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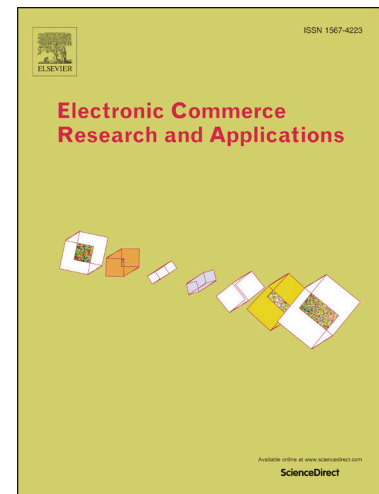
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## The influence of virtual streamer on purchase intention: the moderated mediating effect of message strategy and live-streaming environment

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### Abstract

In the realm of live-streaming, virtual streamers represent a significant area of industry expansion. Despite the widespread adoption of both human-backed and AI-backed virtual streamers in marketing campaigns, the differential effects of these two types remain underexplored. Through three experimental studies, this research systematically examines how virtual streamer types (AI-backed vs. human-backed) influence purchase intention, while elucidating the underlying mechanisms and boundary conditions. The findings demonstrate three key insights: First, human-backed virtual streamers exert significantly stronger impacts on purchase intention compared to their AI counterparts, with perceived usefulness serving as the critical mediator. Second, a two-sided message strategy outperforms positive unilateral messaging in amplifying virtual streamers' effectiveness via enhanced perceived usefulness. Third, the live-streaming environment moderates this mechanism differentially: human-backed streamers prove more effective in real-life environments, whereas AI-backed streamers show superior performance in virtual environments. Both effects operate through the pathway of perceived usefulness. This study advances theoretical understanding of virtual streamer efficacy while providing actionable guidelines for businesses to optimize streamer selection strategies.

**Keywords:** virtual streamer, perceived usefulness, purchase intention, message strategy, live-streaming environment

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## Author contribution

Yuxian Zhang: Writing – review & editing. Xueying Wang: Writing – original draft, Methodology, Conceptualization.

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### Abstract

In the realm of live-streaming, virtual streamers represent a significant area of industry expansion. Despite the widespread adoption of both human-backed and AI-backed virtual streamers in marketing campaigns, the differential effects of these two types remain underexplored. Through three experimental studies, this research systematically examines how virtual streamer types (AI-backed vs. human-backed) influence purchase intention, while elucidating the underlying mechanisms and boundary conditions. The findings demonstrate three key insights: First, human-backed virtual streamers exert significantly stronger impacts on purchase intention compared to their AI counterparts, with perceived usefulness serving as the critical mediator. Second, a two-sided message strategy outperforms positive unilateral messaging in amplifying virtual streamers' effectiveness via enhanced perceived usefulness. Third, the live-streaming environment moderates this mechanism differentially: human-backed streamers prove more effective in real-life environments, whereas AI-backed streamers show superior performance in virtual environments. Both effects operate through the pathway of perceived usefulness. This study advances theoretical understanding of virtual streamer efficacy while providing actionable guidelines for businesses to optimize streamer selection strategies.

**Keywords:** virtual streamer, perceived usefulness, purchase intention, message strategy, live-streaming environment

## 1. Introduction

Live-streaming has fundamentally transformed consumer shopping behaviors, overcoming the

temporal and spatial constraints of traditional offline retail while establishing an interaction-driven commerce paradigm (Wang et al., 2023). The advancement of artificial intelligence (AI) has accelerated this evolution, with virtual streamers emerging as the latest innovation frontier (Gao et al., 2023). Defined as digitally rendered avatars with anthropomorphic features created through technological systems and operated by either human or AI controllers, virtual streamers are gaining business adoption due to their operational flexibility, cost-efficient 24/7 service capabilities, and minimized reputational risks (Wu et al., 2023; Yao et al., 2024). According to industry forecasts, the virtual streamer market is projected to reach 523.16 billion yuan by 2025 (Chang et al., 2025). While some companies deploy AI-backed virtual streamers like Hatsune Miku and Luo Tianyi, others employ human-backed counterparts such as the virtual group A-soul (Hu & Ma, 2023). Current research identifies a critical knowledge gap: although consumers struggle to distinguish between human-backed and AI-backed streamers due to limited discernible cues (Miao et al., 2022), empirical evidence suggests distinct variations in human-AI interaction patterns (Choi et al., 2024). The differential impacts of these two streamer types on consumer decision-making remain unclear, creating challenges for businesses seeking to optimize purchase intention enhancement strategies. Clarifying this distinction will enable companies to determine whether disclosing the operational nature of virtual streamers can maximize their commercial effectiveness.

Current research on virtual streamers predominantly examines their comparative advantages over human streamers (Niu et al., 2023) and investigates how external attributes—including linguistic patterns (Hu & Ma, 2023), visual aesthetics (Chen et al., 2024a), and gender representations (Chen et al., 2024b)—influence consumer behavior. Existing studies predominantly focus on the external characteristics of virtual streamers. Moreover, as pointed out by Gao et al. (2023), research on virtual streamers is still in its infancy. Notably, this focus overlooks critical operational variations: even streamers with identical external features may differ fundamentally in their internal operational mechanisms, particularly regarding controller types. From an operational dimension, virtual streamers bifurcate into two distinct categories: human-backed variants employing motion capture and voice modulation technologies to replicate human expressiveness, and AI-backed counterparts governed entirely by algorithmic systems (Hu & Ma, 2023). Mind perception theory posits that consumers assess social actors through dual cognitive dimensions—agency (capacity for intention) and experience (capacity for feeling)—which subsequently shape behavioral responses (Yoganathan & Osburg, 2024). According to the mind perception theory, different types of virtual streamers result in different evaluations of agency and experience, which lead to different customers' response. However, as Wang and Qiu (2024) have highlighted, the psychological mechanisms underlying consumer perceptions of digital endorsers require empirical validation. Therefore, based on the mind perception theory, this study aims to analyze the different impacts of virtual streamer (AI-backed vs. human-backed) on purchase intention.

Perceived usefulness, defined as consumers' assessment of how effectively virtual streamers' information fulfills their functional needs (Zhou et al., 2017). As a crucial factor influencing consumers' acceptance of new technologies, when consumers perceive that a certain new technology has relatively high usefulness, they tend to be more inclined to adopt it (Shehawy et al., 2025). Mind perception theory delineates two evaluative dimensions for technological agents: agency (capacity for analytical processing and goal-directed action) and experience (capability for sensory perception and emotional resonance) (Wang & Qiu, 2024; Gong & Sun, 2025). Complementarily, social-

psychology research identifies warmth and competence as fundamental axes in social evaluation (Im et al., 2023; Xiong et al., 2025). Warmth emerges through perceived friendliness and authenticity, whereas competence reflects assessments of intellectual capacity and task proficiency (Cheng et al., 2024). This study synthesizes mind perception theory with social-psychological research to advance a conceptual alignment: warmth corresponds to experience, while competence parallels agency. Consumers' overall evaluations of virtual streamers in these two dimensions ultimately form the perceptions of usefulness, which is an established antecedent of purchase intention (Recalde et al., 2024; Li et al., 2023b). However, there is still a lack of in-depth research on how different types of virtual streamers influence consumers' mind perception process (Liu and Lee, 2024). Therefore, based on mind perception theory, this study further explores the mediating role that perceived usefulness plays in the process of virtual streamers influencing consumers' purchase intention.

Live-streaming enhances purchase intention by offering comprehensive auditory and visual cues (Xi et al., 2023). The message strategy employed by virtual streamers acts as a critical auditory cue, significantly influencing purchase intention (Sheng et al., 2022). Message strategy can be categorized into positive message strategy, which conveys only favorable information, and double-sided message strategy, which includes both positive and negative information (Meng et al., 2023). The interactive nature of these strategies results in varying impacts on consumer evaluations (Liu et al., 2023). Yao et al. (2024) suggest that more exploration is needed into how different message presentation methods influence the impact of virtual streamers on consumers. Therefore, this study further investigates how message strategy moderates the impact of virtual streamers on purchase intention. Moreover, integrating visual cues that consumers seek in the environment is essential for businesses to enhance purchase intention (Han et al., 2024). Cue consistency theory suggests that consistency among cues perceived by consumers can improve their positive perceptions and increase persuasion (Han and Balabanis, 2024). Han et al. (2024) point out that more exploration is needed into the digital technologies and environments in the context of virtual streamers. Therefore, this study combines the mind perception theory and cue consistency theory to analyze how the live-streaming environment moderates the impact of virtual streamers on purchase intention.

In summary, this study is grounded in the mind perception theory and cue consistency theory. By examining the influence of different types of virtual streamers on purchase intention through perceived usefulness. Additionally, this study examines the moderating roles of message strategy and live-streaming environment in the above effects. The research questions of this study are as follows:

RQ1: What are the differences in the impacts of human-backed virtual streamer and AI-backed virtual streamer on purchase intention?

RQ2: Does the perceived usefulness play a mediating role in the impacts of virtual streamers on purchase intention?

RQ3: Do message strategy and live-streaming environment moderate the impacts of virtual streamers on purchase intention?

This study offers new insights into the understanding of virtual streamers by uncovering the

different impacts of virtual streamer (AI-backed vs. human-backed) on purchase intention. Moreover, it provides strategic guidance for companies in selecting appropriate virtual streamers to effectively enhance purchase intention.

