social

connection between the brand and the consumer, which can be used to promote consumer preference and dependence on the brand. This individual-brand relationship can be referred to as a partnership or a friendly relationship (Qiu and Benbasat, 2009). Building on this, Aggarwal and McGill (2012) found that, in addition to partnerships that co-create benefits but are equal and independent of each other, there is also a master-servant relationship that is subordinate and dependent. This relationship is characterized by the servant being the facilitator of the master's or employer's interests, being controlled as well as possessed by the master, and the relationship of interest between the two parties being one of prosperity and loss, respectively, for the master and the servant (Aggarwal and McGill, 2012). For example, when brands are anthropomorphized, materialists prefer servant brands over partner brands, and this preference is mediated by materialists' desire to control servant brands (Kim and Kramer, 2015). This suggests that different anthropomorphic roles (partner vs. servant) assigned to products based on AI technology significantly affect consumers' cognitive attitudes and decisions.

However, while VCAs have brought great convenience and a rich sense of experience to people's lives, the way they possess, analyze, and use customers' personal information has also raised privacy concerns for consumers (Bawack et al., 2021). According to the communication privacy management theory, privacy boundaries exist on a scale from completely open to completely closed. When users share their private information with others, a shared boundary is formed between users and others around the shared privacy information, and this boundary relationship is moderated by the way information is shared, as well as the sensitivity of the information (Baruh et al., 2017; Dadgar and Joshi, 2018). Specifically, in this study, the relationship between users and VCAs is more of a human-computer interaction based on technology, and they continuously establish boundary rules through information sharing and real-time feedback. As a corollary, when users disclose information to VCAs, a boundary connection is formed between users and VCAs, and the strength of this boundary connection depends largely on the sensitivity of the disclosed information.

Based on the above analysis, we argue that both anthropomorphic roles and information sensitivity have a significant impact on users' behavioral decisions during their interactions with VCAs. When the sensitivity of information requested by VCAs is high, users will develop a higher level of vigilance. This is because in the internet era users can easily learn about many examples of serious consequences of personal information leakage, which can result in consumers making negative assumptions about VCAs. However, users are forced to disclose more information to achieve the desired goal of obtaining personalized services or convenience. At this point, they tend to choose servant VCAs with a lower social status to form a community of interest. This is because, for users, the individuals in a partnership are independent and cooperative. Good cooperation can be achieved when both parties in the partnership share common goals. However, when the interests of the two diverge, there is a high possibility of a competitive relationship or even betrayal by the other party. In contrast, the master-servant relationship is one of subordination and dependence, forming a community of interest. The servant VCAs are rewarded only when the user's goal is achieved. Therefore, servant VCAs will not sabotage themselves and disclose private information, which is more conducive to the security of private information. Conversely, when VCAs request information with low sensitivity, users are less concerned about such information and have lower wariness. They are more concerned about the achievement of the target task and tend to align their behavior with their preferred "partner" and value the competence of the partner more. Compared to servant VCAs, partner VCAs bring a more obvious perception of competence to users. Therefore, it is easier to open boundaries to partner anthropomorphic VCAs to facilitate the achievement of common goals. We propose the following hypothesis:

H1: The interaction between information sensitivity of VCAs requests (high vs. low) and anthropomorphic roles (partner vs. servant) has a

significant impact on privacy concerns.

H1a: When a VCA requests highly sensitive information, user privacy concerns will be greater with a partner VCA compared to a servant VCA.

H1b: When a VCA requests low-sensitivity information, user privacy concerns will be greater with a servant VCA compared to a partner VCA.

The stereotype content model states that individuals' perceptions and evaluations of others revolve around two dimensions: "enthusiasm" and "competence." The "enthusiasm" dimension answers the question of the likelihood that others will convey goodwill to them; the "competence" dimension refers to the ability of others to carry out their intentions (Cuddy et al., 2008). When a brand or product is given the qualities of cooperation, sincerity, trustworthiness, and friendliness, it embodies the anthropomorphic role of "enthusiasm"; conversely, when a brand or product is given the qualities of strong execution or high skill level, it embodies the anthropomorphic role of "competence" (Kolbl et al., 2019).

It is inferred that when the information requested by VCAs is more sensitive, users have higher vigilance toward information disclosure. This is because, on the one hand, the disclosure of information may bring potential risks and cause greater losses to them; on the other hand, the frequent exposure of spam, malicious marketing, and online fraud caused by privacy leakage has intensified users' concern about privacy leakage. In this situation, users tend to choose sincere and trustworthy servant VCAs that can be possessed and controlled by them, to protect their privacy more strongly. And, users have higher moral trust in servant VCAs than in partner VCAs, thus reducing their concern about privacy information. This is because, in the master-servant relationship, the servant is the creator of the master's or employer's interests and is controlled as well as possessed by the master. The master-servant relationship is one of subordination and dependence in terms of interests. The servant's remuneration is derived from the master and determined by the master (Fournier and Alvarez, 2012). At the same time, in the master-servant relationship, the user is self-centered and demands that VCAs listen to and satisfy his or her individual needs. In this context, there is a "community of interest" between the master and servant, and the servant's attitude toward the master becomes more loyal and trustworthy due to their interests being interlinked. In this case, users have a higher moral trust in servant VCAs than in partner VCAs, which reduces their concern about privacy information (Kim and Kramer, 2015).

Conversely, when VCAs request information with lower sensitivity, users have lower levels of wariness about information disclosure. In this case, their concern focuses mainly on whether the target task can be achieved or whether the operational efficiency can be improved. Users are more in need of a competent VCA to assist them in their work, and thus will choose partner VCAs who are perceived to be efficient, intelligent, and skillful. Previous research has shown that consumers identify with the partner role and construct an idea of partners as "people like themselves." Consumers are more willing to work with or follow the advice of a partner brand (Aggarwal and McGill, 2012). Consumers may have higher confidence in the partner brand's capabilities than the servant brand, and expect the partner brand to be able to accomplish the task at a technical level, which is a sign of trust (Ha et al., 2021). At this point, users have higher trust in the competence of partner VCAs compared to servant VCAs, which helps to reduce their concerns about privacy information. We propose the following hypothesis:

H2: There is a significant interaction between information sensitivity of VCAs' requests (high vs. low) and anthropomorphic personas (partner vs. servant) on privacy concerns, and this interaction effect is mediated by consumers' trust in VCAs.

H2a: When a VCA requests highly sensitive information, integrity-based trust mediates the relationship between servant VCAs and privacy concerns.

H2b: When a VCA requests low-sensitivity information, competence-based trust mediates the relationship between servant VCAs and privacy concerns.

In summary, the theoretical model of this paper is shown in Fig. 1.

We adopt an experimental approach to test the validity of the above model’s assumptions. The step-by-step process is as follows (Fig. 2.)

