

## Different dimensions of anthropomorphic design cues

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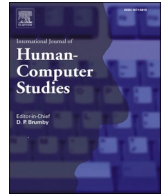
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# Different dimensions of anthropomorphic design cues: How visual appearance and conversational style influence users' information disclosure tendency towards chatbots

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## ABSTRACT

Text-based chatbots are widely used to deliver personalized services by leveraging user-provided information, and anthropomorphic design is crucial for their effectiveness. However, most earlier studies investigated the effects of anthropomorphic design of chatbots while manipulating only one dimension of anthropomorphic cues. The current research investigated how different dimensions of anthropomorphic design cues affect users' information disclosure tendency towards chatbots. That is, the present study examined the effects of visual appearance (high anthropomorphism vs. low anthropomorphism), manipulating the visual cues dimension, and conversational style (human-like vs. mechanical), manipulating the verbal cues dimension, on users' information disclosure tendency towards chatbots. Results showed positive effects of human-like conversational style on users' information disclosure tendency. Of particular significance, an interaction effect between visual appearance and conversational style on users' information disclosure tendency was found. Users reported a higher information disclosure tendency when the chatbot was designed with anthropomorphic cues consistent over dimensions. This finding suggested that an expectancy violation effect occurs when a chatbot exhibits inconsistent anthropomorphic design cues on two different dimensions. Besides, perceived security was identified as a positive mediating factor in the relationship between conversational style and users' information disclosure tendency. This study advances research on users' information disclosure tendency towards anthropomorphic chatbots and highlights the importance of different dimensions of anthropomorphic cues in chatbot design. Additionally, practical guidance for chatbot designers was also provided.

## 1. Introduction

With the ongoing progress of artificial intelligence (AI) technology, chatbots are gradually taking over frontline services and providing smart customer experiences (Bowman et al., 2024; Fan et al., 2023; Følstad and Taylor, 2021; Haugeland et al., 2022; Xie et al., 2024). Typically, chatbots have been widely used to provide personalized recommendations for users in some specific fields including diet options (Balloccu et al., 2021), restaurant recommendations (Kim et al., 2020), and healthy lifestyle coaching (Jin and Eastin, 2024; Piao et al., 2020; Seitz et al., 2022). The Computers Are Social Actors Paradigm (CASA) indicates that people tend to use human social norms and expectations

during the interaction with computers and robots (Nass et al., 1996). Chatbots with anthropomorphic cues (e.g., anthropomorphic visual cues and linguistic cues) could make users feel like they are interacting with human beings and lead to intimate human-chatbot relationships, which may promote users' information disclosure tendency towards chatbots (Konya-Baumbach et al., 2023; Li and Wang, 2023). Therefore, anthropomorphic design plays a crucial role in human-chatbot interaction.

Chatbots with anthropomorphic design cues (e.g., visual appearance and conversational style) enhanced users' personalized service experience (Saraf et al., 2024). However, the personalization-privacy paradox suggests that user data collected during the personalized service

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process may pose privacy security concerns (Zeng et al., 2021). On the one hand, users appreciate personalized services. On the other hand, users also worry about information disclosure risk (Agnihotri and Bhattacharya, 2024; Martin et al., 2017). In practice, users' basic information and sometimes even highly sensitive data are collected during the interaction with chatbots, which may increase users' concerns regarding perceived security and decrease information disclosure tendency. In addition, users' information disclosure data served as the driving force for providing personalized services (Tucker, 2014). Therefore, for the purpose of enhancing personalized user experience, it's imperative to investigate the impact of anthropomorphic design cues on users' information disclosure tendency towards chatbots.

For the anthropomorphic design of chatbots, early research primarily used social cues to increase perceived social presence, which in turn promoted chatbot anthropomorphism (Konya-Baumbach et al., 2023). Based on the taxonomy from Feine et al. (2019), existing studies about anthropomorphic chatbot design primarily focused on two different dimensions: visual cues (Go and Sundar, 2019; Zhang and Patrick, 2023) and verbal cues (Konya-Baumbach et al., 2023; Zogaj et al., 2023). However, most earlier studies investigated the effects of anthropomorphic design of chatbots while manipulating *only one dimension* (visual cues dimension or verbal cues dimension) (Konya-Baumbach et al., 2023; Pawlik, 2022; Roy and Naidoo, 2021; Zhang and Patrick, 2023) and few studies considered *two different dimensions* simultaneously (visual cues dimension and verbal cues dimension). Additionally, earlier research on the influence of anthropomorphic design cues within the same dimension has not found consistent results (Ghazali et al., 2018; Nowak, 2004).

We argue that it is crucial to investigate the effects of anthropomorphic design cues on each of these dimensions, because existing research does not yield a consensus about how anthropomorphic cues within the same dimension affect user perceptions towards chatbots. More importantly, inconsistencies between anthropomorphic cues on the same versus different dimensions may have different effects on user perceptions of the chatbot. That is, earlier research suggested that when anthropomorphic cues on the same dimension are inconsistent, they may give rise to the expectancy violation effect. The expectancy violation effect is a negative evaluation of an object, caused by the user's perception being different from what he or she expected (Burgoon, 1993). Specifically, Go and Sundar (2019) showed that chatbots with high anthropomorphic cues (identity cues manipulating the visual cues dimension) raised users' expectations of the chatbot being human-like, but these expectations were violated when the chatbot also showed low anthropomorphic visual appearance (visual appearances manipulating the visual cues dimension). In other words, inconsistent anthropomorphic cues on the same dimension (visual cues dimension, manipulating identity cues and visual appearances) led to expectancy violation effects. Nevertheless, it is not clear whether such an effect also exists between two different dimensions of anthropomorphic design cues.

To bridge this research gap, the current study conducted a hypothetical scenario-based experiment to investigate the effects of manipulating two different dimensions of anthropomorphic cues (visual appearance and conversational style) on users' information disclosure tendency towards chatbots. Additionally, considering that perceived security is associated with trust being positively related to anthropomorphic design cues (Akalın et al., 2022; Cheng et al., 2022), the present study assumed that chatbots with high anthropomorphic design cues may increase users' perceptions of security, thereby promoting users' information disclosure tendency towards chatbots. Therefore, this study aims to answer the following research questions:

(1) How do anthropomorphic visual appearances and conversational styles in two different dimensions affect users' information disclosure tendency towards the chatbot?

(2) How does perceived security mediate the effects of anthropomorphic visual appearances and conversational styles on users'

information disclosure tendency towards the chatbot?

## 2. Related work

### 2.1. Different dimensions of anthropomorphic design cues

Anthropomorphism refers to a psychological phenomenon of applying human characteristics to a non-human object (Epley et al., 2007), such as chatbots. An effective strategy for anthropomorphizing agents involves incorporating social cues into their design, because when computers exhibit social cues, individuals tend to respond to them in a manner similar to how they would respond to real people (Nass and Moon, 2000). According to earlier research, social cues for conversational agents can be classified into four dimensions: visual cues, verbal cues, auditory cues, and invisible cues (Feine et al., 2019). Of these, anthropomorphic design for chatbots mainly includes two dimensions: visual cues (e.g., visual appearance) and verbal cues (e.g., conversational style) (Kang and Kang, 2023; Konya-Baumbach et al., 2023). The visual cues dimension consists of observable cues that are visually perceptible (except words themselves). Visual cues are identified as anthropomorphic observable cues, as they trigger humanness heuristics in the context of human-computer interaction (Sundar, 2008), leading users to perceive agents (e.g., chatbots) as human beings and interact with them socially (Kim and Sundar, 2012). As a label of humanness, anthropomorphic visual appearance could evoke the user's perception of human nature and allow users to judge chatbots based on human heuristics. Based on the anthropomorphic characteristics, visual appearance can be divided into two different levels: high anthropomorphism and low anthropomorphism (Go and Sundar, 2019).