## 2. Literature review

### 2.1 *The mind perception theory*

The mind perception theory suggests that consumers assess other objective entities along the dimensions of agency and experience, which in turn trigger psychological and behavioral responses (Yoganathan and Osburg, 2024). Agency refers to the capacity for analysis and reasoning, while experience refers to the capacity for sensation and emotion (Zhang and Song, 2024).

Previous research has utilized the mind perception theory to analyze consumer perceptions of AI products, including AI telemarketers (Li et al., 2023a), conversational agents (Yoganathan and Osburg, 2024), and digital influencers (Wang and Qiu, 2024). For instance, Li et al. (2023a) focused on the experiential dimension of the mind perception theory, discovering that the empathy exhibited by AI in telemarketing contexts can extend the duration of consumers' calls. Yoganathan and Osburg (2024) explored the impact of perceived agency in conversational agents on highly innovative users, identifying a significant positive correlation with satisfaction. Additionally, Wang and Qiu (2024) investigated the experiential dimension and found that the transparency of digital influencers can enhance purchase intention.

Existing studies, based on the mind perception theory, have systematically explored the influence mechanism of AI products on consumers. However, there are still research limitations in the specific area of virtual streamers. Specifically, the existing literature has not clearly analyzed how different types of virtual streamers influence consumer decision-making by activating the agency and experience differently. Therefore, this study, through the framework of the mind perception theory, deeply explores the path through which the type characteristics of virtual streamers affect consumers' purchase intention. Notably, social-psychology research provides important theoretical support for this. When individuals conduct social cognition, an evaluation system is generally constructed through two dimensions: warmth (reflecting friendliness and sincerity) and competence (reflecting professionalism and efficacy) (Im et al., 2023). Among them, the perception of warmth is used to enhance consumers' sense of belonging and social connection by transmitting prosocial cues, thereby positively influencing perceived usefulness, while the perception of competence is used to promote perceived usefulness by strengthening the cognition of technological efficacy (Li et al., 2023b). In this study, the mind perception theory is combined with social psychology research to establish the following corresponding relationships: warmth is associated with the evaluation of experience (perception of emotional interaction), and competence corresponds to the judgment of agency (evaluation of technological efficacy). Together, they form the basis for consumers to form an evaluation of perceived usefulness. Given that perceived usefulness has been proven to significantly and positively predict purchase intention (Recalde et al., 2024), this study, based on the mind perception theory, further analyzes how different types of virtual streamers affect consumers' purchase intention through the mediating variable of perceived usefulness. Additionally, the presentation of messages can influence consumer evaluations (Liu et al., 2023). However, the impact of different message representation methods on consumer

evaluations remains inadequately explored. Therefore, based on the mind perception theory, this study investigates how message strategy moderates the effect of virtual streamers on purchase intention.

## **2.2 Cue consistency theory**

Cue consistency theory posits that the degree of consistency among cues received by consumers influences their attitudes and behaviors (Hsieh, 2023). When consumers encounter various cues, these cues' consistency enhances consumer attitudes, leading to a more positive perception of information (Han and Balabanis, 2024).

Previous research, based on cue consistency theory, has examined the impact of consistency among different cues from influencers on consumers. For instance, Hsieh (2023) demonstrated that higher consistency between an influencer's message and image on social media leads to greater cognitive and emotional identification among consumers. Ren et al. (2023) investigated the effect of congruity between influencer type and brand, finding that whistleblowers, when matched with competitive brands, have a more significant impact on consumers compared to entertainers. Li et al. (2023a) focused on the alignment between digital human avatars and products, revealing that this fit positively influences consumer attitudes.

Although prior research has examined the impact of cue consistency from various types of influencers on consumers, the effect of consistency between different types of virtual streamers and the live-streaming environment on purchase intention remains unclear. In the context of live-streaming, consumers are influenced not only by cues from the streamer but also by those from the live-streaming environment (Han et al., 2024). According to cue consistency theory, a high level of consistency between virtual streamers and the live-streaming environment enhances consumer attitudes and improves their evaluation of virtual streamers' agency and experience. This strengthens consumers' perception of the virtual streamers' competence and warmth, increases perceived usefulness, and ultimately enhances purchase intention. Therefore, this study employs both the mind perception theory and cue consistency theory to analyze how the consistency between different types of virtual streamers and the live-streaming environment affects perceived usefulness and, ultimately, purchase intention.

## **2.3 Virtual streamer**

Virtual streamers are defined as digital avatars created by technology and controlled by humans or AI, characterized by anthropomorphic features (Wu et al., 2023). Based on external characteristics such as celebrity status, identity, and gender, human streamers can be categorized into KOLs (Zhang et al., 2025), celebrity and sports streamers (Li et al., 2022), merchant streamers and internet streamers (Zhang et al., 2023a), and male and female streamers (Yang et al., 2023). For virtual streamers, even when their external characteristics are the same, there can be differences in their internal characteristics, specifically the controllers. Based on the type of controller, virtual streamers are categorized into human-backed and AI-backed virtual streamers (Gao et al., 2023). Human-backed virtual streamers involve live operations by human actors who use motion capture technology to control the avatars' movements and facial expressions and voice modulation devices to adjust their voices (Miao et al., 2021). An example is the Chinese virtual girl group A-Soul, where



each member is brought to life by a voice actor during live-streaming (Lin, 2022). Despite the lack of obvious cues, consumers often find it difficult to discern the controller of a virtual streamer (Miao et al., 2022). Consumer reactions will be different when they know whether they are interacting with a human or an AI (Choi et al., 2024). However, the impact of virtual streamers with varying internal characteristics on consumers has been inadequately explored. Therefore, based on Gao et al. (2023), this study focuses on the virtual streamers with different internal characteristics, specifically by dividing virtual streamers into human-backed and AI-backed virtual streamers.

Research on virtual streamers primarily encompasses two categories: comparative analyses between the effects of virtual streamers and human streamers on consumers, and investigations into how virtual streamers with different external characteristics influence consumers. First, in studies comparing virtual and human streamers, Niu et al. (2023) examined the impact of virtual streamers and KOLs on cross-border consumer behavior, revealing that under conditions of strong external network effects among live audiences, the influence of virtual streamers surpassed that of KOLs. Second, investigations into the external attributes of virtual streamers-spanning language (Hu and Ma, 2023), appearance (Chen et al., 2024a), and gender (Chen et al., 2024b)-have yielded significant insights. Hu and Ma (2023) analyzed the effects of language strategies used by virtual streamers, finding that the employment of sensory language adversely affects purchase intention. Chen et al. (2024a) studied the appearance characteristics of virtual streamers and discovered that anthropomorphism positively influences consumers' willingness to accept virtual live streamers. Additionally, Chen et al. (2024b) explored the gender of virtual streamers and observed that female customers exhibit higher purchase intent for female-gendered products endorsed by male virtual anchors compared to real anchors.

Previous research has compared the different impacts of human and virtual streamers on consumers and has examined the effects of virtual streamers' external characteristics such as language, appearance, and gender on consumers. However, these studies have paid less attention to the internal characteristics of virtual streamers, specifically the controllers, which can vary between human and AI-backed types despite the same external characteristics. Gao et al. (2023) have called for future research to focus more on the impact of virtual streamers on consumers. The mind perception theory posits that consumers evaluate other entities based on dimensions of agency and experience, leading to psychological and behavioral responses (Zhang and Song, 2024). According to the mind perception theory, it is unclear whether consumers would differ in their evaluations of virtual streamers along these dimensions of agency and experience, resulting in different purchase intentions. Wang and Qiu (2024) have also emphasized the need for future research to further explore the differences in mind perception among consumers influenced by various types of digital endorsers. Therefore, this study, based on the mind perception theory, investigates the impact of virtual streamers (AI-backed vs. human-backed) on purchase intention.

#### ***2.4 Purchase intention***

Live-streaming represents an innovative approach to selling products or services, mitigating the drawbacks of traditional online shopping by enhancing authenticity, visualization, and interactivity (Wongkitrungrueng and Assarut, 2020). As the sole performers in live-streaming, streamers play a crucial role in determining consumers' willingness to engage with or make purchases during live-

streaming sessions (Gao et al., 2023).

Research on consumer purchase intention within the context of live-streaming can be categorized into four main areas. The first category investigates the attributes of streamers, specifically identifying which characteristics are most effective in stimulating purchase intention. Gao et al. (2023) found that streamer attractiveness, proficiency, and communication style significantly influence purchase intention. Yang et al. (2023) further analyzed the differential effects of user gender on purchase intention, revealing that hedonic products tend to sell better among male users, while utilitarian products are more appealing to female users. The second category explores consumer characteristics and examines how these traits impact purchase intention. Zheng et al. (2022) demonstrated a positive correlation between consumer engagement and purchase intention during live-streaming, indicating that different levels of engagement among consumers result in differing purchase intentions. The third category focuses on product characteristics, with particular attention to variations in purchase intention across different product types. Chen et al. (2024) concluded that live-streaming significantly enhances the appeal of hedonic products compared to utilitarian products. Finally, the fourth category investigates contextual features, analyzing the influence of the live-streaming environment on purchase intention. Zhang et al. (2023b) found that incorporating background music into live-streaming can enhance both consumer purchase intention and arousal levels.

Previous research has extensively examined the impact of streamers, consumer, product, and contextual features on purchase intention. Consumers are influenced by both auditory and visual cues when watching live-streaming (Xi et al., 2023). Yao et al. (2024) have called for future research to further investigate the effects of different message presentation methods on consumers. However, how varying message strategy influences the impact of virtual streamers on purchase intention remains unclear. Additionally, Han et al. (2024) have emphasized the need for future research to explore the effectiveness of digital technologies and environments in the context of virtual streamers. However, whether the influence of virtual streamers on purchase intention differs across various live-streaming environments remains to be further examined. Therefore, this study further investigates how message strategy and live-streaming environment moderate the impact of virtual streamers on purchase intention.