4. Pilot studies

4.1. Pretest 1: personal information requested in survey

Before the formal experiments began, we measured the sensitivity (high vs. low) of user information, drawing on Hui et al. (2007), Sutanto et al. (2013), Milne et al. (2017) and Markos et al. (2018) for the specific manipulation. First, we identified several popular VCAs with many users, filtered and aggregated the information requested during their interactions with users, and finally identified 24 items of personal information. Second, we invited 120 MBA students from a university in China and asked them to give a score to this information based on their sensitivity to it. The scores were based on a seven-point Likert scale, with higher scores indicating higher sensitivity to the information. A total of 120 questionnaires were distributed in this survey, and 102 valid questionnaires were returned. In this paper, hierarchical cluster analysis was used to classify the different sensitivity levels of user information. The results showed that the 24 personal information items of users were classified into five categories (see Fig. 3). Among them, very sensitive information included passport number, current address, accounts stored on the device, phone number, photo album, and network access record. Sensitive information was divided into online shopping record, call recording, and camera. Neutral information included microphone, audio, phone state, location information, calendar events, contacts and e-mail address. Insensitive information included body sensors, age, Bluetooth and device information, and very insensitive information included highest education achieved, gender, favorite attractions types and preferred food. Based on the classification, combined with the research content of this paper, we regard passport number, current address, and phone number as highly sensitive information, and gender, favorite attractions types, and preferred food as low-sensitive information.

4.2. Pretest 2: anthropomorphic roles

In VCA scenarios, anthropomorphism is generally expressed by addressing the user with words that indicate a relationship, such as “dear friend” or “dear master” (Xie et al., 2020). First, in order to maximize the scenario of using VCAs and to facilitate the presentation of their interface with users, subjects were asked to fill out a questionnaire on their cell phones. The manipulation of the formal experiment uses a virtual communication assistant called Small U, which can exclude the influence of factors such as consumer trust, brand, and inherent perceptions of the existing app on the willingness to disclose privacy (Bansal et al., 2016). In addition, this virtual communication assistant integrates artificial intelligence, natural language processing and machine learning to make traditional chatbots more intelligent and capable

of more human-like conversations. As a result, it provides a more personalized experience for users through smoother and smarter conversations. Secondly, this study combined Kim and Kramer (2015) to manipulate the anthropomorphic roles of VCAs through the following eight scenarios (Appendix A). This can be divided into four forms: anthropomorphic role (partner vs. servant) × information sensitivity (high vs. low). In this study, we invited 60 MBA students from a university in China, and divided them into 2 groups (30 in each group). The subjects in the first group were asked to read the dialogues in Appendix A (Fig. A1-A4) and then answer the question “To what extent do you agree that the other person is your servant?” The subjects in the other group were shown the dialogues in Appendix A (Fig. A5–8) and answered “to what extent do you agree that the other person is your equal partner?” Both questions were measured on a seven-point Likert scale (1 = “strongly disagree,” and 7 = “strongly agree.”). The results of the study are as follows:

First, we use the passport number as a high-sensitivity information item and the gender as a low-sensitivity information item. The results of the manipulation test are as follows: there is a significant difference ($P = 0.000$) between VCAs requesting the user’s passport number and addressing them as “dear friend...” ($M = 2.53, SD = 1.167, F(3,116) = 136.267$) and VCAs requesting the same information but addressing them as “Dear master...” in the conversation ($M = 6.13, SD = 0.819, F(3,116) = 136.267$). There is a significant difference ($P = 0.000$) between VCA requests for the user’s gender and addressing them as “dear friend...” ($M = 2.47, SD = 0.937, F(3,116) = 136.267$) and VCA requests for the same information but addressing them as “Dear master...” in the conversation ($M = 6.03, SD = 0.928, F(3,116) = 136.267$). Second, to check the stability of the results, we used the cell phone number and the current address as high-sensitivity information, and the favorite attractions types and preferred food as low-sensitivity information. The results show that there is a significant difference ($P = 0.000$) between VCAs requesting the user’s cell phone number and the current address and addressing him/her as “dear friend...” ($M = 6.00, SD = 0.983, F(3,116) = 162.165$) and VCAs requesting the same information but addressing them as “Dear master...” in the conversation ($M = 2.40, SD = 0.968, F(3,116) = 162.165$). There is a significant difference ($P = 0.000$) between VCA requests for the user’s favorite attractions types and preferred food and addressing them as “Dear friend...” ($M = 6.03, SD = 0.850, F(3,116) = 162.165$) and VCAs requests for the same information but addressing them as “dear master...” in the conversation ($M = 2.20, SD = 0.887, F(3,116) = 162.165$). The results showed that the partner VCAs and servant VCAs were manipulated successfully.

5. Empirical overview

5.1. Study one

5.1.1. Participants and design

In Study 1, we adopted a 2 (high sensitivity information vs. low sensitivity information) × 2 VCA anthropomorphic role (partner vs.

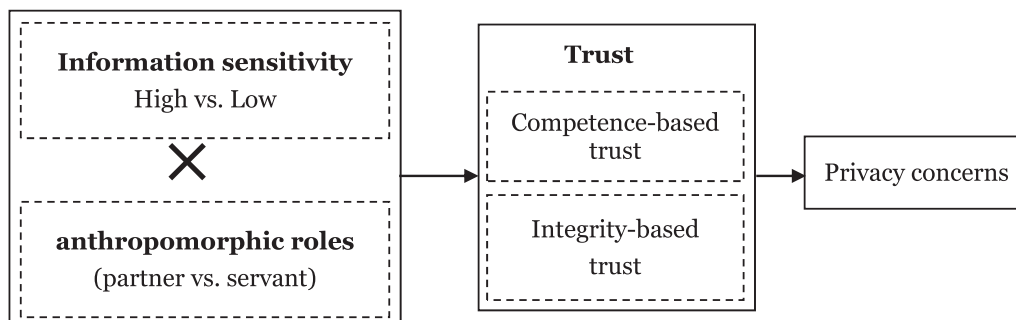


Fig. 1. The theoretical model.

