



How do virtual streamers affect purchase intention in the live streaming context? A presence perspective

Wei Gao^a, Ning Jiang^{b,*}, Qingqing Guo^c

^a College of Economics and Management, Southwest University, 2 Tiansheng Rd, Chongqing, China

^b Antai College of Economics and Management, Shanghai Jiao Tong University, 1954 Huashan Rd, Shanghai, China

^c School of Communication, East China University of Political Science and Law, 555 Longyuan Rd, Shanghai, China

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ABSTRACT

The rise of live streaming commerce has attracted attention from scholars and practitioners as a new opportunity to reach consumers. However, few studies have focused on the role of virtual streamers in this context. Based on the stimulus organism response framework, we explore the impact of three characteristics of virtual streamers—likeability, animacy, and responsiveness—on social presence, telepresence, and purchase intention. We use partial least squares structural equation modeling analysis with online survey data from 378 consumers concerning their experiences of viewing virtual streamers. The findings indicate that likeability, animacy, and responsiveness enhance social presence and telepresence, which then promote purchase intention. Likeability and responsiveness directly increase purchase intention, but animacy does not. Multi-group analysis reveals differences between the effects of humanoid and zoonotic virtual streamers on social presence and telepresence. These results shed light on the role of virtual streamer characteristics and contribute to the literature on live streaming commerce, presence, and virtual humans.

1. Introduction

Although it is a relatively recent phenomenon, live streaming commerce has rapidly become one of the most popular and profitable forms of e-commerce (Xu et al., 2021; Tong et al., 2022; Bharadwaj et al., 2022), especially since the onset of the COVID-19 pandemic (Zhang et al., 2022; Chong et al., 2022; Mao et al., 2022; Lo et al., 2022). By the end of 2021, the number of live streaming commerce users reached 464 million, an increase of 75.79 million from 2020 (CNNIC, 2022). China's live streaming e-commerce industry was worth 1.2012 trillion yuan in 2021, and it is expected to reach 2.1373 trillion yuan by 2025 (iiMedia Research, 2022).

Compared with traditional online shopping, live streaming commerce displays products more vividly and offers consumers the experience of real-time interaction through the live streamer (Wongkitrungrueng et al., 2020; Fei et al., 2021; Zhang et al., 2022). The streamer is thus a critical feature of live streaming commerce (Guo et al., 2022) and is directly responsible for the success of live streaming commerce. In other words, choosing a streamer wisely will lead to a huge growth in sales (Guo et al., 2022; Zhu et al., 2021).

Recently, digital technologies such as artificial intelligence (AI),

virtual reality, three-dimensional graphics, and augmented reality have led to further developments in live streaming commerce. An increasing number of virtual streamers—that is, computer-generated, AI-powered characters—have emerged on live streaming commerce platforms. Taobao, one of the largest e-commerce platforms, has announced that virtual streaming is a new growth area. The estimated average annual growth rate of the virtual streamer market increased by 127.89% from 2021 to 2025 (LeadLeo, 2021). Although real live streamers have many advantages over virtual streamers, they cannot livestream 24 h a day. Brands that hire live streamers to sell their products may also be exposed to risk or potential scandals by the streamers' actions and personal lives. Accordingly, many firms have adopted virtual streamers in their live streaming shows.

Due to the significance of streamers in the live streaming commerce environment, previous studies have explored their role. These studies have found that streamer characteristics, such as attractiveness, professionalism, passion, expertise, popularity, warmth, humor, interaction style, value similarity, and trustworthiness (Liao et al., 2023; Guo et al., 2022; Hou et al., 2020; Zhou and Tong, 2022; Zhu et al., 2021; Chen and Liao, 2022; Li and Peng, 2021; Park and Lin, 2020; Chen et al., 2022a; Bharadwaj et al., 2022), influence consumers' cognition, emotion, and

* Corresponding author.

E-mail addresses: gaoweibaggio@qq.com (W. Gao), jn63668@126.com (N. Jiang), 648919580@qq.com (Q. Guo).

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behavior, and lead to positive outcomes. Although these studies have provided insights into live streaming commerce, the role of virtual streamers in live streaming commerce remains little understood.

Given the new developments in live streaming commerce and the research gap outlined above, we explore the impact of virtual streamers in the context of live streaming commerce. Specifically, we focus on two issues. First, how do the likeability, animacy, and responsiveness of virtual streamers affect consumers in the live streaming commerce context? Second, what are the effects of humanoid vs. zoonotic design in virtual streamers? To address these questions, we examine the effect of virtual streamer characteristics (i.e., likeability, animacy, and responsiveness) on purchase intention through social presence and telepresence by drawing on the stimulus organism response (SOR) framework, and we compare the different influences of humanoid and zoonotic virtual streamers in live streaming commerce.

We make three major contributions to the literature. First, we contribute to live streaming commerce research by examining the influence of virtual streamer characteristics on consumers. Second, we extend the presence literature by examining the mediating role of social presence and telepresence between virtual streamer characteristics and purchase intention. Third, we enrich the virtual human literature by comparing humanoid and zoonotic virtual streamers. Moreover, we provide practical implications for live streaming practitioners.

2. Theoretical background

2.1. Live streaming commerce

Live streaming commerce is a novel form of e-commerce in which streamers can interact with consumers or viewers in real time (Wongkitrungrueng et al., 2020; Guo et al., 2022; Zheng et al., 2022). Its most prominent feature is real-time interaction through video- and text-based chat functions, which enables streamers to promote products and interact with consumers instantaneously (Li et al., 2021; Chen et al., 2022a; Liao et al., 2023). Live streaming commerce thus offers a more vivid and authentic online shopping environment, which enables consumers to better understand the product and helps them decide whether to purchase it (Gao et al., 2021; Wongkitrungrueng and Assarut, 2020;

Mao et al., 2022; Lo et al., 2022).