### **3. Hypothesis development**

#### ***3.1 The effect of virtual streamer on purchase intention***

Virtual streamers are defined as digital avatars that simulate human-like traits and can be categorized into two types based on their controllers: human-backed and AI-backed virtual streamers (Wu et al., 2023; Miao et al., 2022). Human-backed virtual streamers are operated in real-time by humans, while AI-backed virtual streamers operate solely through AI (Hu and Ma, 2023). The mind perception theory posits that consumers evaluate other entities based on two dimensions: agency (the capacity for thought, planning, and action) and experience (the capacity for sensation, experience, and awareness) (Yoganathan and Osburg, 2024). According to the mind perception theory, different types of virtual streamers are evaluated by consumers based on agency and experience, leading to different purchase intentions.

Human-backed virtual streamers, controlled by humans, are endowed with professional knowledge and skills, facilitating the communication of product-related expertise to consumers. This process effectively reduces the effort and cost consumers expend in seeking information, thereby endowing human-backed virtual streamers with high levels of agency. This enhancement in agency strengthens consumers' evaluative judgments and purchase intention (Li et al., 2024). Furthermore, the human operation of these virtual streamers induces a perception of warmth and interpersonal connection. This fosters positive experience evaluations, which in turn increase purchase intention (Aw et al., 2022). Therefore, human-backed virtual streamers exhibit high levels of agency and experience, thereby enhancing purchase intention.

AI-backed virtual streamers, managed by AI, exhibit significant responsiveness, addressing consumers' information queries in a timely and effective manner (Gao et al., 2023). Additionally, leveraging AI and big data analytics, these streamers proficiently identify consumer preferences, facilitating the provision of customized information and product demonstrations (Dai and Cui, 2022). This capability meets consumer needs, enhances the evaluation of agency, and thus increases purchase intention (Gao et al., 2023). However, AI products are often perceived as lacking experiential capabilities and an understanding of consumer emotions, lacking empathy (Han et al., 2024). This perception leads consumers to rate AI-backed virtual streamers lower in experience evaluations compared to human-backed virtual streamers. Therefore, compared to AI-backed virtual streamers, which possess only agency, human-backed virtual streamers, which possess both agency and experience, are more likely to trigger purchase intention.

**H1.** Virtual streamer positively affects purchase intention. Specifically, human-backed virtual streamer leads to higher purchase intention than AI-backed virtual streamer.

### ***3.2 The mediating effect of perceived usefulness***

Perceived usefulness refers to the extent to which consumers believe that the information obtained from virtual streamers aligns with their own needs (Zhou et al., 2017). As a core factor influencing consumers' acceptance of new technologies, perceived usefulness plays a pivotal role in the process of consumers' interaction with new technologies (Shehawy et al., 2025). The mind perception theory posits that consumers evaluate the minds of objective entities from two dimensions: agency (i.e., the ability of analysis and reasoning) and experience (i.e., the ability of sensation and emotion) (Wang and Qiu, 2024; Gong & Sun, 2025). Social-psychological research also reveals that individuals typically evaluate others based on warmth and competence and take corresponding behavioral actions according to the evaluation results (Im et al., 2023). This study combines the mind perception theory with social-psychological research and establishes the following corresponding relationships: warmth is associated with experience (perception of emotional interaction), and competence corresponds to agency (evaluation of technological efficacy). Together, they form the basis for consumers to form perceived usefulness. Specifically, when virtual streamers can provide professional product information and engage in warm and friendly interactions with consumers, consumers' evaluations of their competence and warmth will increase accordingly. This positive evaluation will further strengthen consumers' perceived usefulness (Li et al., 2023b). The improvement of perceived usefulness will prompt consumers to enhance their purchase intention (Recalde et al., 2024). However, different types of virtual streamers may trigger significantly

different evaluations from consumers (Hu and Ma, 2023). This difference in evaluation may lead to disparities in the perceived usefulness of human-backed and AI-backed virtual streamers in consumers' minds, which in turn causes consumers to have different purchase intentions towards these two different types of virtual streamers.

Human-backed virtual streamers are a novel form of online hosts that rely on AI technology and are operated in real-time by human beings. Different from AI with merely high competence, humans demonstrate remarkable performance in both competence and warmth (Li et al., 2023a). According to the mind perception theory and social-psychological research, high levels of competence and warmth can enhance the likelihood of consumers adopting the suggestions of virtual streamers (Gong & Sun, 2025; Xiong et al., 2025). Specifically, human-backed virtual streamers possess the ability to promptly respond to consumers' demands for product information (Hu and Ma, 2023). This efficient response ability conveys a signal of strong efficacy perception to consumers, thereby exerting a positive influence on consumers' perceived usefulness (Li et al., 2023b). Moreover, human-backed virtual streamers can also create a pleasant emotional experience for consumers (Hu and Ma, 2023). The warm experiences, which contain prosocial cue information, such as friendliness they convey, can strengthen the perceived benefits like consumers' sense of belonging and social connection, thus further enhancing consumers' perceived usefulness (Li et al., 2023b). Existing research has indicated that the improvement of perceived usefulness is closely associated with a more positive attitude of consumers, and this positive attitude will ultimately prompt consumers to have a higher purchase intention (Kim and Park, 2024).

AI-backed virtual streamers are presented as highly professional, equipped with a comprehensive product knowledge system, and are capable of accurately and reliably conveying various product information to consumers (Chetioui et al., 2019). This remarkable ability has brought great convenience to consumers, significantly reducing the time and effort they invest in the information search process and effectively shortening the time required for purchase decisions. During this process, consumers' evaluations of the capabilities of AI-backed virtual streamers have been notably enhanced, thereby strengthening their perceived usefulness (Gao et al., 2023; Chang & Chen, 2021; Li et al., 2023b). However, AI often exhibits obvious deficiencies in emotional expression and is generally regarded as lacking empathy and emotional depth. This characteristic causes consumers to give lower evaluations of the emotional engagement of AI-backed virtual streamers during interactions, thus reducing their perception of warmth (Luo et al., 2019). The research findings of Cheng et al. (2024) indicate that when warmth and competence are combined, they can prompt consumers to have positive psychological responses. Conversely, when consumers have a high perception in one dimension but a low perception in the other, they are prone to having conflicting emotional experiences and behavioral responses (Fiske et al., 2007). Based on the above circumstances, compared with human-backed virtual streamers that possess both high competence and warmth, AI-backed virtual streamers, although outstanding in terms of competence, show obvious deficiencies in warmth. This difference causes the perceived usefulness of consumers stimulated by AI-backed virtual streamers to be lower than that of human-backed virtual streamers. Given that perceived usefulness is a crucial factor influencing consumers' purchase intentions (Guo and Sun, 2022), human-backed virtual streamers may trigger higher perceived usefulness than AI-backed virtual streamers that can only satisfy agency, thereby motivating consumers to have stronger purchase intentions.

**H2.** Perceived usefulness mediates the effect of virtual streamer on purchase intention, that is, compared with AI-backed virtual streamer, human-backed virtual streamer can generate higher perceived usefulness and thus purchase intention.

### ***3.3 The moderated mediating effect of message strategy***

Live-streaming provides consumers with a rich array of auditory cues conveyed by the streamer, including message strategy designed to enhance purchase intention (Xi et al., 2023). Message strategy refers to the methods employed by sellers in providing product message during the sales process, which can be categorized into positive message strategy and double-side message strategy (Meng et al., 2023). Positive message strategy involves only the positive aspects of a product, whereas double-side message strategies provide both positive and negative information about the product (Meng et al., 2023). According to the mind perception theory and social-psychological research, consumers evaluate other individuals along two dimensions: competence and warmth, and they respond based on these evaluations (Gong & Sun, 2025; Xiong et al., 2025). In the context of consumer interactions with virtual streamers, different message strategies influence consumers' assessments of the virtual streamer's competence and warmth, leading to varying perceived usefulness, which ultimately affects purchase intention.

When virtual streamers employ double-side message strategy, it can provide consumers with more comprehensive information, including both the positive and negative aspects of a product, thereby allowing consumers to perceive that the virtual streamer offers more extensive information to help them evaluate the product (Sheng et al., 2022). This enhances consumers' assessment of the virtual streamer in terms of competence. Additionally, compared to a positive message strategy that emphasizes only positive information, double-side message strategies make consumers feel more authentic (Jiang et al., 2022). Higher authenticity leads to consumers experiencing more genuine and honest emotional responses (Meng et al., 2023). This results in higher evaluations of the virtual streamer in terms of warmth. Consumers' holistic evaluations of virtual streamers along competence and warmth ultimately shape perceptions of usefulness (Li et al., 2023b). However, there is still a lack of in-depth research on how different types of virtual streamers influence consumers' mind perception process (Liu and Lee, 2024). Therefore, compared to positive message strategy, double-side message strategy improves assessments of the virtual streamer in terms of both competence and warmth, resulting in higher perceived usefulness. Perceived usefulness significantly influences purchase intention, with higher levels of perceived usefulness being associated with higher purchase intention (Han and Du, 2023). Consequently, double-side message strategy, in contrast to positive message strategy, enhances the impact of virtual streamers on perceived usefulness, thereby increasing purchase intention.

**H3.** Compared to positive message strategy, double-side message strategy enhances the impact of both AI-backed virtual streamer and human-backed virtual streamer on purchase intention through perceived usefulness.