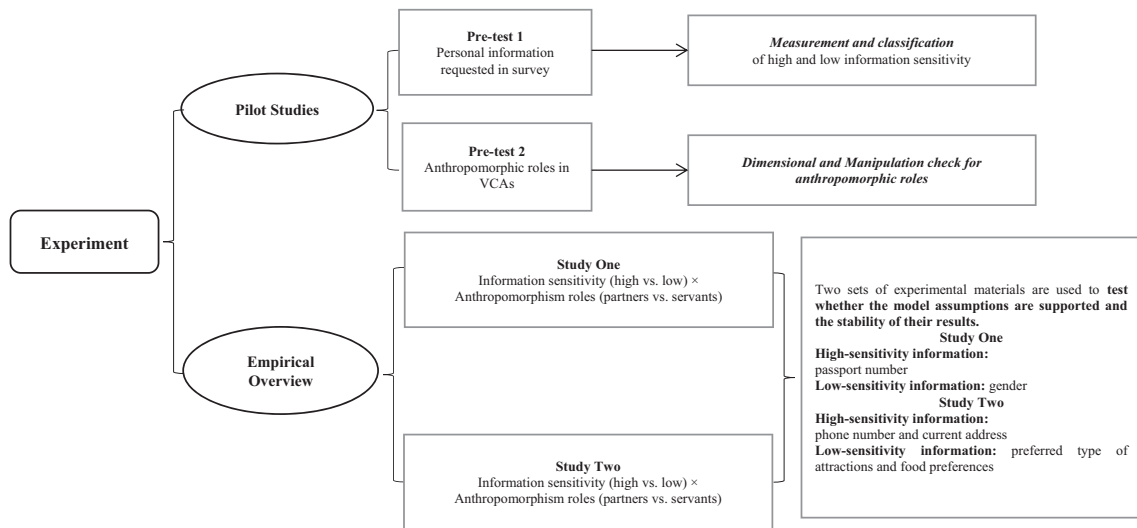


Fig. 2. The experimental procedure.

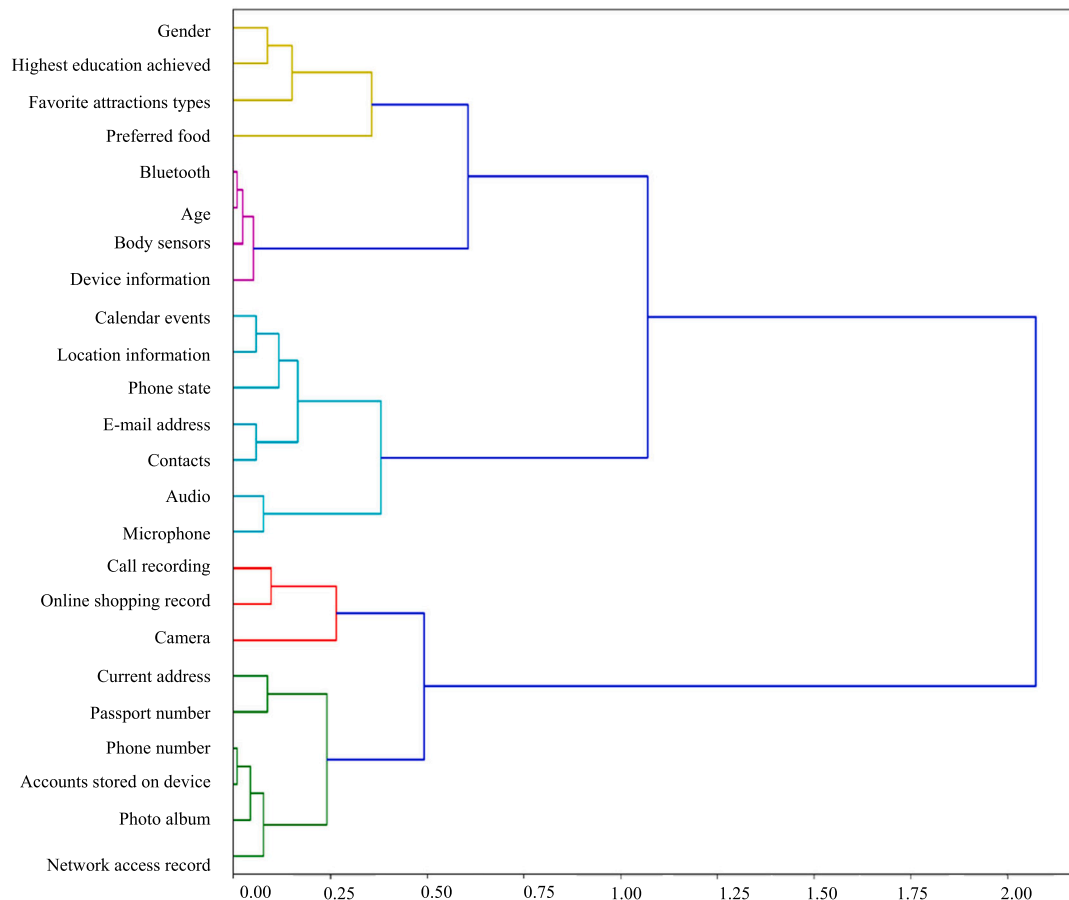


Fig. 3. Clustering of user information sensitivity in the context of VCAs.

servant) between-subjects design and invited 280 students (including MBA students and Ph.D. students) from a university in China to participate in the experiment, and there were 261 valid subjects. Among them, 47.9% were male and 52.1% were female; 42.9% were between 20 and 29 years old and 37.2% were between 30 and 39 years old; 88.1% of the subjects had more than 5 years of Internet experience, and 70.5% of them spent more than 3 h online every day. Additionally, 62.1% of the subjects said they had experienced privacy information being violated.

5.1.2. Procedure

In this experiment, passport number was used as a high-sensitivity information item and gender was considered as low-sensitivity information. The manipulation of anthropomorphic roles drew on the study by Kim and Kramer (2015). To avoid subjects being influenced by existing brand knowledge about the VCAs, and previous experience using them, we used a fictitious VCA called Small U. Before the experiment began, we told each participant to forget their real identity for the

duration of the experiment, and imagine that they were in the following scenario:

You have been sent to Korea on a business trip by your company and will have a free day after the assignment is completed. You are eager to enjoy the local culture, food and famous attractions, but you don't like to make a travel guide. You decide to ask for help from a smart virtual assistant called Small U. Small U can customize a travel guide based on your preferences, habits, and personality, but before that, you need to provide some personal information.

After reading the background material, the subjects were randomly divided into four groups, corresponding to four different scenarios (Figs. 1-4). We asked the subjects to put themselves in the above situation and answer the questions based on how it made them feel.

5.1.3. Measures

To ensure the reliability and validity of the questionnaire, the measures of the constructs in this paper drew on existing research and were modified in the context of specific research scenarios. A seven-level Likert scale was used for the experiment. The higher the score, the higher the subject's approval of the measured items. Specifically, for the measurement of competence-based trust, we drew on Connelly et al. (2018) and; Cui et al. (2018). The items were: "Given the Small U's response, I feel confident about its skill in solving such problems"; "Given the Small U's response, I see no reason to doubt its competence"; "Given the Small U's response, I can rely on it to meet my expectations"; "Given the Small U's response, I believe it is able to avoid repetition of such problems." For the measurement of integrity-based trust, we drew on Connelly et al. (2018) and Cui et al. (2018). The items were: "I believe the Small U's response is honest"; "I believe the Small U's response has a great deal of integrity"; "Judging from the Small U's response, I believe the Small U's response is enthusiastic"; "Judging from the Small U's response, I believe the Small U's response has a good value system." For the measurement of privacy concerns, we drew on Smith et al. (1996), Dinev and Hart (2005), and Jang and Sung (2021). The items were: "I am concerned that the personal information that I provide to the Small U could be misused"; "I am concerned about giving my personal information to the Small U because of what other people might do with it"; "I am concerned about providing my information to the Small U because it may be used in an unpredictable manner"; "I am quiet sensitive about how the Small U handles my personal information" (Dinev and Hart, 2005; Jang and Sung, 2021; Smith et al., 1996). Additionally, for the manipulation of anthropomorphic roles, we drew on Kim and Kramer (2015). Specifically, the measurement items of partner VCAs were: "Given the Small U's response, I feel like it is my partner"; "Given the Small U's response, I feel like we are a mutually independent partnership"; "Given the Small U's response, I think we have equal social status." The measurement items of servant VCAs were: "Given the Small U's response, I feel like it is my servant"; "Given the Small U's response, I feel that we have a master-servant relationship"; "Given the Small U's response, it has a lower social status." Finally, we introduced gender, hours of Internet use, daily Internet market, and privacy invasion experience as control variables because these factors may have an

impact on privacy concerns.