The verbal cues dimension refers to social cues that are created by words (Feine et al., 2019). Anthropomorphic verbal cues are more likely to be perceived as human-to-human conversations, mainly including emotional expressions at different levels, such as conversational style, topic selection, vocabulary, and speech (Mairesse et al., 2007). As a unique verbal cue in chatbot communication, conversational style is related to the variation in language used in messages and can elicit different social responses (Feine et al., 2019). For example, Chen et al. (2023) demonstrated that anthropomorphic conversational styles (e.g., "how can I help you?") could create a feeling of communicating with people and increase users' perceived satisfaction. The conversational styles of chatbots can be divided into two categories according to the degree of anthropomorphism: human-like styles and mechanical styles. The distinction between them lies in the degree of anthropomorphism reflected in the conversational language (Gnewuch et al., 2018).

In the anthropomorphic design of disembodied agents (e.g., text-based chatbot), visual cues and verbal cues are widely employed to increase users' information disclosure towards chatbots during the interaction (Li and Wang, 2023; Zhang and Patrick, 2023). Visual appearance affects users' social perception of chatbots (Go and Sundar, 2019). Conversational style could significantly influence users' impression of communication with chatbots (Thomas et al., 2018). During the interaction with chatbots, users may primarily focus on what the chatbot looks like (visual appearance) and how the chatbot communicates (conversational style). Therefore, the present study focused on the visual appearance and conversational style. Besides, considering that visual appearance and conversational style belong to two different dimensions of anthropomorphic cues, the impact of these anthropomorphic cues on users' information disclosure towards chatbots might also be different. Additionally, most earlier studies investigated the effects of anthropomorphic design of chatbots while manipulating only one dimension (Konya-Baumbach et al., 2023; Roy and Naidoo, 2021), it remains unclear whether there exists an interaction effect between anthropomorphic visual appearance and conversational style on users' information disclosure tendency towards chatbots.

2.2. Chatbot anthropomorphism in information disclosure tendency

Information disclosure is an act of disclosing personal private information to others (Altman and Taylor, 1973). CASA paradigm suggested that users are more likely to disclose personal information when computers follow the rules of human conversation (Nass et al., 1996). Following rules of human conversation may decrease users' perceived privacy risk and lead to higher information disclosure tendency. Several earlier studies investigated the topic of users' information disclosure (Kang and Kang, 2023; Kang and Kim, 2022). Still, existing research has not reached a consensus about the effect of chatbots on users' information disclosure. Specifically, there are two perspectives on information disclosure towards artificial agents. On the one hand, people are afraid of disclosing themselves to other people due to a fear of negative assessment. Thus, they are more likely to disclose personal information to chatbots (Lucas et al., 2014). On the other hand, chatbots are assumed to be worse than humans in emotional communication, which may negatively influence users' emotional disclosure (Madhavan et al., 2006; Pickard and Roster, 2020).

As anthropomorphic cues of chatbots continue to be exploited, many academic scholars have begun to pay attention to the impact of chatbot anthropomorphism on users' information disclosure (see Table 1 for an

overview). Earlier research suggested that anthropomorphic cues could increase privacy concerns and social anxiety, resulting in less information disclosure during the interaction with agents (Pickard and Roster, 2020). Specifically, Kang and Kang (2023) revealed that users are more conscious of agents with anthropomorphic visual cues, which leads to negative effects on self-disclosure. Further, Pickard et al. (2016) suggested that users prefer to discuss sensitive information with agents rather than humans because agents cannot judge them. Additionally, the presence of anthropomorphic visual cues will decrease users' trust in the agent and further result in less information disclosure during human-agent interaction (Bailenson et al., 2006; Kim et al., 2018).

However, as argued above, some earlier studies also found insignificant or even opposite results. For example, Ho et al. (2018) found that the effect of emotional disclosure was equivalent to whether participants thought they were disclosing to a chatbot or a human. Further, Zhang and Patrick (2023) showed that users tend to disclose more to an agent with anthropomorphic visual cues rather than an agent with robot cues since anthropomorphic cues could induce users' trust and perceived social presence. Besides, Shi et al. (2020) found that people are more willing to disclose personal-related questions to a chatbot that was perceived to have a human identity rather than a bot identity. Therefore, although most studies showed that anthropomorphic cues have a

**Table 1**  
Overview of prior anthropomorphism research on information disclosure.

Authors	Anthropomorphic cues	Dimension type	Measures	Key findings
Cox and Ooi (2022)	Conversational style	Verbal cues	Users' self-disclosure	Chatbots with a formal conversational style may positively promote users' self-disclosure in the context of sensitive health information.
Kang and Kang (2023)	Gender, personality, and visual images	Visual cues and verbal cues	Users' self-disclosure and companionship	Anthropomorphized visual interfaces designed in chatbots exhibited a negative influence on users' self-disclosure and companionship. Besides, interaction effects were found between different combinations of anthropomorphic cues.
Lee and Lee (2023)	Visual images	Visual cues	Self-disclosure, liking, and mind perception	The anthropomorphism of the psychotherapy chatbots' profile picture did not exert a significant influence on users' self-disclosure. However, with the increase in profile picture anthropomorphism, users had more favorable feelings to the psychotherapy chatbot.
Liu et al. (2023)	Name	Visual cues	Users' willingness to self-disclose	Participants were more likely to disclose information in the functional communication context.
Noguchi et al. (2020)	Personality	Visual cues	Ease of Self-disclosure	A social mediator robot may effectively foster self-disclosure among elderly people, especially for topics to which they typically experience resistance in communicating with others.
Pickard et al. (2016)	Visual image	Visual cues	Self-disclosure	Users were more likely to disclose negative and personally sensitive information to embodied conversational agents' interviewers, while positive and less-threatening information was more easily disclosed to human interviewers. No significant difference between the preference for the two interviewer types was observed concerning topics perceived as mildly sensitive or threatening.
Pickard and Roster (2020)	Visual images	Visual cues	Information disclosure	Users were more likely to disclose personal information towards faceless agents rather than humans or agents with human-like faces. Besides, the difference between human and human-like face in users' information disclosure was not significant.
Pizzi et al. (2023)	Visual images	Visual cues	Warmth, competence, trust, and willingness to disclose	The perception of warmth and competence could facilitate consumers' skepticism towards chatbots, which in turn influences consumers' trust and leading their willingness to disclose personal information.
Sah and Peng (2015)	Visual cues and linguistic cues	Visual cues and verbal cues	Social perception, self-awareness, and information disclosure	Anthropomorphic visual cues increased users' public self-awareness, which in turn hindered information disclosure to the website. Anthropomorphic language cues increased users' social perception and facilitated information disclosure to the website. The interaction effect between these two-dimensional cues was not significant.
Stock et al. (2023)	Visual images	Visual cues	Information disclosure	Users were more likely to disclose information to a chatbot with high human likeness compared to a chatbot with low human likeness or without embodiment.
Sundar and Kim (2019)	Visual cues	Visual cues	Intention to disclose personal information	Users trust machine agents over human agents when it comes to disclosing personal information. Users with greater belief in the trustworthiness of machines tend more to disclose to online agents (whether machine or human) than those with lesser belief in machine trustworthiness.
Wang et al. (2024)	Linguistic cues	Verbal cues	Trust, and information disclosure	High anthropomorphic recommendation systems could decrease users' information disclosure tendency.
Zhang and Patrick (2023)	Visual images and social role	Visual cues	Information disclosure tendency, emotional attachment, and satisfaction	Users showed a tendency to disclose more personal information to the human-servant and robot-mentor intelligent agents (IAs) rather than human-mentor and robot-servant IAs.
Zhang and Rau (2022)	Linguistic cues	Verbal cues	Users' self-disclosure, satisfaction, privacy concern, and preference	Social responses could promote users' information disclosure tendency towards anthropomorphic agents.

negative impact on users' information disclosure tendency, there are still studies presenting different points of view.

As noted, earlier studies have not yet drawn similar conclusions on how anthropomorphic chatbots influence users' information disclosure tendency. More importantly, most early studies considered only involved anthropomorphic design cues in one dimension (e.g., visual appearance manipulating of visual cues dimension, or conversational style manipulating of verbal cues dimension), ignoring the possible effects of both visual appearances and conversational styles in different dimensions on users' information disclosure tendency. Although Kang and Kang (2023) investigated the influence of counseling chatbots' anthropomorphic features including conversational behaviors and visual interface on user self-disclosure, conversational behaviors were designed to reflect different personality traits (introversion and extroversion) of anthropomorphic chatbots. It's worth noting that Sah and Peng (2015) explored the effect of two different dimensions of anthropomorphic cues (visual cues and linguistic cues) on users' information disclosure behaviors. However, their focus was specifically directed towards the context of health websites as opposed to an intelligent agent, and the experiment requested participants to complete a questionnaire on the website rather than engage in an interactive conversation. The results revealed that anthropomorphic visual images increased users' public self-awareness, which in turn led to lower information disclosure tendency. However, anthropomorphic language promoted users' information disclosure tendency, and no interaction effect was observed. Although this study made valuable contributions to comprehending the impacts of anthropomorphic cues on users' information disclosure within the context of a health website, the interplay between these anthropomorphic cues on two different dimensions and their influence on users' information disclosure tendency in the realm of human-agent interaction remains unclear.

### 2.3. Perceived security in human-chatbot interaction

The increasing prevalence of chatbots has been accompanied by rising concerns regarding personal information security. Many earlier studies showed that users worry about privacy and perceived security when interacting with chatbots (Følstad et al., 2018; Ischen et al., 2020; Lappeman et al., 2023). Perceived security refers to the subjective probability perceived by users that their personal information will not undergo inappropriate manipulation or exploitation during transmission and storage (Flavián and Guinalfú, 2006). During the interaction with chatbots, users have to provide personal or even highly sensitive information to chatbots in order to obtain a personalized service experience. However, chatbot service delivery is a double-edged sword; some users appreciate the benefits of personalized service, while others show heightened awareness of risks associated with the disclosure of personal information during the interaction with chatbots (Kim et al., 2023). For example, personalized service from chatbots was believed to improve brand loyalty (Ho et al., 2018). Whereas some users were also concerned about the perceived security of their personal information (Lappeman et al., 2023).

In the context of human-robot interaction, the degree of robot anthropomorphism will affect users' perceived security (Akalın et al., 2022). For instance, Haring et al. (2016) indicated that people perceived higher security of anthropomorphic robots in comparison to android robots. The communication ways in human-chatbot interaction mainly include topic-oriented and task-oriented (Haugeland et al., 2022). Chatbots primarily provide functions related to product sales and service provision (Følstad and Skjuve, 2019). During the handling of service requests, chatbots may acquire users' personal information to provide efficient and personalized services. Whereas these personal information might be stored and utilized by chatbots without users' awareness, thereby resulting in a risk of information disclosure (Ischen et al., 2020). Despite anthropomorphic design cues increasing users' trust in chatbots, users are still concerned about the leakage of personal information (Song

et al., 2023). Additionally, few studies investigated the impact of the anthropomorphic design in chatbots on users' perceived security and its subsequent influence on personal information disclosure. Therefore, the present study focuses on two different dimensional anthropomorphic cues (visual appearance and conversational style) and explores the mediating role of perceived security concerning the effect of anthropomorphic design cues in chatbots on users' information disclosure tendency.

## 3. Research model and hypotheses

Drawing upon a comprehensive review of extant literature, the present study proposes a research model that describes the influence of anthropomorphic cues across two different dimensions on users' information disclosure tendency within the realm of human-chatbot interaction. Fig. 1 shows the research model.

### 3.1. Hypotheses for the main and interaction effects

Information disclosure tendency refers to an individual's inclination to reveal personal information to others. In the context of human-chatbot interaction, users may avail themselves of personalized services through the voluntary disclosure of personal information. Earlier research on the effects of anthropomorphic design cues on users' information disclosure tendency primarily reported positive outcomes. That is, chatbots with anthropomorphic cues could induce users' trust and lead to higher information disclosure tendency (Stock et al., 2023; Zhang and Patrick, 2023). However, some earlier studies also yielded adverse outcomes. Specifically, one strand of research indicated that users are more likely to disclose personal information to faceless agents in comparison to agents with human-like faces (Pickard and Roster, 2020). Another body of research posits that highly conspicuous anthropomorphic visual avatars can also reduce users' willingness to disclose information (Kang and Kang, 2023), potentially due to the uncanny valley effect associated with excessively prominent visual features.

Given the absence of sensitive information and the non-utilization of highly conspicuous visual cues within this study, we speculate that chatbots with anthropomorphic cues will positively influence users' information disclosure tendency. Hence, the following hypotheses were proposed.

H1. Participants who interact with chatbots with high anthropomorphic visual appearances (visual cues dimension) will report higher scores on information disclosure tendency than those who interact with chatbots with low anthropomorphic visual appearances.

H2. Participants who interact with chatbots with human-like conversational styles (verbal cues dimension) will report higher scores on information disclosure tendency than those who interact with chatbots with mechanical conversational styles.

Considering that both the visual cues dimension (e.g., visual appearance) and verbal cues dimension (e.g., conversational style) have been shown separately to significantly affect users' impressions of chatbots (Pawlik, 2022; Thomas et al., 2018), it is imperative to explore the interplay of visual appearance and conversational style across different dimensions on users' information disclosure tendency towards the chatbot. Additionally, the expectancy violation effect suggests that high anthropomorphic cues can increase users' expectations of a chatbot. However, these expectations will be violated and even lead to disappointment when the chatbot simultaneously exhibits low anthropomorphic cues (Go and Sundar, 2019). That is, inconsistent anthropomorphic cues on two different dimensions may result in expectancy violation effects. Thus, we hypothesized that:

H3. In the condition of high anthropomorphic visual appearances (vs. low anthropomorphic visual appearances), chatbots with mechanical conversational styles (vs. human-like conversational styles) will elicit participants' lower scores on information disclosure tendency.

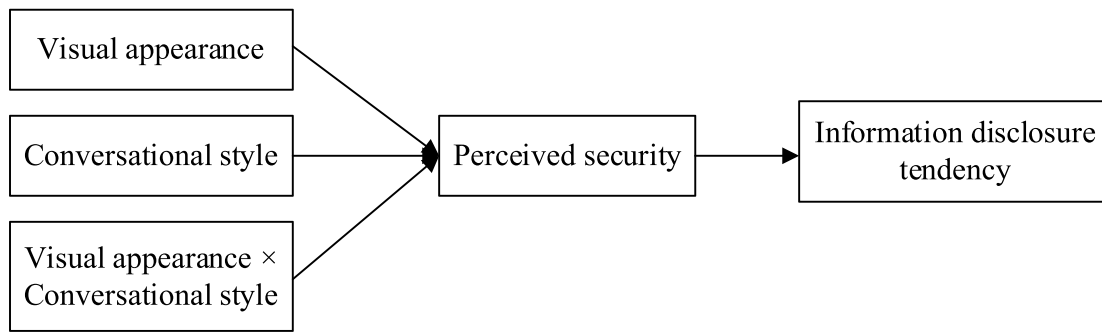


Fig. 1. Research model.

3.2. Hypotheses for the mediating effects

The motivation for users’ information disclosure tendency depends on the risk-benefit calculus (Dinev et al., 2013). According to this theory, positive feelings (e.g., perceived security) induced from social interaction may be viewed as beneficial factors and promote users’ information disclosure tendency (Hallam and Zanella, 2017).

While earlier research has investigated the connection between chatbots with anthropomorphic design cues and users’ information disclosure, there remains a research gap in understanding the mediating effect of perceived security. One perspective might be that anthropomorphic design cues could positively increase users’ trust in the chatbot (Li and Wang, 2023), which may promote users’ personal information disclosure tendency. Another perspective might be that chatbots with anthropomorphic design cues can affect users’ perceived privacy security, which further hinders information disclosure tendency (Zhang and Patrick, 2023). Perceived security, as the users’ perception of the level of danger when interacting with a robot, is often aligned with several common factors investigated in various disciplines including comfort, sense of control, and trust (Akalin et al., 2022). The examination of perceived security in human-robot interaction deserves much attention, given the potential psychological, cognitive, and emotional consequences of interactions. Nyholm et al. (2021) examined users’ perception of security in interactions with humanoid robots, revealing ambivalence among participants who concurrently regarded humanoid robots as reliable and unreliable, safe and unsafe, likable and scary, caring and uncaring. While in the context of human-chatbot interaction, how perceived security influences users’ information disclosure tendency towards anthropomorphic chatbots is still unknown. In light of the potential benefits associated with perceived security, it is conceivable that such factors may promote users’ information disclosure tendency (Hallam and Zanella, 2017). Therefore, we proposed the following hypotheses:

H4. The effect of anthropomorphic visual appearances on users’ information disclosure tendency will be mediated by perceived security.

H5. The effect of human-like conversational styles on users’ information disclosure tendency will be mediated by perceived security.

4. Method

This study conducted a hypothetical scenario-based experiment with the 2 (visual appearance anthropomorphism: high anthropomorphic vs. low anthropomorphic) × 2 (conversational style: human-like vs. mechanical) between-subject experiment. This study was approved by the ethical review board affiliated with the Human-Technology Interaction research group at Eindhoven University of Technology.

4.1. Participants

A priori analysis using G-power 3.1 manifested that a minimum sample size of 231 would be required to detect a large effect size ( $f =$

0.25,  $\alpha = 0.05$ ,  $1 - \beta = 0.90$ ) (Cohen, 1988). A total of 336 participants were recruited from Credamo (<https://www.credamo.com>), a Chinese online survey platform similar to Amazon MTurk (Li and Wang, 2023). Since this experiment required participants to carefully watch a short video and then complete several tasks, the data of those participants who could not pass an attention check during the task or only spent less than 3 min on the experiment were not included in the analysis. Additionally, participants who selected the same response to all questions were also discarded. After the data-cleaning process, 248 valid participants were retained. To eliminate the potential impact of familiarity on the experiment, participants were asked whether they are familiar with chatbot applications in general. The results showed that all participants were familiar with the chatbot application. Table 2 shows all participants’ demographic information for the different conditions. Participants were compensated for an amount equal to 1.5 euros for their voluntary participation.

4.2. Stimuli material

Scenario-based experiments have been widely employed in earlier research, where screenshots or videos can be used as stimuli instead of a live chat (Chung et al., 2020; Li and Wang, 2023). To set up the hypothetical experimental scenario, four different conditions of videos about the conversation between a human and a chatbot were developed in this study. Differences between these videos only involved chatbots’ visual appearance and conversational style. This study followed the approach of manipulating anthropomorphic visual appearances and conversational styles of chatbots used in earlier studies (Araujo, 2018; Chen et al., 2023; Zhang and Patrick, 2023). For the condition of high anthropomorphic visual appearance, the chatbot was represented by a 2D animation to avoid the uncanny valley effect. For the condition of low anthropomorphic visual appearance, a robot appearance was used. To manipulate conversational styles, the chatbot used human-like conversational style to interact with participants employing informal language (e.g., “Hello, I’m your service assistant, what can I do for you? You’re

Table 2 Demographic information of participants.

Demographic information	Specification	Frequency HH HM LH LM				Total
Age in years $M = 31.69$ $SD = 9.18$	Number	62	64	60	62	248
	Male	30	34	32	32	128
	Female	32	30	28	30	120
Educational level	High school or less	6	2	5	1	14
	University	45	56	40	49	190
	Postgraduate	11	6	15	12	44

Notes: HH means high anthropomorphic appearance and human-like conversational style; HM means high anthropomorphic appearance and mechanical conversational style; LH means low anthropomorphic appearance and human-like conversational style; LM means low anthropomorphic appearance and mechanical conversational style.

welcome, come on!”). Or the chatbot used a mechanical conversational style to interact with participants (e.g., “This is a chatbot, conversation starts.”). Two screenshots of these videos are displayed in Fig. 2. Dialogue scripts in two different conversational styles are shown in Table 3.

### 4.3. Pre-study

Before the formal experiment, a pre-study with a sample of 60 participants (ages ranging from 20 to 40,  $M = 30.77$  years old,  $SD = 5.19$ , 30 females) was conducted to check the validity of the manipulation. Half of the participants (30 participants) were tasked with assessing a specific level of visual appearance, followed by the evaluation of a distinct conversational style. Subsequently, the other half assessed another specific level of visual appearance, followed by the evaluation of a different conversational style. To eliminate potential interference, all stimuli pertaining to visual appearance and conversational style were deliberately separated during the evaluation process. For the chatbot appearance check, participants were asked to evaluate the perceived anthropomorphism with items on a 7-point Likert scale from Nowak and Rauh (2005) (e.g., “The chatbot looks very human”, “The chatbot looks very realistic”). The result showed that participants evaluated the chatbot with the high anthropomorphic appearance as more anthropomorphic ( $M = 5.06$ ,  $SD = 1.05$ ) than the chatbot with the low anthropomorphic appearance ( $M = 2.07$ ,  $SD = 0.84$ ), as indicated by a significant  $t$ -test,  $t(58) = 12.19$ ,  $p < 0.001$ . For the chatbot conversational style check, participants were asked to evaluate the perceived anthropomorphism with items on a 5-point Likert scale from Bartneck et al. (2009) (e.g., “The chatbot’s language style is humanlike”). Similarly, results showed that participants evaluated the chatbot with the human-like conversational style as more anthropomorphic ( $M = 4.03$ ,  $SD = 0.61$ ) than the chatbot with the mechanical conversational style ( $M = 2.11$ ,  $SD = 0.72$ ), as indicated by a significant  $t$ -test,  $t(58) = 11.14$ ,  $p < 0.001$ . Results confirmed the successful manipulation of the chatbot’s visual appearance and conversational style.

**Table 3**

Dialogue scripts in human-like conversational style and mechanical conversational style.

Dialogue scripts in human-like style		Dialogue scripts in mechanical style	
User:	Hello!	User:	Hello!
Chatbot:	Hello, I'm your service assistant. What can I do for you?	Chatbot:	This is a chatbot, and the conversation starts.
User:	I felt very upset lately.	User:	I felt very upset lately.
Chatbot:	Can you tell me the problem you encountered? I will provide you with targeted advice.	Chatbot:	Please enter a question.
User:	I often experience insomnia at night.	User:	I often experience insomnia at night.
Chatbot:	Are you feeling upset due to insomnia?	Chatbot:	Question confirmation: insomnia made you upset?
User:	Yes!	User:	Yes!
Chatbot:	You can try mindfulness meditation.	Chatbot:	Mindfulness meditation.
User:	What should I do?	User:	What should I do?
Chatbot:	I can provide you with a simple method. First, find a quiet place to sit and focus attention on your breath. Adjust in time when you notice your mind wandering. It may be boring but practicing this for 10 min daily can be beneficial.	Chatbot:	Find a quiet place to sit and focus attention on your breath. Adjust in time when your mind wanders and aim to practice this for 10 min every day. —From Baidu Encyclopedia.
User:	Ok, I will try. Thank you!	User:	Ok, I will try. Thank you!
Chatbot:	You're welcome. Keep going!	Chatbot:	Conversation closed.

### 4.4. Procedure

After signing an informed consent form, participants were randomly assigned to one of the four conditions and were instructed to review a short conversation video. The conversation involved a person who recently suffered from insomnia chatting with a chatbot, and he or she was told to try mindfulness meditation. Participants were required to imagine they were troubled by insomnia recently and asked a chatbot for help as if they were interacting with the chatbot. To make the effect of the experiment stimuli clear, all participants were instructed to watch the video on a computer rather than a mobile phone with a small screen. After watching the video about human-chatbot interaction, participants were required to answer several questions regarding their perceptions of the chatbot. Finally, they were asked to complete a demographic survey questionnaire, thanked, and debriefed about the study.

### 4.5. Measures

The perceived anthropomorphism of chatbots was measured to check the validity of experimental stimuli. Visual appearance anthropomorphism was measured using three items on a 7-point Likert scale by Nowak and Rauh (2005). Conversational style was measured using four items on a 5-point Likert scale by Bartneck et al. (2009). Anthropomorphism measures were used to ask participants’ perceptions regarding the chatbot’s visual appearance and conversational style. Perceived security was measured using three items on a 7-point Likert scale by Shin and Shin (2011). Information disclosure tendency was measured using ten items on a 7-point Likert scale by Zhang and Patrick (2023) and Joinson et al. (2008). All measured items were evaluated from “strongly disagree = 1” to “strongly agree = 7”. Considering that information disclosure was defined as the voluntary sharing of personal history, preferences, attitudes, feelings, values, secrets, etc., with another person (Griffin, 2006), and the general context of information disclosure in the present study, different dimensional items including basic items (e.g., tastes in music), health-related items (e.g., health information), and sensitive items (e.g., longest relationship) were used to



Fig. 2. Two screenshots of experiment stimuli.

make the measurement of users' information disclosure tendency as comprehensive as possible. Additionally, this method of measuring users' information disclosure tendency can also reduce the impact of a single-dimensional factor on the results.

The validity and reliability of the questionnaire were checked and presented in Appendix A. Cronbach's alpha and composite reliability (CR) of each construct were greater than 0.7, indicating good internal consistency. The factor loadings for each item were greater than 0.7 (except one is 0.69) and the average variance extracted (AVE) scores were all greater than 0.5, further confirming the convergent validity.

## 5. Results

### 5.1. Manipulation check

The same measurement items for chatbots' visual appearance and conversational style as in the pre-study were employed to check the manipulation. For the chatbot appearance check, participants were asked to evaluate the perceived anthropomorphism with items on a 7-point Likert scale from Nowak and Rauh (2005). Results showed that participants evaluated the chatbot with the high anthropomorphic appearance as more anthropomorphic ( $M = 4.34, SD = 1.50$ ) than the chatbot with the low anthropomorphic appearance ( $M = 2.67, SD = 1.12$ ), as indicated by a significant  $t$ -test,  $t(233.33) = 9.92, p < 0.001$ . For the chatbot conversational style check, participants were asked to evaluate the perceived anthropomorphism with items on a 5-point Likert scale from Bartneck et al. (2009). Similarly, results showed that participants evaluated the chatbot with the human-like conversational style as more anthropomorphic ( $M = 4.04, SD = 0.71$ ) than the chatbot with the mechanical conversational style ( $M = 1.99, SD = 0.85$ ), as indicated by a significant  $t$ -test,  $t(240.84) = 20.61, p < 0.001$ . Therefore, the manipulation in this study was successful.

### 5.2. Hypotheses testing

Table 4 summarizes the mean and standard deviations of measured variables in the different conditions. To test the hypotheses, a two-way ANOVA was conducted to test the main effects and interaction effects of anthropomorphic visual appearances and conversational styles on users' information disclosure tendency.

Effects size and statistical power were calculated and reported to provide an evaluation of statistical analyses. The partial eta squared ( $\eta_p^2$ ) was computed using SPSS 25 and subsequently imported into G\*power 3.1 to estimate the statistical power (Faul et al., 2007). All statistical power values exceed 0.8, indicating that this study recruited a sufficient number of participants and achieved robust statistical results (Cohen, 1988).

To test Hypothesis 1 (positive effects of anthropomorphic visual appearances on users' information disclosure tendency) and Hypothesis 2 (positive effects of human-like conversational styles on users' information disclosure tendency), results of two-way ANOVAs showed that the main effect of visual appearances on participants' information disclosure tendency was not significant [ $F(1, 244) = 0.193, p = 0.661, \eta_p^2 = 0.001$ ]. Therefore, Hypothesis 1 was not supported. However, the main effect of conversational styles on participants' information disclosure tendency was significant [ $F(1, 244) = 35.398, p = 0.000, \eta_p^2 = 0.127$ ]. This partial eta squared showed a medium (0.06) to high (0.14) effect size (Cohen, 1988). Participants reported a higher information disclosure tendency towards the chatbot with human-like conversational style ( $M = 5.222, SD = 0.115$ ) than towards the chatbot with mechanical style ( $M = 4.264, SD = 0.113$ ). Thus, Hypothesis 2 was supported.

It is worth noting that the interaction effect between visual appearance and conversational style on participants' information disclosure tendency was significant [ $F(1, 244) = 4.649, p = 0.032, \eta_p^2 = 0.019$ ]. This partial eta squared showed a small (0.01) to medium (0.06) effect size (Cohen, 1988). Fig. 3 shows the visualized interaction pattern. The simple effect of chatbot conversational style indicated that participants reported a higher information disclosure tendency when the chatbot was designed with a human-like conversational style ( $M = 5.360, SD = 0.161$ ) than when the chatbot was designed with mechanical conversational style ( $M = 4.055, SD = 0.158$ ) in the condition of high anthropomorphic visual appearance ( $p = 0.000$ ). Similarly, participants reported a higher information disclosure tendency when the chatbot was designed with a human-like conversational style ( $M = 5.083, SD = 0.164$ ) than when the chatbot was designed with a mechanical conversational style ( $M = 4.473, SD = 0.161$ ) in the condition of low anthropomorphic visual appearance ( $p = 0.008$ ). However, no significant difference was observed in participants' information disclosure tendency towards chatbots with high anthropomorphic visual appearances compared to chatbots with low anthropomorphic visual appearances in the condition of human-like conversational style ( $p = 0.230$ ). Still, a marginally significant result showed that participants reported a higher information disclosure tendency when the chatbot was designed with a low anthropomorphic visual appearance ( $M = 4.473, SD = 0.161$ ) than when the chatbot was designed with a high anthropomorphic visual

appearance (Fig. 3). The interaction effect between visual appearance and conversational style on participants' information disclosure tendency was significant [ $F(1, 244) = 4.649, p = 0.032, \eta_p^2 = 0.019$ ]. This partial eta squared showed a small (0.01) to medium (0.06) effect size (Cohen, 1988). Fig. 3 shows the visualized interaction pattern. The simple effect of chatbot conversational style indicated that participants reported a higher information disclosure tendency when the chatbot was designed with a human-like conversational style ( $M = 5.360, SD = 0.161$ ) than when the chatbot was designed with mechanical conversational style ( $M = 4.055, SD = 0.158$ ) in the condition of high anthropomorphic visual appearance ( $p = 0.000$ ). Similarly, participants reported a higher information disclosure tendency when the chatbot was designed with a human-like conversational style ( $M = 5.083, SD = 0.164$ ) than when the chatbot was designed with a mechanical conversational style ( $M = 4.473, SD = 0.161$ ) in the condition of low anthropomorphic visual appearance ( $p = 0.008$ ). However, no significant difference was observed in participants' information disclosure tendency towards chatbots with high anthropomorphic visual appearances compared to chatbots with low anthropomorphic visual appearances in the condition of human-like conversational style ( $p = 0.230$ ). Still, a marginally significant result showed that participants reported a higher information disclosure tendency when the chatbot was designed with a low anthropomorphic visual appearance ( $M = 4.473, SD = 0.161$ ) than when the chatbot was designed with a high anthropomorphic visual

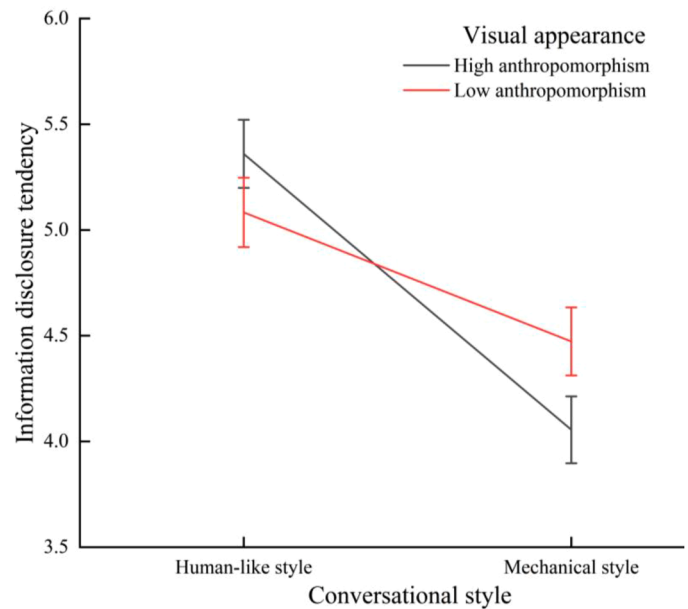


Fig. 3. Interaction effect between visual appearance and conversational style.

Table 4  
Mean and standardized deviations of measured variables in different conditions.

	HH		HM		LH		LM	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Anthropomorphism in visual appearance	4.72	1.46	3.98	1.46	3.08	1.29	2.44	1.07
Human likeness of conversational style	4.10	0.65	2.06	0.92	4.05	0.67	1.93	0.77
Perceived security	4.62	1.49	3.43	1.61	4.55	1.41	3.79	1.57
Information disclosure tendency	5.36	0.91	4.05	1.59	5.08	1.05	4.47	1.39

appearance ( $M = 4.055$ ,  $SD = 0.158$ ) in the condition of mechanical conversational style ( $p = 0.065$ ). Therefore, Hypothesis 3 (in the condition of high anthropomorphic visual appearances (vs. low anthropomorphic visual appearances), chatbots with mechanical conversational styles (vs. human-like conversational styles) will elicit participants' lower scores on information disclosure tendency) was not supported.

Additionally, to test Hypothesis 4 (the effect of anthropomorphic visual appearances on users' information disclosure tendency will be mediated by perceived privacy security) and Hypothesis 5 (the effect of human-like conversational styles on users' information disclosure tendency will be mediated by perceived security), a mediating effect analysis of perceived security was conducted with model 4. A bootstrapping procedure using 5000 bootstrap samples was performed (Hayes, 2017). The results showed that perceived security mediated the effect of conversational style on participants' information disclosure tendency (Table 5), supporting Hypothesis 5. Still, the result provided no evidence in support of Hypothesis 4, as the mediating effect was not significant on visual appearance. It's not surprising that no mediating effect on visual appearance was found given that the present study also did not find the main effect of visual appearances [ $F(1, 244) = 0.540$ ,  $p = 0.463$ ,  $\eta_p^2 = 0.002$ ] on the mediator. In addition, the result of moderated mediation analysis showed that no mediating effect on the interaction effect was observed.

## 6. Discussion

This study investigated how chatbots' anthropomorphic visual appearances and conversational styles affect users' information disclosure tendency. Results showed an interaction effect between the chatbot's visual appearance and conversational style on users' information disclosure tendency. Additionally, this study also found that perceived security mediated the effect of conversational style on users' information disclosure tendency towards the chatbot.

### 6.1. Main and interaction effects on information disclosure tendency

Information disclosure is crucial in the personalized recommendation service of chatbots. The present study found that chatbots with human-like conversational styles can promote users' information disclosure tendency. This result is completely in line with earlier research (Sah and Peng, 2015) which showed that users are more likely to disclose personal information to health websites with human-like verbal cues. Compared to websites with mechanical conversational styles, human-like conversational styles increase users' perception of trust, leading to higher information disclosure tendency. This also aligns with the results from Shi et al. (2020) that human-like chatbots are perceived as competent, confident, and sincere, so users are willing to disclose personal-related questions to chatbots.

However, the effect of chatbots with anthropomorphic visual appearances on users' information disclosure tendency was not significant. This result partly aligns with earlier research suggesting that anthropomorphic visual cues did not yield an increase in users' social perception and behavioral intention towards the chatbot (Go and Sundar, 2019). It seems probable that due to the functional characteristics of

chatbots, users devoted more attention to the conversation task rather than visual appearances during the interaction with chatbots. Hence, although anthropomorphic visual cues increased users' perception of anthropomorphism, they still could not improve users' information disclosure tendency. Contrastingly, existing research also pointed out that chatbots with anthropomorphic visual appearances on the visual cues dimension are more likely to increase users' perception of social presence, trust, and satisfaction (Chen et al., 2023; Qiu and Benbasat, 2009). It is worth noting that both Chen et al. (2023) and Qiu and Benbasat (2009) designed agents with a textual interface and required participants to view the static interface for a specific purpose. Thereby, visual cues may have attracted users' attention and potentially increased perceptions of anthropomorphism. However, the present study showed participants a video of the text-based interaction between a chatbot and a human. Participants might be drawn to the interaction task and pay more attention to the dynamic conversation message rather than the visual cues. We argue that this may be the reason (or one of the reasons) why anthropomorphic visual appearance failed to improve users' information disclosure tendency towards the chatbot.

In the current study, chatbots with human-like verbal cues may have given a sense of intimacy and trust so that users might have become more inclined to disclose personal information. Although anthropomorphic visual appearance may contribute to an increased perception of visual cues in chatbots, human-like verbal cues can facilitate a sense of comfort for users during the conversation and thus promote users' information disclosure tendency. This result was also supported by earlier studies that users were more likely to interact with chatbots that used human-like conversational styles in the verbal cues dimension (Araujo, 2018; Chen et al., 2023; Roy and Naidoo, 2021). Therefore, the human-like conversational style in the verbal cues dimension results in users' higher information disclosure tendency.

It is noteworthy that an interaction effect between visual appearance and conversational style on users' information disclosure tendency was observed. When the chatbot used a high anthropomorphic visual appearance, users showed higher information disclosure tendency towards the chatbot with human-like conversational style. On the contrary, a marginally significant result indicated that users showed a higher information disclosure tendency towards the chatbot with a low anthropomorphic visual appearance when the chatbot used mechanical conversational style. This finding suggested that chatbots with consistently anthropomorphic cues (visual cues and verbal cues) can promote users' information disclosure tendency. This result aligned with the expectancy violation effect (Burgoon, 1993) that users' expectations will be violated and become disappointed when there is an incongruity between anthropomorphic cues in the visual cues dimension and the verbal cues dimension. Chatbots with anthropomorphic visual cues make users expect human-like verbal cues, but the use of mechanical verbal cues may be perceived as dishonest and thereby reducing users' information disclosure tendency. That is, users are more willing to disclose personal information to chatbots with consistent design cues. However, our results did not reach a strongly significant level. One possible reason is that chatbots' conversational style has a greater impact on users' information disclosure tendency than their visual appearance. Regardless of the anthropomorphic degree of visual appearance, users showed higher information disclosure tendency towards the chatbot with human-like conversational style than the chatbot with mechanical conversational style. Therefore, even though anthropomorphic visual appearance can enhance users' perception of social presence, it did not significantly affect the willingness to disclose information.

In summary, our results showed two different main effects of visual appearance and conversational style on users' information disclosure tendency, which supported that chatbots with anthropomorphic design cues in two dimensions exert distinct effects on users. The interaction effect also indicated that visual appearances and conversational styles in different dimensions could jointly affect users' information disclosure tendency towards the chatbot. Compared to the visual appearance, the

**Table 5**  
Mediating effects of social presence and perceived security.

Mediation path	Coeff.	BootSE	95 % Confidence intervals LL UL	
Visual appearance→Perceived security→Disclosure tendency	0.083	0.118	-0.150	0.311
Conversational style→Perceived security→Disclosure tendency	0.281	0.046	0.194	0.373
Visual appearance × Conversational style →Perceived security→Disclosure tendency	0.041	0.025	-0.011	0.089

chatbot's conversational style has a greater impact on users' information disclosure tendency.

## 6.2. Mediation effects of perceived security on information disclosure tendency

In addition to the interaction effect, perceived security was found to mediate the effect of conversational style on users' information disclosure tendency in the current study. Specifically, the chatbot with human-like conversational style positively increased users' perception of security, which further enhanced users' information disclosure tendency. This result is supported by the risk-benefit calculus (Dinev et al., 2013). Perceived security instigated by human-like verbal cues may be viewed as a beneficial factor that promotes users' information disclosure tendency towards chatbots (Hallam and Zanella, 2017). In addition, this result is in line with the earlier research that anthropomorphic verbal cues heightened social perception and then promoted users' information disclosure tendency (Sah and Peng, 2015). Furthermore, Heckman and Wobbrock (2000) and Moon (2000) found that anthropomorphic chatbots can improve users' feeling of trust, which may make users perceive security and further promote personal information disclosure tendency. Perceived security is associated with several factors, including comfort, predictable situations, a sense of control, and trust (Akalin et al., 2019). One of these factors would influence users' perceived security.

Whereas, some previous studies suggested that anthropomorphic cues will increase privacy concerns and social anxiety, resulting in less information disclosure tendency during the interaction with agents (Cox et al., 2023; Pickard and Roster, 2020). It can be explained that these previous studies primarily focused on health-related information, which increased users' privacy concerns in interactions with chatbots, the present study did not specifically concentrate on a such health-related context. Hence, human-like verbal cues increased perceived security, which in turn promoted users' information disclosure tendency.

In the current study, it's not surprising that the mediating effect on visual appearance was not significant, considering that this study also did not observe the main effect of visual appearance on the mediator. Additionally, this study did not find the main effect of chatbots with anthropomorphic visual appearances on users' information disclosure tendency. On the one hand, owing to the functional attributes of chatbots, users may allocate more attention to conversational tasks rather than visual appearances during the interaction with chatbots. Therefore, anthropomorphic visual cues failed to evoke users' positive feelings, such as perceived security and subsequently did not contribute to promoting users' information disclosure tendency. On the other hand, earlier research implied that users' evaluation of robots' social capabilities is influenced by the roles assigned to the robots (Dautenhahn, 2007). As a disembodied agent, the main function of chatbots is to provide services to users. Therefore, users were more likely to disclose personal information to chatbots who showed consistent anthropomorphic features (e.g., human-like conversational style) with social roles during the interaction. That is, compared to verbal cues, anthropomorphic visual cues were found to lack a pivotal role in shaping users' information disclosure tendency during the interaction with chatbots.

In conclusion, the current study discerned that perceived security mediated the effect of human-like conversational style on users' information disclosure tendency towards the chatbot. However, such kind of effects were not observed in anthropomorphic visual appearance and interaction effects. This result further implies that the effects of anthropomorphic design cues in two different dimensions on users' information disclosure tendency are different.

## 6.3. Implications and limitations

### 6.3.1. Theoretical contributions

The anthropomorphic design of chatbots has obtained more and more attention from academic researchers. Earlier research mainly

focused on anthropomorphic design cues within one dimension, such as the visual cues dimension (e.g., visual appearance) (Kang and Kang, 2023; Pawlik, 2022) or verbal cues dimension (e.g., language style) (Chung et al., 2023; Li and Wang, 2023). However, how anthropomorphic design cues in different dimensions affect users' information disclosure tendency towards the chatbot is not sufficiently investigated. Therefore, the present study considered visual appearance and conversational style from two dimensions in research variables and identified different effects of these anthropomorphic design cues on users' information disclosure tendency. Additionally, this study contributes to the expectancy violation effect. Specifically, the interaction effect indicated that users showed higher information disclosure tendency towards the chatbot with human-like conversational style. On the contrary, when the chatbot used mechanical conversational style, users showed a higher information disclosure tendency towards the chatbot with a low anthropomorphic visual appearance. That is, an expectancy violation effect occurred. Besides, this study also contributes to CASA paradigm that users prefer to disclose personal information to chatbots with human-like verbal cues. Furthermore, this study explored the importance of perceived security in relation to the effect of human-like conversational style on users' information disclosure tendency. The mediating analysis indicated that anthropomorphic design cues in different dimensions could lead to differentiation in user perception of chatbots.

### 6.3.2. Practical implications

The findings of the current study are of interest not only to researchers but also to practitioners. As a kind of service agent, a chatbot's anthropomorphic design plays an important role in human-chatbot interaction. Our results highlighted that human-like conversational style could benefit user experience and the likelihood of higher information disclosure tendency during the interaction with chatbots. Thus, chatbot designers ought to consider adopting human-like conversation styles (e.g., "Hello, I'm your service assistant, what can I do for you?") when interacting with users. Additionally, the expectancy violation effect suggested that users are more willing to disclose personal information to chatbots with consistently anthropomorphic cues (visual cues and verbal cues). That is, consistently anthropomorphic design cues should be used in human-chatbot interaction. Further, our findings also indicated that perceived security promoted users' willingness to disclose information. Users prefer to share personal information with the chatbot when they perceive the conversational environment as secure. Therefore, to foster information disclosure tendency, it is advisable to create a conversation context that feels safe for users.

### 6.3.3. Limitations and future directions

This study also has limitations that can seed future inquiry. First, hypothetical scenario-based video materials were used as experiment stimuli in the current study. Although this method can be regarded to be richer than picture materials (i.e., screenshots) in earlier studies (Konya-Baumbach et al., 2023; Li and Wang, 2023), a potential discrepancy may exist between users' perceptions and actual responses when encountering a similar situation in reality. Therefore, future research is still encouraged to engage participants in a real interaction context, in which users interact with a live chatbot (Klein and Martínez, 2022). Second, to make the measurement as comprehensive as possible and reduce the interference of a single-dimensional factor, the current research measured users' information disclosure tendency by employing different dimensional items. However, the variability in sensitivity across different types of items has the potential to influence users' evaluation of information disclosure tendency. Therefore, future research may consider the utilization of more refined measurement items characterized by an equivalent level of item sensitivity. Additionally, the present study only focused on text-based interaction. As voice interfaces have been widely used in many conversational agents (Liebrecht and van Hooijdonk, 2020), it is becoming more and more

popular to apply voice communication in human-agent interaction. Therefore, future research may extend our study on anthropomorphic design for different types of interactions including text-based, voice-based, and hybrids. Last but not least, this study only explored the effects of anthropomorphic design cues on two different dimensions. Future research can consider validating our results in more different dimensions.

### 7. Conclusion

Anthropomorphic design cues play an important role in creating a better user experience in human-chatbot interaction. The present study investigated the impacts of anthropomorphic design cues in two different dimensions (visual appearance and conversational style) on users' information disclosure tendency towards the chatbot. Results suggested that the human-like conversational style can increase users' information disclosure tendency towards the chatbot. Moreover, the interaction effect indicated that users showed a higher information disclosure tendency towards the chatbot with human-like conversational style. On the contrary, when the chatbot used mechanical conversational style, users showed a higher information disclosure tendency towards the chatbot with a low anthropomorphic visual appearance. To conclude, this study highlighted that anthropomorphic design cues on different dimensions have diverse effects on users' perceptions of chatbots. The result of the present study enriched the knowledge of users' information disclosure behaviors towards the chatbot and also provided practical insights into chatbot design.

### Appendix A

Convergent validity and reliability statistics for questionnaire items

Construct	Items	Factor loadings	$\alpha$	CR	AVE
Visual Appearance (VA) (Nowak and Rauh, 2005)	VA-1: The chatbot's avatar looks very human.	0.916	0.897	0.913	0.778
	VA-2: The chatbot's avatar looks very realistic.	0.868			
	VA-3: The chatbot's avatar looks very cartoon-like.	0.791			
Conversational style (CS) (Bartneck et al., 2009)	CS-1: The chatbot's language style is natural.	0.929	0.943	0.884	0.655
	CS-2: The chatbot's language style is humanlike.	0.951			
	CS-3: The chatbot's language style is conscious.	0.931			
	CS-4: The chatbot's language style is elegant.	0.794			
Perceived Security (PS) (Shin and Shin, 2011)	PS-1: I believe the information I provide with the chatbot will be manipulated by inappropriate parties. (reversed item)	0.849	0.942	0.890	0.730
	PS-2: I am confident that the private information I provide with the chatbot will be secured.	0.984			
	PS-3: I believe inappropriate parties may deliberately view the information I provide with this chatbot. (reversed item)	0.929			
Disclosure tendency (D) (Joinson et al., 2008; Zhang and Patrick, 2023)	D-1: I am willing to disclose the number of my sexual partners to this chatbot.	0.691	0.941	0.907	0.522
	D-2: I am willing to disclose my height to this chatbot.	0.824			
	D-3: I am willing to disclose how long my longest relationship lasted to this chatbot.	0.848			
	D-4: I am willing to disclose my monthly revenue to this chatbot.	0.790			
	D-5: I am willing to disclose how many different serious relationships I have had since age 18 to this chatbot.	0.830			
	D-6: I am willing to disclose my weight to this chatbot.	0.810			
	D-7: I am willing to disclose my monthly expenditure to this chatbot.	0.786			
	D-8: I am willing to disclose my tastes in music to this chatbot.	0.750			
	D-9: I am willing to disclose my health information to this chatbot.	0.800			
	D-10: I am willing to disclose my negative emotions (such as anxiety) to this chatbot.	0.752			

### CRedit authorship contribution statement

**Jiahao Chen:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mingming Li:** Writing – review & editing, Validation, Investigation, Funding acquisition, Data curation. **Jaap Ham:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

### Declaration of competing interest

The authors declare that they have no potential conflicts of interest in this paper.

### Data availability

Data will be made available on request.

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