### ***3.4 The moderated mediating effect of live-streaming environment***

The live-streaming environment, characterized by visual cues created using virtual reality technology, can be categorized into two types: real live-streaming environment (real settings) and

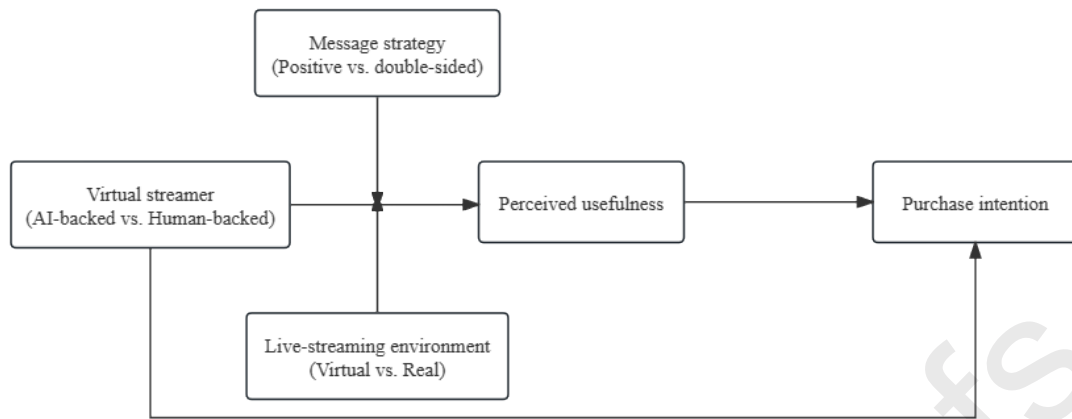
virtual live-streaming environment (environments created using virtual technology) (Wei et al., 2023). Real live-streaming environments are developed by converting physical spaces from the real world into the virtual domain through virtual reality technology, while virtual live-streaming environments are created through simulations of reality (Bin et al., 2023). According to cue consistency theory, when consumers are exposed to information from consistent sources, their attitudes are enhanced, which in turn influences their behavior (Hsieh, 2023). In live-streaming, different matches between virtual streamers and live-streaming environments trigger varying levels of perceived consistency, thereby differently affecting purchase intention.

In a real live-streaming environment, characterized by familiarity with consumers' everyday settings, the level of abstraction is lower, and psychological distance is closer (Fan et al., 2023). Human-backed virtual streamers not only exhibit a highly realistic human appearance but also demonstrate greater behavioral similarity and warmth in emotional communication (Kim et al., 2023). This perception leads consumers to view human-backed virtual streamers as more relatable, resulting in a closer psychological distance (Ahn et al., 2021). Conversely, although AI-backed virtual streamers present a highly similar appearance to humans (Wu et al., 2023), consumers perceive them as lacking emotional depth, which creates a greater psychological distance (Wang and Qiu, 2024). According to cue consistency theory, the alignment between the live-streaming environment and the virtual streamer, as external cues, enhances consumers' perception of consistency in psychological distance, thereby improving consumer attitudes (Kim et al., 2023). This enhancement increases the perceived usefulness of the virtual streamer, which, in turn, bolsters consumers' purchase intention (Guo and Sun, 2022). Therefore, compared to AI-backed virtual streamers, real live-streaming environments amplify the impact of human-backed virtual streamers on perceived usefulness, ultimately enhancing purchase intention.

In virtual live-streaming environments, higher abstraction leads to greater psychological distance (Park, 2019). Human-backed virtual streamers exhibit higher behavioral similarity and warmth in emotional communication, resulting in closer psychological distance with consumers (Kim et al., 2023). Conversely, AI-backed virtual streamers are perceived by consumers as lacking emotional depth, leading to lower perceived similarity and thus greater psychological distance (Wang and Qiu, 2024). According to cue consistency theory, in this scenario, the greater consistency between the psychologically distant virtual live-streaming environments and AI-backed virtual streamers enhances the perceived usefulness of the information among consumers (Andajani et al., 2021). This increased perceived usefulness, in turn, improves purchase intention. Therefore, AI-backed virtual streamers increase purchase intention through heightened perceived usefulness compared to human-backed virtual streamers.

**H4.** Compared to real live-streaming environment, virtual live-streaming environment enhances the impact of AI-backed virtual streamer on purchase intention through perceived usefulness. While, compared to virtual live-streaming environment, real live-streaming environment enhances the impact of human-backed virtual streamer on purchase intention through perceived usefulness.





**Fig. 1** Conceptual framework

#### 4. Overview of studies

We tested our hypotheses across three studies. Study 1 examined the effect of human-backed (vs. AI-backed) virtual streamer on purchase intention (H1). Meanwhile, Study 1 also verified the mediating effect of perceived usefulness in the effect of virtual streamer on purchase intention. (H2). Study 2 identified message strategy as a boundary condition of virtual streamer, that virtual streamer was more effective in generating purchase intention through perceived usefulness when in the double-side message strategy condition, and not in the positive message strategy condition (H3). Study 3 examined the moderating mediating effect of live-streaming environment on the effect of virtual streamer on purchase intention through perceived usefulness (H4).

##### 4.1 Study 1

The purposed of Study 1 was to examine the effect of virtual streamer (human-backed vs. AI-backed) on purchase intention (H1), and the mediating effect of perceived usefulness between virtual streamer and purchase intention (H2). Specifically, we proposed that compared to a human-backed virtual streamer, an AI-backed virtual streamer would generate higher purchase intention. Meanwhile, compared to AI-backed virtual streamer, human-backed virtual streamer inspired a higher degree of perceived usefulness, which in turn triggered a higher purchase intention.

##### 4.1.1 Methodology

*Participants and design.* The G\*Power was adopted to determine the sample size. A power test showed that roughly 130 participants would be adequate (Faul et al.,2009). A total of 199 participants were recruited through Credamo, which was similar to MTurk but for the Chinese population. We retained only questionnaires from those participants who answered the attention check correctly. 27 respondents were eliminated due to failing this check, leaving 172 valid respondents (48.8% male; 32.6% ranging from 21 to 30 years old).

*Procedure and measures.* At the beginning. Participants read a passage about "Imagine you're going to give a friend a laptop, and while browsing the live-streaming, you find a streamer selling

a laptop." Second, participants were randomly assigned to two conditions (human-backed vs. AI-backed). Following Hu and Ma (2023), we manipulated the type of virtual streamer by having participants read a text prior to viewing the video material, specifying whether the virtual streamer was human-backed or AI-backed. Specifically, under the condition of an AI-backed virtual streamer, participants read: "The virtual streamer is supported by AI, with all actions and dialogues performed automatically." In contrast, under the condition of a human-backed virtual streamer, participants read: "The virtual streamer is controlled by humans, who use motion capture and language devices to direct its actions and dialogues." To control for the influence of extraneous factors, as suggested by Yao et al. (2024), we ensured consistency in appearance, hairstyle, and attire between the two types of virtual streamers. Concurrently, live-streaming entails rich and "additional" information (Zhang et al., 2023b). To eliminate the influence of extraneous factors in live-streaming on experimental outcomes, while keeping the virtual streamer and product information constant, we excluded external factors such as live stream titles, viewer counts, and barrage comments. Furthermore, to mitigate the impact of brand information on consumers, we omitted brand details. To validate the effectiveness of the experimental materials, we recruited 106 participants to test the materials. Participants were shown the experimental materials and asked to indicate: "What type of virtual streamer do you believe it to be? 1 = AI-backed, 7 = human-backed." Analysis revealed that participants could distinguish between the two types of virtual streamers ( $M_{AI-backed}=2.04$ ,  $M_{human-backed}=5.72$ ,  $t=20.51^{***}$ ), confirming the effectiveness of the experimental materials. Third, participants were asked to watch a 30-second live clip of a virtual streamer. Virtual streamers typically introduced products to consumers in a direct manner, and consumers only had brief encounters with the virtual streamers under discussion. Hence, drawing upon Hu et al. (2023), we posit that videos were suitable for our study. Then, participants read the definitions of human-backed virtual streamer and AI-backed virtual streamer, and judged the type of virtual streamer in the video they just saw (1= AI-backed, 7= human-backed). Finally, participants responded to the measures of purchase intention which was adapted from Guo et al. (2022) (i.e., "I will buy the products that this streamer promotes in his/her live-streaming."). Then, participants answered a scale about perceived usefulness which was adapted from Hsieh and Lee (2021) (i.e., "The virtual streamer provides good quality information."; "The virtual streamer increases my effectiveness for informed choices online."). The scales for purchase intention and perceived usefulness are both rated on a seven-point Likert scale. After that, we collected several demographic characteristics regarding the respondents (see Appendix 1 for details).

#### 4.1.2 Results

*Realism check.* We asked the participants to rate how they perceived the scenarios to be realistic and how likely they felt that the situation could happen in real life. One-sample t-tests with the test value of 4 (neutral point on a 7-point scale) were conducted for all experimental conditions. All realism scores exceeded the value of 4 and the test results were all significant ( $M_{AI-backed}=5.432$ ,  $t=7.300^{***}$ ;  $M_{human-backed}=5.977$ ,  $t=13.173^{***}$ ).

*Manipulation check.* We check if the manipulation was successful. As expected, participants in the human-backed virtual streamer rated the virtual streamer to be more likely to be controlled by human than those in the AI-backed virtual streamer ( $M_{AI-backed}=2.286$ ,  $M_{human-backed}=5.634$ ,  $t=8.7874^{***}$ ).