5.1.4. Results

Manipulation check ANOVA was conducted to verify the effectiveness of the anthropomorphic role manipulation. In the contextual dialogues, when Small U requested the user's passport number, there was a significant difference ($P = 0.000$) between the dialogues starting with "Dear friend..." ($M = 5.64$, $SD = 0.608$, $F(3,257) = 332.131$) (Fig.A1) and "Dear master..." ($M = 2.87$, $SD = 0.689$, $F(3,257) = 332.131$) (Fig. A2) in the scores of the question "To what extent does Small U make you think it is a partner of equal status with you." When Small U requested information about the user's gender, there was a significant difference ($P = 0.000$) in the scores for the question "To what extent does Small U make you think it is a servant of lower social status than you" when the conversation began with "Dear friend..." ($M = 3.23$, $SD = 0.555$, $F(3,257) = 332.131$) (Fig.A3) and "Dear master..." ($M = 5.00$, $SD = 0.510$, $F(3,257) = 332.131$) (Fig.A4). The above results reconfirm the successful manipulation of anthropomorphic characters (partner vs. servant).

Hypothesis Test First, ANOVA was used to test H1 (see Fig. 4). The results showed that there was a significant interaction between information sensitivity of VCA requests (high vs. low) and anthropomorphic personas (partner vs. servant) on privacy concerns. When Small U requested the user's passport number, there was a significant difference ($P = 0.000$) between the privacy concerns raised by conversations beginning with "Dear friend..." ($M = 6.20$, $SD = 0.540$, $F(3,257) = 36.956$) and those raised by "Dear master..." ($M = 5.74$, $SD = 0.498$, $F(3,257) = 36.956$). That is, the impact of servant VCAs on consumer privacy concerns decreases significantly when the information sensitivity of VCA requests is higher compared to partner VCAs. When Small U requested information about the user's gender, there was a significant difference ($P = 0.000$) between the privacy concerns raised by addressing the user as "Dear friend..." ($M = 5.15$, $SD = 0.720$, $F(3,257) = 36.956$) and those raised by "Dear master..." ($M = 5.60$, $SD = 0.502$, $F(3,257) = 36.956$). That is, when the information sensitivity of VCA requests is low, the impact of partner VCAs on consumer privacy concerns is significantly lower compared to that of servant VCAs. H1 was supported by the results.

Second, we use the PROCESS written by Hayes (2012) to test the mediating effect (H2). In the first step, the mediation effect of integrity-based trust at high information sensitivity was analyzed. According to the results of the Bootstrap analysis, the interval (BootLLCI = 0.0015, BootULCI = 0.3771) does not contain 0 at a 95 % confidence level when VCAs request higher sensitivity information from consumers, which indicates that integrity-based trust currently mediates the relationship between servant VCAs and privacy concerns. Also, the mediating role of competence-based trust at high information sensitivity is verified. According to the results of the Bootstrap analysis, the interval (BootLLCI = -0.0089, BootULCI = 0.1545) contains 0 at a 95 % confidence level when VCAs request information of higher sensitivity from consumers, which indicates that the mediating role of competency trust between servant VCAs and privacy concerns is not significant in this case. In the second step, the mediating effect of competence-based trust at low information sensitivity was analyzed. According to the results of the Bootstrap analysis, the interval (BootLLCI = 0.3388, BootULCI = 0.7556) does not contain 0 at a 95 % confidence level when VCAs request low-sensitivity information from consumers, which indicates that competence-based trust plays a mediating effect between partner VCAs and privacy concerns in this scenario. Also, the mediating role of integrity-based trust at low information sensitivity is verified. According to the results of the Bootstrap analysis, the interval (BootLLCI = -0.1120, BootULCI = 0.0090) contains 0 at a 95 % confidence level when VCAs request information of lower sensitivity from consumers, which indicates that the mediating effect of integrity-based trust between partner VCAs and privacy concerns in this scenario is not significant. These findings support H2.

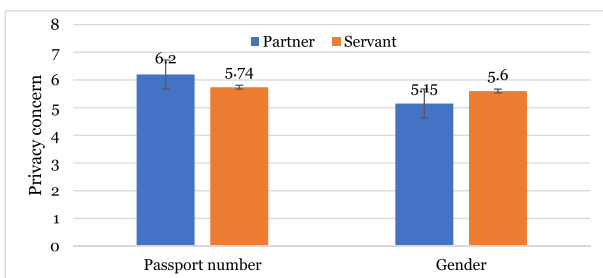


Fig. 4. Analysis of results (Study 1).

Experiment 1 confirmed not only the effect of the interaction between information sensitivity and anthropomorphic roles on privacy concerns (H1) but also the mediating effect of competence and integrity-based trust played in different information sensitivity contexts (H2). However, only passport number and gender were selected as high-sensitivity and low-sensitivity information in the experiment, thus the findings may be subject to some variation. Therefore, to check the robustness of the results, we selected phone number and current address as high-sensitivity information, favorite attraction types, and preferred food as low-sensitivity information, and reconfirmed H1 and H2 through scenario experiments.

5.2. Study two

5.2.1. Participants and design

Experiment 2 adopted a between-subjects design of 2 (high-sensitivity information vs. low-sensitivity information) \times VCAs anthropomorphic role (partner vs. servant) and invited 270 students from a university in China to participate in the experiment, with a total of 254 valid subjects. Among them, 46.9 % were male and 53.1 % were female; 42.5 % were between 20 and 29 years old and 38.9 % were between 30 and 39 years old; 87.8 % of the subjects had more than 5 years of Internet experience, and 71.7 % of them spent more than 3 h online every day. Additionally, 65.4 % of the subjects said they had experienced privacy information being violated.

5.2.2. Procedure

In this experiment, phone number and current address were used as high-sensitivity information, and preferred type of attractions and food preferences were used as low-sensitivity information. The manipulation of anthropomorphic characters and the process design were the same as in Study 1. Subjects were randomly divided into four groups corresponding to four different scenarios (Fig. A5-A8). We asked the subjects to put themselves in the situation and answer the questions based on their real feelings.

