Article

Is AI Better than Humans? Unveiling the Boundary Conditions Under Which Virtual Influencers Outperform Human Influencers in Endorsing Sustainable Products

Xu Yan, Hon Tat Huam and Abu Bakar Sade

Article

Is AI Better than Humans? Unveiling the Boundary Conditions Under Which Virtual Influencers Outperform Human Influencers in Endorsing Sustainable Products

Xu Yan [1,2,*] **, Hon Tat Huam** [3] **and Abu Bakar Sade** [1]

1   Putra Business School, Universiti Putra Malaysia, Seri Kembangan 43400, Malaysia;
    abubakar.sade@putrabs.edu.my
2   School of Business Administration, Chongqing Vocational College of Light Industry, Chongqing 401329, China
3   Faculty of Business, City University of Macau, Avenida Padre Tomás Pereira, Taipa, Macau;
    hontathuam@cityu.edu.mo
*   Correspondence: pbs22104086@grad.putrabs.edu.my

Abstract: With the rising trend toward sustainable consumption and the pivotal role of social media in the buying behavior, brands are keen to promote sustainable products through these platforms. Virtual influencers (VIs) have emerged as lower-cost and scandal-resistant alternatives to human influencers (HIs). However, their artificial nature may evoke credibility concerns, potentially undermining marketing effectiveness. Currently, it is unclear whether humans or virtual influencers achieve better endorsement outcomes for sustainable products. This study explores the effectiveness of VIs and HIs in endorsing sustainable products and the conditions under which VIs may outperform HIs. Through two studies (N = 1097), we investigate the impact of influencer type, advertising appeals, and product involvement on consumer purchase intentions and brand attitudes. Our findings reveal that, in low-involvement product scenarios with emotional appeals, HIs are more effective, while in high-involvement product scenarios featuring rational appeals, VIs exhibit superior effectiveness. These results suggest that the choice of influencer type should be tailored to the product involvement level and the nature of the advertising appeal, providing guidance for brands to enhance the impact of their green marketing strategies.

1. Introduction

In today's society, as environmental issues have become incredibly severe, companies are placing increased emphasis on promoting sustainable development [1]. This approach reflects a company's sense of social responsibility and responds to the increasing consumer demand for eco-friendly products and services [2]. The rise of social media has allowed brands and companies to use social media influencers, online personalities known for their capacity to create targeted content and build strong connections with their audience [3,4], to disseminate sustainable concepts and products, which has become a common phenomenon [5]. These influencers play a crucial role by sharing environmentally friendly lifestyles, promoting green products, and raising public awareness of environmental issues [6]. In the global market environment, brands need to quickly and widely spread their sustainable concepts and products to attract the attention and trust of consumers worldwide [7].

However, traditional human influencers (HIs), while playing an essential role in promoting sustainable products, also have certain limitations. For example, personal behavior, controversies, or uncontrollable factors associated with HIs may negatively impact a brand's

image [8,9]. In addition, the promotional activities of HIs are restricted by physical conditions, such as geographical location and scheduling, which may limit a brand's rapid spread and promotional coverage on a global scale. In this context, the emergence of virtual influencers (VIs)—digital beings with human-like appearances and personalities that can interact with people, either controlled by humans or AI algorithms [4,10]—offers a new option for brand endorsement [8,11]. Compared with traditional HIs, VIs have unique advantages, which make them an ideal choice for brands to implement global marketing strategies. They can not only promote globally in a way that is not limited by physical constraints but also have relatively lower endorsement costs [12]. At the same time, it is possible to completely control their image and message delivery, avoiding the moral controversies and risks that human endorsers may involve [8,13]. Moreover, VIs can be better aligned with a brand's sustainable mission, providing greater flexibility and innovation for the brand's marketing planning [13]. Currently, VIs are widely applied in the commercial field, including innovative practices in promoting sustainable products. For example, in 2022, a Chinese virtual influencer, Ling, became the Chinese ambassador for Tesla's electric vehicles.

As VIs gain social traction on social media, they have garnered significant attention from industry professionals and have sparked substantial interest within the academic sphere regarding their value and potential applications [14,15]. There is a noticeable gap in studies that explore the differential impacts of VIs and HIs on endorsing sustainable products, while existing research has primarily examined the varying consumer reactions that VIs and HIs elicit, such as emotional responses (including emotional attachment [16] and parasocial relationships [17]), behavioral changes (like brand attitude [18], purchase intention [15], engagement [9], and word of mouth [19]), and cognitive assessments (e.g., perceived credibility, [18]; perceived authenticity [8], and perceived similarity [9]). Consequently, our study seeks to address the following research question:

RQ1: *In endorsing sustainable products, which type of influencer—VI or HI—is more effective?*

Additionally, the dual-process theory posits that cognition is processed through two distinct pathways: System 1, which is fast, intuitive, and heuristic, and System 2, which is slow, analytical, and logical [20]. In the current era, where streaming platforms are driven by user interest algorithms, users can quickly achieve a sense of gratification with minimal effort, such as a simple screen swipe [21,22]. This reliance on immediate feedback may foster a cognitive habit: when engaging with social media, users often default to System 1's heuristic and emotional processing methods rather than to the in-depth analysis and rational thinking of System 2 [23]. As a result, in influencer marketing, emotional appeals—the marketing strategies that aim to influence consumers' feelings and emotions, rather than their rational decision-making processes—have become a prevalent strategy to enhance persuasiveness [13,24]. When VIs share well-crafted stories on social media, they can, like HIs, capture users' attention and engagement by triggering emotional responses [19]. In the realm of sustainable product endorsements, compassion, as a potent emotional appeal, has been widely recognized for its role in promoting sustainable consumption and prosocial behaviors [25].

While emotional appeal is often enough to sway consumers in the case of low-involvement products—which carry a low level of decision-making risk—the endorsement of high-involvement products—which carry a high level of decision-making risk—requires a more deliberate approach. The dual-process theory suggests that, for these more significant purchases, consumers will likely activate System 2, engaging in rational contemplation and a detailed assessment of the message content [20,26]. Beyond the intrinsic attributes of a product, such as price, functionality, and quality, ecological innovation—covering both product and process aspects—is the critical consideration for consumers when it comes to sustainable consumption and the key area of practice and research in sustainable development [2].

Currently, it remains uncertain how the interplay between advertising appeals and the nature of the product (in terms of product involvement) affects the comparative effective-

ness of VIs and HIs in promoting sustainable products and whether VIs could outperform HIs under certain conditions. To address this gap in knowledge, the aim of our study is to explore these dynamics. This leads us to our second research question:

RQ2: *What specific conditions, considering the interaction between advertising appeals and product involvement, might make VIs more effective than HIs in endorsing sustainable products?*

Overall, although previous research examined the effectiveness of VIs (animated VIs vs. human-like VIs) in green marketing [13] and VIs' performance in promoting green causes [27], no studies have directly compared the impact of VIs and HIs on the endorsement of sustainable products. This study pioneers a comparative analysis of the effectiveness of VIs and HIs in endorsing sustainable products. We believe that our findings could potentially benefit sustainable marketing practices. For instance, when devising marketing strategies (e.g., for the promotion of new-energy vehicles), brands can leverage our insights to consider product features and types of advertising appeals in order to select more suitable endorsers, thereby optimizing the marketing outcomes and maximizing the return on investment of marketing campaigns. In light of this, the aim of the present study is to investigate the comparative effectiveness of VIs and HIs in endorsing sustainable products and to identify the conditions under which VIs may outperform HIs.

2. Literature Review

2.1. VIs and Sustainable Products

VIs are artificial characters created by using AI and computer graphics [12,15,18]. Although they are not self-governing and are managed by humans offstage [10], they wield social media influence by crafting engaging digital identities and narratives [28]. By blending AI with content marketing, VIs provide an economical way to boost brand awareness, engagement, and market share [15].

VIs possess distinct advantages over HIs, such as limitless operation and immunity to illness, which enable them to create value at any time and space [8]. However, their intangible nature may hinder their endorsement outcome despite their comparable ability to engage audiences and influence brand image and attitudes [9,15]. They are less effective in promoting sensory products like food and cosmetics, possibly due to a perceived lack of sensory experience (please see Table 1) [29–31]. In contrast, their tech-savvy attributes make VIs well suited for endorsing utilitarian products such as headphones, matching HIs in their endorsement power [14].

Table 1. Overview of comparative studies of virtual and human influencers.

Reference	Method	Product Type	Key Findings
[19]	Experiment	-	Viewers show similar parasocial interactions with VIs and HIs but rate VIs lower in mental anthropomorphism and self-similarity.
[31]	Experiment	-	While HIs and VIs can both heighten appearance anxiety, exposure to VIs tends to result in lower anxiety levels than exposure to HIs.
[12]	Experiment	Cosmetic vs. technical	For cosmetic ads, human influencers are preferred over virtual ones for endorsement and evaluation.
[32]	Mixed methods	Sensory cue salience: high vs. low	The efficacy of VIs as endorsers is found to be inferior to that of HIs with regard to shaping brand attitude and stimulating purchase intention.
[33]	Experiment	-	Empathetic participants are more likely to engage with VIs and find them more socially appealing than HIs with similar traits.

Table 1. *Cont.*

Reference	Method	Product Type	Key Findings
[34]	Case study	-	VIs resembling humans garner less positive engagement than those with human or anime-like appearances.
[35]	Interview	-	Luxury brand reps consider the physical appearance of HIs and VIs insignificant, yet consumers value VIs' physical appearance or perceived humanness.
[36]	Experiment	Cosmetic vs. technical vs. food	Consumers assign different levels of responsibility in VI endorsements, holding HIs more accountable than VIs.
[37]	Mixed methods	-	VIs are seen as less human-like and trustworthy than HIs, which leads to less intent to follow their advice and increased feelings of uncanniness.
[18]	Experiment	Software	VIs are often seen as less credible than HIs, but using rational endorsement language can make them as credible and enhance positive brand attitudes.
[38]	Experiment	-	Human-like VIs are less trusted than anime-like VIs or HIs, but trust increases when they are in virtual rather than real-world settings.
[39]	Mixed methods	-	Consumers view VIs as less warm, trustworthy, and useful than HIs, which results in lower engagement and less favorable attitudes.
[40]	Experiment	-	Humanness boosts influencer credibility, with interactivity being more crucial for VIs than for HIs. Source credibility mediates the impact of humanness on CSR engagement and brand reputation.
[14]	Experiment	Proximal sensory vs. distal sensory	Consumers view VIs and HIs similarly on distant sensory attributes but rate VIs lower on immediate senses, which affects purchase intentions for VI-backed products.
[41]	Experiment	Drinks	Human-like VIs create weaker parasocial bonds due to less emotional engagement, which lessens their influence on brand interest and purchase intent, but this can be mitigated by using videos in posts.
[4]	Experiment	Functional vs. symbolic vs. experiential	VIs are perceived as less authentic than HIs, which affects brand attitudes and purchase intentions. For symbolic or experiential products, VIs have less impact but are as effective for functional products.
[42]	Experiment	Luxury	Increasingly human-like VIs boost parasocial interactions and brand positivity, which indicates that greater human resemblance in VIs may drive improved brand outcomes.
[29]	Experiment	Hedonic vs. utilitarian	VIs are seen as more effective for utilitarian products, while HIs increase consumer identification with hedonic offerings.
[43]	Experiment	Hedonic vs. utilitarian	VIs have a stronger impact on consumer ad identification than HIs, with ad recognition mediating this effect on brand attitudes, but this is lessened by VIs' perceived sensory limitations.
[30]	Experiment	Technical	Disclosing a fully anthropomorphic VI's synthetic nature does not affect perceptions or acceptance, and users remain receptive to their emotion-based communication despite the VIs' lack of genuine emotion.