*Reliability and validity test.* SPSS 26.0 statistical showed that the reliability coefficient, Cronbach's  $\alpha$  of purchase intention and perceived usefulness were 0.952 and 0.838. The combined composite reliability (CR) value was 0.852 and 0.838. This indicated that the variable was highly reliable. The average variance extracted (AVE) for the variable was greater than 0.500, indicating good convergent validity, which indicated that the scale had good convergence validity. The square root of AVE of purchase intention (0.933) was greater than the correlation coefficient between purchase intention and perceived usefulness (0.182), which proved that the discriminant validity was good.

*Direct effects.* We set virtual streamer as independent variable, purchase intention as dependent variable, and gender, age, employment and monthly income as control variables. The results showed that gender ( $F=3.034$ ,  $p>0.05$ ), age ( $F=1.475$ ,  $p>0.05$ ), employment ( $F=2.316$ ,  $p>0.05$ ) and monthly income ( $F=5.293$ ,  $p>0.05$ ) had no significant influence on purchase intention. A one-way analysis of variance (ANCOVA) on purchase intention showed a significant effect of virtual streamer ( $F=565.881$ ,  $p<0.000$ ). The scores of purchase intention in the human-backed virtual streamer group were significantly higher than those in the AI-backed virtual streamer group ( $M_{AI-backed}=4.909$ ,  $M_{human-backed}=6.390$ ,  $t=23.689^{***}$ ). For details, see Fig. 2. Therefore, our findings provided evidence for the impact for human-backed virtual streamer triggered higher purchase intention than AI-backed virtual streamer; thus, H1 was supported.

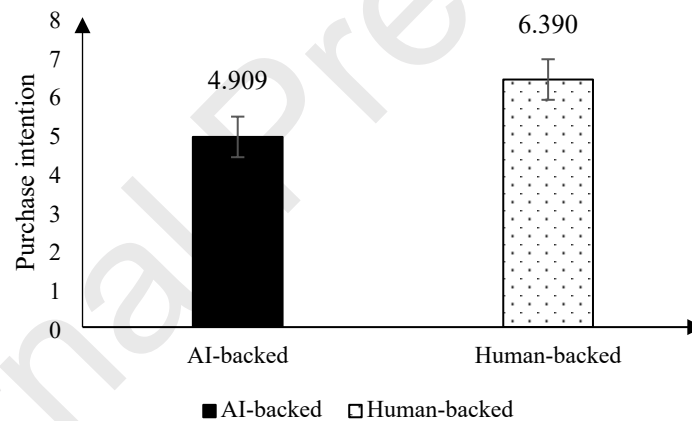


Fig.2. The effect of virtual streamer on affective trust.

*Indirect effects.* We used an ANCOVA on perceived usefulness. The results showed that that gender ( $F=0.531$ ,  $p>0.05$ ), age ( $F=0.006$ ,  $p>0.05$ ), employment ( $F=0.001$ ,  $p>0.05$ ) and monthly income ( $F=1.083$ ,  $p>0.05$ ) insignificantly affected perceived usefulness. The effect of virtual streamer on perceived usefulness was significant ( $F=43.258$ ,  $p<0.000$ ). Specifically, compared with AI-backed virtual streamer, human-backed virtual streamer had a higher effect on perceived usefulness ( $M_{AI-backed}=4.372$ ,  $M_{human-backed}=5.662$ ,  $t=6.603^{***}$ ). For details, see Fig. 3.

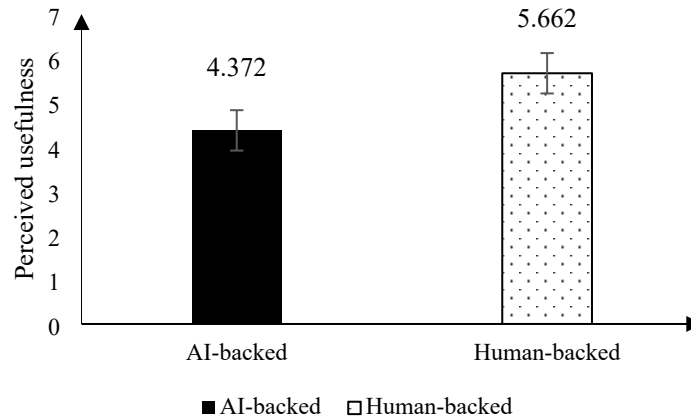


Fig.3. The effect of virtual streamer on perceived usefulness.

The mediation effect of perceived usefulness was tested using Hayes (2013) PROCESS (model 4) with 5000 bootstrapped samples. Specially, we constructed a model in which we set gender, age, employment, and monthly income as control variables, virtual streamer as independent variables, purchase intention as dependent variables, and perceived usefulness as mediating variable. The result showed perceived usefulness mediates the effect of virtual streamer on purchase intention (effect=0.1004, 95% CI [0.0396, 0182]). The findings indicated that when compared to AI-backed virtual streamer, human-backed virtual streamer had a greater effect on perceived usefulness, and perceived usefulness acting as a mediator in the relationship between virtual streamer and purchase intention. Hence, the results supported H2, demonstrating that human-backed virtual streamers prompted higher perceived usefulness than AI-backed virtual streamer, consequently reinforcing purchase intention.

## 4.2 Study 2

Study 2 tested the role of message strategy in the moderating mediating effect of virtual streamer on purchase intention through perceived usefulness. Specifically, whether it is a human-backed virtual streamer or AI-backed virtual streamer, compared with positive message strategy, the double-side message strategy enhanced the effect of virtual streamer on purchase intention through perceived usefulness.

### 4.2.1 Methodology

*Participants and design.* The G\*Power was adopted to determine the sample size. A power test showed that roughly 130 participants would be adequate (Faul et al.,2009). 282 participants were recruited from Credamo. After excluding 42 participants due to failed attention checks, we had a final sample of 240 valid responses (51.7% male. 35.8% ranging from 21 to 30 years old, see Table 2 in Appendix 2).

*Procedure and measures.* The design of Study 2 was a 2 (virtual streamer: human-backed vs. AI-backed)  $\times$  2 (message strategy: double-side vs. positive) between subject design. First, all participants were randomly assigned to one of four groups. Under the positive message strategy condition, the virtual streamer introduces the mouse in the following language: "The baseball cap is

made of pure cotton and is very comfortable. It comes in blue, red and white." Under the condition of double-side message strategy, the virtual streamer introduction said: "The baseball cap is made of pure cotton and is very comfortable. It comes in blue, red and white. But the fabric of this hat is thick, and the breath ability will be affected." The control of the virtual streamer is the same as in Study 1. To validate the effectiveness of the experimental materials, 116 participants were recruited to test the materials. The analysis revealed that the manipulation of the message strategy and the type of virtual streamer was successful ( $M_{AI-backed}=2.03$ ,  $M_{human-backed}=5.79$ ,  $t=19.61^{***}$ ;  $M_{positive}=2.16$ ,  $M_{double-side}=5.57$ ,  $t=17.50^{***}$ ). Second, participants were asked to watch a 30-second clip of a live-streaming from a virtual streamer. After watching the video, participants read the introduction of the human-backed virtual streamer and the AI-backed virtual streamer, and judged the type of virtual streamer in the video they had just watched (1= AI-backed virtual streamer, 7= human-backed virtual streamer). Third, participants completed the same perceived usefulness and purchase intention measurements as in Study 1 and provided their demographic information.

#### 4.2.2 Results

*Realism check.* We also checked the experimental and mundane realism of the four scenarios in Study 3. The realism scores for all experimental conditions were consistently above the test value of 4 using one-sample t-test ( $M_{AI-backed}=6.200$ ,  $t=15.138^{***}$ ;  $M_{human-backed}=6.100$ ,  $t=16.269^{***}$ ;  $M_{positive}=6.300$ ,  $t=18.422^{***}$ ;  $M_{double-side}=6.050$ ,  $t=16.269^{***}$ ), indicating that all experimental scenarios were experimentally and mundanely realistic.

*Manipulation check.* Participants rated virtual streamer as more human-backed in the human-backed virtual streamer condition than in the AI-backed virtual streamer ( $M_{AI-backed}=1.950$ ,  $M_{human-backed}=5.950$ ,  $t=13.802^{***}$ ). Moreover, the results of the double-side message strategy group were significantly higher than those of the positive message strategy group ( $M_{positive}=1.550$ ,  $M_{double-side}=6.050$ ,  $t=17.582^{***}$ ), which proved that participants could distinguish the types of message strategy. Therefore, our control of the virtual streamer and message strategy was successful.

*Reliability and validity test.* According to SPSS 26.0, the Cronbach's  $\alpha$  coefficient of perceived usefulness and purchase intention was 0.934 and 0.741, and the CR value was 0.897 and 0.830. Additionally, the AVE was greater than 0.500. In summary, it is proved that the measurement scale has good reliability and validity. The square root of the AVE value for purchase intention (0.791) exceeds the inter-construct correlations (0.388), thereby confirming discriminant validity.

*Direct effects.* As anticipated in H3, a 2 (virtual streamer: human-backed vs. AI-backed)  $\times$  2 (message strategy: double-side vs. positive) ANCOVA was conducted. The results revealed gender ( $F=0.637$ ,  $p>0.05$ ), age ( $F=0.022$ ,  $p>0.05$ ), employment ( $F=2.189$ ,  $p>0.05$ ) and monthly income ( $F=0.046$ ,  $p>0.000$ ) had no significant effect on perceived usefulness. The interaction effect between virtual streamer and message strategy on perceived usefulness was significant ( $F=10.824$ ,  $p<0.05$ ). Specifically, compared with positive message strategy, double-side message strategy enhanced higher effect of AI-backed virtual streamer ( $M_{positive}=3.921$ ,  $M_{double-side}=4.775$ ,  $t=2.73^*$ ) and human-backed virtual streamer ( $M_{positive}=4.421$ ,  $M_{double-side}=6.229$ ,  $t=9.483^{***}$ ) on perceived usefulness. For details, see Fig. 4.