5.2.3. Results

Manipulation check ANOVA was conducted to verify the effectiveness of the anthropomorphic role manipulation. In the contextual dialogues, when Small U requested the user's phone number and current address, there was a significant difference ($P = 0.000$) between the dialogues starting with "Dear friend..." ($M = 5.34$, $SD = 0.462$, $F(3,250) = 300.765$) (Fig. A5) and "Dear master..." ($M = 3.02$, $SD = 0.574$, $F(3,250) = 300.765$) (Fig. A6) in the scores of the question "To what extent does Small U make you think it is a partner of equal status with you." When Small U requested information about the user's gender, there was a significant difference ($P = 0.000$) in the scores for the question "To what extent does Small U make you think it is a servant of lower social status than you" when the conversation began with "Dear friend..." ($M = 3.17$, $SD = 0.617$, $F(3,250) = 300.765$) (Fig. A7) and "Dear master..." ($M = 5.21$, $SD = 0.653$, $F(3,250) = 300.765$) (Fig. A8). The above results reconfirm the successful manipulation of

anthropomorphic characters (partner vs. servant).

Hypothesis Test First, an ANOVA was conducted to test H1 (see Fig. 5). The results showed that there was a significant interaction between the information sensitivity of VCA requests (high vs. low) and anthropomorphic roles (partner vs. servant) on privacy concerns. When Small U requested a phone number and current address, there was a significant difference ($P = 0.000$) between the privacy concerns raised by conversations beginning with "Dear Friend..." ($M = 5.83$, $SD = 0.447$, $F(3,250) = 11.187$) and those raised by "Dear Master..." ($M = 5.35$, $SD = 0.693$, $F(3,250) = 11.187$). That is, when the information sensitivity of VCAs' requests is high, the impact of servant VCAs on consumer privacy concerns is significantly lower compared to partner VCAs. When Small U requested preferred type of attractions and food preferences, there was a significant difference ($P = 0.000$) between the privacy concerns raised by conversations beginning with "Dear Friend..." ($M = 5.50$, $SD = 0.610$, $F(3,250) = 11.187$) and those raised by "Dear Master..." ($M = 5.82$, $SD = 0.518$, $F(3,250) = 11.187$). That is, when VCAs request less sensitive information, the impact of partner VCAs on consumer privacy concerns is significantly reduced compared to servant VCAs. Thus, H1 is further reinstated by these findings.

Second, we use the PROCESS written by Andrew F. Hayes (2012) to test the mediating effect (H2). In the first step, the mediating effect of integrity-based trust at high information sensitivity (phone number and current address) is analyzed. According to the Bootstrap analysis, the interval (BootLLCI = 0.5563, BootULCI = 0.9732) does not contain 0 at a 95 % confidence level when VCAs request higher sensitivity information from consumers, which indicates that integrity-based trust mediates the relationship between servant VCAs and privacy concerns in this case. Meanwhile, the mediating role of competency-based trust under high information sensitivity is verified. According to the results of the Bootstrap analysis, the interval (BootLLCI = -0.0121, BootULCI = 0.1572) contains 0 at the 95 % confidence level when VCAs request information of higher sensitivity from consumers, which indicates that the mediating role of competence trust between servant anthropomorphic VCAs and privacy concerns is not significant in this case. In the second step, the mediating effect of competence trust at low information sensitivity (preferred types of attractions and food preferences) was analyzed. According to the results of the Bootstrap analysis, the interval (BootLLCI = 0.3836, BootULCI = 0.6395) does not contain 0 at a 95 % confidence level when VCAs request low-sensitivity information from consumers, which indicates that competence-based trust plays a mediating effect between partner VCAs and privacy concerns in this scenario. Also, the mediating role of integrity-based trust at low information sensitivity is verified. According to the results of the Bootstrap analysis, the interval (BootLLCI = -0.0475, BootULCI = 0.0875) contains 0 at a 95 % confidence level when VCAs request information of lower sensitivity from consumers, which indicates that the mediating effect of integrity-based trust between partner VCAs and privacy concerns in this scenario is not significant. Hence, H2 is further reinforced.

6. Discussion and implications

VCAs based on consumer data sharing and implemented using AI technologies such as machine learning and NLP have raised user concerns about privacy information while reducing costs for businesses, improving their operational efficiency, and having a profound impact on human relationships. At the same time, anthropomorphic VCAs with different roles (partner vs. servant) assigned by the developers and different sensitivity levels of information collection also result in contrasting privacy perception experiences for the users. This demonstrates that there are boundary conditions between the different roles (partner vs. servant), and the privacy attributes of anthropomorphic VCAs in the process of interacting with users' privacy information. Based on the above research background, this paper manipulates the level of information sensitivity and anthropomorphic type through two pre-experiments (pre-test 1 and pre-test 2) from the perspective of

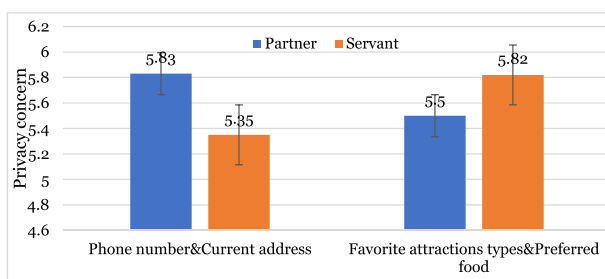


Fig. 5. Analysis of results (Study 2).

consumers' psychological needs. Then, the interaction effects of information sensitivity and anthropomorphic role on consumers' privacy concerns are explored through two formal experiments, and the mediating effects of competence-based trust and integrity-based trust are analyzed.

First, in pre-test 1, we used Hierarchical cluster analysis to classify users' perceived levels of sensitivity to VCAs' access to their information into five categories. Based on the classification, combined with the research content of this paper, we regard passport number, current address, and phone number as highly sensitive information, and gender, favorite attraction types and preferred food as low-sensitive information. In addition, we simulate a scenario that is realistic and consistent with the research question of this paper. A virtual communication agent called Small U was used after an iterative process, which can exclude the influence of privacy concerns due to factors such as consumers' trust in existing VCAs, brand reputation and inherent perceptions (Bansal et al., 2016). Meanwhile, in pre-test 2, we combined the study of Kim and Kramer (2015) to manipulate the anthropomorphic roles (partner vs. servant) of VCAs through eight different scenarios (Appendix A). This can be divided into four specific forms: anthropomorphic role (partner vs. servant) \times information sensitivity (high vs. low). The measurement of users' perceived sensitivity to VCAs' access to their different privacy information based on the study scenarios makes up for the gap in previous studies that empirically designate a category as high or low sensitivity information without investigation, which is also consistent with the discussion of information sensitivity in Acquisti et al. (2015) and Wirth et al. (2019).