Research on the impact of VIs on the promotion of sustainable products is still limited. Sustainable products are designed to reduce environmental harm throughout their lifecycle, adhering to the principles of economic performance, environmental protection, and social advancement [2]. These products embody values like environmental stewardship, social duty, and ethical consumption, which should be reflected in the endorser's image and actions [44]. HIs, as conscious and independent authors of their social media content, offer less control to sponsors and brands, which can lead to unforeseen risks [45]. Conversely, VIs, being computer-generated and lacking consciousness, are developed based on the specific plans of their creators, allowing for more direct control over their behavior and content [10]. This control helps maintain alignment with marketing strategies and effectively communicates a strong sense of environmental awareness and social responsibility [35]. While VIs' consistency and alignment might enhance their effectiveness in endorsing sustainable products, their lack of human qualities like emotions and consciousness and their inability to offer physical experiences might counteract these benefits [4,14]. As a result, VIs may not foster deep consumer relationships and trust as effectively as HIs [4,15]. The theory of meaning transfer suggests that consumer perceptions of VIs, be they positive or negative, can influence their attitudes toward products and brands [46]. With this in mind, we believe that HIs and VIs have distinct impacts on consumers' purchase intention (the likelihood or probability that a consumer will buy a particular product or service in the future [15]) and brand attitude (the overall evaluation or feeling that consumers have towards a brand [15]) and propose the following hypothesis:

H1. *HIs (in comparison to VIs) lead to higher (a) purchase intention and (b) brand attitude.*

2.2. The Mediating Role of Perceived Credibility and Parasocial Relationships

Perceived credibility refers to the believability of a source, based on perceptions of trustworthiness and expertise [18,47], while a parasocial relationship is a one-sided emotional bond between a fan and a public figure, such as a celebrity or fictional character, where the fan feels they know and are connected to the figure despite no actual relationship existing [17]. The perceived credibility of influencers and the parasocial relationships established with their audience are vital factors in the success of HIs, as confirmed by extensive research [14,17]. These factors significantly influence consumers' purchase intentions and brand attitudes. However, VIs tend to be less effective in cultivating credibility and parasocial relationships than HIs [14,17,18,48].

Mind perception theory offers a valuable lens through which to view these differences. Gray and Wegner [49] define mind perception as attributing psychological states—such as thoughts, emotions, and intentions—to humans, animals, or even inanimate objects like robots and virtual characters. This perception involves two primary dimensions: experience and agency [50]. Experience pertains to the degree to which an entity is perceived as having subjective experiences, including sensory perception. Agency refers to the ability of an entity to act autonomously, make decisions, and possess intentions and goals. Generally, humans are perceived as having more mind characteristics than computer programs like VIs [51]. VIs do not have experience due to their virtual existence. Although VIs can demonstrate a high degree of agency through advanced AI, such as performing tasks autonomously and providing empathetic feedback, audiences may still view them as lacking true agency. This perception could stem from an awareness of the human creators and controllers behind the VIs [10]. Even if VIs can execute complex tasks, audiences might believe their actions are programmed and directed by human designers. Thus, despite technological advancements, audiences may psychologically regard VIs as tools that humans control rather than autonomous entities. This perception could impact the quality of interaction and trust in the messages conveyed by VIs [4]. Furthermore, even though VIs can exhibit sensitivity and empathy through advanced algorithms, audiences may still question the authenticity of these responses, affecting the establishment of parasocial relationships [52].

In summary, we believe that the type of influencer leads to varying degrees of credibility and parasocial relationships, ultimately affecting brand outcomes. Therefore, we propose the following hypotheses:

H2. *Perceived credibility mediates the relationship between influencer type and the following: (a) purchase intention; (b) brand attitude.*

H3. *Parasocial relationships mediate the relationship between influencer type and the following: (a) purchase intention; (b) brand attitude.*

2.3. Advertising Appeal and Product Involvement

This study seeks to optimize the endorsement impact of sustainable products through various advertising appeals, focusing on VIs. Advertising appeals encompass the key messages that should be highlighted in ads, such as emotional and rational appeals [53], feasibility and desirability appeals [54], passionate and competent appeals [55], and self-interest and altruistic appeals [56]. Brands leverage these diverse appeals to connect with consumers effectively and gain a market edge [57]. In the realm of sustainable products and green marketing, emotional and rational appeals are especially prevalent [57,58]. VIs and HIs form parasocial interactions and exert opinion leadership by engaging in emotional expression and rational analysis [10,17,28]. Thus, blending rational and emotional appeals in influencers' endorsements of sustainable products can effectively foster consumer communication and encourage sustainable consumption behaviors.

From the standpoint of altruism and morality—as these perspectives are crucial in promoting prosocial actions—this study chooses compassion as the emotional appeal and innovation as the rational appeal, recognizing their pivotal roles in fostering sustainable behavior [2,25]. Compassion is selected for its power as a positive moral emotion that can stimulate consumers' altruistic actions and encourage sustainable consumption [25,59]. This emotion is intimately linked to altruism; it is sparked when individuals observe the suffering of others or the environment, motivating them to act to alleviate that suffering [59]. In the context of sustainable products and green consumption, evoked compassion leads consumers to connect with environmental concerns emotionally, thereby increasing their likelihood of engaging in prosocial behaviors aimed at reducing environmental distress. Such behaviors include supporting charitable organizations, responding positively to social marketing campaigns, and choosing to buy sustainable products [60,61].

The rational appeal of innovation in this context pertains specifically to environmental innovation, which encompasses both ecological process innovation and ecological product innovation [4,62]. This form of innovation mitigates environmental harm by enhancing production methods and product design, thereby showcasing the brand's dedication to sustainable development and ethical accountability [63]. According to attribution theory, consumers' assessments of a brand's actions are influenced by their perceptions of its underlying motives, with altruistic intentions leading to favorable brand evaluations [64]. Consumers anticipate that a brand will assume social responsibilities and they will deduce a brand's motives through its environmental innovation initiatives [4,64]. While consumers might not be able to assess a company's environmental innovation directly, they can gauge the brand's ethical standards and sense of duty through its spokespersons' actions, communications, and endorsements [4]. The theory of meaning transfer suggests that when consumers believe that the environmental innovation messages conveyed by spokespersons stem from genuine altruistic motives, they are more likely to view a brand positively [65].

We suggest that emotional and rational appeals will influence the endorsement effectiveness of VIs and HIs in distinct ways. Specifically, under conditions of emotional appeal, HIs might be more effective than VIs; conversely, under rational appeal conditions, VIs might surpass HIs. Social identity theory posits that individuals develop their sense of self by classifying themselves and others into different social groups [66]. In advertising, audiences might perceive HIs as part of their in-group, while VIs are seen as out-group

members [17,51]. This process of categorization shapes not only how people relate to HIs and VIs but also how they interact with them [51]. As in-group members, HIs may more readily trigger the audience's empathetic responses, resulting in stronger parasocial relationships and more favorable endorsement effects when compassion is used as an emotional appeal [17].

Conversely, individuals base their expectations for future events on past experiences and learning, the crucial factor in engagements with social media influencers [67]. These expectations can vary between interactions with HIs and VIs, shaping both behavioral and emotional anticipations. Discrepancies between expected and actual outcomes can diminish user satisfaction [18]. Generally, VIs are perceived as mechanical entities devoid of genuine thoughts and emotions [4]. This perception can clash with consumers' expectations when VIs are used to convey emotional appeals in sustainable product endorsements. Studies indicate that when information sources fail to align with these expectations, this can result in negative perceptions of the source, dampening its persuasive power and credibility [18]. Moreover, the literature on human–technology interaction suggests that people commonly attribute emotional expressions to humans and cognitive information to both machines and humans [68]. This implies that, in ads with emotional appeals, such as compassion, consumers might anticipate emotional responses from HIs and rational content from VIs. As a result, in emotional appeal campaigns, VIs might be less effective than HIs because they might not fulfill consumer expectations for emotional communication, thereby reducing the ad's persuasiveness and consumer trust.

H4. *Perceived credibility mediates the interaction effect of influencer type and compassion on the following: (a) purchase intention; (b) brand attitude.*

H5. *Parasocial relationships mediate the interaction effect of influencer type and compassion on the following: (a) purchase intention; (b) brand attitude.*

Regarding the rational appeal of innovation, we posit that VIs could match or even surpass HIs in endorsing sustainable products. Research into human–computer interactions suggests that entities like robots or digital characters are perceived as possessing cognitive capabilities, and, for cognitively demanding tasks, people tend to place greater trust in these machines or algorithms [69]. The concept of machine heuristic reveals that individuals hold positive beliefs about machines, regarding their objectivity, accuracy, and fairness, compared to humans [70]. This trust in and positive perception of machines can influence consumers' views on the credibility of VIs and might even foster parasocial relationships. Studies show that parasocial relationships with media figures are linked to emotional connections and rational assessments, like the figures' expertise and rationality [71]. In the context of advertising, when consumers encounter VIs presenting environmental innovation as a rational appeal, their expectations of machine objectivity and logic are readily engaged. These cues resonate with consumers' preconceived notions of machine behavior, effectively triggering the concept of machine heuristic. Consumers' cognitive systems are inclined to accept information that aligns with their expectations; so, consumers are more likely to trust this information when VIs exhibit traits of rationality and objectivity associated with machines [18,68,69]. Consequently, when promoting sustainable products, consumers might view VIs as providing more objective and impartial information, aligning with their rational appeal expectations. Hence, we propose the following hypotheses:

H6. *Perceived credibility mediates the interaction effect of influencer type and innovation on the following: (a) purchase intention; (b) brand attitude.*

H7. *Parasocial relationships mediate the interaction effect of influencer type and innovation on the following: (a) purchase intention; (b) brand attitude.*

Product involvement measures consumers' interest, concern, and engagement with specific products or categories [72]. In scenarios with low-involvement products, consumers typically lack the motivation to evaluate products thoroughly and instead rely on heuristic processing, using simple decision rules like emotional reactions or intuitive judgments of the people in the advertisements [73]. HIs can naturally express emotions, which makes them more likely to trigger consumers' emotional resonance. On the other hand, while VIs can also convey emotional appeals, they lack real human emotional experiences and may not stimulate the same level of emotional resonance. Therefore, emotional appeals might make HIs more effective than VIs in situations with low-involvement products.