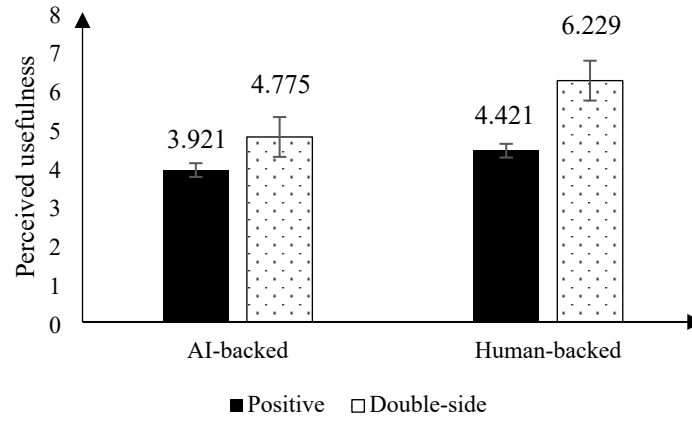


Fig. 4. The interaction effect of virtual streamer and message strategy on perceived usefulness.

*Indirect effects.* Moderated mediation analyses (model 8) were performed. Virtual streamer was selected as the independent variable, message strategy as the moderator, purchase intention as the dependence variable, and perceived usefulness as the mediator. The data indicated a significant effect of moderated mediating (effect=0.094, 95% CI [0.034, 0.166]). In the double-side message strategy, the human-backed and AI-backed virtual streamer enhanced higher purchase intention through perceived usefulness (effect=0.145, 95% CI [0.038, 0.166]) than in the positive message strategy (effect=0.051, 95% CI [0.042, 0.217]). For details, see Table 1. Therefore, compared with positive message strategy, double-side message strategy triggered higher mediating effect of perceived usefulness in the effect of both human-backed and AI-backed virtual streamer on purchase intention, supporting H3.

Table 1. Moderating analysis of Study 2.

	Effect	LLCI	ULCI
Moderating effect	0.094	0.034	0.166
Double-side message	0.145	0.038	0.166
Positive message	0.051	0.042	0.217

### 4.3 Study 3

Study 3 tested H3, which states that the moderating mediating effect of live-streaming environment of the effect of virtual streamer on purchase intention through perceived usefulness. Specifically, in the real live-streaming environment, compared to AI-backed virtual streamer, human-backed virtual streamer inspired higher perceived usefulness, and then triggered higher purchase intention. While, in the virtual live-streaming environment, compared to human-backed virtual streamer, AI-backed

virtual streamer inspired higher perceived usefulness, and then triggered higher purchase intention.

#### 4.3.1 Methodology

*Participants and design.* The G\*Power was adopted to determine the sample size. A power test showed that roughly 130 participants would be adequate (Faul et al., 2009). The sample was recruited via Credamo to complete an online survey. The survey was administered to a sample of 293 participants. We retained questionnaires where participants correctly answered the attention checks. 25 respondents were eliminated due to failing this check. The final sample comprised 281 respondents 48.4% male, 34.8% ranging from 21 to 30 years old, see Table 3 in Appendix 3).

*Procedure and measures.* The design of Study 3 was a 2 (virtual streamer: human-backed vs. AI-backed)  $\times$  2 (live-streaming environment: real vs. virtual) design, which procedure contained four parts. First, participants read materials about assuming that they want to buy a chocolate, they are watching live-streaming, found that a virtual streamer is selling the chocolate. Based on the methodology proposed by Wei et al. (2023), we manipulated the live-streaming environment. Concretely, real live-streaming settings incorporated real-life backgrounds, while virtual live-streaming environment was created using Jianying software, which cartoonized the real live-streaming environment to generate virtual live-streaming environment. Second, they were then randomly divided into two conditions to watch a live-streaming video by a virtual streamer. Third, participants read AI-backed and human-backed virtual streamer introductions. Then, participants answered a 7-point scale about perceived usefulness and purchase intention, which were the same as Study 1. Participants also answered the scales of purchase intention which was the same as Study 1. After that, they completed the anthropomorphism manipulation check measures.

#### 4.3.2 Results

*Realism check.* We also checked the experimental and mundane realism of the two scenarios in the study. The realism score for all experimental conditions were consistently above the test value of 4 using one-sample t-test ( $M_{AI-backed}=5.70>4$ ,  $t=25.082^{***}$ ;  $M_{human-backed}=5.82>4$ ,  $t=28.748^{***}$ ;  $M_{real}=5.64>4$ ,  $t=26.675^{***}$ ;  $M_{virtual}=5.39>4$ ,  $t=16.695^{***}$ ).

*Manipulation check.* The manipulation check confirmed that the manipulation of human-backed virtual streamer resulted in stronger perceptions of human-backed than in the AI-backed virtual streamer condition ( $M_{AI-backed}=2.13$ ,  $M_{human-backed}=5.65$ ,  $t=28.459^{***}$ ). Besides, the results indicated that participants could distinguish between the virtual streamer and the live-streaming environment ( $M_{real}=2.32$ ,  $M_{virtual}=5.33$ ,  $t=19.367^{***}$ ), confirming the effectiveness of the experimental materials.

*Reliability and validity test.* According to SPSS 26.0 analysis results, the reliability coefficients, Cronbach's  $\alpha$  of perceived usefulness and purchase intention were 0.910, 0.751, respectively. The CR values were 0.911, 0.752, indicating that the variable was highly reliable. The AVE value of the average variance extraction of the variable was greater than 0.500, indicating good convergent validity. It proved that the discriminant validity was good. Meanwhile, the square root of the AVE value for perceived usefulness (0.847) exceeded the inter-construct correlations (0.675), thereby confirming discriminant validity.

*Direct effects.* The ANCOVA was conducted with virtual streamer and live-streaming environment as independent variables; perceived usefulness as dependent variable; and gender, age, employment, and monthly income as controls. Results revealed significant interaction effect of virtual streamer and live-streaming environment on perceived usefulness ( $F=12.662$ ,  $p<0.001$ ). Specially, in real live-streaming environment, human-backed virtual streamer had higher perceived usefulness than AI-backed virtual streamer ( $M_{AI-backed}=4.352$ ,  $M_{human-backed}=6.113$ ,  $t=8.777^{***}$ ). In the virtual live-streaming environment, compared with human-backed virtual streamer, AI-backed virtual streamer had a higher perceived usefulness ( $M_{AI-backed}=5.574$ ,  $M_{human-backed}=3.859$ ,  $t=8.203^{***}$ ). For details, see Fig. 5.

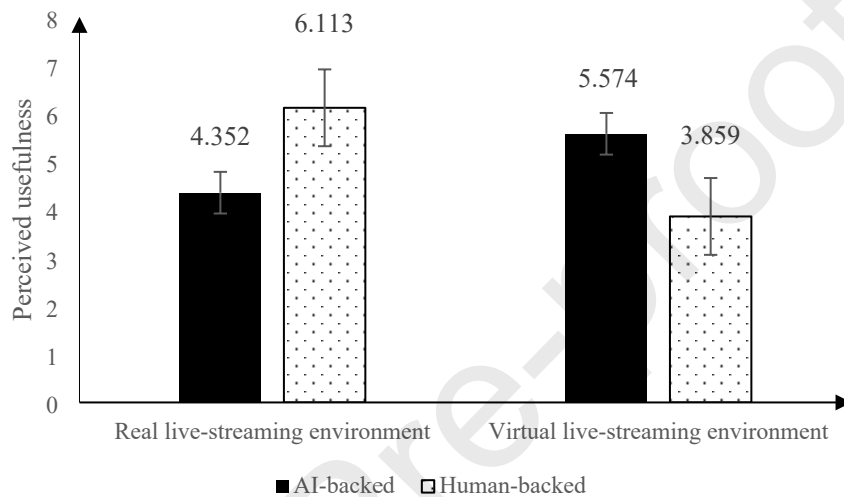


Fig. 5. The interaction effect of virtual streamer and live-streaming environment on perceived usefulness.

*Indirect effects.* Moderation mediation analyses (model 8) were performed, selecting virtual streamer as the independent variable, virtual-streaming environment as moderator, purchase intention as the dependent variable, and perceived usefulness as the mediator. The data indicated a significant effect of moderated mediating effect of virtual-streaming environment (effect=0.221, 95% CI [0.077, 0.433]). In virtual live-streaming environment, compared with the human-backed virtual streamer, AI-backed virtual streamer could generate higher purchase intention through perceived usefulness (effect=0.262, 95% CI [0.139, 0.427]). While in the real live-streaming environment, compared with the AI-backed virtual streamer, human-backed virtual streamer could generate higher purchase intention through perceived usefulness (effect=0.483, 95% CI [0.261, 0.769]), verifying H4. For details, see Table 2.

Table 2. Moderating analysis of Study 3.