Besides, previous studies have discussed more anthropomorphic roles at the external and internal levels, while paying relatively little attention to anthropomorphism at the social level. Moreover, several studies classify anthropomorphic types as anthropomorphic vs. non-anthropomorphic, robot vs. human, or humanoid vs. nonhumanoid, and focus less on companion and servant anthropomorphic roles at the human-computer social hierarchy level, which is inconsistent with the trend of anthropomorphic VCAs development. This is not in line with the trend of anthropomorphic VCAs, because in the process of VCAs assisting users' decision-making practices, developers design anthropomorphic VCAs with a variety of anthropomorphic interfaces (avatars), anthropomorphic characters, and simulated human voices and emotions to engage in natural dialogues with users. This allows users to perceive them as "smart, friendly, witty, and humorous" while bringing them closer to each other. For example, Newman (2014) also discusses how Apple Siri provides social support to users and becomes the "best friend forever" of a boy with autism. These applications of anthropomorphizing in practice provide support for the argument that users reflect anthropomorphized versus objectified VCAs differently for different roles or characteristics.

Second, the interaction between information sensitivity and anthropomorphic roles has a significant effect on users' privacy concerns. Specifically, when a VCA requests highly sensitive information, user privacy concerns will be greater with a partner VCA compared to a servant VCA; when a VCA requests low-sensitivity information, user privacy concerns will be greater with a servant VCA compared to a partner VCA. Partners are often considered to be the coproducer of benefit. Partners are equals in the relationship, and their synonyms are "collaborators" and "teammates". In a partnership, partners are coproducers of benefits. They work together on an activity and share the results, and their interests are relatively independent of each other. Although both partners cooperate for the common goal, when it comes to the distribution of benefits, there may be competition, and even the relationship may be sacrificed for the sake of personal benefit. The term "servant" refers to the outsourced provider of the benefit, a person who is of low status, at the disposal of the master, without personal freedom and economic rights, and performing odd jobs. In the master-servant relationship, the servant is the creator of the master's or employer's interests, and is controlled and possessed by the master.

The relationship between master and servant is one of subordination and dependence in terms of interests. The servant's remuneration is provided by, and determined by the master. Therefore, to a certain extent, the master and servant can be considered as a "community of interest". Therefore, when the sensitivity of information requested by VCAs is high, it will lead to a high level of caution among users. This is because, in the era of rapid information dissemination on the Internet, users are easily exposed to many examples of the serious consequences of personal information leakage, which can easily trigger consumers to think negatively about VCAs. However, users are forced to disclose more information to obtain personalized services or convenience to achieve their desired goals. At this point, they will tend to choose servant VCAs with a lower social status to form a community of interest. Conversely, when VCAs are less sensitive to information requests, they are more concerned with achieving their goals and tend to align their behavior with their preferred "partners" and value the capabilities of their partners more. Compared with servant VCAs, partner VCAs are perceived as having more abilities by users, and hence they are more likely to open toward partner anthropomorphic VCAs, to facilitate the achievement of their common goals.

Finally, this paper validates the mediating effects of competence-based trust and integrity-based trust. When a VCA requests highly sensitive information, integrity-based trust mediates between servant VCAs and privacy concerns, whereas, when a VCA requests low-sensitivity information, competence-based trust mediates between servant VCAs and privacy concerns. This is because, in the context of high-sensitivity information, the user is concerned about task realization and privacy concerns at the same time. In this case, they need a role that can be controlled by themselves, and servant VCAs show more loyalty and trustworthiness due to the characteristics of the master-servant relationship and the association of interests. Therefore, users will have a higher level of moral trust in servant VCAs, which reduces their privacy concerns. Conversely, in the context of low-sensitivity information, users are less sensitive to the information itself. Their concern is mainly focused on whether the target task can be achieved or whether the operational efficiency can be improved. In this case, users need competent VCAs to assist them in their work. This is because partner VCAs are perceived to be efficient, intelligent, and skilled, which leads to a higher level of trust in their capabilities and reduces privacy concerns.

6.1. Theoretical contribution

First, we consider the application of VCAs of different anthropomorphic roles (partner vs. servant) in privacy concern studies at the level of social hierarchy and human-computer interaction, which enriches the study of anthropomorphic roles in privacy contexts. Previous studies on anthropomorphic roles have mainly focused on anthropomorphic products and brands, leaving other subjects less analyzed, and anthropomorphism in the service field is a topic that has only emerged in recent years. Next, in terms of the expression of anthropomorphism, it can be mainly divided into the external (Aggarwal and McGill, 2007), internal (Chandler and Schwarz, 2010; Landwehr et al., 2011) and the social level of anthropomorphism (Schuetzler et al., 2018; Weihrach and Huang, 2021; Wonseok et al., 2021). Among them, previous studies have discussed anthropomorphic roles at the external and internal levels, while relatively little attention has been paid to them at the social level. Also, an analysis of the classification of anthropomorphic roles reveals that previous research has mostly explored anthropomorphism vs. non-anthropomorphism, robot vs. human, human vs. object, etc., and has focused less on partner vs. servant anthropomorphic roles at the level of human-computer social hierarchy. Therefore, this paper focuses on human-computer interaction (service) anthropomorphism at the social level and classifies VCAs into partner anthropomorphism and servant anthropomorphism according to their hierarchical relationship with users. The results show that the interaction effects of different types

of VCAs' anthropomorphic roles (partner vs. servant) and information sensitivity (high vs. low) have different effects on privacy concerns.

Second, this paper elucidates the mechanisms by which the sensitivity of VCAs to request user information, and the interaction effects of their anthropomorphic roles, impact on privacy concerns. When VCAs request user information, consumers need to process numerous information and form a cognitive system to make decisions in a limited time. When VCAs request information with high sensitivity, users have a high level of caution about information disclosure (Bansal and Gefen, 2010; Milne et al., 2017; Mothersbaugh et al., 2012; Pentina et al., 2016; Rohm and Milne, 2004; Wirth et al., 2019). In this case, users tend to choose servant VCAs that are sincere, trustworthy and can be possessed and controlled by themselves to ensure privacy is not violated. In this case, users have higher moral trust in servant VCAs compared with partner VCAs, thus reducing their concern about privacy information. Conversely, when VCAs request information with lower sensitivity, users have lower levels of wariness about information disclosure. Now, their concern focuses mainly on whether the target task can be achieved or whether the operational efficiency can be improved. A capable VCAs is what users want, therefore, they will choose partner VCAs who feel efficient, intelligent, and skillful. At this point, users have higher trust in the competence of partner VCAs compared to servant VCAs, which helps to reduce their concerns about privacy information. Therefore, this paper explains the mediation process undertaken for competence-based trust and integrity-based trust in anthropomorphic roles, and information sensitivity affecting the level of privacy concern from the perspective of trust.