Moreover, since consumers in low-involvement contexts are unlikely to conduct an in-depth rational analysis, the rational appeal of innovation is unlikely to play a moderating role. Consumers may not fully consider the innovative characteristics of the product and instead rely on more intuitive emotional reactions or heuristics to make quick decisions. Thus, although rational appeals will not impose excessive cognitive loads on consumers, they may activate the concept of machine heuristic, due to these visual cues aligning with consumers' expectations of machine behavior, leading to positive responses to VIs such as attitude and behavioral intention changes [18]. Consequently, rational appeals will only enhance the endorsement effects of VIs in low-involvement product situations and will not affect HIs. In summary, we propose the following hypothesis:

H8. *In low-involvement product scenarios, HIs (in comparison to VIs) with compassion appeals will result in the following: (a) higher purchase intentions; (b) higher brand attitudes.*

In high-involvement product scenarios, consumers tend to engage in more rational and systematic information processing, meticulously assessing all facets of a product [74]. In these situations, rational appeals, such as innovation, become pivotal in swaying consumer decisions. Research indicates that, as global environmental concerns grow, and public awareness of the environment increases, consumers are more likely to weigh the environmental impact of products or services during their purchase, use, and disposal [2,75]. For instance, when buying electric vehicles, consumers prioritize environmental performance over price value and range confidence [76]. Thus, VIs might be more effective at conveying rational appeals, because their perceived objectivity and professionalism meet the consumers' demands for comprehensive and precise information in high-involvement contexts.

Conversely, emotional appeals, such as compassion, may not substantially influence the persuasiveness of either HIs or VIs in these situations, as consumers are more focused on the product's specific features and benefits rather than the emotional aspects of the advertisement [74]. Consequently, VIs could be more effective in communicating information about environmental innovation than HIs, and emotional appeals are unlikely to significantly moderate the impact of either type of influencer. In conclusion, we propose the following hypotheses (please see Figure 1):
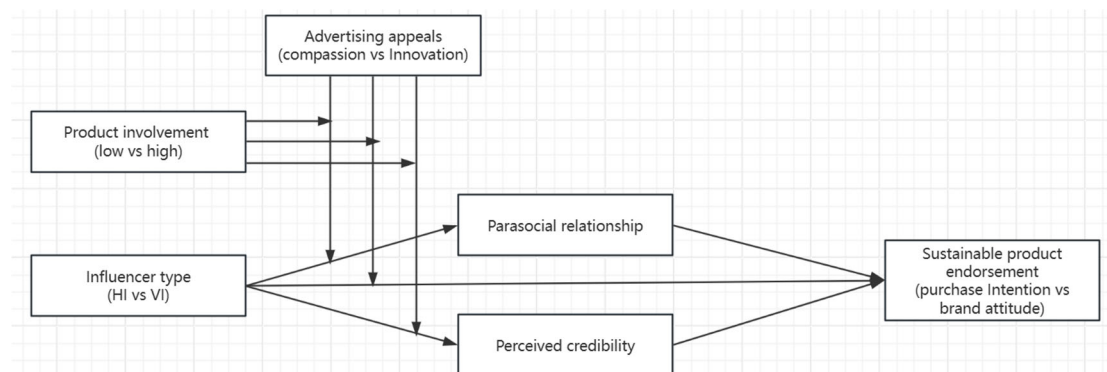
Figure 1. Conceptual framework proposed by the authors.

H9. *In high-involvement product scenarios, VIs (in comparison to HIs) with innovation appeals will result in the following: (a) higher purchase intentions; (b) higher brand attitudes.*

H10. *Perceived credibility mediates the interaction effect of influencer type, advertising appeals, and product involvement on the following: (a) purchase intention; (b) brand attitude.*

H11. *Parasocial relationships mediate the interaction effect of influencer type, advertising appeals, and product involvement on the following: (a) purchase intention; (b) brand attitude.*

3. Material and Methods

3.1. Overview of the Performed Studies

Two studies were carried out to confirm the proposed hypotheses. Firstly, to strengthen the internal validity of our study and neutralize the influence of external variables on participant perceptions, we strictly controlled for visual similarities between VIs and HIs. This standardization encompassed the use of the same background settings, poses, layouts, and facial expressions across conditions (VIs and HIs) [13,18,38]. Furthermore, we maintained consistency in the linguistic style and structural content of all advertising materials [13]. Then, to ensure that our research findings were not influenced by pre-existing perceptions or prior exposure to VIs or known brands, we asked a professional artist to utilize the AI application StableDiffusion 3.0 to generate a fictional influencer named Lisa and a brand called LvXin [18]. This method provided a controlled and neutral environment, allowing us to accurately evaluate the intrinsic effects of influencer type on consumer behavior and perception without the interference of existing brand or individual preconceptions [30].

To ensure the generalizability of our study's results, our sample included participants across various demographic characteristics, such as gender, age (over 18 years old), and so on. We chose Credamo as our sampling platform, a Chinese professional survey platform whose participant database covers nearly all regions in China, contributing to the universality of our research outcomes. Furthermore, the rigorous quality control measures of the Credamo platform guarantee the reliability of the data. For example, given the multifaceted experimental conditions in our study, we utilized Credamo's features to limit participants from engaging in more than one experimental condition. Concurrently, to prevent the same individual from responding via multiple devices, we ensured that the IP addresses of the participants were separated by at least 5 km.

Study 1 investigated the differential effects of virtual and human influencers on the endorsement of sustainable products (brand attitude and purchase intention) and the mediating effects of parasocial relationships and perceived credibility. Study 2 examined the varying effects of different types of influencers under the interaction of distinct advertising appeals (compassion vs. innovation) and varying levels of product involvement (low vs. high). When selecting low-involvement and high-involvement products as experimental stimuli, we took into account consumers' risk perception and value assessment in purchasing decisions and products' universal appeal across different demographics (gender, age, and so on). For instance, we chose an eco-friendly body wash as a representative of low-involvement products because it is generally considered a routine, low-risk purchase; meanwhile, we selected new-energy vehicles as representatives of high-involvement products due to the higher decision-making risks and financial investments involved in their purchase.

All the research findings were analyzed using SPSS 27. One-way ANOVA was employed to examine the direct effects, such as whether there were significant differences between virtual influencers and human influencers in terms of brand attitude and purchase intention. Hayes' Process Macro in SPSS was utilized to test for mediation and moderation effects, specifically whether perceived credibility and parasocial relationships significantly mediated the relationship between influencer type and purchase intention/brand attitude. Additionally, it assessed whether advertising appeal and product involvement enhanced

or diminished the significant differences in endorsement effectiveness between human and virtual influencers.

3.2. Study 1: The Impact of Influencer Type on Sustainable Product Preference and the Mediating Role of Perceived Credibility and Parasocial Relationships

3.2.1. Research Design

The study conducted had a 2-factor (influencer type: VI, HI) between-groups design. After filtering out the recruits who responded too quickly, gave pattern answers, or failed the attention check, we obtained 178 samples (68.5% female, Mage = 29.76, SD = 6.879) from Credamo (https://www.credamo.com, accessed on 3 October 2024).

The survey was divided into three parts. First, the participants were asked to fill in their demographic information and read a brief description of the influencers (VIs or HIs). Then, they were randomly assigned to an advertising condition with a VI or an HI endorser. Following Thomas and Fowler's [77] methodology, we manipulated the influencer conditions by manipulating their names. Both conditions used the same hyper-realistic human-like image and content to avoid possible interfering factors such as attractiveness, similarity, and celebrity worship (please, see the Appendix A). After carefully reading the fictitious XiaoHongShu post (this platform is primarily known for product recommendations and boasts over two hundred million users), the participants were asked to respond using a seven-point scale about their opinion of perceived credibility (trustworthy/reliable/honest/expert; $\alpha = 0.91$; [47]), parasocial relationship ("I would like to meet this influencer/virtual influencer in person"; "this influencer/virtual influencer feels like an old friend"; $\alpha = 0.84$; [17]), purchase intention ("I would likely/definitely buy this product"; $\alpha = 0.85$; [78]), and brand attitude ("my overall impression towards the brand (LvXin) is positive"; "my overall feeling towards the brand (LvXin) is good"; $\alpha = 0.87$; [18]). During the experimental process, the participants underwent an attention check to ensure that they were fully engaged and paying close attention to the task ("The brand name that the virtual influencer is presenting in the advertisement you just saw is?"). They also underwent a manipulation check for their perception of the influencer, using a seven-point semantic differential scale (as developed by [79]), which asked them to assess the perceived humanness of the influencer on a scale from 1 (definitely virtual) to 7 (definitely human), in order to verify the effectiveness of our manipulation ("Please, rate whether you think you viewed a virtual influencer or a human influencer anchored by a virtual influencer (1) and human influencer (7)").

3.2.2. Results

The results of the ANOVA (with influencer type as the independent variable and perceived humanness as the dependent variable) showed that perceived humanness was significantly higher for the HI group compared to the VI one (MHIs = 5.40, MVIs = 2.54, $F(1,176) = 125.10$, $p < 0.01$). Thus, the manipulation of the influencer type was successful.

After setting perceived credibility and parasocial relationship as the dependent variables and influencer type as the independent variable, one-way ANOVA showed that perceived credibility was higher for HIs than for VIs (MHIs = 5.10, SD = 1.12, MVIs = 4.49, SD = 1.44; $F(1,176) = 10.10$, $p < 0.005$; $\eta2 = 0.054$). However, the situation was reversed for parasocial relationships (MHIs = 4.39, SD = 1.44, MVIs = 6.06, SD = 2.60; $F(1,176) = 27.37$, $p < 0.001$; $\eta2 = 0.135$). All the results are presented in graph form (Figure 2).

ANOVA (with purchase intention and brand attitude as the dependent variables and influencer type as the independent variable) found that HIs, compared to the VIs, resulted in higher purchase intention (MHIs = 4.88, SD = 1.24, MVIs = 4.38, SD = 1.56; $F(1,176) = 5.86$, $p < 0.05$, $\eta2 = 0.03$) and brand attitude (MHIs = 5.60, SD = 1.06, MVIs = 5.16, SD = 1.36; $F(1,176) = 5.87$, $p < 0.05$, $\eta2 = 0.03$).

We conducted a mediation analysis using bootstrapping (with 5,000 re-samples and PROCESS model 4 [80]), with influencer type as the independent variable (0 = human influencer, 1 = virtual influencer) and perceived credibility and parasocial relationship as

mediators. When using purchase intention as the dependent variable, the mediating effects of both parasocial relationship (B = 0.84, SE = 0.18; 95% CI = [0.50, 1.20], $p < 0.05$) and perceived credibility (B = −0.54, SE = 0.17; 95% CI = [−0.89, −0.20], $p < 0.05$) were significant. Similarly, when brand attitude was used as the dependent variable, the mediating effects of both perceived credibility (B = −0.47, SE = 0.16; 95% CI = [−0.80, −0.17]) and parasocial relationship (B = 0.65, SE = 0.14; 95% CI = [0.39, 0.94], $p < 0.05$) were again significant.
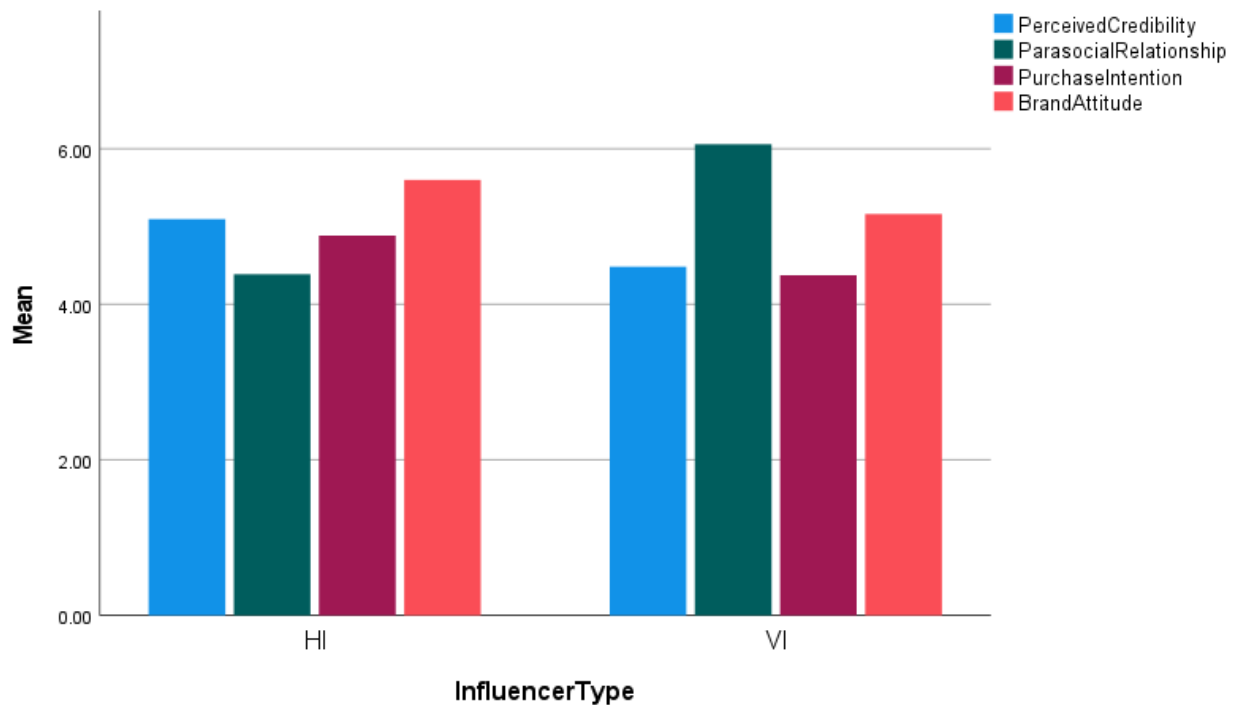
Figure 2. Mean purchase intention, brand attitude, perceived credibility, and parasocial relationship.

Our research findings support H1, H2, and H3, validating the mediating effect of perceived credibility and parasocial relationship on the interaction between influencer type and purchase intention and brand attitude. Interestingly, while the reduction in perceived credibility specifically among VIs appeared to negatively impact both purchase intention and brand attitude, the parasocial relationship seemed to mitigate the negative impact of lower credibility. However, HIs were found to still surpass VIs in enhancing purchase intentions and brand attitudes when it comes to sustainable products endorsement.

3.3. Study 2: The Moderating Role of Emotional and Rational Appeal and That of Product Involvement

3.3.1. Research Design

Study 2 used a 2 (influencer type: HI, VI) × 3 (appeal type: compassion, innovation, and a no-appeal control condition) × 2 (product involvement: low, high) between-subjects design. We conducted the study with 919 participants who met our criteria, including passing attention checks and avoiding patterned or rapid responses (73.9% female, Mage = 29.97, SD = 8.43), who were sourced from Credamo and given a few incentives.

We used an eco-friendly body wash as the stimulus under low-involvement product conditions and a new-energy vehicle as the stimulus under high-involvement product conditions, based on their perceived risk and value factors [13]. Following the studies in [13], we manipulated emotional appeal (compassion) and rational appeal (innovation) through content (please, see Appendix A). The participants were tasked with reading advertising materials on a fictitious XiaoHongShu post and then assessing the perceived humanness of the influencer on a scale from 1 (definitely virtual) to 7 (definitely human), in order to verify the effectiveness of our manipulation. Subsequently, we measured their

perceived credibility (α = 0.88), parasocial relationships (α = 0.75), purchase intentions (α = 0.87), and brand attitudes (α = 0.85). The attention check question was the same as in Study 1.

3.3.2. Results

The study's manipulation was successful. The results from one-way ANOVA, with perceived humanness as the dependent variable and influencer type as the independent variable, showed that perceived humanness was higher for HIs compared to VIs (MHIs = 5.08, MVIs = 2.34, F(1,917) = 649.21, $p < 0.01$). Afterward, a three-factor ANOVA found that, while influencer type alone did not significantly affect purchase intention ($p > 0.05$), there were significant interaction effects between influencer type and appeal type (F(1,907) = 11.34, $p < 0.05$, $\eta2$ = 0.024), as well as between influencer type and product involvement (F(1,907) = 22.33, $p < 0.05$, $\eta2$ = 0.024). In terms of brand attitude, both the direct effect of influencer type (F(1,907) = 15.16, $p < 0.05$, $\eta2$ = 0.016) and the interaction effects were significantly related (influencer type and appeal type, F(1,907) = 6.24, $p < 0.05$, $\eta2$= 0.014; influencer type and product involvement, F(1,907) = 15.73, $p < 0.05$, $\eta2$ = 0.017)), except for the three-way interaction between influencer type, appeal type, and product involvement (F(1,907) = 1.27, $p > 0.05$, $\eta2$ = 0.003). The results are presented in graph form in Figures 3 and 4.
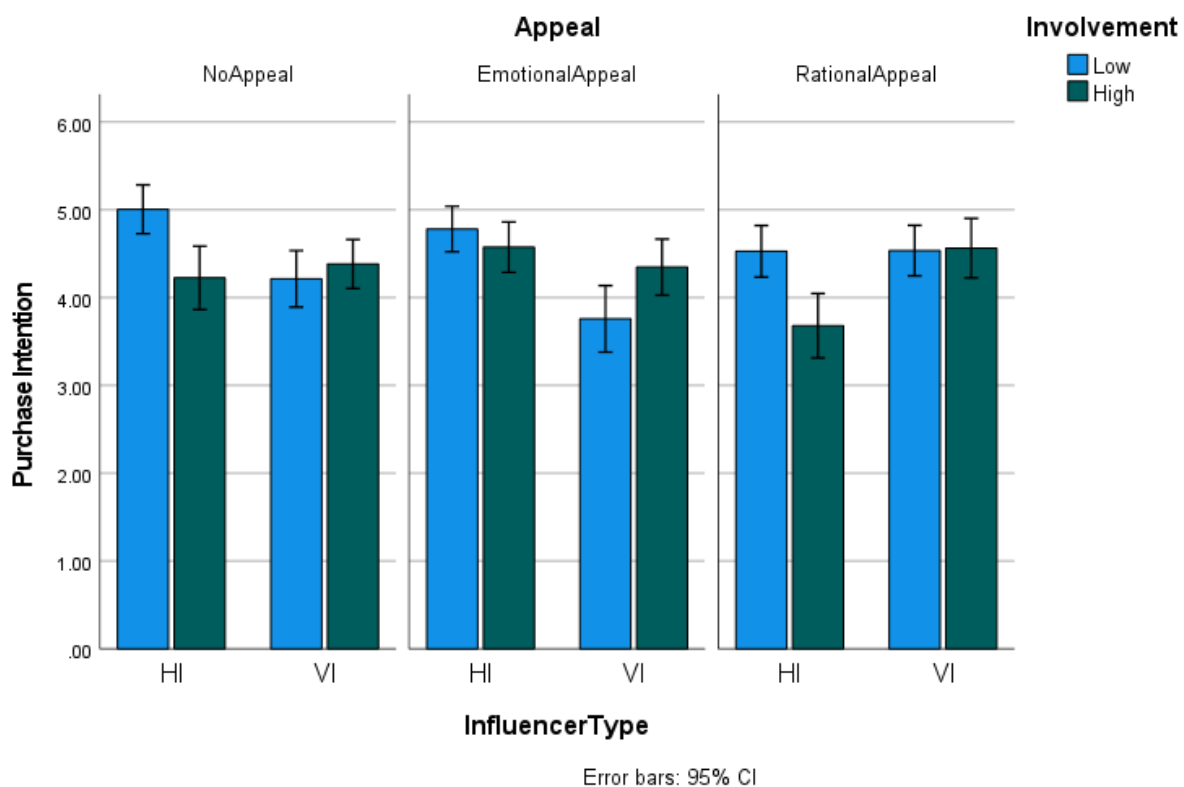
Figure 3. Mean purchase intention under different conditions.

After setting purchase intention and brand attitude as the dependent variables and influencer type as the independent variable in our ANOVA analysis, we found that HIs led to significantly higher purchase intentions and brand attitude than VIs in situations with no appeal (PI: MHIs = 5.01, SD = 0.15, MVIs = 4.21, F(1,907) = 12.04, $p < 0.01$; BA: MHIs = 5.7, SD = 0.11, MVIs = 5.18, SD = 0.13, F(1,907) = 9.19, $p < 0.05$) and in situations with emotional appeal (compassion) (PI: MHIs = 4.79, SD = 0.15, MVIs = 3.76, F(1,907) = 19.90, $p < 0.01$; BA: MHIs = 5.6, SD = 0.11, MVIs = 4.64, SD = 0.13, F(1,907) = 30.93, $p < 0.01$), but there was no significant difference in the case of rational appeal (innovation) (PI: $p = 0.969$, BA: $p = 0.14$).

The results of the ANOVA demonstrated that VIs using rational appeal generated greater purchase intention compared to HIs (MHIs = 3.68, SD = 0.2, MVIs = 4.56, SD = 0.17, F(1,907) = 11.14, *p* < 0.01). However, no significance was detected within the conditions of no appeal (*p* = 0.46) and emotional appeal (*p* = 0.28). Similarly, no significant differences were observed between HIs and VIs for brand attitude across all three appeal conditions (*p* > 0.05).
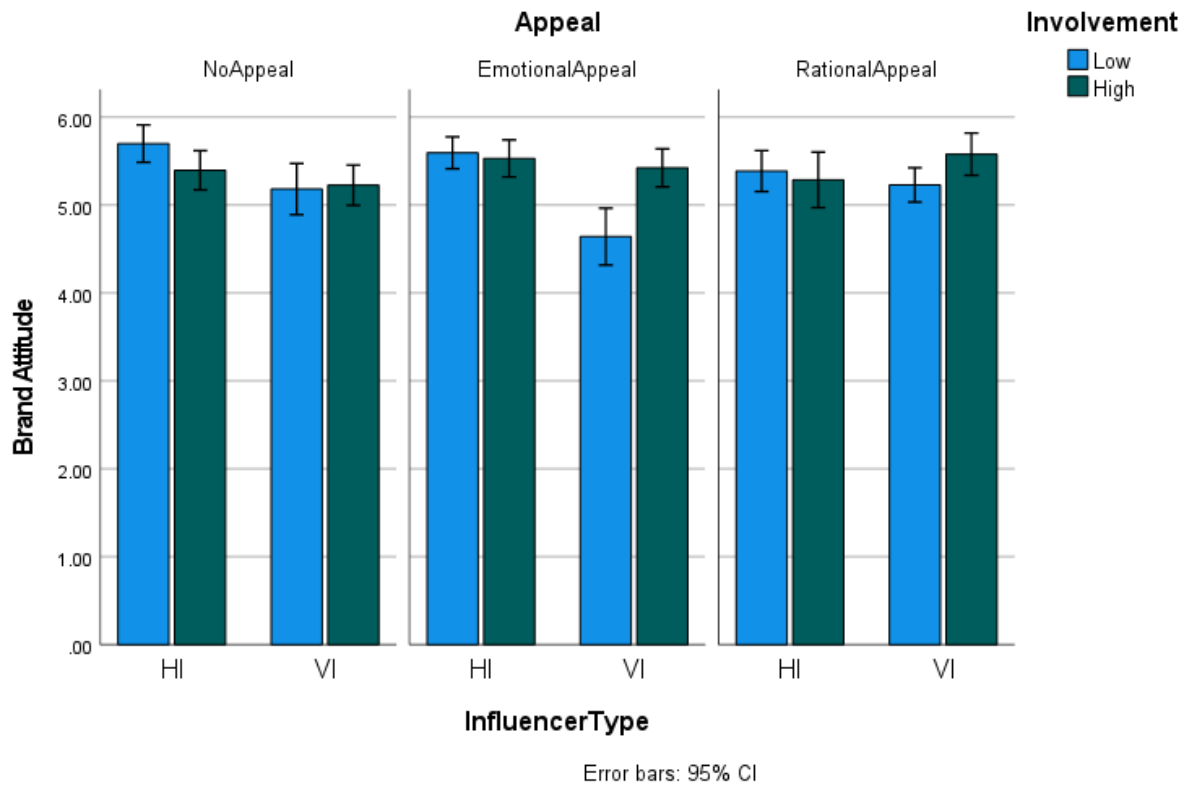
Figure 4. Mean brand attitude under different conditions.

Firstly, we conducted a mediation analysis using bootstrapping (PROCESS Model 8; [80]), with influencer type (human = 0, virtual = 1) as the independent variable, perceived credibility and parasocial relationship as the mediators, purchase intention and brand attitude as the dependent variables, and appeal type as moderator W, which was dummy-coded based on the three-condition variable (emotional appeal and rational appeal), with the no-appeal condition as the baseline. Three regression equations were estimated for testing H4a–H7b; then, PROCESS Model 12 was run to test H10a–H11b, with product involvement as moderator Z (low = 0, high = 1). The results partially validated our proposed model, indicating a significant moderated mediation effect, but the index for moderate moderated mediation was not significant. Specifically, in PROCESS Model 8, when we considered purchase intention as the dependent variable, perceived credibility did not mediate the interaction between influencer type and emotional appeal (B = −0.29, SE = 0.16; 95%CI = [−0.61, 0.03]), while parasocial relationship significantly mediated this interaction effect (B = −0.34, SE = 0.15; 95%CI = [−0.63, −0.05]). Then, we found that both perceived credibility (B = 0.53, SE = 0.16; 95%CI = [0.22, 0.84]) and parasocial relationship (B = 0.45, SE = 0.14; 95%CI = [0.19, 0.73]) mediated the interaction between influencer type and rational appeal. Subsequently, we analyzed brand attitude as the dependent variable and found that perceived credibility mediated the effects of both emotional (B = −0.19, SE = 0.11; 95%CI = [−0.40, −0.02]) and rational appeal (B = 0.35, SE = 0.11; 95%CI = [0.14, 0.56]) interactions with influencer type. The mediating role of parasocial relationship was significant for the interaction between emotional appeal and influencer type (B = −0.21,

SE = 0.09; 95%CI = [−0.39, −0.03] but not for the interaction with rational appeal (B = 0.28, SE = 0.90; 95%CI = [0.11, −0.46].

Next, we investigated H10a–H11b, which pertain to the moderate moderated mediation effect. We assessed all the related complex interactions using PROCESS Model 12 [80] with 5000 bootstrap resamples. However, the resultant 95% confidence interval included zero, suggesting that the effect was not statistically significant. This lack of significance may be due to the three-way interaction between influencer type, appeal type, and product involvement not significantly impacting purchase intention or brand attitude.

The results indicated that H4a, H7b, H9b, H10a, H10b, H11a, and H11b were rejected, while H4b, H5a, H5b, H6a, H6b, H7a, H8a, H8b, and H9a were supported. Specifically, in conditions with low-involvement products, HIs were found to be more effective than VIs under emotional appeals, while no significant difference was observed under rational appeals. With high-involvement products, VIs outperformed HIs when using rational appeals. These findings hold a significant implication for sustainable marketing practices. Initially, brands can leverage our discoveries to select the most appropriate type of influencer, thereby enhancing the effectiveness of their green marketing campaigns. For instance, for everyday, low-risk sustainable products such as eco-friendly body washes, HIs are more effective, as they can enhance consumer trust and purchase intentions through emotional resonance. In contrast, for high-involvement products that involve higher levels of decision-making risk and financial investments, such as new-energy vehicles, VIs (vs. HIs) are able to result in better marketing outcomes due to their higher perceived objectivity. Furthermore, our research indicates that brands need to adjust their advertising contents based on product characteristics and types of advertising appeals to maximize the impact of influencer marketing.

4. Discussion and Conclusions

4.1. General Discussion

With the swift advancements in artificial intelligence, the use of VIs in influencer marketing is growing. Our study zeroed in on the impact of VIs on consumer behavioral intentions and attitudes when endorsing sustainable products. It also looked at how the endorsement effects of VIs compare to those of HIs under varying advertising stimuli. Through two studies, we explored the interplay of influencer type, advertising appeal type, and product involvement in sustainable product endorsement to uncover the conditions under which VIs might outperform HIs.

In Study 1, we discovered that HIs generally have more substantial effects than VIs, as seen in purchase intentions and brand attitudes toward sustainable products. The underlying reason for this difference is attributed to the artificial nature of VIs, which hinder their ability to provide authentic product experiences and genuine product evaluations [4]. This lack of authenticity made it difficult to establish the perceived credibility of VIs, which is often a direct predictor of consumer responses [3,69].

Mediation analysis revealed the mechanism behind this: although VIs are better at forming parasocial relationships, which can boost purchase intentions and brand attitudes, this advantage does not fully compensate for the negative impact of consumers' lower trust in VIs.

Study 2 expanded the experimental conditions to include product involvement levels (low vs. high) and types of advertising appeals related to moral ethics (emotional appeal and rational appeal). We found that the endorsement effects fluctuated under these different conditions. Particularly under low-involvement product conditions, both brand attitudes and purchase intentions were less effective for VIs than for HIs. The gap widened with the introduction of an emotional appeal like compassion. However, under rational appeals, the differences between VIs and HIs diminished.

Conversely, under high-involvement product conditions, there were no significant differences in brand attitudes and purchase intentions between VIs and HIs, regardless of the presence of emotional appeals. However, with the introduction of rational appeals,

VIs led to significantly higher purchase intentions and brand attitudes than HIs. This was mainly due to users' habitual thinking patterns on social media.

Today's interest-based recommendation algorithms minimize the need for deep thought by serving up highly personalized content, leading to greater reliance on intuitive reactions over critical analysis of information on social media [22]. Especially when browsing ads for low-involvement products, users may lean more on quick emotional responses for swift decision-making. Here, perceptions of VIs or HIs and the emotional triggers in ads could be the most immediate and potent predictors of consumer purchase intentions and brand attitudes. The absence of emotional and autonomous traits in VIs might lead the audience to question their emotions' authenticity. This skepticism can undermine VIs' ability to foster the transformation of purchase intentions and brand attitudes through emotional resonance. Thus, under low-involvement product conditions, HIs' endorsements, driven by emotional stimulation, tend to be more effective than those of VIs. However, under high-involvement product conditions, where product value and decision-making risk are high, users are prompted to engage in deeper rational thinking and rely less on quick emotional responses. Our findings confirm that emotional appeals do not significantly differentiate consumer purchase intentions and brand attitudes between HIs and VIs under high-involvement product conditions. However, when rational appeals are introduced, VIs show significantly better endorsement effects than HIs. In high-involvement product decisions, particularly for sustainable products, consumers need to conduct thorough assessments of the product's environmental characteristics and the objectivity and authenticity of the information conveyed by the product spokesperson. Also, because rational appeal cues align with consumers' expectations of machine behavior and trigger the concept of machine heuristic, consumers may view VIs as more objective and accurate in processing or conveying information than HIs.

Hence, our study identifies the boundary conditions under which VIs are more effective than HIs in endorsing sustainable products: high-involvement products and rational appeals. This insight underscores the importance of considering product characteristics, types of advertising appeals, and consumer decision-making motivations when crafting endorsement strategies to optimize the use of VIs and enhance endorsement effects.

4.2. Theoretical Contributions

This study probed into how consumers respond differently to VIs and HIs endorsing sustainable products and uncovered the conditions that might make VIs more effective than HIs. While the existing body of literature discusses VIs' ability to trigger consumer emotions and cognition and their general effectiveness in endorsing consumer goods, there is a gap when it comes to their specific roles and impact in promoting sustainable products, especially compared to those of HIs [15,18,30]. Our research addressed this void, adding to the discourse on virtual influencer marketing and green marketing.

Our findings are in line with much of the existing research, which suggests that HIs are generally more effective than VIs at endorsing sustainable products, mainly when ads play on emotions like compassion [4,14]. However, our study also shows that using rational cognition-oriented advertising strategies, such as focusing on innovation, can tip the scales in favor of VIs over HIs. Previous studies noted that VIs can be as credible and potent as real people when they use rational language in their endorsement messages. However, these studies did not fully explore how product types and influencers interact [18]. Thus, our study delved deeper, analyzing the effect of the interplay between emotional and rational appeals on endorsement outcomes and scrutinizing these multifaceted interactions under sustainable product scenarios and varying degrees of product involvement.

Furthermore, our research bolsters the theoretical literature on perceived credibility and parasocial relationships, validating these theories' relevance in explaining the VI phenomenon. Interestingly, we found a balancing effect: while VIs' lower perceived credibility makes them less effective than HIs at driving consumer purchase intentions, they excel at forming parasocial relationships. This strength can offset their credibility shortcom-

ings, thereby boosting consumer purchase intentions to some degree. This finding, which contrasts with previous studies [14,19], reveals potential mechanisms by which VIs can effectively spur consumer behavior under certain conditions, offering fresh insights on optimizing VI use in the future. One possible explanation is that while VIs cannot offer genuine product experiences or reviews, their 'virtualness' also shields them from personal scandals or controversies that might plague HIs [8]. For sustainable products, consumers seek not only quality but also influencers who share their moral and environmental values [7]. VIs, hence, with their pristine image and consistent behavior, can more effectively embody consumers' ideals. These parasocial relationships with consumers are founded on consumers' identification with the values that VIs represent. In this regard, VIs may surpass HIs in articulating consumers' desires for sustainable and ethical consumption. Based on consumers' alignment with the values epitomized by VIs, this bond creates a solid parasocial connection when promoting sustainable products.

In conclusion, this study offers novel insights into VI and green marketing theories. It provides a theoretical foundation for brands to select the most appropriate influencer type based on product characteristics and advertising appeals. By grasping VIs' advantages in specific scenarios, brands can leverage these digital figures more effectively to promote sustainable products and refine their marketing strategies.

4.3. Practical Implications

The practical implication of this study is to offer guidance for brands' marketing strategies, helping them choose the most fitting influencer type based on product features and to craft effective advertising strategies that maximize the endorsement impact of sustainable products. Based on the distinct mechanisms by which VIs and HIs promote sustainable products, as revealed by our study, brands should consider the following when selecting a spokesperson: HIs enhance trust and parasocial relationships through emotion-eliciting content such as compassion, which in turn stimulates consumers' purchase intentions and brand attitudes; conversely, VIs positively influence consumer perceptions by conveying objective and rational information, such as innovation, thereby optimizing marketing effectiveness. Furthermore, it is crucial for brands to consider the interaction of sustainable product's traits (low- vs. high-involvement products) and the type of appeal in the endorsement advertisement—whether rational (innovation) or emotional (compassion)—to determine the most suitable influencer.

Emotional appeal plays a significant role in consumer decision-making for products with low consumer involvement, such as organic cotton T-shirts or eco-friendly bath products. Consumers typically rely on intuition and emotional reactions to assess these products, an area wherein VIs may fall short. Although VIs can mimic human appearance and behavior, they are often seen as machines devoid of genuine emotions and thoughts, which limits their ability to convey emotional stimulation and thus impacts their endorsement effectiveness [18,51]. Therefore, when marketing low-involvement sustainable consumer products like reusable shopping bags or recycled paper products, brands should consider partnering with HIs. These products often pertain to habitual purchases and customer retention, and HIs can use their authentic sensory experiences and emotional resonance to trigger consumers' emotional responses and build trust more effectively [14]. As a result, HIs often show greater persuasiveness than VIs in transforming user behavior.

However, in high-involvement product scenarios, such as with eco-friendly cars, VIs' advantages become more apparent. When making high-value, high-risk purchase decisions, consumers seek objective and precise information. Here, VIs' machine attributes turn into an advantage, as people generally trust machines to be more objective, accurate, and unbiased than HIs [69]. This mindset, known as machine heuristic, allows VIs to more effectively foster consumer purchase intentions when delivering rational-oriented advertising messages [4,69]. By highlighting the product's environmental innovation, VIs can achieve stronger market persuasiveness than HIs. Thus, when promoting high-involvement sustainable products like new-energy vehicles or energy-saving home appliances, brands

should present detailed product performance data, environmental protection technologies, and innovative features through VIs, ensuring consistency across channels to establish the brand's authority and professionalism, thereby earning consumer trust.

In summary, brands can harness the unique strengths of VIs, particularly in sustainable product sectors, for long-term brand strategy planning and cross-cultural marketing. Since VIs lack a real identity, they avoid personal scandals or controversies that human spokespersons might face, reducing the risk of damaging the brand's reputation [8]. Moreover, VIs' high controllability and customization allow brands to precisely convey their commitment to environmental responsibility and ethical consumption, creating a positive, consistent, and enduring brand image. Such strategies reinforce consumers' positive attitudes towards the brand and promote the brand's sustainable ethos in the global market, allowing it to gain a competitive edge in a crowded marketplace.

4.4. Limitations and Future Research Directions

While this study sheds light on how VIs and HIs compare in endorsing sustainable products, it has certain limitations.

Firstly, while we summarized previous comparative studies of HIs and VIs in our literature review, we did not employ a meta-analysis approach to synthesize and quantify data from multiple studies. This omission may affect the precision of our assessment of the consistency across different study findings. Future research should consider incorporating meta-analytic methods during the literature review process to provide a more comprehensive analytical framework.

Secondly, our research mainly looked at the effects of VIs and HIs under specific conditions without exploring how these effects might differ across various cultural backgrounds or market environments. This gap could limit our insight into how global brands can use VI strategies across diverse markets. Thus, we suggest that future studies explore cultural differences or the perception of VIs across different social contexts.

Thirdly, the limitations of the current study include the fact that it focused solely on a single social media platform and a specific consumer response. This narrow scope may not have fully captured the diverse dynamics of consumer engagement and the broader implications of VIs and HIs in the realm of green marketing across various online environments. To overcome this limitation and gain a more comprehensive understanding of the marketing performance of VIs, future research could employ web scraping and text analysis techniques to extract insights from discussions within different social media platforms (e.g., TikTok, Weibo, and so on) related to sustainable consumption and green campaigns. By analyzing a wider range of consumer perceptions and behaviors, including information search, pre-purchase decision-making, and post-purchase activities, we can better understand the influence of VIs and HIs on consumer engagement and the effectiveness of green marketing strategies

Fourthly, our study presents a snapshot view, focusing on the immediate effects of VIs and HIs, without considering how consumer attitudes and behaviors might change over time with more exposure to VIs. Moreover, the agency capabilities of VIs (their ability to mimic human behavior and interaction) are rapidly advancing with the progress of AI technology. As the agency capabilities of VIs improve, consumers may perceive them as having a higher degree of authenticity, which could potentially increase their trust and acceptance of sustainable products endorsed by VIs. Moreover, different consumer groups may have varying reactions to the agency capabilities of VIs; some may embrace the idea of machines resembling humans, while others might feel fear and discomfort, which can directly affect the effectiveness of sustainable product endorsements. This may necessitate brands to adopt tailored strategies for different market segments. Future research may consider longitudinal studies to examine the evolution of consumer attitudes toward VIs.

Lastly, although our study focused on the interactive effects of advertising appeal types and product involvement on the endorsement effectiveness of sustainable products, future research could benefit from including consumer personal traits, such as environmental

consciousness and technological acceptance. This could reveal more subtle dynamics behind consumer perceptions and reactions to VI endorsements of sustainable products, enhancing our understanding of VI endorsements' effects and aiding brands in developing more targeted marketing strategies. Additionally, the degree to which consumers identify with the sustainable values represented by VIs and how this identification influences consumer perceptions and purchasing behaviors toward sustainable products are other important areas for future research.

In conclusion, future research should consider factors like temporal dynamics, cultural differences, personal traits, AI technology development, and multidimensional consumer responses in order to deepen our understanding of how VIs function in green marketing.

4.5. Conclusions

The present study set out to uncover the differences between humans and virtual influencers in order to achieve better endorsement outcomes for sustainable products. Through the examination of influencer type, advertising appeals, and product involvement, we discovered that HIs (vs. VIs) using emotional appeal (compassion) generally led to higher purchase intention and brand attitude to sustainable products. We also identified boundary conditions in which VIs outperformed HIs in the endorsement of sustainable consumption: high-involvement products with innovation (rational appeal). Despite the insights gained, our study acknowledges its limitations and suggests areas for future research in order to further explore the dynamic interplay between VIs, HIs, and consumer perceptions across diverse social media platforms and cultural contexts. Our research highlights the strategic importance of influencer selection in green marketing and provides a foundation for brands to navigate the evolving landscape of influencer marketing, ultimately driving the adoption of sustainable products and practices.

Appendix A

Appendix A.1. Study 1 Stimuli

The participants were randomly assigned to a fabricated promotional content condition (VI or HI) in which all the visual elements (language and figure) were exactly the same.

Lisa

10/10 Highly recommend this Lvxin organic T-shirt!🌱
Made from 100% organic cotton grown without the use
of harmful chemicals.🍀
It is not only comfortable and skin-friendly but super
eco-friendly.🍀
#SustainableDesign #Lvxin T-shirt

Appendix A.2.1. Controlled Condition for Low-Involvement Products

In this advertising condition, there was no advertising appeal, either compassion or innovation.

10/10 Highly recommend this LvXin shower gel.🌱
100% pure natural organic ingredients, avoiding the use of any components harmful to the environment and health.🍀
Every shower is a gentle care for the Earth.🍀
#SustainableDesign #Lvxin shower gel

Appendix A.2.2. Compassion (Emotional Appeal) for Low-Involvement Products

In this advertising scenario, the compassion appeal was present.

Earth is hurting ! Caring for the Earth!
Our planet needs us now more than ever.

10/10 Highly recommend this LvXin shower gel.🌱
100% pure natural organic ingredients, avoiding the use of any components harmful to the environment and health.🍀
Every shower is a gentle care for the Earth.🍀
#SustainableDesign #Lvxin shower gel

Appendix A.2.3. Innovation (Rational Appeal) for Low-Involvement Products
Rational appeal and innovation were present in this condition.

Innovative Choices: Crafting a Cleaner, Greener World.
Our products are designed with state-of-the-art manufacturing techniques, reducing waste, conserving energy, and minimizing harm to the environment.

10/10 Highly recommend this LvXin shower gel.🌱
100% pure natural organic ingredients, avoiding the use of any components harmful to the environment and health.🍀
Every shower is a gentle care for the Earth.🍀
#SustainableDesign #Lvxin shower gel

Appendix A.2.4. Controlled Condition for High-Involvement Products
No advertising appeal was present in this advertising condition.

The latest new energy vehicle released by LvXin.🌱
With outstanding performance, safety and stability,
and an ultra-long driving range, it is equipped with the
latest intelligent driving system, starting a green life
with zero emissions.🍀

#SustainableDesign #Lvxin EV

Appendix A.2.5. Compassion (Emotional Appeal) for High-Involvement Products
Compassion was present in this condition.

‹ Lisa · · ·

Earth is hurting ! Caring for the Earth!
Our planet needs us now more than ever.

The latest new energy vehicle released by LvXin.🌱
With outstanding performance, safety and stability,
and an ultra-long driving range, it is equipped with the
latest intelligent driving system, starting a green life
with zero emissions.🍀
#SustainableDesign #Lvxin EV

Appendix A.2.6. Innovation (Rational Appeal) for High-Involvement Products
Innovation appeal was present in this condition.

References

1. Shcherbina, K.; Espey, M.; He, G. Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environ. Dev.* **2017**, *22*, 35–49. [CrossRef]
2. Long, S.; Liao, Z. Would consumers pay for environmental innovation? The moderating role of corporate environmental violations. *Environ. Sci. Pollut. Res.* **2021**, *28*, 29075–29084. Available online: https://link.springer.com/article/10.1007/s11356-021-12811-2 (accessed on 18 May 2024). [CrossRef] [PubMed]
3. Kim, D.Y.; Kim, H.Y. Trust me, trust me not: A nuanced view of influencer marketing on social media. *J. Bus. Res.* **2021**, *134*, 223–232. [CrossRef]
4. Liu, F.; Lee, Y.H. Virtually authentic: Examining the match-up hypothesis between human vs virtual influencers and product types. *J. Prod. Brand Manag.* **2024**, *33*, 287–299. [CrossRef]
5. Laroche, M.; Bergeron, J.; Barbaro-Forleo, G. Targeting consumers who are willing to pay more for environmentally friendly products. *J. Consum. Mark.* **2001**, *18*, 503–520. [CrossRef]
6. Pittman, M.; Oeldorf-Hirsch, A.; Brannan, A. Green advertising on social media: Brand authenticity mediates the effect of different appeals on purchase intent and digital engagement. *J. Curr. Issues Res. Advert.* **2022**, *43*, 106–121. [CrossRef]
7. Ottman, J. *The New Rules of Green Marketing: Strategies, Tools, and Inspiration for Sustainable Branding*; Routledge: London, UK, 2017. [CrossRef]

8. Conti, M.; Gathani, J.; Tricomi, P.P. Virtual influencers in online social media. *IEEE Commun. Mag.* **2022**, *60*, 86–91. [CrossRef]

9. Sands, S.; Campbell, C.L.; Plangger, K.; Ferraro, C. Unreal influence: Leveraging AI in influencer marketing. *Eur. J. Mark.* **2022**, *56*, 1721–1747. [CrossRef]

10. Byun, K.J.; Ahn, S.J. A systematic review of virtual influencers: Similarities and differences between human and virtual influencers in interactive advertising. *J. Interact. Advert.* **2023**, *23*, 293–306. [CrossRef]

11. Mouritzen SL, T.; Penttinen, V.; Pedersen, S. Virtual influencer marketing: The good, the bad and the unreal. *Eur. J. Mark.* 2023; *ahead-of-print*. [CrossRef]

12. Franke, C.; Groeppel-Klein, A.; Müller, K. Consumers' responses to virtual influencers as advertising endorsers: Novel and effective or uncanny and deceiving? *J. Advert.* **2023**, *52*, 523–539. [CrossRef]

13. Jiang, K.; Zheng, J.; Luo, S. Green power of virtual influencer: The role of virtual influencer image, emotional appeal, and product involvement. *J. Retail. Consum. Serv.* **2024**, *77*, 103660. [CrossRef]

14. Zhou, X.; Yan, X.; Jiang, Y. Making sense? The sensory-specific nature of virtual influencer effectiveness. *J. Mark.* **2024**, *88*, 84–106. [CrossRef]

15. Lou, C.; Kiew ST, J.; Chen, T.; Lee TY, M.; Ong JE, C.; Phua, Z. Authentically fake? How consumers respond to the influence of virtual influencers. *J. Advert.* **2023**, *52*, 540–557. [CrossRef]

16. Yan, J.; Xia, S.; Jiang, A.; Lin, Z. The effect of different types of virtual influencers on consumers' emotional attachment. *J. Bus. Res.* **2024**, *177*, 114646. [CrossRef]

17. Lim, R.E.; Lee, S.Y. "You are a virtual influencer!": Understanding the impact of origin disclosure and emotional narratives on parasocial relationships and virtual influencer credibility. *Comput. Hum. Behav.* **2023**, *148*, 107897. [CrossRef]

18. Ozdemir, O.; Kolfal, B.; Messinger, P.R.; Rizvi, S. Human or virtual: How influencer type shapes brand attitudes. *Comput. Hum. Behav.* **2023**, *145*, 107771. [CrossRef]

19. Stein, J.P.; Linda Breves, P.; Anders, N. Parasocial interactions with real and virtual influencers: The role of perceived similarity and human-likeness. *New Media Soc.* **2024**, *26*, 3433–3453. [CrossRef]

20. Frankish, K. Dual-process and dual-system theories of reasoning. *Philos. Compass* **2010**, *5*, 914–926. [CrossRef]

21. Camilleri, M.A.; Falzon, L. Understanding motivations to use online streaming services: Integrating the technology acceptance model (TAM) and the uses and gratifications theory (UGT). *Span. J. Mark. ESIC* **2021**, *25*, 217–238. [CrossRef]

22. Kissinger, H.A.; Schmidt, E.; Huttenlocher, D. *The Age of AI: And Our Human Future*; Hachette UK: London, UK, 2021.

23. Kahneman, D. *Thinking, Fast and Slow*; Farrar, Straus and Giroux: New York, NY, USA, 2011.

24. Lee, M.T.; Theokary, C. The superstar social media influencer: Exploiting linguistic style and emotional contagion over content? *J. Bus. Res.* **2021**, *132*, 860–871. [CrossRef]

25. Goenka, S.; Van Osselaer, S.M. Charities can increase the effectiveness of donation appeals by using a morally congruent positive emotion. *J. Consum. Res.* **2019**, *46*, 774–790. [CrossRef]

26. Chen, H.; Chen, H.; Tian, X. The dual-process model of product information and habit in influencing consumers' purchase intention: The role of live streaming features. *Electron. Commer. Res. Appl.* **2022**, *53*, 101150. [CrossRef]

27. Gerrath, M.H.; Olya, H.; Shah, Z.; Li, H. Virtual influencers and pro-environmental causes: The roles of message warmth and trust in experts. *J. Bus. Res.* **2024**, *175*, 114520. [CrossRef]

28. Arsenyan, J.; Mirowska, A.; Piepenbrink, A. Close encounters with the virtual kind: Defining a human-virtual agent coexistence framework. *Technol. Forecast. Soc. Chang.* **2023**, *193*, 122644. [CrossRef]

29. Belanche, D.; Casaló, L.V.; Flavián, M. Human versus virtual influences, a comparative study. *J. Bus. Res.* **2024**, *173*, 114493. [CrossRef]

30. De Cicco, R.; Iacobucci, S.; Cannito, L.; Onesti, G.; Ceccato, I.; Palumbo, R. Virtual vs. human influencer: Effects on users' perceptions and brand outcomes. *Technol. Soc.* **2024**, *77*, 102488. [CrossRef]

31. Deng, F.; Jiang, X. Effects of human versus virtual human influencers on the appearance anxiety of social media users. *J. Retail. Consum. Serv.* **2023**, *71*, 103233. [CrossRef]

32. Li, H.; Lei, Y.; Zhou, Q.; Yuan, H. Can you sense without being human? Comparing virtual and human influencers endorsement effectiveness. *J. Retail. Consum. Serv.* **2023**, *75*, 103456. [CrossRef]

33. Mirowska, A.; Arsenyan, J. Sweet escape: The role of empathy in social media engagement with human versus virtual influencers. *Int. J. Hum. Comput. Stud.* **2023**, *174*, 103008. [CrossRef]

34. Arsenyan, J.; Mirowska, A. Almost human? A comparative case study on the social media presence of virtual influencers. *Int. J. Hum. Comput. Stud.* **2021**, *155*, 102694. [CrossRef]

35. Baudier, P.; de Boisseu, E.; Duchemin, M.H. Source credibility and emotions generated by robot and human influencers: The perception of luxury brand representatives. *Technol. Forecast. Soc. Chang.* **2023**, *187*, 122255. [CrossRef]

36. Liu, F.; Lee, Y.H. Unveiling behind-the-scenes human interventions and examining source orientation in virtual influencer endorsements. In Proceedings of the 2022 ACM International Conference on Interactive Media Experiences, Aveiro, Portugal, 22–24 June 2022; pp. 175–192. [CrossRef]

37. Nissen, A.; Conrad, C.; Newman, A. Are you human? Investigating the perceptions and evaluations of virtual versus human Instagram influencers. In Proceedings of the 2023 Chi Conference on Human Factors in Computing Systems, Hamburg, Germany, 23–28 April 2023; pp. 1–14. [CrossRef]

38. Qu, Y.; Baek, E. Let virtual creatures stay virtual: Tactics to increase trust in virtual influencers. *J. Res. Interact. Mark.* **2024**, *18*, 91–108. [CrossRef]

39. Wan, A.; Jiang, M. Can virtual influencers replace human influencers in live-streaming e-commerce? An exploratory study from practitioners' and consumers' perspectives. *J. Curr. Issues Res. Advert.* **2023**, *44*, 332–372. [CrossRef]

40. Yang, J.; Chuenterawong, P.; Lee, H.; Chock, T.M. Anthropomorphism in CSR endorsement: A comparative study on humanlike vs. cartoonlike virtual influencers' climate change messaging. *J. Promot. Manag.* **2023**, *29*, 705–734. [CrossRef]

41. Zhou, Q.; Li, B.; Li, H.; Lei, Y. Mere copycat? The effects of human versus human-like virtual influencers on brand endorsement effectiveness: A moderated serial-mediation model. *J. Retail. Consum. Serv.* **2024**, *76*, 103610. [CrossRef]

42. Ma, Y.; Li, J. How humanlike is enough?: Uncover the underlying mechanism of virtual influencer endorsement. *Comput. Hum. Behav. Artif. Hum.* **2024**, *2*, 100037. [CrossRef]

43. Deng, F.; Tuo, M.; Chen, S.; Zhang, Z. Born for marketing? The effects of virtual versus human influencers on brand endorsement effectiveness: The role of advertising recognition. *J. Retail. Consum. Serv.* **2024**, *80*, 103904. [CrossRef]

44. Cuomo, M.T.; Foroudi, P.; Tortora, D.; Hussain, S.; Melewar, T.C. Celebrity endorsement and the attitude towards luxury brands for sustainable consumption. *Sustainability* **2019**, *11*, 6791. [CrossRef]

45. Moustakas, E.; Lamba, N.; Mahmoud, D.; Ranganathan, C. Blurring lines between fiction and reality: Perspectives of experts on marketing effectiveness of virtual influencers. In Proceedings of the 2020 International Conference on Cyber Security and Protection of Digital Services (Cyber Security), Dublin, Ireland, 15–19 June 2020; IEEE: New York, NY, USA, 2020; pp. 1–6. [CrossRef]

46. Czellar, S. Consumer attitude toward brand extensions: An integrative model and research propositions. *Int. J. Res. Mark.* **2003**, *20*, 97–115. [CrossRef]

47. Ohanian, R. Construction and validation of a scale to measure celebrity endorsers' perceived expertise, trustworthiness, and attractiveness. *J. Advert.* **1990**, *19*, 39–52. [CrossRef]

48. Chiu, C.L.; Ho, H.C. Impact of celebrity, Micro-Celebrity, and virtual influencers on Chinese gen Z's purchase intention through social media. *SAGE Open* **2023**, *13*, 21582440231164034. [CrossRef]

49. Gray, K.; Wegner, D.M. Feeling robots and human zombies: Mind perception and the uncanny valley. *Cognition* **2012**, *125*, 125–130. [CrossRef]

50. Gray, H.M.; Gray, K.; Wegner, D.M. Dimensions of mind perception. *Science* **2007**, *315*, 619. [CrossRef]

51. Meng, L.M.; Bie, Y.; Yang, M.; Wang, Y. Watching it motivates me to become stronger: Virtual influencers' impact on consumer self-improvement product preferences. *J. Bus. Res.* **2024**, *178*, 114654. [CrossRef]

52. Laukkanen, T.; Xi, N.; Hallikainen, H.; Ruusunen, N.; Hamari, J. Virtual technologies in supporting sustainable consumption: From a single-sensory stimulus to a multi-sensory experience. *Int. J. Inf. Manag.* **2022**, *63*, 102455. [CrossRef]

53. Feng, W.; Liu, Y.; Li, D. Emotional or rational? The congruence effect of message appeals and country stereotype on tourists' international travel intentions. *Ann. Tour. Res.* **2022**, *95*, 103423. [CrossRef]

54. Han, N.R.; Baek, T.H.; Yoon, S.; Kim, Y. Is that coffee mug smiling at me? How anthropomorphism impacts the effectiveness of desirability vs. feasibility appeals in sustainability advertising. *J. Retail. Consum. Serv.* **2019**, *51*, 352–361. [CrossRef]

55. Kim, T.; Ball, J.G. Unintended consequences of warmth appeals: An extension of the compensation effect between warmth and competence to advertising. *J. Advert.* **2021**, *50*, 622–638. [CrossRef]

56. Dai, J.; Sheng, G. Advertising strategies and sustainable development: The effects of green advertising appeals and subjective busyness on green purchase intention. *Bus. Strategy Environ.* **2022**, *31*, 3421–3436. [CrossRef]

57. Quach, S.; Septianto, F.; Thaichon, P.; Chiew, T.M. Mixed emotional appeal enhances positive word-of-mouth: The moderating role of narrative person. *J. Retail. Consum. Serv.* **2021**, *62*, 102618. [CrossRef]

58. Shan, M.; Zhu, Z.; Song, C.; Chen, H.A. The effectiveness of advertising appeals: A culturally-derived power perspective. *J. Retail. Consum. Serv.* **2023**, *75*, 103522. [CrossRef]

59. Keltner, D.; Horberg, E.J.; Oveis, C. Emotions as moral intuitions. In *Affect in Social Thinking and Behavior*; Psychology Press: London, UK, 2012; pp. 161–176.

60. Septianto, F.; Garg, N. The impact of gratitude (vs pride) on the effectiveness of cause-related marketing. *Eur. J. Mark.* **2021**, *55*, 1594–1623. [CrossRef]

61. Liang, J.; Guo, L. Gratitude and sustainable consumer behavior: A moderated mediation model of time discounting and connectedness to the future self. *Psychol. Mark.* **2021**, *38*, 1238–1249. [CrossRef]

62. Horbach, J. Determinants of environmental innovation—New evidence from German panel data sources. *Res. Policy* **2008**, *37*, 163–173. [CrossRef]

63. Ellen, P.S.; Webb, D.J.; Mohr, L.A. Building corporate associations: Consumer attributions for corporate socially responsible programs. *J. Acad. Mark. Sci.* **2006**, *34*, 147–157. [CrossRef]

64. Dai, L.; Guo, Y. Perceived CSR impact on purchase intention: The roles of perceived effectiveness, altruistic attribution, and CSR-CA belief. *Acta Psychol.* **2024**, *248*, 104414. [CrossRef]

65. Leckie, C.; Rayne, D.; Johnson, L.W. Promoting customer engagement behavior for green brands. *Sustainability* **2021**, *13*, 8404. [CrossRef]

66. Turner, J.C.; Brown, R.J.; Tajfel, H. Social comparison and group interest in ingroup favouritism. *Eur. J. Soc. Psychol.* **1979**, *9*, 187–204. [CrossRef]

67. Klaaren, K.J.; Hodges, S.D.; Wilson, T.D. The role of affective expectations in subjective experience and decision-making. *Soc. Cogn.* **1994**, *12*, 77–101. [CrossRef]

68. Reeves, B.; Nass, C. *The Media Equation: How People Treat Computers, Television, and New Media like Real People*; Cambridge University Press: Cambridge, UK, 1996; Volume 10, pp. 19–36. Available online: https://www.researchgate.net/publication/37705092_The_Media_Equation_How_People_Treat_Computers_Television_and_New_Media_Like_Real_People_and_Pla (accessed on 3 August 2024).

69. Lee, H.; Shin, M.; Yang, J.; Chock, T.M. Virtual influencers vs. human influencers in the context of influencer marketing: The moderating role of machine heuristic on perceived authenticity of influencers. *Int. J. Hum. Comput. Interact.* **2024**, 1–18. [CrossRef]

70. Lee, M.K. Understanding perception of algorithmic decisions: Fairness, trust, and emotion in response to algorithmic management. *Big Data Soc.* **2018**, *5*, 2053951718756684. [CrossRef]

71. Meng, B.; Zhang, J.; Choi, K. The formation of parasocial relationships in tourism social media: A rational and emotional trust-building process. *Int. J. Tour. Res.* **2024**, *26*, e2650. [CrossRef]

72. Dholakia, U.M. A motivational process model of product involvement and consumer risk perception. *Eur. J. Mark.* **2001**, *35*, 1340–1362. [CrossRef]

73. Petty, R.E.; Cacioppo, J.T.; Schumann, D. Central and peripheral routes to advertising effectiveness: The moderating role of involvement. *J. Consum. Res.* **1983**, *10*, 135–146. [CrossRef]

74. Akbari, M. Different impacts of advertising appeals on advertising attitude for high and low involvement products. *Glob. Bus. Rev.* **2015**, *16*, 478–493. [CrossRef]

75. Moisander, J. Motivational complexity of green consumerism. *Int. J. Consum. Stud.* **2007**, *31*, 404–409. [CrossRef]

76. Degirmenci, K.; Breitner, M.H. Consumer purchase intentions for electric vehicles: Is green more important than price and range? *Transp. Res. Part D Transp. Environ.* **2017**, *51*, 250–260. [CrossRef]

77. Thomas, V.L.; Fowler, K. Close encounters of the AI kind: Use of AI influencers as brand endorsers. *J. Advert.* **2021**, *50*, 11–25. [CrossRef]

78. Pichierri, M.; Peluso, A.M. Underscoring flavor or healthiness? The effectiveness of different communication appeals in promoting local food and the moderating role of individual construal. *Psychol. Mark.* **2023**, *40*, 1521–1538. [CrossRef]

79. Mozafari, N.; Weiger, W.H.; Hammerschmidt, M. Trust me, I'm a bot–repercussions of chatbot disclosure in different service frontline settings. *J. Serv. Manag.* **2021**, *33*, 221–245. [CrossRef]

80. Hayes, A.F.; Preacher, K.J. *Conditional Process Modeling: Using Structural Equation Modeling to Examine Contingent Causal Processes*; IAP Information Age Publishing: Charlotte, NC, USA, 2013; Available online: https://psycnet.apa.org/record/2014-01991-006 (accessed on 15 September 2024).