	Effect	LLCI	ULCI
Moderating effect	0.221	0.077	0.433

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Virtual live-streaming environment	0.262	0.139	0.427
Real live-streaming environment	0.483	0.261	0.769

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## 5. Discussion and conclusion

### 5.1 Discussion

Firstly, this study demonstrates a positive effect of virtual streamers on purchase intention. Choi et al. (2023) found that consumers exhibit different responses when they learn that their interaction is with AI rather than a human. Based on Choi et al. (2023), this research further investigates whether human-backed and AI-backed virtual streamers have different impacts on purchase intention. Specifically, this research reveals that human-backed virtual streamers have a higher effect on purchase intention compared to AI-backed virtual streamers.

Secondly, this study reveals that perceived usefulness mediates the relationship between virtual streamers and purchase intention. Li et al. (2023a) indicated that human and AI agents trigger varying degrees of mind perception and lead to different consumer responses. Based on Li et al. (2023a), this research applies the mind perception theory to explain how two types of virtual streamers satisfy consumers' external motivations, leading to varied evaluations of agency and experience, which in turn affect perceived usefulness and purchase intention differently. It was observed that human-backed virtual streamers triggered higher perceived usefulness compared to AI-backed virtual streamers, resulting in a greater purchase intention.

Thirdly, this study reveals that message strategy serves as a moderator in the influence of virtual streamers on purchase intention through perceived usefulness. Hernandez et al. (2023) found that double-side messages can foster increased consumer trust, making them more effective than positive messages in enhancing purchase intention. Based on Hernandez et al. (2023), this research further clarifies the moderating role of message strategy. Specifically, it was discovered that, compared to a positive message strategy, a double-side message strategy enhances the impact of virtual streamers on perceived usefulness, thereby increasing purchase intention.

Finally, this study reveals the moderating role of live-streaming environment. Wei et al. (2023) discovered that matching human and virtual endorsers with the context of advertising enhances purchase intention. Based on Wei et al. (2023), this research further analyzes the match between virtual streamers and live-streaming environment. Specifically, it was found that a real live-streaming environment enhances the perceived usefulness of human-backed virtual streamers, thereby increasing purchase intention. Conversely, a virtual live-streaming environment amplifies the influence of AI-backed virtual streamers on perceived usefulness, thus strengthening purchase intention.

### 5.2 Theoretical contributions

Firstly, this study, based on the mind perception theory, clarifies the impact of different types of



virtual streamers on purchase intention, thereby expanding the scope of research on virtual streamers and expanding the application of the mind perception theory. Gao et al. (2023) noted that research on virtual streamers remains in its early stages. Additionally, Wang and Qiu (2024) called for future investigations to examine the differences in how various types of digital endorsers affect consumer perceptions. In response to the calls from Gao et al. (2023) and Wang and Qiu (2024), based on the mind perception theory, this study explores the differing impacts of human-backed and AI-backed virtual streamers on purchase intention. This research not only extends the field of the mind perception theory but also enriches the existing literature on virtual streamers.

Secondly, this study clarifies the influence of virtual streamers on purchase intention through perceived usefulness, thereby enhancing our understanding of the underlying mechanisms. Liu and Lee (2024) suggested that future research can focus on how different characteristics of virtual influencers alter consumers' psychological evaluation processes. In response to Liu and Lee (2024), this study provides evidence of how virtual streamers drive purchase intention through perceived usefulness. This contributes to a deeper understanding of the mechanisms by which virtual streamers influence purchase intention.

Finally, by considering message strategy and live-streaming environment, this study supplements the boundary conditions of virtual streamers. Yao et al. (2024) called for future research to further examine the impact of different message presentation methods on consumers. In response to Yao et al. (2024), this study finds that a double-side message strategy exhibits a moderated mediating effect in the process whereby virtual streamers influence purchase intention through perceived usefulness. Furthermore, this research addresses the call by Han et al. (2024) to further explore the effectiveness of digital technology and environments in the context of virtual streamers. Based on cue consistency theory, this study clarifies how the consistency between the type of virtual streamers and live-streaming environment influences consumers, thereby expanding the application of cue consistency theory.

### ***5.3 Practical implications***

Firstly, this study finds that human-backed virtual streamers have a more positive impact on purchase intention compared to AI-backed virtual streamers. Therefore, when marketers utilize human-backed virtual streamers, providing clear cues that allow consumers to easily discern the human control behind the virtual streamer can lead to more positive consumer attitudes. For instance, marketers can leverage technology to enhance the naturalness of human-backed virtual streamers' movements and the interactive experience, thereby increasing purchase intention. With the maturation of AI motion capture and facial capture technologies, marketers can utilize software such as VTube Studio and Facerig. Through these software, the webcam can be used to capture the real-time facial movements of human operators and map them onto virtual streamers, reducing the stiffness of the virtual streamers' movements. This technology enables the expressions and gestures of virtual streamers to closely resemble those of the human operators. For instance, during the presentation, the virtual streamers can smile naturally or emphasize points with gestures, creating a more realistic interactive scene and enhancing consumers' acceptance. For example, when a virtual streamer is explaining skin care products, it can display an amiable expression according to the actual smiling amplitude of the operator, thus constructing a more immersive interactive scene with



a strong sense of engagement. This effectively improves consumers' acceptance and trust in virtual streamers.

Secondly, this study identifies perceived usefulness as the mediating mechanism through which virtual streamers influence purchase intention. Therefore, brands or retailers are advised to enhance the knowledge base of virtual streamers to provide consumers with greater perceived usefulness. Brands or retailers can use advanced technologies, such as big data, to collect and organize content relevant to consumers' interests, encourage viewer engagement by posing questions and providing prompt responses, and create positive interactive scenarios. Specifically, with the iterative upgrades of large language models (LLMs) such as GPT and Deepseek, AI has been able to achieve precise understanding and natural responses in multi-round dialogues. Merchants can deeply integrate large language models with virtual streamers to construct an intelligent shopping guide system available throughout the day. Through this system, virtual streamers can go beyond the traditional function of product display. Based on users' real-time questions and historical interaction data, the content of answers that fits the consumption scenarios can be dynamically generated. For example, after the virtual streamer "Mulan" is integrated with Baidu's ERNIE language model, different questions raised by consumers can be answered fluently and concisely, which greatly enhances consumers' interactive experience.

Thirdly, this study finds that the live-streaming environment moderates the influence of virtual streamers on purchase intention through perceived usefulness. Brands should prioritize selecting suitable live-streaming environments, as different environments yield varying effects. When AI-backed virtual streamers are employed, brands can utilize real-time rendering engines (such as Unreal Engine 5), spatial computing, and XR technologies. Through these means, virtual live-streaming environment that break through the limitations of reality can be constructed, enhancing the visual impact and novelty. For human-backed virtual streamers, real live-streaming environment can be replicated by brands through environmental modeling and lighting simulation technologies. In this way, consumers' sense of authenticity and trust can be strengthened.

#### ***5.4 Limitations and future research***

This study also has certain limitations and areas for future research. Firstly, the study was validated solely through experimental methods, which may limit external validity. Therefore, future research could enhance external validity by collecting real-world data. For instance, future studies could gather actual live-streaming data or collaborate with virtual-streaming platforms to further validate the applicability of the findings.

Secondly, this study categorizes virtual streamers based solely on their internal characteristics, specifically whether they are controlled by humans or AI, without covering the new types of virtual streamers empowered by LLMs. These virtual streamers, with capabilities such as real-time semantic understanding, dynamic content generation, and cross-modal interaction, form a mechanism that significantly influences consumer perception, which is quite different from that of traditional AI-backed virtual streamers. Future research could systematically compare the differential impacts of virtual streamers driven by different AI technologies on consumer decision-making.

Thirdly, although this study has verified that perceived usefulness plays a mediating role in the relevant mechanism, the dimensions for examining the mediating mechanism are rather limited. Currently, the differential action paths presented by the two dimensions of agency and experience have not been thoroughly analyzed. Future research can focus on this aspect to further analyze the mediating effects respectively exerted by the psychological perceptions of agency and experience. Moreover, subsequent studies can also, based on the dual-system theory, explore whether utilitarian value and hedonic value will also play mediating roles in this mechanism.

Finally, in this study, only message strategy and live-streaming environment were regarded as moderating variables. Future research could explore whether other variables, such as cultural background or product types, can also moderate the influence of virtual streamers on consumers' behavioral intentions. For example, future research could consider product types (utilitarian vs. hedonic) and cultural backgrounds (collectivism vs. individualism) as moderating variables.

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## Appendix 1

### Experiment scenarios

Imagine that you need to buy a baguette, and while you're browsing a live stream, you stumble upon a streamer selling a baguette.