Considering its rapid development and significance, scholars have paid much attention to live streaming commerce. Previous studies have mainly focused on the factors that enhance consumers' purchase intention, engagement, and viewing intention (Lu and Chen, 2021). Scholars have found that streamer-related factors (Bharadwaj et al., 2022; Liao et al., 2023; Park and Lin, 2020), IT factors (Sun et al., 2019; Li et al., 2021), product-related factors (Lu and Chen, 2021), platform-related factors (Zhang et al., 2021; Chong et al., 2022), and consumer-related factors (Gao et al., 2021; Chen et al., 2022b; Zheng et al., 2022) all affect consumers. Many studies have examined the influence of streamers' characteristics, including expertise (Li and Peng, 2021), warmth and passion (Guo et al., 2022), humor (Hou et al., 2020), popularity (Zhou and Tong, 2022), professionalism (Zhu et al., 2021), interaction communication style (Liao et al., 2023), attractiveness (Chen and Liao, 2022), trustworthiness (Park and Lin, 2020), and value similarity (Chen et al., 2022a). Although previous research has thoughtfully explored streamer characteristics, it is still in its infancy. To the best of our knowledge, there is no study focusing on the effect of virtual streamer characteristics in live streaming commerce.

Virtual streamers can be distinguished into two groups based on their appearance: humanoid versus zoonotic designs (see examples in Fig. 1A and B). Humanoid features are likely to convey humanlike emotional qualities (Blut et al., 2021) and thus gain consumers' trust (van Pinxteren et al., 2019; Song et al., 2022) and elicit social responses (Blut et al., 2021). In addition, a growing number of virtual streamers are designed to imitate living creatures. Zoonotic virtual streamers usually resemble pets or wild animals. These virtual streamers can attract consumers' attention and enhance their engagement and attachment (Blut et al., 2021). Although both designs are widely used among virtual streamers, few studies have examined their differential impacts. Hence, we explore the difference between humanoid and zoonotic virtual streamers.

2.2. Virtual streamer characteristics

Previous studies of AI-enabled non-human entities have focused on service robots, smart home technology, chatbots, and intelligent



A

Virtual streamer with humanoid design



B

Virtual streamer with zoonotic design

Fig. 1. (A) Virtual streamer with humanoid design, (B) Virtual streamer with zoonotic design.

personal assistants (Hu et al., 2021; Ahn et al., 2022). These studies have shown that the warmth and competence of AI-enabled non-human entities evokes feelings, emotions, and behaviors in human beings (Hu et al., 2021; Cheng et al., 2022). Accordingly, we focus on virtual streamer characteristics from the perspectives of warmth and competence, based on the literature on AI-enabled non-human entities. Specifically, the warmth factors are likeability and animacy, and the competence factor is responsiveness.

Likeability refers to the extent to which someone is perceived as friendly, kind, nice, and pleasant to be around (Ellegaard, 2012). In this study, it reflects live streaming consumers' assessment regarding streamers' likeable, pleasant, kind, nice, and friendly personas. Likeability is a positive impression that someone has of another person (Bartneck et al., 2009), and can be considered an emotional connection (Nagel et al., 2021). Research has suggested that the more likeable a person is, the more positively they are evaluated (Bartneck et al., 2009). In addition, likeability has a significant impact on trust (Nagel et al., 2021), parasocial interactions (Aw et al., 2022), and willingness to engage in collaboration (Pulles and Hartman, 2017).

Animacy is defined as regarding objects as individuals who can move on their own accord and have the capacity for interaction (Balakrishnan and Dwivedi, 2021). Thus, the animacy of virtual streamers reflects the extent to which consumers perceive them as living beings who can move independently and interact. The concept of animacy derives from psychological research, but it has been used in research on information systems (Bartneck et al., 2009), service robots (Amelia et al., 2022), and digital assistants (Aw et al., 2022; Balakrishnan and Dwivedi, 2021). Animacy emphasizes the lifelike form of an object, but it does not necessarily indicate human form (Bartneck et al., 2009; Balakrishnan and Dwivedi, 2021). Thus, it can better describe the common features of humanoid and zoonotic virtual streamers, as distinct from real streamers. Previous studies have found that animacy can deeply involve users emotionally (Bartneck et al., 2009) and positively influence consumers' attitude and behavior toward digital assistants and robots (Amelia et al., 2022; Balakrishnan and Dwivedi, 2021).

Responsiveness refers to the ability to quickly respond to consumers' requests (Wongkitrungrueng and Assarut, 2020). In live streaming commerce, it can be defined as the extent to which consumers receive fast and effective replies from streamers (Xue et al., 2020). Thus, responsiveness reflects streamers' ability to help consumers and deliver timely service (Xue et al., 2020). Specifically, streamers can respond quickly to consumers' inquiries, such as providing product details and promotion information, which are conducive to consumers' purchase decision-making. Researchers have found that responsiveness can significantly increase perceived usefulness and decrease perceived risk and psychological distance (Xue et al., 2020); it is an important indicator of interaction quality (Zhang et al., 2021) and service quality (Ma, 2021).

2.3. Presence

Presence refers to a subjective feeling of "being there" in a computer-mediated environment (Xu et al., 2021). The concept has been widely adopted in various research contexts including online education (Zou et al., 2021), social commerce (Nadeem et al., 2020), social media (Ledbetter and Meisner, 2021), online community (Nadeem et al., 2020), live streaming commerce (Sun et al., 2019), and augmented reality (Nikhashemi et al., 2021). Presence has two dimensions, social presence and telepresence, which have been widely recognized in past research (Gao et al., 2018; Ye et al., 2020; Xu et al., 2021). Social presence is the feeling of psychological intimacy, whereas telepresence is the sense of physical proximity (Ou et al., 2014). Although they represent different aspects of presence and play vital roles in the online environment, few studies have examined their synchronized effect (Gao et al., 2018).

Social presence is defined as "the degree of salience of the other

person in a mediated communication and the consequent salience of their interpersonal interactions" (Short et al., 1976, p. 65). It is the sense of being with another (Lim et al., 2021), and conveys a perception of human warmth, personalness, human contact, and sensitivity (Bao and Wang, 2021). Social presence has been identified as an important construct in the mediated environment (Kim et al., 2020), and it can drive trust (Jiang et al., 2019), commitment and loyalty (Nadeem et al., 2020), purchase intention (Tan and Liew, 2020), approach behaviors (Otterbring, 2021), and continued use intention (Song et al., 2021). Methods for creating a high level of social presence have received much attention. Social presence is determined by the technological mediated environment's ability to show content associated with social cues, including audio, facial expressions, video, reviews, and posture (Short et al., 1976; Amin et al., 2021; Nadeem et al., 2020). Scholars have found that brand anthropomorphism (Kim et al., 2020), virtual agents (Tan and Liew, 2020), and IT affordance (Sun et al., 2019) build social presence.

Telepresence refers to "the extent to which one feels present in the mediated environment, rather than in the immediate physical environment" (Steuer, 1992, p. 6). It describes a sense of virtually being present in a remote environment (Algharabat et al., 2018; Ongsakul et al., 2020). High telepresence can be evoked through interactivity and vividness (Kim et al., 2021), which are associated with rich mediated environments involving video, spatial audio, 3D vision, and animation (Nikhashemi et al., 2021; Cowan et al., 2021; Steuer, 1992). Telepresence is a critical element affecting consumers in online environments (Ye et al., 2020). Previous studies have found that telepresence is helpful for shaping purchasing behavior (Xu et al., 2021), perceived usefulness and enjoyment (Kim et al., 2021), flow (Ma et al., 2021), and playfulness (Han et al., 2020).

Although presence has been examined in various research contexts and some scholars have explored its role in live streaming commerce (e.g., Sun et al., 2019; Ma, 2021; Xu et al., 2021; Chen and Liao, 2022), few have focused on the presence induced by virtual streamers. Hence, there is a need to examine the link between virtual streamer characteristics and presence.

2.4. Stimulus organism response framework

The SOR framework explains how external stimuli influence behavioral response via individuals' organism states (Mehrabian and Russell, 1974; Cheng et al., 2022). In this framework, the stimulus (S) reflects the external environmental factor faced by the individual. The organism's (O) states are the individual's internal perceptions and experiences. The response (R) is the behavioral outcome following the external stimulus. In this study, virtual streamers' characteristics can be regarded as the online shopping environment stimuli, because virtual streamers play a vital role in live streaming commerce. Presence is a virtual experience that represents the consumers' organism state (Animesh et al., 2011; Fang et al., 2018). Consumers' purchase intention is a form of behavioral response to environmental stimuli (Tuncer, 2021; Guo et al., 2021). The SOR framework has been widely used to explain individual behaviors in online environments, such as live streaming commerce (Guo et al., 2021), chatbots (Cheng et al., 2022), online social commerce (Tuncer, 2021), and video websites (Fang et al., 2018). Thus, we apply the SOR framework to explore how virtual streamer characteristics (i.e., likeability, animacy, and responsiveness) affect purchase intention through social presence and telepresence (see Fig. 2).

3. Hypotheses

3.1. The effect of virtual streamer characteristics

Likeability is a positive first impression created by virtual streamers (Blut et al., 2021). Likeable virtual streamers are perceived as friendly, pleasant, nice, and kind to consumers when they interact with them

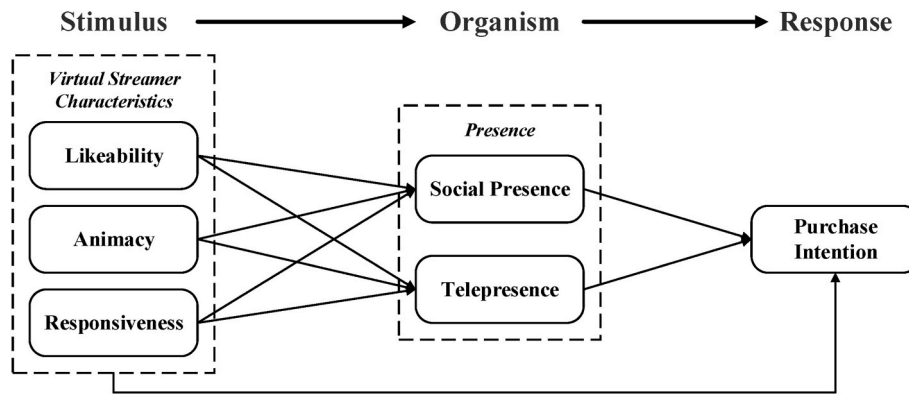


Fig. 2. Conceptual model.

through the live streaming show (Ellegaard, 2012). These positive feelings can shorten the psychological distance between consumers and virtual streamers, and increase consumers' sense of human contact and sensitivity. Such positive evaluations can immerse consumers in the virtual streamers' live streaming room and increase their enjoyment of the shopping experience. In addition, likeability helps to build trust (Nagel et al., 2021) and convince others to engage in collaboration (Pulles and Hartman, 2017). To sum up, the more likeable virtual streamers are, the more positive the outcomes (Bartneck et al., 2009). Thus, we propose the following hypotheses.

- H1a: Likeability is positively related to social presence.
- H1b: Likeability is positively related to telepresence.
- H1c: Likeability is positively related to purchase intention.

Animacy describes the perception that an object is alive (Fu et al., 2021). Virtual streamers with a high level of animacy derived from integrated AI attributes, including voice, speech, expression, and gesture (Balakrishnan and Dwivedi, 2021), can make consumers believe they are real (Spatola et al., 2021). When consumers feel a sense of high animacy they will consider the virtual streamers to be living creatures capable of building deep connections and triggering emotions (Blut et al., 2021). Accordingly, virtual streamers high in animacy produce a feeling of personalness, warmth, and human contact, and they make consumers feel like they are shopping in the real world with real streamers. Furthermore, when the animacy of virtual streamers is perceived by consumers in a live streaming context, they will gain great comfort and believe in their interactions with them (Aw et al., 2022), facilitating positive attitudes and enhancing purchase intention (Balakrishnan and Dwivedi, 2021). Therefore, we propose the following hypotheses.

- H2a: Animacy is positively related to social presence.
- H2b: Animacy is positively related to telepresence.
- H2c: Animacy is positively related to purchase intention.

Due to the interactive nature of live streaming commerce, virtual streamers' responsiveness is critical to its success (Wongkitrungrueng and Assarut, 2020). Benefiting from virtual streamers' responsiveness, consumers can instantly obtain the information they need (Zhang et al., 2021). Through this quick response service, virtual streamers help consumers resolve problems effectively, which may make them feel that the virtual streamers are warm and amiable, shortening the psychological distance between them (Xue et al., 2020) and strengthening their connection (Wongkitrungrueng and Assarut, 2020). Because of virtual streamers' quick response, consumers may feel their interactions with them happen in the real world. Furthermore, virtual streamers' responsiveness can promote consumers' perceived value and comfort (Chung et al., 2020), consumer experience (Chen et al., 2021), and

usefulness (Xue et al., 2020), and it can reduce shopping effort (Prentice et al., 2019) and risk (Xue et al., 2020). Therefore, we propose the following hypotheses.

- H3a: Responsiveness is positively related to social presence.
- H3b: Responsiveness is positively related to telepresence.
- H3c: Responsiveness is positively related to purchase intention.

3.2. The effect of social presence

In this study, we suggest that social presence induces purchase intention. A live streaming room with a high level of social presence indicates that the psychological distance between virtual streamers and consumers has been shortened (Lim et al., 2021), which is beneficial to establishing a closer relationship between them (Sun et al., 2019). Social presence creates a sense of familiarity, intimacy, and contact between virtual streamers and consumers (Nadeem et al., 2020), thus improving the shopping experience. In addition, social presence has been found to positively influence consumers' emotions (Chen and Liao, 2022), increasing their trust in virtual streamers (Jiang et al., 2019) and enhancing behavior intention (Chen and Liao, 2022; Amin et al., 2021). Therefore, we propose the following hypothesis.

- H4: Social presence is positively related to purchase intention.

3.3. The effect of telepresence

Telepresence is an immersive experience that reflects the perception of a mediated environment (Steuer, 1992; Algharabat et al., 2018). When the level of telepresence is high, consumers will be psychologically transported into the live streaming room (Steuer, 1992) and have a greater feeling of being there (Lim et al., 2021). In other words, telepresence makes the live streaming show more authentic, and consumers are immersed in the world the virtual streamer has created (Xu et al., 2021; Ou et al., 2014). The perception of telepresence can also make consumers feel comfortable even in a mediated environment (Lim et al., 2021), and it can help them obtain more product information through virtual streamers' vivid product displays and introductions (Sun et al., 2019). Furthermore, telepresence has been found to significantly facilitate purchasing behavior (Xu et al., 2021), trust and enjoyment (Ye et al., 2020), and behavior intention (Ongsakul et al., 2020). Therefore, we propose the following hypothesis.

- H5: Telepresence is positively related to purchase intention.

3.4. The mediating effect of presence

According to the SOR framework, external stimuli influence behaviors by intervening in the individual's organism states (Mehrabian and Russell, 1974; Cheng et al., 2022). In this three-stage framework,

internal states mediate the linkages between environment stimuli and behavioral response (Mehrabian and Russell, 1974). Therefore, we suggest that social presence and telepresence play mediating roles in the causal relationship between the virtual streamer's characteristics and purchase intention.

Likeable virtual streamers, which seem kind, nice, and friendly to consumers, convey human warmth and make consumers feel as if they are present in the virtual streamers' live streaming rooms (Ellegaard, 2012). Virtual streamers with high levels of animacy can forge strong connections with consumers (Blut et al., 2021), promoting consumers' perception of presence. Virtual streamers with high levels of responsiveness can quickly respond to consumers' requirements (Zhang et al., 2021), which gives consumers a sense of human contact and a real-world purchasing experience. When feelings of social presence and telepresence are stimulated by a virtual streamer's characteristics (i.e., likeability, animacy, and responsiveness), consumers are more likely to purchase in the virtual streamer's live streaming room (Sun et al., 2019; Xu et al., 2021). Furthermore, studies have suggested that social presence and telepresence mediate the relationships between their antecedents and behavior intention (e.g., Sun et al., 2019; Sun et al., 2021; Liu et al., 2022; Chen and Liao, 2022). This implies that likeability, animacy, and responsiveness have positive effects on consumers' purchase intention by increasing their perceptions of social presence and telepresence. We therefore propose the following hypotheses.

H6. Social presence positively mediates the effects of likeability (a), animacy (b), and responsiveness (c) on purchase intention.

H7. Telepresence positively mediates the effects of likeability (a), animacy (b), and responsiveness (c) on purchase intention.

4. Research methodology

4.1. Measurement

All of the measurement items were adapted from previous research and modified to suit the context of live streaming commerce. Five items for likeability were adapted from Bartneck et al. (2009). Four items for animacy were adapted from Balakrishnan and Dwivedi (2021). Four items for responsiveness were adapted from Xue et al. (2020). Social presence and telepresence were both measured by four items adapted from Ou et al. (2014). Three items for purchase intention were adapted from Guo et al. (2022). All of the items were measured on a 5-point Likert scale. Detailed information on the measurement items is presented in Table 1. We also included gender, age, education, and income as control variables.

4.2. Data collection and sample

To test our hypotheses, data were collected through online questionnaires distributed through a professional survey platform in China called Wenjuanxing (<https://www.wjx.cn/>). Because the number of consumers with experience of watching virtual streamers in a live streaming commerce context was relatively small, we used snowball sampling procedures to collect data. After qualifying respondents had finished the questionnaire, we invited them to share the link to our survey with other consumers with a similar experience, which helped us to identify more potential valid respondents.

The online questionnaire contained three sections. In the first section, we introduced the purpose of the research and promised to keep the respondents' information safe and anonymous. In addition, we described virtual streamers in live streaming commerce to ensure the respondents comprehended our research context. In the second section, to guarantee the validity of the questionnaire, we set a pre-screening question to ask the consumers whether they had watched a virtual streamer in live streaming commerce. Only those who answered "yes" were permitted to participate in the survey. Then, the qualified

Table 1
Measurement items.

Likeability (LIK)	
LIK1.	This virtual streamer is likeable.
LIK2.	This virtual streamer is friendly.
LIK3.	This virtual streamer is pleasant.
LIK4.	This virtual streamer is nice.
LIK5.	This virtual streamer is kind.
Animacy (ANI)	
ANI1.	This virtual streamer feels alive.
ANI2.	This virtual streamer is lively.
ANI3.	This virtual streamer feels organic.
ANI4.	This virtual streamer is lifelike.
Responsiveness (RES)	
RES1.	This virtual streamer is very happy to communicate with me.
RES2.	This virtual streamer can answer my questions and requests in time.
RES3.	The response of this virtual streamer is closely related to my problems and requests.
RES4.	This virtual streamer can provide relevant information for my inquiry in time.
Social presence (SOP)	
SOP 1.	There is a sense of human contact in this virtual streamer's live streaming room.
SOP 2.	There is a sense of personalness in this virtual streamer's live streaming room.
SOP 3.	There is human warmth in this virtual streamer's live streaming room.
SOP 4.	There is a sense of human sensitivity in this virtual streamer's live streaming room.
Telepresence (TEL)	
TEL1.	When watching this virtual streamer's live streaming, my body was in the room, but I felt my mind was inside the world created by this virtual streamer.
TEL2.	When watching this virtual streamer's live streaming, I felt that I was immersed in the world this virtual streamer had created.
TEL3.	This virtual streamer's live streaming shopping-generated world seemed to me to be "somewhere I visited" rather than "something I saw".
TEL4.	I felt I was more in the "real world" than the "computer world" when I was watching this virtual streamer's live streaming.
Purchase intention (PIN)	
PIN1.	I will buy the products that this virtual streamer promotes in the live streaming.
PIN2.	I intend to purchase the products that this virtual streamer promotes in the live streaming.
PIN3.	I will consider this virtual streamer's live streaming room as my first shopping choice.

respondents answered the questions about the research constructs based on their latest viewing experience of virtual streamers in a live streaming commerce. Additionally, we asked the respondents to describe the virtual streamer they most recently watched as humanoid or zoonotic. In the third section, we collected the respondents' demographic information, including their gender, age, education, and income.

We obtained 378 valid responses, which is more than 10 times the largest number of structural paths directed at a particular variable in the structural model and satisfies the minimum sample size requirement for partial least squares structural equation modeling (PLS-SEM) (Hair et al., 2021). The demographic information is presented in Table 2.

Table 2
Demographic information.

		Number	Percentage
Gender	Male	177	46.8
	Female	201	53.2
Age (year)	18–25	57	15.08
	26–35	176	46.56
	36–45	128	33.86
	≥46	17	4.5
Education	High school or below	25	6.6
	Junior college	99	26.2
	Undergraduate	203	53.7
	Postgraduate	51	13.5
Income (yuan)	≤3000	93	24.6
	3001–6000	110	29.1
	6001–9000	118	31.2
	9001–12000	51	13.5
	≥12001	6	1.6

5. Data analysis and results

We used PLS-SEM implemented with SmartPLS 3 to conduct the data analysis. We applied PLS-SEM for several reasons. First, it is primarily used in exploratory research (Hair et al., 2021), which fits our study. Second, the data of our study do not meet the requirement of normal data distribution, indicating that the PLS-SEM is more suitable than the covariance-based SEM (CB-SEM; Hair et al., 2021). Third, the PLS-SEM can yield greater statistical power than the CB-SEM (Hair et al., 2021).

5.1. Measurement model

The measurement model was checked by evaluating the reliability and validity of the constructs. As shown in Table 3, all of the constructs' Cronbach's α and composite reliability (CR) scores were greater than the ideal value of 0.7 (Fornell and Larcker, 1981). The scores of rho_A ranged from 0.751 to 0.930, thus exceeding the threshold value of 0.7 (Dijkstra and Henseler, 2015). These results indicate that our constructs had good reliability. The average variance extracted (AVE) was adopted to test convergent validity. Table 3 shows that the AVE values of all of the constructs ranged from 0.667 to 0.776, thus exceeding the suggested threshold of 0.5 (Fornell and Larcker, 1981). Then, discriminant validity was assessed by comparing the inter-construct correlations with the value of the square root of the AVE for each construct. The results in Table 4 show that all values of the square root of the AVE were larger than any correlation coefficient, suggesting good discriminant validity (Fornell and Larcker, 1981). In addition, the heterotrait-monotrait (HTMT) value was calculated. In this study, the largest HTMT score was 0.806, which is less than the stringent threshold of 0.85 (Henseler et al., 2015). In summary, all of these results suggest that our constructs had sufficient reliability and validity.

5.2. Common method variance

Given that the data were self-reported, we reduced the risk of common method variance (CMV) by optimizing the research design and statistical testing. Before the data collection, the questionnaire was structured to be succinct, demographic questions were collected at the end of the questionnaire, and the respondents were promised

anonymity. After the data collection, we used three statistical methods to check for CMV. First, we followed the method recommended by Lindell and Whitney (2001). The correlation coefficients were adjusted based on the lowest positive correlation ($r = 0.004$). The results are shown in Table 4, and they indicate that the originally significant inter-construct correlations maintained their significance in the adjusted correlation matrix. Second, we adopted the procedure recommended by Liang et al. (2007). The results in Table 5 indicate that the average substantive constructs explained 74.8% of the variance, but the method factor only explained 0.9% of the variance on average. The ratio of average substantive variance to method variance was very great. In addition, most method factor loadings were not significant. Third, we included a latent marker variable to control the influence of CMV in the research model, based on the suggestion of Liang et al. (2007). The result indicates that the path significance of the original model did not change after controlling the influence of the marker variable. To sum up, CMV is not a serious issue in this study.

5.3. Structural model

SmartPLS 3 was adopted to test our conceptual model and hypotheses. As shown in Table 6, likeability significantly increased social presence ($\beta = 0.144, p < 0.05$), telepresence ($\beta = 0.151, p < 0.01$), and purchase intention ($\beta = 0.140, p < 0.01$), supporting H1a, H1b, and H1c. Animacy positively influenced social presence ($\beta = 0.253, p < 0.001$) and telepresence ($\beta = 0.278, p < 0.001$), but it did not significantly affect purchase intention ($\beta = 0.067, p > 0.05$). H2a and H2b were thus confirmed, but H2c was not. One possible explanation is that the effect of animacy on purchasing is mediated by social presence and telepresence. There was a significantly positive relationship between responsiveness and social presence ($\beta = 0.437, p < 0.001$), telepresence ($\beta = 0.372, p < 0.001$), and purchase intention ($\beta = 0.211, p < 0.01$), supporting H3a, H3b, and H3c. Social presence ($\beta = 0.248, p < 0.001$) and telepresence ($\beta = 0.263, p < 0.001$) had a positive impact on purchase intention. Our model explains 51.3% of variance in social presence, 46.4% of variance in telepresence, and 59.9% of variance in purchase intention.

5.4. Mediation effect test

To further reveal the underlying influencing mechanisms by which virtual streamer characteristics affect purchase intention, we adopted a bootstrapping method with 5000 resamples to conduct a mediation analysis. The results, shown in Table 7, suggest that all of the indirect effects were significant in the 95% bias-corrected confidence interval. This means that social presence and telepresence play important roles in the relationship between virtual streamer characteristics and purchase intention, confirming H6a, H6b, H6c, H7a, H7b, and H7c.

5.5. Post-hoc analysis

To explore the differential impact of virtual streamer type (i.e., humanoid versus zoonotic design), we conducted a post-hoc analysis with PLS multi-group analysis (PLS-MGA). Before doing so, measurement invariance needed to be established. Thus, we used the measurement invariance of composite models (MICOM) recommended by Henseler et al. (2016) to check measurement invariance based on the permutation algorithm. In MICOM's step 1, configural invariance was established because the constructs were equally parameterized and estimated in both groups (Rodríguez Torrico et al., 2020). Thus, we then checked the compositional invariance in MICOM's step 2. As the results in Table 8 show, none of the c values were significantly different from one; thus, compositional invariance was established (Henseler et al., 2016). In MICOM's step 3, the results shown in Table 9 indicate that the composites' mean and variances were equal, indicating full measurement invariance (Henseler et al., 2016).

Table 3
Construct reliability and validity.

Variable	Item	Loading	Cronbach's α	rho_A	CR	AVE
Likeability	LIK1	0.885	0.926	0.930	0.944	0.771
	LIK2	0.877				
	LIK3	0.887				
	LIK4	0.861				
	LIK5	0.880				
Animacy	ANI1	0.893	0.904	0.907	0.933	0.776
	ANI2	0.863				
	ANI3	0.877				
	ANI4	0.891				
Responsiveness	RES1	0.852	0.880	0.881	0.918	0.736
	RES2	0.844				
	RES3	0.859				
	RES4	0.876				
Social presence	SOP1	0.858	0.886	0.887	0.921	0.746
	SOP2	0.859				
	SOP3	0.870				
	SOP4	0.867				
Telepresence	TEL1	0.845	0.872	0.873	0.913	0.723
	TEL2	0.849				
	TEL3	0.846				
	TEL4	0.860				
Purchase intention	PIN1	0.777	0.750	0.751	0.857	0.667
	PIN2	0.817				
	PIN3	0.853				

Table 4

Correlation coefficients and discriminant validity analysis.

	1	2	3	4	5	6	7	8	9	10
1. Gender	NA									
2. Age	−0.011	NA								
3. Education	0.075	0.004	NA							
4. Income	0.026	−0.050	0.363**	NA						
5. Likeability	−0.088	−0.137**	0.025	0.020	0.878					
6. Animacy	−0.060	−0.113*	0.051	0.088	0.526**	0.881				
7. Responsiveness	−0.040	−0.079	0.043	0.152**	0.517**	0.595**	0.858			
8. Social presence	0.004	−0.091	0.092	0.096	0.500**	0.587**	0.660**	0.864		
9. Telepresence	−0.080	−0.114*	0.087	0.117*	0.487**	0.578**	0.615**	0.532**	0.850	
10. Purchase intention	−0.037	−0.173**	0.061	0.112*	0.544**	0.573**	0.656**	0.645**	0.638**	0.817
Mean	0.468	33.040	2.740	2.380	3.775	3.931	3.917	3.914	3.919	3.939
SD	0.500	7.390	0.772	1.047	1.020	0.930	0.900	0.906	0.899	0.835

Note: * $p < 0.05$, ** $p < 0.01$, NA = Not applicable. The numbers in the diagonal row are square roots of the AVE.**Table 5**

Common method variance analysis.

Variable	Item	Substantive factor loading (R_1)	R_1^2	Method factor loading (R_2)	R_2^2
Likeability	LIK1	0.790***	0.624	0.116***	0.013
	LIK2	0.974***	0.949	−0.116**	0.013
	LIK3	0.840***	0.706	0.053	0.003
	LIK4	0.916***	0.839	−0.064	0.004
	LIK5	0.874***	0.764	0.005	0.000
Animacy	ANI1	0.839***	0.704	0.062	0.004
	ANI2	0.946***	0.895	−0.095*	0.009
	ANI3	0.833***	0.694	0.050	0.003
	ANI4	0.910***	0.828	−0.021	0.000
Responsiveness	RES1	0.744***	0.554	0.124*	0.015
	RES2	0.839***	0.704	0.008	0.000
	RES3	0.933***	0.870	−0.086	0.007
	RES4	0.915***	0.837	−0.046	0.002
Social presence	SOP1	0.780***	0.608	0.093	0.009
	SOP2	0.875***	0.766	−0.020	0.000
	SOP3	0.940***	0.884	−0.083	0.007
	SOP4	0.858***	0.736	0.011	0.000
Telepresence	TEL1	0.798***	0.637	0.055	0.003
	TEL2	0.917***	0.841	−0.080	0.006
	TEL3	0.796***	0.634	0.059	0.003
	TEL4	0.890***	0.792	−0.035	0.001
Purchase intention	PIN1	0.530***	0.281	0.266***	0.071
	PIN2	0.985***	0.970	−0.179**	0.032
	PIN3	0.917***	0.841	−0.067	0.004
Average		0.860	0.748	0.00042	0.009

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.**Table 6**

Results of hypothesis testing (N = 378).

Hypothesis	β	T-Values	Remark
H1a: Likeability → Social presence	0.144*	2.582	Supported
H1b: Likeability → Telepresence	0.151**	2.736	Supported
H1c: Likeability → Purchase intention	0.140**	3.153	Supported
H2a: Animacy → Social presence	0.253***	3.795	Supported
H2b: Animacy → Telepresence	0.278***	4.115	Supported
H2c: Animacy → Purchase intention	0.067	1.289	Unsupported
H3a: Responsiveness → Social presence	0.437***	6.268	Supported
H3b: Responsiveness → Telepresence	0.372***	5.309	Supported
H3c: Responsiveness → Purchase intention	0.211**	3.217	Supported
H4: Social presence → Purchase intention	0.248***	4.245	Supported
H5: Telepresence → Purchase intention	0.263***	4.052	Supported

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

After the measurement invariance was established, we performed PLS-MGA. Figs. 3 and 4 show the results for the different sample groups ($N_{\text{Humanoid}} = 213$ vs. $N_{\text{Zoonotic}} = 165$). The findings in Table 10 suggest

Table 7

Results of mediation effect test.

Mediation path	Mediation effect	95% BC-CI	Remark
Likeability → Social presence → Purchase intention	0.036	[0.009, 0.078]	Significant
Likeability → Telepresence → Purchase intention	0.040	[0.012, 0.089]	Significant
Animacy → Social presence → Purchase intention	0.063	[0.030, 0.114]	Significant
Animacy → Telepresence → Purchase intention	0.073	[0.035, 0.134]	Significant
Responsiveness → Social presence → Purchase intention	0.108	[0.057, 0.182]	Significant
Responsiveness → Telepresence → Purchase intention	0.098	[0.050, 0.182]	Significant

Note: BC-CI = bias-corrected confidence interval.

Table 8

Results of MICON step 2.

Variable	c value	Permutation p-value	Verified
Likeability	1	0.893	Yes
Animacy	1	0.763	Yes
Responsiveness	1	0.834	Yes
Social presence	1	0.147	Yes
Telepresence	1	0.481	Yes
Purchase intention	1	0.987	Yes

that the likeability of the zoonotic virtual streamers enhanced social presence more than that of the humanoid virtual streamers. However, the responsiveness of the humanoid virtual streamers increased telepresence more than that of the zoonotic virtual streamers, although responsiveness significantly positively affected telepresence in both groups. We also found that the influence of virtual streamer characteristics in the humanoid group on social presence, telepresence, and purchase intention was weaker. This may be because humanoid virtual streamers have much more anthropomorphic features than those with zoonotic designs, and consumers may expect them to perform more like humans (Yoganathan et al., 2021). Thus, humanoid virtual streamers may not satisfy consumers' high expectations, resulting in lower performance.

6. Implications

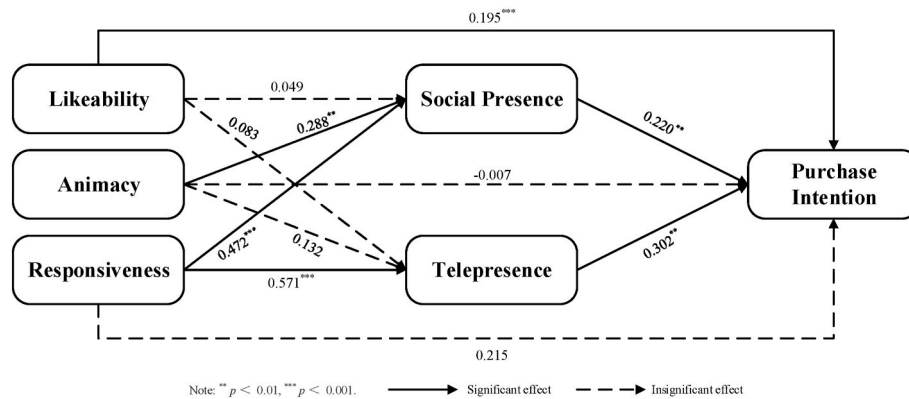
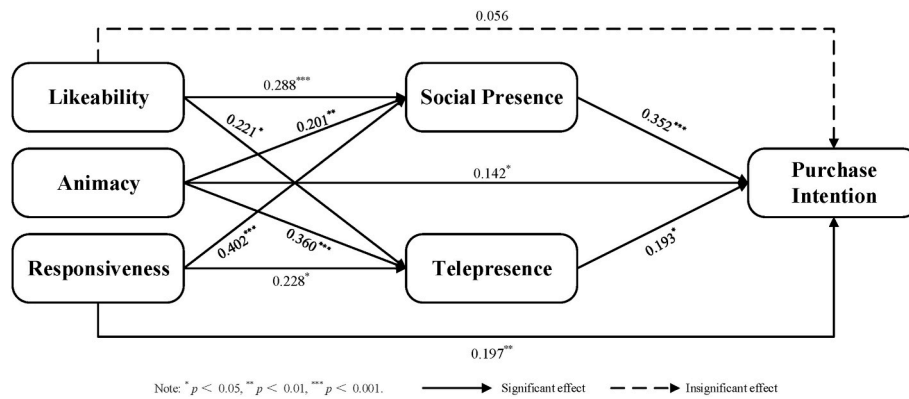
6.1. Theoretical implications

The findings of this study have a number of implications. First, we contribute to the live streaming commerce literature by examining the impact of virtual streamer characteristics. Research on live streaming has focused on streamer-related factors (Liao et al., 2023), IT factors

Table 9

Results of MICON step 3.

Variable	Mean diff.	Permutation <i>p</i> -value	Verified	Variance diff.	Permutation <i>p</i> -value	Verified
Likeability	0.112	0.281	Yes	−0.177	0.300	Yes
Animacy	0.129	0.221	Yes	−0.246	0.224	Yes
Responsiveness	0.147	0.153	Yes	−0.267	0.174	Yes
Social presence	−0.095	0.360	Yes	0.198	0.293	Yes
Telepresence	0.111	0.278	Yes	−0.317	0.094	Yes
Purchase intention	0.070	0.494	Yes	−0.195	0.323	Yes

**Fig. 3.** Results for the humanoid group (N = 213).**Fig. 4.** Results for the zoonotic group (N = 165).**Table 10**

Result of PLS-MGA

Path	β_{Humanoid}	β_{Zoonotic}	$\beta_{\text{Difference}}$	MGA <i>p</i> -value
Likeability → Social presence	0.049	0.288***	−0.238*	0.025
Likeability → Telepresence	0.083	0.221*	−0.138	0.200
Likeability → Purchase intention	0.195***	0.056	0.139	0.138
Animacy → Social presence	0.288**	0.201**	0.087	0.482
Animacy → Telepresence	0.132	0.360***	−0.228	0.061
Animacy → Purchase intention	−0.007	0.142*	−0.149	0.157
Responsiveness → Social presence	0.472***	0.402***	0.069	0.577
Responsiveness → Telepresence	0.571***	0.228*	0.343**	0.007
Responsiveness → Purchase intention	0.215	0.197**	0.018	0.879
Social presence → Purchase intention	0.220**	0.352***	−0.132	0.255
Telepresence → Purchase intention	0.302**	0.193*	0.109	0.415

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

(Sun et al., 2019), product-related factors (Lu and Chen, 2021), platform-related factors (Zhang et al., 2021), and consumer-related factors (Chen et al., 2022b). In particular, streamer characteristics such as expertise, warmth, passion, humor, popularity, professionalism, attractiveness, and trustworthiness (Guo et al., 2022; Li and Peng, 2021; Hou et al., 2020; Zhou and Tong, 2022; Zhu et al., 2021; Chen and Liao, 2022; Park and Lin, 2020) have received much attention. However, previous studies have neglected the role of virtual streamers. By identifying three virtual streamer characteristics (i.e., likeability, animacy, and responsiveness) and examining their influence on presence and purchase intention, we are the first to examine the role of virtual streamers. In doing so, we extend the understanding of live streaming commerce from this perspective.

Second, this study complements presence research by exploring how social presence and telepresence bridge the relationship between virtual streamer characteristics and purchase intention. Prior studies have demonstrated the impact of presence in various online environments (Zou et al., 2021; Qing and Haiying, 2021; Ledbetter and Meisner, 2021; Nadeem et al., 2020), and a few researchers have focused on its role in live streaming commerce (e.g., Sun et al., 2019; Ma, 2021; Xu et al.,

2021; Chen and Liao, 2022). However, as far as we are aware, no study has examined the role of social presence and telepresence in virtual streamers' live rooms. By exploring the mediating role of presence between virtual streamer characteristics (i.e., likeability, animacy, and responsiveness) and purchase intention, we introduce presence into a new research context and expand its range of application. Furthermore, we shed light on how to craft presence from the perspective of virtual streamers, by comparing the effectiveness of humanoid and zoonotic virtual streamers in creating social presence and telepresence.

Third, we reveal the significant role of virtual streamers in live streaming commerce and extend the knowledge of virtual humanity. As an advanced technology, virtual humanity has been explored by scholars in medical, education, service, and marketing contexts (Pauw et al., 2022; Soderlund et al., 2021; Blut et al., 2021). However, the effect of virtual streamers in a live streaming commerce environment remains little understood. By comparing the different impacts of humanoid and zoonotic virtual streamers, we provide a comprehensive understanding of virtual streamer characteristics and contribute new insights to the virtual human literature.

6.2. Practical implications

By exploring the role of virtual streamer characteristics and comparing humanoid and zoonotic virtual streamers, we offer implications for live streaming commerce practitioners. In general, our findings suggest that virtual streamers' likeability, animacy, and responsiveness shape presence. Hence, firms that want to adopt virtual streamers should select them based on these three characteristics. First, they need to improve the responsiveness of virtual streamers to build social presence and telepresence. They should respond to consumers' questions more quickly and effectively, and provide relevant information based on advanced artificial intelligence (Xue et al., 2020). Firms also need to constantly train virtual streamers to improve their capacity for responding to consumers' requirements through machine learning.

Second, firms should note the difference between the two types of virtual streamers. For humanoid virtual streamers, responsiveness can induce more telepresence, and firms should make them feel more alive and organic. However, for zoonotic virtual streamers, likeability is more effective in building social presence. Moreover, firms should increase the perception of animacy and likeability by carefully designing appropriate zoomorphic forms of virtual streamers (Blut et al., 2021). Firms should realize that zoonotic virtual streamers have a significant effect on consumers (Blut et al., 2021), select suitable virtual streamers based on their needs, and fully consider their different characteristics' impacts on social presence and telepresence.

Third, designers of virtual streamers should enhance the characteristics of likeability, animacy, and responsiveness. Specifically, they should use AI voice technology, virtual reality, and motion capture to create verbal and non-verbal behaviors, such as reciprocal self-disclosure, quick response, and encouraging head nods and smiles (Pauw et al., 2022; Miao et al., 2022), which can improve virtual streamers' likeability, animacy, and responsiveness.

7. Limitations and future research directions

This study has several limitations. First, we used the survey method to collect data based on consumers' actual feelings about virtual streamers. Future studies could adopt experimental methods to better manipulate virtual streamer characteristics and examine their effects. Second, future research could focus on other mediation variables, such as flow, virtual consumer experience, and perceived uncertainty, to reveal other mechanisms by which virtual streamer characteristics affect consumers. Third, to improve the generalizability of our findings, future studies could examine our conceptual model and hypotheses in other cultural contexts.

Data availability

Data will be made available on request.

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