Finally, this paper builds on the study of the impact of VCAs on user privacy concerns. The rapid increase in the self-learning capabilities of VCAs has far-reaching social and personal implications, affecting personal and professional relationships, interpersonal interactions, trust, and potentially social structures (Chatterjee et al., 2021; Xie et al., 2020). Despite the growing popularity and adoption of VCAs, their increasing connection to people's daily lives and the increasing complexity of task execution inevitably demand higher levels of access to both the depth and breadth of user information, which not only exacerbates users' concerns about private information but also presents new challenges to their privacy and security (Xiao and Kumar, 2021; Yang et al., 2021). Previous studies have identified user perception of information sensitivity as an important issue in virtual environments. When virtual products request information from users with high sensitivity, consumers usually have higher privacy concerns due to uncertainty about whether their information can be effectively secured (Dadgar and Joshi, 2018; Ha et al., 2021; Wu and Jiang, 2019). As a result, virtual products are more cautious in requesting sensitive user information. However, we found that the negative impact of this access to highly sensitive information on consumer privacy concerns can be mitigated. However, although VCAs bring a lot of convenience to people's lives, they collect and store a large amount of user privacy information in order to improve product performance and meet users' personalized needs, which also raises serious privacy concerns. Therefore, the study in this paper examines users' privacy concerns from the perspectives of information sensitivity and anthropomorphic roles, which can provide a possible explanation for the privacy concerns arising from users' use of VCAs to a certain extent.

6.2. Managerial implications

First, this paper provides guidance for developers of VCAs to determine the boundaries of information use and resolve the personalization-privacy paradox. With the development of personalization and virtual agent technologies, consumer data plays a crucial role in both product development and iteration. Within this process, developers of VCAs must be conscious of the issue of user information usage boundaries (Liu and Wang, 2018). That is, the information requested by VCAs must match the needs of the tasks they are trying to perform and avoid over-

requesting that could trigger user concerns about information disclosure. Additionally, for developers of VCAs, it has been a difficult topic to balance the importance of protecting users' private information with the development of personalized services. A little carelessness can lead to "data overstepping," which can lead to privacy concerns and even account cancellation (Gozman and Willcocks, 2019). However, the effective completion of interactive tasks between users and VCAs relies heavily on information sharing by users and real-time feedback from VCAs to achieve high-quality human-computer interaction in a continuous task cycle. An important concept within this process is how developers balance accessing information and reducing user privacy concerns, which is known as the personalized privacy paradox. The personalized privacy paradox refers to the conflict between developers' desire to obtain as much information as possible about users, and their fear of inducing privacy concerns. The research in this paper provides a new perspective to help solve this problem. That is, developers who want to achieve the goal of reducing users' privacy concerns can do so in two ways: (1) Reducing access to sensitive user information, or (2) Designing different anthropomorphic roles to enhance users' trust in the product, both of which can effectively enhance users' intention to disclose privacy information.

Second, this paper guides developers of VCAs to design different types of anthropomorphic roles based on product usage scenarios. When users interact with VCAs, they naturally perceive each other as real people. Previous research has mostly explored anthropomorphism vs. non-anthropomorphism, robot vs. human, human vs. object, etc., arguing that anthropomorphism tends to bring a better experience and more engagement to users. However, the research in this paper shows that the effect of anthropomorphism is not positive in all contexts. The anthropomorphic roles need to be distinguished according to the different scenarios which are applicable (Karpinska-Krakowiak and Eisend, 2021). When VCAs obtain low-sensitivity information, users are more concerned about the security of the disclosed information. In this case, users prefer VCAs to be honest, upright, and warm servants. Such anthropomorphic roles are also more conducive to enhancing users' moral trust in the product and thus reducing their privacy concerns. However, when VCAs obtain low-sensitivity information, users are more concerned about the realization of the task. Currently, users prefer VCAs to be capable, intelligent, and thoughtful partners. Such anthropomorphic roles are also more conducive to enhancing users' trust in the capabilities of the product and thus reducing their privacy concerns.

6.3. Limitations and future research direction

There are some limitations to this study. First, the scenario in this paper is that users are on a business trip to South Korea and want VCAs to provide a "day trip" guide to the local culture. This only explores the privacy concerns of users when service VCAs request different levels of sensitive information during task execution. Second, this study did not consider the subjects' original risk preference level for the use of VCAs, which may affect users' perception of privacy concerns when VCAs access their sensitive information. Third, this study explored the effect of the interaction effect of different roles anthropomorphized by VCAs with information sensitivity on privacy concerns, and did not discuss the combination of different anthropomorphic roles with anthropomorphic types. Fourth, this paper examines users' privacy concerns only from the perspective of the platform without considering the dynamics between the market and the platform (Buganza et al., 2020; Trabucchi et al., 2017, 2020), which to some extent ignores the role played by regulators in the process of accessing user information by the proposed VCAs. Fifth, although the use of experimental methods can exclude many confounding factors, small-sample statistics and scenario-based experiments are not fully consistent with the privacy decisions made by consumers in real-world settings, and the privacy paradox is a special case.

Therefore, future research directions can include the following:

First, future research could consider various other research scenarios. Examples include exploring chatty VCAs that are used to simulate human conversations or chats (Elbot, winner of the “Chatterbox Challenge” in 2001 and 2002); therapeutic VCAs that are used to help patients alleviate personal pain and loss; and *Rep lika* and *Mitsuku*, an advanced friendship VCA that can self-improve by extracting data from ongoing conversations and look like humans, which have their personalities and emotions.

Second, future research could include the effect of users’ original risk preference level on privacy concerns to analyze whether there is a matching effect between users with different risk preference levels and anthropomorphic VCAs types (humanoid vs. nonhumanoid) or roles (warmth vs. competency).

Third, VCAs can generally be divided into three categories: Social VCAs (e.g., virtual anchors, virtual teachers, virtual customer service, etc.), functional VCAs (implanted in APPs or hardware through motion capture technology, AR live technology, etc., to complete the interaction between real people and virtual characters) and companionship VCAs (e.g., virtual pets, virtual partners, virtual idols, etc., to real humans [mainly to produce companionship value]). Different types of VCAs focus on different functions. For example, some VCAs are good at topic maintenance, they will start small talk around a topic and will not be inconsistent; some VCAs are good at knowledge integration, they will quote scriptures during the conversation and insert a lot of life knowledge when replying; and some VCAs are pleasing personality settings, they will make predictions based on the information disclosed by the user and be consistent with their ideas. Ultimately, however, the high-quality realization of the interactive task between VCAs and users relies heavily on the information shared by users and the real-time feedback from VCAs, both of which achieve high-quality human-computer interaction in a continuous task cycle. Therefore, the disclosed data and feedback from users are the basis for VCAs to provide high quality services. Future research can simultaneously explore whether there is a matching effect between anthropomorphic types and anthropomorphic roles, and analyze the tolerance boundaries of users’ information

sensitivity for different types of VCAs in performing diverse tasks and satisfying personalized needs according to their functional settings.

Fourth, in the face of the current situation that platform companies abuse user data to exclude and restrict competitors utilizing data-driven operator concentration and abuse their dominant market position, thus seeking monopoly benefits. Many internet users choose to remain silent because they are “unable to respond” or “respond ineffectively” (Guynn, 2020). It is also difficult for government regulators to reach out to individual sectors for efficient regulation due to the high cost of comprehensive governance of large-scale online platforms. Moreover, the information source of traditional regulation is relatively single, and the efficiency of identifying user information leaked by online platforms is low. Therefore, to solve the contradiction between the limited regulatory resources and the wide range of regulatory objects, and solve the dilemma of “silent governance” of users and “limited governance” of regulatory agencies, future research can build a three-way evolutionary game model among network platforms, users and regulatory agencies. This game model can explore the equilibrium strategy of users’ privacy information leakage on network platforms under the perspective of multiparty co-regulation. Finally, future research can use real data on consumer use of VCAs or crawl data using artificial intelligence techniques to expand the sample size and data quantity, making the findings more generalizable.

Data availability

Data will be made available on request.

Acknowledgements

We are grateful to Prof. Guoquan Zang for supporting this paper with the National Social Science Fund of China (21&ZD338). In addition, Zhuo Sun would like to thank Dr. Yali Wei for her continuous support and tolerance. Stars are love letters from the Milky Way to the Moon you are a gift from the world to me.

Appendix

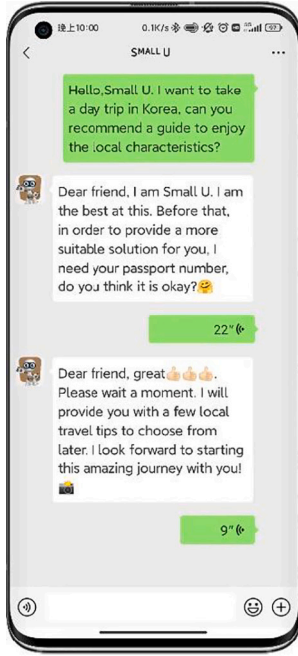


Fig.A1

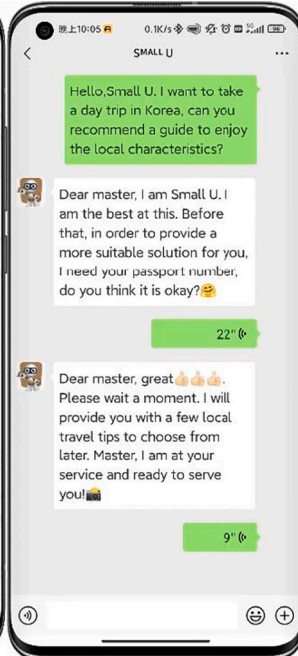


Fig.A2

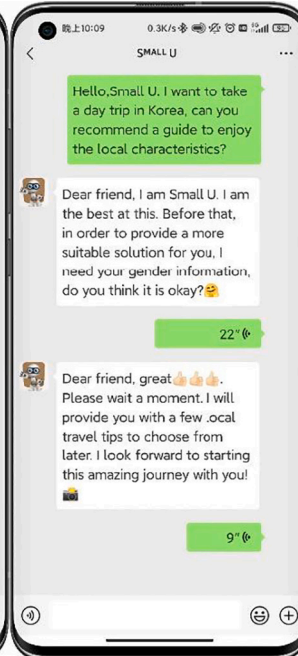


Fig.A3

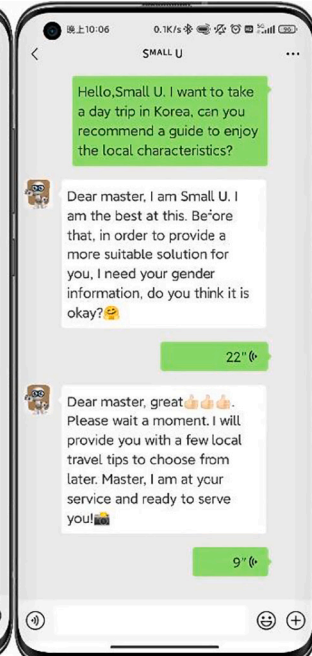


Fig.A4

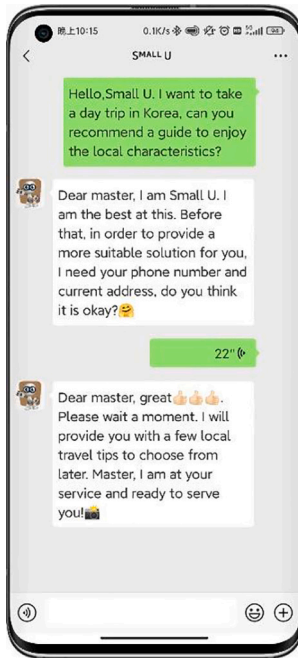


Fig.A5

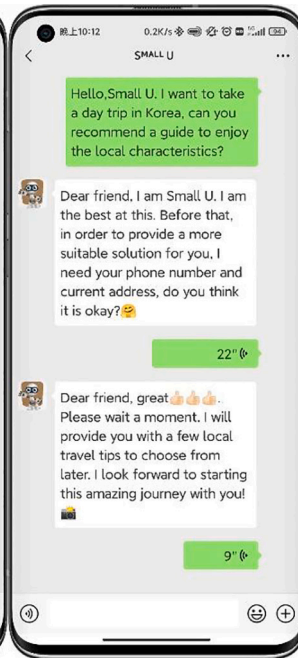


Fig.A6

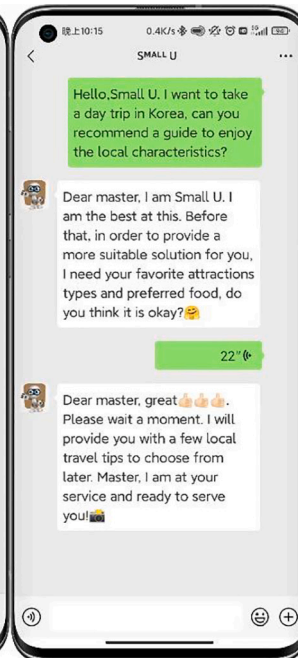


Fig.A7

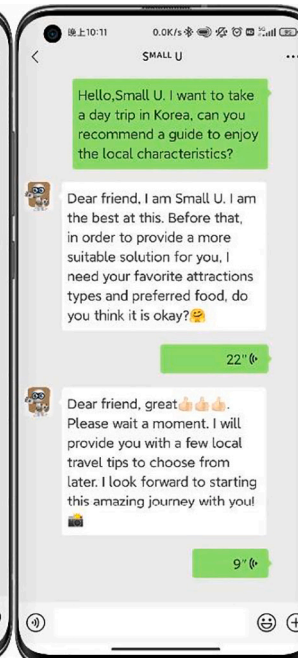


Fig.A8

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