### Experimental stimuli



### Descriptive statistics of experiment participants(N=172)

Variable	Level	Frequency	Percentage
Gender	Male	84	48.8
	Female	88	51.2
Age	21 and under	49	28.5



	21-30	56	32.6
	31-40	37	21.5
	41 and above	30	17.4
<hr/>			
	< 3000 yuan	14	8.1
	3000-5000	64	37.2
<b>Monthly income</b>	5000-8000	37	21.5
	8000-15000	33	19.2
	> 15000 yuan	21	13.9
<hr/>			
	Unemployed	37	21.5
	Student	70	40.7
<b>Employment</b>	Part-time employed	23	13.4
	Full-time employed	30	17.4
	Self-employed	12	7.0
<hr/>			

**Measurement items**

<b>Construct</b>	<b>Item description</b>	<b>Cronbach's <math>\alpha</math></b>	<b>AVE</b>	<b>CR</b>
<hr/>				
<b>Dependent variable</b>				
<hr/>				

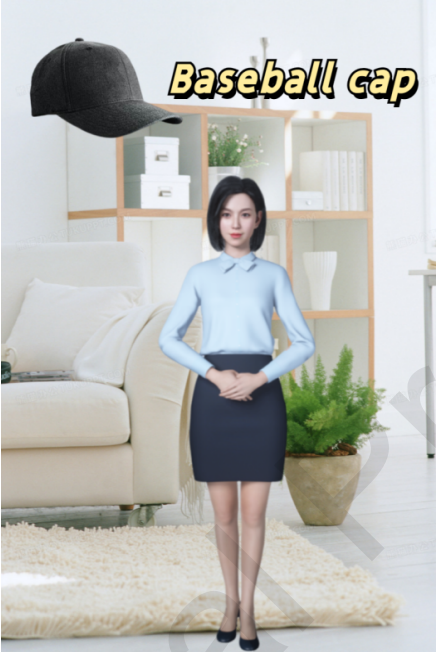
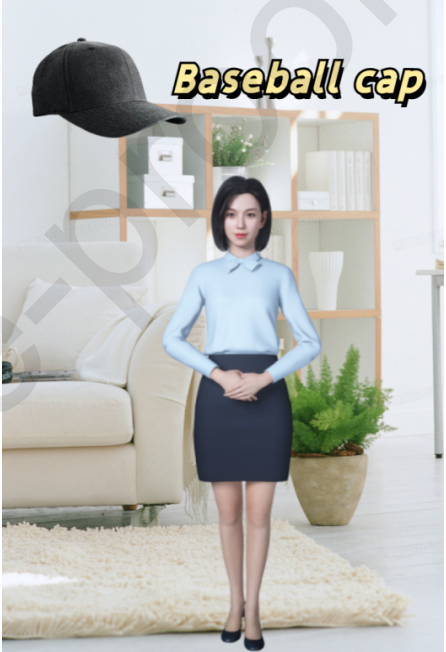
<b>Purchase intention</b>	<ul style="list-style-type: none"> <li>• I will buy the products that this streamer promotes in his/her live-streaming.</li> </ul>	0.952	0.870	0.952
(Guo <i>et al.</i> , 2022)	<ul style="list-style-type: none"> <li>• I intend to purchase the products that this streamer promotes in his/her live-streaming.</li> <li>• I will consider this streamer's live-streaming room as my first shopping choice.</li> </ul>			
<b>Mediators</b>				
<b>Perceived usefulness</b>	<ul style="list-style-type: none"> <li>• The virtual streamer provides good quality information.</li> </ul>	0.838	0.564	0.838
(Hsieh and Lee, 2021)	<ul style="list-style-type: none"> <li>• The virtual streamer increases my effectiveness for informed choices online.</li> <li>• The virtual streamer is useful for assessing information choices online.</li> <li>• The virtual streamer improves my performance in assessing information choices.</li> </ul>			

Appendix 2

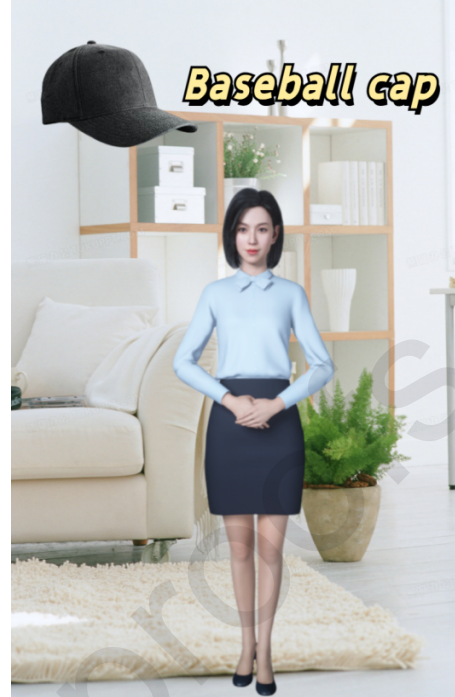
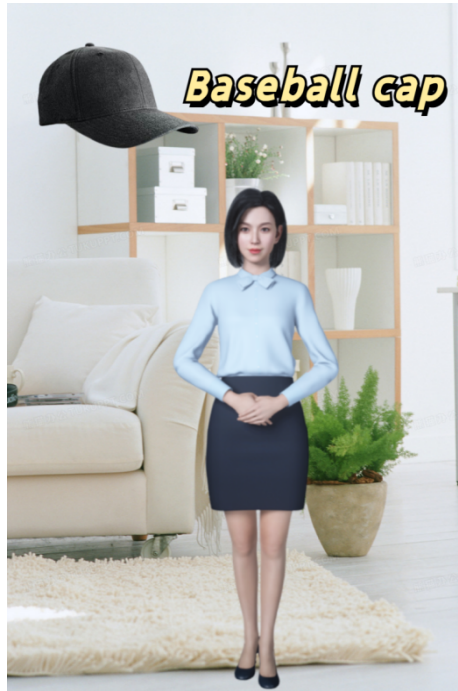
Experiment scenarios

Imagine you're going to give a friend a dark chocolate, and while browsing the live-streaming, you find a streamer selling dark chocolate.

Experimental stimuli

	Human-backed virtual streamer	AI-backed virtual streamer
double-side message strategy	 A photograph of a woman with short dark hair, wearing a light blue long-sleeved shirt and a dark blue skirt, standing in a modern living room. A black baseball cap is floating in the air above her head. The text "Baseball cap" is written in a stylized, bold, yellow font with a black outline above the cap. The background includes a white sofa, a wooden shelving unit, and a potted plant.	 A photograph of a woman with short dark hair, wearing a light blue long-sleeved shirt and a dark blue skirt, standing in a modern living room. A black baseball cap is floating in the air above her head. The text "Baseball cap" is written in a stylized, bold, yellow font with a black outline above the cap. The background includes a white sofa, a wooden shelving unit, and a potted plant.

Positive  
message  
strategy



Variable	Level	Frequency	Percentage
Gender	Male	124	51.7
	Female	116	48.3
Age	21 and under	71	29.6
	21-30	86	35.8
	31-40	70	29.2
	41 and above	13	5.4
Monthly income	< 3000 yuan	25	10.4
	3000-5000	67	27.9

	5000-8000	80	33.3
	8000-15000	49	20.4
	> 15000 yuan	19	7.9
<b>Employment</b>	Unemployed	40	16.7
	Student	88	36.7
	Part-time employed	48	20.0
	Full-time employed	48	20.0
	Self-employed	16	6.7

#### Descriptive statistics of experiment participants(N=240)

#### Measurement items

Construct	Item description	Cronbach's $\alpha$	AVE	CR
<b>Dependent variable</b>				
<b>Purchase intention</b> (Guo <i>et al.</i> , 2022)	• I will buy the products that this streamer promotes in his/her live-streaming.	0.741	0.625	0.830
	• I intend to purchase the products that this streamer promotes in his/her live-streaming.			
	• I will consider this streamer's live-streaming room as my first shopping choice.			

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**Mediators**


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<b>Perceived usefulness</b>	<ul style="list-style-type: none"> <li>• The virtual streamer provides good quality information.</li> </ul>	0.934	0.689	0.897
(Hsieh and Lee, 2021)	<ul style="list-style-type: none"> <li>• The virtual streamer increases my effectiveness for informed choices online.</li> <li>• The virtual streamer is useful for assessing information choices online.</li> <li>• The virtual streamer improves my performance in assessing information choices.</li> </ul>			





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Appendix 3

Experiment scenarios

Assuming that they want to buy a hand cream to friends, live on browsing, find a streamer was selling a hand cream

Experimental stimuli

	Human-backed virtual streamer	AI-backed virtual streamer
Real live-streaming environment		
Virtual live-streaming environment		

Descriptive statistics of experiment participants(N=256)

Variable	Level	Frequency	Percentage
<b>Gender</b>	Male	124	48.4
	Female	132	51.6
<b>Age</b>	21 and under	76	29.7
	21-30	89	34.8
	31-40	77	30.1
	41 and above	14	5.5
<b>Monthly income</b>	< 3000 yuan	25	9.8
	3000-5000	95	37.1
	5000-8000	56	21.9
	8000-15000	66	25.8
	> 15000 yuan	14	5.5
<b>Employment</b>	Unemployed	14	5.5
	Student	95	37.1
	Part-time employed	68	26.6
	Full-time employed	63	24.6
	Self-employed	16	6.3



**Measurement items**

Construct	Item description	Cronbach's $\alpha$	AVE	CR
Dependent variable				
Purchase intention  (Guo <i>et al.</i> , 2022)	• I will buy the products that this streamer promotes in his/her live-streaming.	0.751	0.504	0.752
	• I intend to purchase the products that this streamer promotes in his/her live-streaming.			
	• I will consider this streamer's live-streaming room as my first shopping choice.			
Mediators				
Perceived usefulness  (Hsieh and Lee, 2021)	• The virtual streamer provides good quality information.	0.910	0.718	0.911
	• The virtual streamer increases my effectiveness for informed choices online.			
	• The virtual streamer is useful for assessing information choices online.			
	• The virtual streamer improves my performance in assessing information choices.			

**Highlights**

- This research seeks to clarify the effects, underlying mechanisms, and conditional boundaries of different backed types of virtual streamer (human backed vs. AI backed ) influencing purchase intention.
- This research seeks to explore the impact of different backed types of virtual streamers on purchase intention through perceived usefulness.
- This research seeks to expand the boundary conditions of virtual streamers from the perspectives of message strategy and live-streaming environment.

#### **Declaration of interests**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The author is an Editorial Board Member/Editor-in-Chief/Associate Editor/Guest Editor for *[Journal name]* and was not involved in the editorial review or the decision to publish this article.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: