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The role of anthropomorphism and racial homophily of virtual influencers in encouraging low- versus high-cost pro-environmental behaviors

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Abstract

Virtual influencers have great potential to shape the audience's perception and motivate behavioral change. Drawing upon anthropomorphism theory and social identity theory, this paper examined the interaction effect of anthropomorphism and racial homophily of virtual influencers in shaping audiences' trust and subsequently pro-environmental behaviors in low- and high-cost contexts. Two online studies employing experimental materials generated by artificial intelligence were conducted. Study 1 revealed that high anthropomorphism (human-like virtual influencers) and high racial homophily (local-like virtual influencers) are more effective for eliciting trust in the context of low-cost pro-environmental behaviors. The findings also showed that low racial homophily (foreign-like virtual influencers) would further weaken the trust level of a virtual influencer in low anthropomorphism (animate-like virtual influencers). Study 2 aimed to replicate the findings from Study 1 in the context of high-cost pro-environmental behaviors. The findings showed that low racial homophily (foreign-like virtual influencers) enhanced the trust in a high anthropomorphism (human-like virtual influencers) virtual influencer. The moderated mediation analyses confirmed the hypothesized relationships in the proposed research model. This research advanced our understanding on the moderating role of racial homophily that serves as a cognitive shortcut for low-cost and quick decisions. However, a low racial homophily (foreign-like) virtual influencer would be more effective for high-cost and symbolic pro-environmental behaviors. These insights provide valuable guidance to businesses, marketers, and environmental advocates aiming to leverage virtual influencers for encouraging sustainability practices.

KEYWORDS

artificial intelligence, influencing marketing, pro-environmental behaviors, sustainability, virtual influencers

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1 | INTRODUCTION

1.1 | The emergence of virtual influencers

Social media influencers, ranging from everyday people to celebrities, leverage their online presence to influence their followers, and they are valued for their ability to attract audiences and shape opinions (Ouvrein et al., 2021). Brands are actively collaborating with influencers to effectively engage audiences and promote their brands (Nascimento et al., 2020). In 2023, global spending on influencer advertising reached USD30 billion, with projections indicating it will maintain its upward momentum, reaching USD56 billion by 2029 (Statista, 2024). Computer-generated virtual influencers have recently emerged as an alternative to human influencers due to the lower marketing costs and reduced risk of public relations scandals (Thomas & Fowler, 2021). Virtual influencers has gaining popularity among businesses and marketers for their influencer marketing campaign and also potentially contribute to a customer perception of innovativeness in promotional activities (Franke et al., 2023). Brands in different sectors, such as Nike, Prada, BMW, and IKEA, have utilized virtual influencers in their marketing campaigns (Shen, 2024). The global virtual influencer market is currently valued at USD4.6 billion, is projected to increase by 26% by 2025 (Kuzminov, 2023). Amid the ongoing digital transformation and evolution of social media platforms, gaining insights into audience perceptions of virtual influencers becomes imperative for businesses and marketers (Jhawar et al., 2023).

1.2 | The potential role of virtual influencers in promoting pro-environmental behaviors

Encouraging pro-environmental behaviors is often seen as a key strategy for mitigating environmental problems (Grilli & Curtis, 2021). Human influencers have emerged as effective advocates for promoting such changes (Boerman et al., 2022; Zhang et al., 2021). Dekoninck and Schmuck (2022) found that influencers' online contents do not only strengthen intentions but also translate into actual offline pro-environmental behaviors. To promote pro-environmental behaviors, Gerrath et al. (2024) suggested that virtual influencers offer a potential solution to the negative publicity associated with human influencers, this is attributed to advertisers' control over virtual influencers and their clean track record that is free from unsustainable practices. Virtual influencers demonstrated effective advertising effects in endorsing green products and pro-environmental campaign (Jiang et al., 2024; Yang, Chunterawong, Lee, & Chock, 2023). In practice, BMW engaged Lil Miquela (@lilmiquela) to endorse its new energy vehicle, and WWF partnered with Noonouri (@noonouri) to promote the earth hour campaign. Utilizing virtual influencers to promote pro-environmental behaviors presents a promising pathway for tackling environmental challenges and motivating behavioral change.

1.3 | Research aim

Gerrath et al. (2024) have pointed out a significant gap in our current understanding of virtual influencers' impact on pro-environmental behavior. While a few research studies have investigated the effectiveness of human influencers in promoting pro-environmental behaviors (e.g., Boerman et al., 2022; Li et al., 2024), less attention has been paid to how audiences perceive and respond to environmental messages delivered by virtual influencers pertaining to different types of pro-environmental behaviors.

Existing studies on virtual influencers have primarily focused on anthropomorphic characteristics and their influence on audience behavior, often comparing human influencers, human-like virtual influencers, and animate-like virtual influencers (e.g., Arsenyan & Mirowska, 2021; Gutuleac et al., 2024), however little is known about other visual traits of virtual influencers (Yang, Chunterawong, et al., 2023). Drawing upon social identity theory (Tajfel, 1978), individuals tend to favor others who share similar characteristics. While the effect of homophily, where influencers and audiences share common characteristics, has been tested in influencer marketing research (Ladhari et al., 2020), the specific impact of racial homophily, recognized as a significant factor in developing social networks in the field of sociology (Leszczensky & Pink, 2019), remains largely unexplored in virtual influencer marketing. This study aims to bridge this gap by examining the interplay between anthropomorphism and racial homophily in shaping pro-environmental behaviors.

Recent studies have found virtual influencers are more effective in promoting certain products, such as technical products (Franke et al., 2023) and products focusing on functional features (Liu & Lee, 2024) than others. This could probably be explained by the match-up hypothesis that product-endorser congruence affects advertising effectiveness (Kamins, 1990). However, the effectiveness of virtual influencers in encouraging different types of pro-environmental behaviors is yet to be studied. Engagement in pro-environmental behaviors is influenced by various factors such as personal experience, knowledge, and other situational factors (Lauren et al., 2016; Truelove & Gillis, 2018). The low-cost hypothesis by Diekmann and Preisendörfer (2003) suggested that the perceived costs is the key factor influencer whether individuals carry out pro-environmental actions, and pro-environmental behaviors can broadly be categorized as low-cost and high-cost. Therefore, we investigate the impacts of virtual influencers' anthropomorphism and racial homophily in the context of both low- and high-cost pro-environmental behaviors.

By employing two online experimental studies, this research makes both theoretical and practical contributions. Primarily, the findings contribute to expanding knowledge base of virtual influencers (Arsenyan & Mirowska, 2021; Franke et al., 2023; Gutuleac et al., 2024) by examining the interaction effect of anthropomorphism and racial homophily on pro-environmental behaviors. The two studies in this research utilize materials generated by artificial intelligence, encompassing virtual influencers' avatars portraying human-like versus animate-like traits and local-like versus foreign-like characteristics. Leveraging images generated by artificial intelligence maintains higher

level of consistency across visual stimuli used in different conditions, with only the relevant differences highlighted for the tested conditions (Kim et al., 2024). Moreover, each of our studies explores the contexts of low- and high-cost pro-environmental behaviors, this helps advance our understanding of virtual influencers' effectiveness in promoting different types of behaviors. Furthermore, this study provides practical implications for businesses and marketers on planning and formulating virtual influencer marketing campaigns in promoting sustainable consumption and lifestyles.

2 | LITERATURE REVIEW

2.1 | Virtual influencer and the advocacy of pro-environmental behaviors

Social media influencers are individuals from everyday people to celebrities who create online contents that influences their followers (Hudders et al., 2021). A virtual influencer is a computer-generated character designed to simulate a human influencer and engage with audiences on social media platforms (Laszkiewicz & Kalinska-Kula, 2023). They are typically created using advanced 3D animation and artificial intelligence technologies. The terms virtual influencers and computer-generated imagery (CGI) influencers are often used interchangeably, however, virtual influencers differ from CGI influencers in several ways. CGI influencers originated from CGI characters are computer-generated characters that appear in movies, video games, and other forms of media (Hetherington & McRae, 2017). They are typically used to create realistic and visually appealing characters for entertainment purposes, such as Barbie (@Barbie), Pokémon (@pokemon). These CGI influencers have often extended their presence onto social media platforms nowadays. Virtual influencers, on the other hand, are designed specifically for social media and marketing purposes. They are created to engage with audiences, promote brands, and influence consumer behaviors. Virtual influencers possess distinct personalities, interests, and visual identities that enables them to connect with audiences and promote brands or products (Mouritzen et al., 2023), such as Lil Miquela (@lilmiquela), Noonourri (@noonourri), Imma (@imma.gram). Virtual YouTubers or VTubers is a distinct category of virtual influencers who specialize in creating video content and live streams (Conti et al., 2022), such as Kizuna Ai (@a.i.channel_official), Ami Yamato (@amiyamato). In most cases, there are teams of people (e.g., animators, social media marketers, digital advertising agencies) working behind the scenes to create and manage virtual influencers, developing the character's backstory, personality, and visual appearance, as well as creating and publishing content on their social media channels.

Virtual influencers have advantages over human influencers because of their consistent image, low risk of indiscretions, and free from ethical issues related to brand attachment (Byun & Ahn, 2023; Tan, 2019). However, in a qualitative study by Moustakas et al. (2020), industry practitioners raised several challenges of virtual

influencer marketing. One key challenge of virtual influencers is to sustain interests among audiences and who may easily lose interest if they perceive virtual influencers as inauthentic, lacking human touch and appearing overly commercial (Sands et al., 2022). The practitioners also raised concerns about the initial investment required to develop virtual influencers, as well as the risks associated with poor strategy or execution, which could negatively impact a brand's image (Moustakas et al., 2020). Furthermore, ethical concerns, disclosure of virtual identity, projection of unattainable beauty standards, and cultivation of fabricated parasocial relationships, are hurdles for brands using virtual influencer, these highlight the importance of thorough deliberation and ethical consideration in the utilization of virtual influencers for marketing purposes (Kim & Wang, 2023). Despite the drawbacks associated with virtual influencers, the emerging trend of using virtual influencers in social media marketing will continue to be an important research topic, particularly in the age of generative artificial intelligence (Laszkiewicz & Kalinska-Kula, 2023). Virtual influencers provide brands with more flexibility and control compared to human influencers. They can, therefore, be designed specifically to advocate for target actions and social and environmental causes. Their messages and actions can be carefully crafted to maximize persuasive impact, as virtual influencers do not have opinions and act as messengers for brands and causes. This means their endorsement of environmentally friendly behaviors and promotion of more sustainable consumption patterns is less likely to be compromised by personal biases or commercial conflicts of interest (Byun & Ahn, 2023; Kim & Kim, 2021). Moreover, virtual influencers have the potential to reach and engage large audiences through their interactive presence on social media. If designed and leveraged effectively, they could help raise awareness of environmental issues and climate change amongst consumers, particularly younger generations that are active social media users (Pradhan et al., 2023).

Table 1 summarizes the recent studies examining virtual influencers' role in encouraging pro-environmental behaviors. These studies mainly investigated the virtual influencers' level of humanness (e.g., Jiang et al., 2024), message appeal (e.g., Gerrath et al., 2024), and interactivity (e.g., Yang, Chunterawong, Lee, Tian, et al., 2023). While these studies contributed valuable insights into the use of virtual influencers for pro-environmental behaviors, they often focused on single and specific characteristics of the influencers that called for a more comprehensive understanding of the various components that constitute an effective virtual influencer campaign.

Virtual influencer research has explored various theoretical frameworks. This study, however, focuses on anthropomorphism theory (Duffy, 2003; Epley et al., 2007) to compare the impact of human-like versus animate-like virtual influencers, social identity theory (Tajfel, 1978) to analyze local-like versus foreign-like virtual influencers, and the low-cost hypothesis (Diekmann & Preisendörfer, 2003) to examine the interaction of anthropomorphism and racial homophily in low- and high-cost pro-environmental behavior contexts. The following subsections present the theoretical foundations and hypotheses of this paper.

TABLE 1 A summary of recent studies on virtual influencers and pro-environmental behaviors.

Reference	Theories used	Key focus	Methodology	Key findings
Gerrath et al. (2024)	Stereotype content model	The impact of message warmth and trust in experts on virtual influencers' effectiveness in promoting environmental causes	Qualitative interviews, experimental studies	The impact of the message warmth of virtual influencers on audiences' pro-environmental engagement is mediated by social-psychological distance.
Guo et al. (2023)	Theory of mind	The effectiveness of virtual avatars in promoting sustainable behaviors in hotels	Survey	Affective and cognitive trust influenced customer experience and engagement with the brand.
Jiang et al. (2024)	Computers-as-social-actors paradigm	The effectiveness of using virtual influencers in green advertising	Experimental studies	Human-like virtual influencers had an advantage over animate-like virtual influencers for green product advertising, particularly for high-involvement products and pride appeals.
Kleinlogel et al. (2023)	Social cognitive theory	The effectiveness of virtual avatars in promoting pro-environmental behaviors in virtual reality	Experimental studies	Virtual avatars (compared to print and video promotion) enhanced the promotional effectiveness of energy-saving attitudes and behaviors.
Yang, Chunterawong, Lee, Tian, et al. (2023)	Expectancy violation theory, source credibility theory	The role of virtual influencers' humanness and interactivity on climate change message	Experimental studies	The interaction effect of virtual influencers' humanness and interactivity strengthened the source credibility and subsequently influenced engagement of the climate change message
Yang, Chunterawong, Lee, Tian, et al. (2023)	Expectancy violation theory, source credibility theory	The impact of virtual influencers' humanness and congruence on the effectiveness of climate change messages	Experimental studies	Virtual influencers with a higher level of humanness elicited a higher level of expertise and trustworthiness, which in turn enhanced audiences' engagement
This Study	Anthropomorphism theory, social identity theory, low-cost hypothesis	The role of anthropomorphism and racial homophily of virtual influencers in encouraging high versus low-cost pro-environmental behaviors	Experimental studies	Racial heterophily reduces the trust of animate-like virtual influencers in low-cost behaviors but increase trust of human-like virtual influencers in high-cost behaviors

2.2 | Anthropomorphism, trust, and pro-environmental behaviors

2.2.1 | Anthropomorphism in virtual influencers

Anthropomorphism refers to the attribution of human-like characteristics to nonhuman entities, such as animals, objects, or in this study, virtual influencers or other related technologies (Epley et al., 2007). Blut et al. (2021) highlighted in a recent meta-analysis on anthropomorphism the two divergent perspectives within anthropomorphism literature. One stream of research adopts anthropomorphism theory focusing its positive effects on technology use (e.g., Chiang et al., 2022; Letheren et al., 2021); another group of literature conversely emphasizes the negative effects of anthropomorphism and often references the uncanny valley theory (e.g., Arsenyan & Mirowska, 2021; Gutuleac et al., 2024). Although there may exist a threshold beyond which human-like entities become unsettling or eerie to users (Mori, 1970), a recent study by Kim et al. (2024) have examined the concept of ambivalence that individuals may experience a mix of feelings, including both coolness and uncanniness, when interacting with anthropomorphic virtual influencers. Therefore, unless the anthropomorphic features become unrealistic and overly sophisticated, carefully designed and implemented anthropomorphic features can enhance user engagement (Chiang et al., 2022). Based on the taxonomy of virtual influencers developed by Mouritzen et al. (2023) and drawing upon prior research (Arsenyan & Mirowska, 2021; Gutuleac et al., 2024), this study focuses on animate-like (low level of anthropomorphism) and human-like (high level of anthropomorphism) virtual influencers.

Animate-like virtual influencer is a virtual influencer with anime characters processing cartoonish representations of humans, such as exaggerated eyes and small mouths (Yang et al., 2020). Human-like virtual influencers appear exceedingly similar to humans and sometimes attempt to create a human-like experience with fans. Studies have found contradictory results on whether human-like or animate-like virtual influencers perform better in influencing audiences' attitudes and behavior. Some research found that human-like virtual influencers can elicit more robust emotional responses in audiences and are received more positively than those that are less human-like (Ozdemir et al., 2023), while others showed that animate-like virtual influencers are more influential (Arsenyan & Mirowska, 2021), depending on the outcome behaviors and mediating factors. Besides the arguments about whether animate-like or human-like virtual influencers are more effective in influencing audiences, the use of virtual influencers in the context of pro-environmental behaviors is limited. Yang, Chuentawong, Lee, Tian, et al. (2023) recently found that human-like influencers drive consumers' corporate social responsibility engagement more effectively. Nevertheless, studies on driving individuals' sustainable behaviors are limited.

2.2.2 | Trust in virtual influencers

Trust in influencers refers to how honest, sincere, and truthful an influencer perceive to be, indicating whether they are seen as a

source of unbiased and truthful information (Ohanian, 1990). Enhanced trust in influencers not only strengthens communication effectiveness but also fosters a rewarding relationship between influencers and their followers (Kim & Kim, 2021). Additionally, trust stands out as the most crucial success factor for influencers (Wiedmann & von Mettenheim, 2020). Boerman et al. (2022) demonstrated that the trustworthiness of green influencers positively influences audiences' intentions towards pro-environmental actions in environmental communication. Building on social exchange and source credibility theories (Homans, 1974; Hovland & Weiss, 1951), Kim and Kim (2021) proved source credibility and source attractiveness are the key factors sharpening trust in influencers. Conversely, research in technology, particularly focused on service robots, particularly focused on service robots, chatbots, and similar technologies, has consistently demonstrated that anthropomorphism plays a significant role in bolstering levels of trust. For instance, De Visser et al. (2016) proposed a theory of human-agent trust and demonstrated that anthropomorphism positively affects trust in automated cognitive agents and a higher resistance to breakdowns in trust, Wu et al. (2023)'s study in shared autonomous vehicles showed that anthropomorphism in physical appearance and communication mode contributed to an increased level of trust, and Van Pinxteren et al. (2019) showed that anthropomorphism drives trust in humanoid service robots. Do et al. (2021) found that when an anthropomorphic virtual character is added to green messages, audiences become more receptive to the recommended green initiatives. Hofeditz et al. (2022)'s study compared human and virtual influencers, revealing that a higher level of anthropomorphism, such as that found in human influencers, results in increased trustworthiness. Thus the following hypothesis is proposed:

Hypothesis 1 (H1). Virtual influencers with high anthropomorphism (i.e., human-like virtual influencers) elicit higher levels of trust compared to virtual influencers with low anthropomorphism (i.e., animate-like virtual influencers).

2.2.3 | Trust in virtual influencers and pro-environmental behaviors

The relationship between trust and pro-environmental behavior is extensively studied in social science literature. For example, Tam and Chan (2018) showed that a higher level of trust increases individuals' engagement in pro-environmental behaviors. Cologna et al. (2022) also demonstrated that trust in climate scientists positively influences the willingness to adopt pro-environmental actions. Furthermore, Joffe-Nelson et al. (2024) proved that trust in regulatory institutions enhances pro-environmental intentions in outdoor recreation contexts. These findings collectively demonstrated the influential role of trust in various entities and its significant role in promoting pro-environmental behaviors. Trust in influencers is a crucial factor driving a range of positive outcomes, including enhancing loyalty, influencing purchase decisions, and motivating intentions to follow

recommendations (Chetioui et al., 2020; Kim & Kim, 2021; Lou & Yuan, 2019). When individuals perceive influencers as trustworthy sources of information and guidance, they are more likely to adopt pro-environmental behaviors advocated by these influencers (Boerman et al., 2022). Trust can also shape individuals' perceptions of environmental issues and strengthen the motivation to engage in sustainable practices (Pittman & Abell, 2021). Therefore, understanding trust in virtual influencers and its impact on pro-environmental behaviors is crucial for developing effective influencer marketing strategies and promoting sustainable lifestyles. The following hypothesis is proposed:

Hypothesis 2 (H2). Trust in virtual influencers positively affects pro-environmental behaviors

2.3 | Racial homophily in low- versus high-cost pro-environmental behaviors

2.3.1 | Racial homophily of virtual influencers

The social identity theory (Tajfel, 1978) suggested that individuals derive a sense of identity from their membership in social category or group and individuals often favor their own group over others. In sociological literature, homophily refers to similarity among individuals, it affects the development of friendship and social networks based on the preferences to connect with similar others (e.g., Hafen et al., 2011; Kandel, 2017). In the context of social media marketing, homophily drives individuals to connect and engage with social media influencers who share similar characteristics or interests as themselves, promotes authenticity judgments through increased feelings of understanding and trust (De Veirman et al., 2017). When audiences perceive an influencer as similar to themselves, they are more likely to find the influencer credible and trust their recommendations (Schouten et al., 2021). Homophily has consistently been proved as a significant factor influencing audiences engagement (Bu et al., 2022; Shoenberger & Kim, 2023).

When audiences perceive similarities between themselves and a message source, it leads to feelings of trust and goodwill toward that source (Kim & Kim, 2021). Audiences are more willing to believe a source "like me" provides accurate information and has their best interests at heart rather than some hidden agenda (Centeno & Wang, 2020). However, on the one hand, virtual influencers cannot be perfectly similar to diverse audiences due to their digital nature. On the other hand, virtual influencers can be tailor-made to be closely similar to the audiences to be reached using highly targeted digital platforms. Homophily is often conceptualized as similarity in appearance, value, attitude, and socioeconomic status (Ladhari et al., 2020), but racial similarity remains relatively underexplored in influencer marketing research and other digital contexts (Azer et al., 2023). This study utilizes foreign-like and local-like virtual influencers to represent low and high levels of racial homophily respectively.

2.3.2 | Low- versus high-cost pro-environmental behaviors

According to low-cost hypothesis (Diekmann & Preisendörfer, 2003), individuals' perception of the costs affects their willingness to engage in pro-environmental behavior and therefore influences their likelihood of taking sustainable actions. Low-cost pro-environmental behaviors typically require low level of effort, such as reusing shopping bags (Arias & Trujillo, 2020), reduction of household energy use (Kothe et al., 2019) and recycling household waste (Andersson & von Borgstede, 2010). High-cost pro-environmental behaviors demand higher costs or effort changes, for example, choosing sustainable transportation over personal vehicles (Ahmat Zainuri et al., 2022), paying extra for sustainable products (Moser, 2015), and using higher-priced eco-friendly travel products (Yin, 2023).

Research has shown that environmental messages highlighting the ease of behaviors like recycling are more effective at promoting action than focusing on more costly behaviors (Gifford & Nilsson, 2014). This is because emphasizing ease alleviates concerns about the costs and difficulties of changing behaviors and allows individuals to feel that their daily routines are affected with minimal disruption (Uren et al., 2021; Wyss et al., 2022). Social media plays an important role in encouraging pro-environmental behaviors, primarily by fostering interpersonal communication (Han & Xu, 2020) and facilitating the sharing of relevant information (Shen et al., 2023). Prior studies have demonstrated that influencers can effectively shape followers' sustainable behaviors (e.g., Dekoninck & Schmuck, 2022), research has yet to address the potential differences between the effectiveness of influencers in promoting low-cost versus high-cost pro-environmental behaviors. Therefore, it is important to explore how virtual influencers can impact both types of pro-environmental behaviors. This would shed light on formulating successful strategies for virtual influencer campaigns. Following the categorization proposed by Uren et al. (2021), this study selected two distinct pro-environmental behaviors, that is, opting out of cutlery in food delivery orders as a representation of low-cost pro-environmental behavior and purchasing carbon offsets as a high-cost pro-environmental behavior.

2.3.3 | The moderating role of racial homophily

Robots and other virtual entities can display racial characteristics and users are able to identify these difference (Sparrow, 2019). Prior studies in different contexts, such as online reviews and interactions with AI bots, has revealed the impact of racial characteristics affecting audiences' perceptions and behaviors (Azer et al., 2023; Bozkurt et al., 2021; Davis et al., 2023). Although previous sociological studies have highlighted the significant role of racial homophily in shaping interpersonal relationships in both offline and online settings (Hofstra et al., 2017; McPherson et al., 2001), its impact may vary (Antonoplis & John, 2022; Leszczensky & Pink, 2019). For instance, McDonald et al. (2013) discovered that racial homophily influences the initial

development of relationships but not their stability. Wimmer and Lewis (2010) also showed that racial background only partially explains the formation of social relationships on social media platforms. Therefore, racial homophily serves as a convenient shortcut for customers for making quick decisions.

In the literature of celebrity endorsement, there are mixed results regarding the impact of racial homophily. While some studies found that endorsers who matched the customer's ethnicity were found to be more persuasive (Erba et al., 2019; Hesapci et al., 2016), others reported that race of endorsers did not have any insignificant impact on customers' attitudes and perception (Apaolaza et al., 2014; Bui, 2017). However, Lord et al. (2019) provide further insights on how that racial homophily influences customers' evaluation of endorsers' attractiveness and trustworthiness in different behavioral contexts, the study findings showed that racial homophily is particularly impactful in contexts of simpler consumer decision-making, rather than in situations involving high-involvement information processing. Several recent studies have investigated the specific circumstances under which racial homophily exerts an influence on the audiences. For example, Tong and Su (2021) found that aligning endorser's ethnicity and products' country-of-origin enhances customers' quality perception and brand attitudes. Similarly, and Li et al. (2022) showed that celebrity endorsement in tourism destination marketing is most effective when the celebrity originates from the destination country. These studies collectively suggested that the impact of racial homophily is dependent upon the behavioral contexts.

While social media influencers' racial homophily plays role in influencing customers' perception (Yu & Hu, 2020), local influencers are proved to be effective for functional goods while foreign influencers are more impactful for promoting symbolic goods (Zhu et al., 2019). In this study, opting out of cutlery in food delivery orders is selected as a low-cost pro-environmental behavior and that is often perceived as a simple and practical action. As audiences tend to rely on the source's race for quick decisions, racial homophily is hypothesized to strengthen the relationship between anthropomorphism and trust in virtual influencers in the low-cost behavioral context. Conversely, purchasing carbon offsets, considered as a high-cost pro-environmental behaviors in this study, impose financial burden on customers (Huang et al., 2020) and is associated with

personal status and uniqueness (Liu et al., 2015). Therefore, considering potential symbolic value of the high-cost pro-environmental behaviors, utilizing a foreign-like virtual influencers would strengthen the impact of anthropomorphism on trust in virtual influencers. The hypotheses are proposed as follows.

Hypothesis 3a (H3a). Virtual influencers with high racial homophily (i.e., local-like virtual influencers) strengthen the relationship between anthropomorphism and trust in the context of low-cost pro-environmental behaviors.

Hypothesis 3b (H3b). Virtual influencers with low racial homophily (i.e., foreign-like virtual influencers) strengthen the relationship between anthropomorphism and trust in the context of high-cost pro-environmental behaviors.

Based on the literature mentioned above, the research model is presented in Figure 1.

3 | OVERVIEW OF RESEARCH DESIGN

3.1 | Study design

This research consists of two online experimental studies that collectively contribute a comprehensive understanding of the role of anthropomorphism and racial homophily in promoting pro-environmental behaviors in both low-cost and high-cost scenarios. Artificial intelligence has become widespread in marketing activities (Karnouskos, 2020; Kietzmann et al., 2018). With the accelerated adoption of generative artificial intelligence, consumers' acceptance of artificial intelligence has also increased. The adoption of generative artificial intelligence in content marketing of virtual influencers will soon become a norm (Insider, 2023). Both studies in this paper leveraged AI-generated materials, this ensures the consistency across virtual influencers while highlighting relevant differences for the tested conditions (Kim et al., 2024).

Study 1 investigates the interaction of anthropomorphism and racial homophily in virtual influencers on audience trust and the

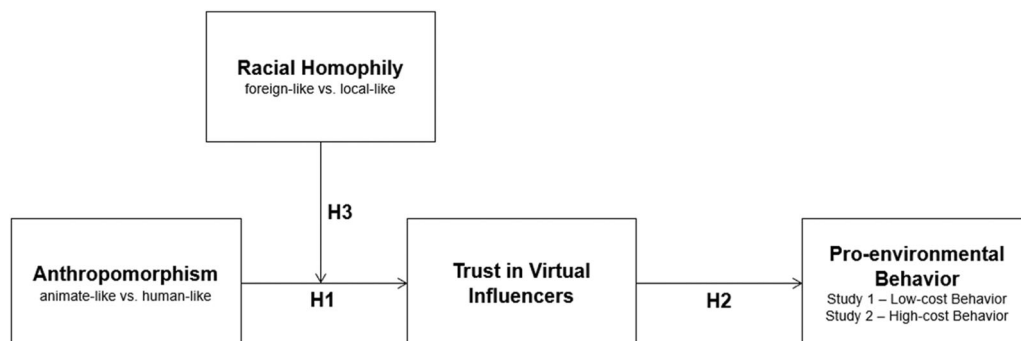


FIGURE 1 The research model.

subsequent impact on audience intentions to engage in low-cost pro-environmental behaviors. Study 2 expands this inquiry to the context of high-cost pro-environmental behaviors. Understanding these dynamics is crucial for businesses and marketers aiming to develop effective virtual influencer marketing strategies for pro-environmental advocacy.

3.2 | Data collection

Participants will be recruited online by a Chinese research agency, their panel covers over 300 million Chinese consumers and is widely representative of the population. The study focuses on Chinese customers because of the country's significant number of social media users (Ruby, 2023) and the pressing need to address environmental challenges (Khan et al., 2022). The minimum sample size is estimated by G*Power 3.1 software (Faul et al., 2009). For the two studies involving four experimental groups, using a significance level of 5%, under a power of 95%, and an estimated medium effect size of 0.25, at least 279 respondents should be recruited for each study.

3.3 | Measures

In addition to the experimental conditions (i.e., anthropomorphism and racial homophily), the measurement items of trust and pro-environmental intentions are measured on a 7-point scale (1 = *Strongly Disagree* to 7 = *Strongly Agree*). These measurement items were adapted from validated scales used in previous studies (see Appendix A). Participants were also required to provide their responses to two control variables, that is, environmental identity and perceived behavioral control, and this helps ensure the findings are unaffected by any pre-existing conditions or external factors during the data analysis process. In addition, respondents' demographic information, including gender, age, and educational level, and their responses to the manipulation check questions were collected.

3.4 | Data analysis

Analysis of variance (ANOVA) would be performed to confirm the difference among the respondents in different experimental groups in terms of their responses to the manipulation questions. Two-way ANCOVA, with demographic variables (gender, age, and educational level) and the two continuous control variables (environmental identity and perceived behavioral control) as co-variables, would also be performed to test the main and interaction effect of anthropomorphism and racial homophily on trust in virtual influencers. To collectively test the relationships hypothesized in the research model, PROCESS MACRO v4.2 (Hayes, 2018) would be employed (95% confidence interval; 10,000 bootstrap samples).

4 | STUDY 1

4.1 | Design, participants, stimuli, and procedures

The purpose of Study 1 was to examine how the virtual influencer's level of anthropomorphism and racial homophily affect trust in the virtual influencers and pro-environmental intentions. A 2 (animate-like vs. human-like virtual influencer) \times 2 (foreign-like vs. local-like virtual influencer) between-subjects experimental design was employed. Four fictitious social media posts were created with both virtual influencer's profile avatars and the message generated by artificial intelligence. The platforms used, prompts, and outputs are presented in Appendix B. Study 1 focuses on the low-cost pro-environmental behavior of using reusable cutlery during food delivery due to its popularity (Mehroli et al., 2021) and the significant rise in single-use cutlery usage worldwide (Janairo, 2021; Molina-Besch, 2020). Therefore, this choice of pro-environmental behavior resonates with the respondents' daily experiences requiring minimal cost and makes it easier for respondents to connect with their own experiences. Each condition comprised a different virtual influencer's profile picture but the same message encouraging the use of reusable cutlery in food delivery orders (see Appendix B).

The market research agency recruited 414 Chinese individuals who participated in Study 1 (age range: 18–60; 41.5% male, 58.5% female). Participants were randomly assigned to one of the four experimental conditions. N for each condition was ranged from 102 to 104. Participants were first presented with the randomly assigned social media post; they were then requested to complete an online survey that included the variables in the research model, control variables, demographic questions, and manipulation checks questions.

4.2 | Results

4.2.1 | Manipulation checks

One-way ANOVA was conducted to evaluate the success of both animate-like versus human-like and foreign-like versus local-like virtual influencers manipulations. As expected, respondents in the animate-like condition rated their perception of the virtual influencers higher as "like an animate character" than those in human-like condition ($M_{\text{Animate}} = 5.74$, $M_{\text{Human}} = 2.09$, $p < 0.001$). By contrast, respondents in human-like condition rated the virtual influencer as "like a real person" than those in animate-like condition ($M_{\text{Animate}} = 2.34$, $M_{\text{Human}} = 5.98$, $p < 0.001$). The items checking the foreign-like and local-virtual influencer manipulations asked respondents whether the virtual influencer resembled "a foreigner" or "a local person" and the responses demonstrated the expected difference between the respondents assigned to both conditions. Respondents in the foreign-like virtual influencer condition rated the virtual influencer as "a foreigner" significantly higher ($M_{\text{Foreign}} = 6.21$, $M_{\text{Local}} = 2.04$, $p < 0.001$). Respondents in local-like virtual influencer condition rated

their perception of the virtual influencer higher as “a local person” than those in the foreign-like virtual influencer condition ($M_{\text{Foreign}} = 1.86$, $M_{\text{Local}} = 5.95$, $p < 0.001$). In sum, both manipulations were successful.

4.2.2 | Hypothesis testing

A two-way ANCOVA analysis was performed to test the main and interaction effects of anthropomorphism (animate-like coded as 0 vs. human-like coded as 1) and racial homophily (foreign-like coded as 0 vs. local-like coded as 1) on trust in the virtual influencer. As explained above, we included three demographic variables, that is gender, age and education level, and two continuous variables, that is, environmental identity and perceived behavioral control, as control variables in the analysis. The results showed that the main effect of anthropomorphism on trust was significant ($M_{\text{Animate}} = 5.433$, $M_{\text{Human}} = 5.783$, $F = 22.170$, $p < 0.001$, $\eta^2 = 0.052$) in which high level of anthropomorphism (human-like virtual influencer) elicited a higher level of trust than low level of anthropomorphism (animate-like virtual influencer). Thus, H1 was supported. The main effect of racial homophily was also significant ($M_{\text{Foreign}} = 5.463$, $M_{\text{Local}} = 5.752$, $F = 15.071$, $p < 0.001$, $\eta^2 = 0.036$) in that high level of racial homophily, that is local-like virtual influencer, elicited a higher level of trust than foreign-like virtual influencer. Furthermore, the interaction effect was significant ($F = 4.698$, $p < 0.05$, $\eta^2 = 0.011$). Follow-up contrast showed that participants in the animate-foreign condition ($M_{\text{Animate-Foreign}} = 5.207$) reported a significantly lower level of trust compared with those in animate-local ($M_{\text{Animate-Local}} = 5.658$, $p < 0.001$) and human-foreign ($M_{\text{Human-Foreign}} = 5.846$, $p < 0.001$) conditions (see Figure 2). H3a was partially supported because high racial homophily did not strengthen the impact of anthropomorphism in the context of low-cost pro-

environmental behaviors, instead racial heterophily, that is, low racial homophily, was found diminish the trust level when anthropomorphism was low (i.e. animate-like virtual influencer).

To collectively test the manipulated and measured variables, a moderated mediation analysis utilizing PROCESS MACRO v4.2 Model 7 (Hayes, 2018) was conducted (95% confidence interval; 10,000 bootstrap samples). Anthropomorphism (0 = animate-like; 1 = human-like) was included as independent variable, racial homophily (0 = foreign-like; 1 = local-like) as a moderator, trust as mediator and pro-environmental intention (to opt-out cutlery in food delivery order) as dependent variable. The control variables were the same as the ANCOVA analysis. The index of moderated mediation was significant (Index = -0.0439 , SE = 0.0250, CI = $[-0.0989, -0.0022]$) indicating that the effect of anthropomorphism on pro-environmental intention via trust was conditional on racial homophily.

Specifically, the results showed a significant positive relationship between anthropomorphism and trust ($\beta = 0.5125$, SE = 0.1058, $p < 0.001$, CI = $[0.3045, 0.7206]$), indicating higher levels of anthropomorphism lead to greater trust in the virtual influencer. The effect of racial homophily was also positively significant ($\beta = 0.4514$, SE = 0.1051, $p < 0.001$, CI = $[0.2447, 0.6580]$), suggesting that high level of homophily contributes to greater trust. There was a negative significant interaction effect of anthropomorphism and racial homophily on trust ($\beta = -0.3249$, SE = 0.1499, $p < 0.05$, CI = $[-0.6196, -0.0302]$). Therefore, H1 was supported. The conditional effect of anthropomorphism at different values of racial homophily revealed that when racial homophily was low (i.e., foreign-like virtual influencer), the effect of anthropomorphism on trust was positive and significant ($\beta = 0.5125$, SE = 0.1058, $p < 0.001$, CI = $[0.3045, 0.7206]$). This indicates that human-like traits enhance the level of trust in a foreign-like virtual influencer.

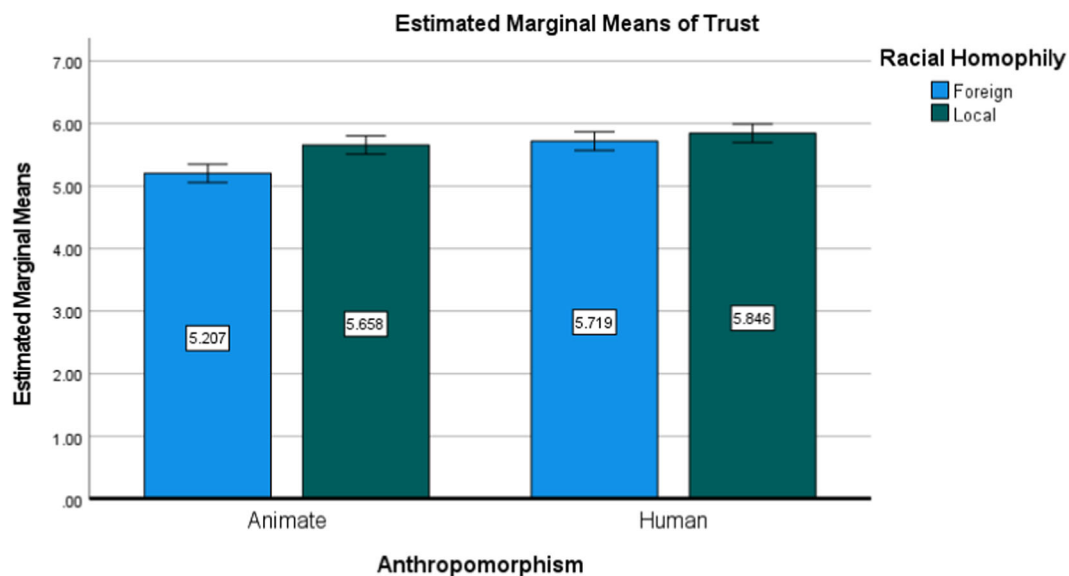


FIGURE 2 Effect of anthropomorphism and racial homophily on trust in virtual influencers (Study 1).

However, the effect of anthropomorphism on trust was insignificant when racial homophily was high (i.e., local-like virtual influencer) ($\beta = 0.1876$, $SE = 0.1053$, $p = 0.0756$, $CI = [-0.0194, 0.3947]$). H3a was partially supported as the impact of anthropomorphism on trust was only significant when the race of the virtual influencer was perceived as different from the audiences (low in racial homophily). Considering the pro-environmental intentions, the direct effect of anthropomorphism on the pro-environmental intentions was insignificant ($\beta = -0.1184$, $SE = 0.0728$, $p = 0.1048$, $CI = [-0.2616, 0.0248]$). However, the relationship between trust and pro-environmental intentions was significant ($\beta = 0.1352$, $SE = 0.0463$, $p < 0.05$, $CI = [0.0441, 0.2263]$) and thus H2 was supported. The results also indicated a significant conditional indirect effect of anthropomorphism on pro-environmental intentions, particularly at low level of racial homophily ($\beta = -0.0693$, $SE = 0.0693$, $CI = [0.0188, 0.1335]$) but not at high level ($\beta = 0.0254$, $SE = 0.0185$, $CI = [-0.0004, 0.0699]$).

5 | STUDY 2

5.1 | Design, participants, stimuli, and procedures

Study 2 aimed to replicate the findings from Study 1 within the context of high-cost pro-environmental behaviors. This involved focusing on purchasing carbon offsets, a high-cost pro-environmental action with notable financial implications (Huber et al., 2018; del Saz Salazar & Pérez y Pérez, 2021). While the voluntary carbon offset schemes are gaining popularity among Chinese consumers (Wu et al., 2024), there is still a need to explore strategies to encourage more customers to engage in such high-cost pro-environmental action (Liu et al., 2015; Truong-Dinh et al., 2023). Additionally, Study 2 employed distinct sets of virtual influencer avatars and messages, further validating the generalizability of the findings in a broader context. Same as Study 1, the materials for Study 2 were generated using artificial intelligence for a 2 (animate-like vs. human-like virtual influencer) \times 2 (foreign-like vs. local-like virtual influencer) between-subjects experimental design. To ensure the generated message resonated with the audiences, the prompt incorporated realistic data on carbon emissions and the pricing of carbon offset schemes (Liu & Jiang, Peng, et al., 2024; The World Bank, 2024). Four fictitious social media posts were created, and the platforms used, prompts, and outputs are presented in Appendix C. Following the same protocol of Study 1, we recruited 402 Chinese individuals through the commissioned marketing research agency (age range: 18–60; 54.0% male, 46.0% female). Participants were randomly assigned to one of the four experimental conditions. N for each condition ranged from 99 to 103. After the participants were presented with the assigned social media post, they would complete an online survey that included the variables in the research model, control variables, demographic questions, and manipulation check questions. Different from Study 1, the pro-environmental behaviors were measured by whether the participants chose to click the “Buy Now” button included in the social media posts.

5.2 | Results

5.2.1 | Manipulation checks

One-way ANOVA was conducted to evaluate the success of both anthropomorphism (animate-like vs. human-like) and racial homophily (foreign-like vs. local-like) virtual influencers manipulations. Respondents in the animate-like condition rated their perception of the virtual influencers higher as “like an animate character” than those in human-like condition ($M_{\text{Animate}} = 5.78$, $M_{\text{Human}} = 2.22$, $p < 0.001$). On the other hand, respondents in human-like condition rated the virtual influencer as “like a real person” than those in animate-like condition ($M_{\text{Animate}} = 2.31$, $M_{\text{Human}} = 5.71$, $p < 0.001$). Furthermore, two items were included for checking the success of foreign-like and local-virtual influencer manipulations by asking respondents whether the virtual influencer resembled “a foreigner” or “a local person.” Respondents in the foreign-like virtual influencer condition rated the virtual influencer as “a foreigner” significantly higher ($M_{\text{Foreign}} = 5.85$, $M_{\text{Local}} = 2.09$, $p < 0.001$). Respondents in local-like virtual influencer condition rated their perception of the virtual influencer higher as “a local person” than those in the foreign-like virtual influencer condition ($M_{\text{Foreign}} = 2.21$, $M_{\text{Local}} = 5.81$, $p < 0.001$). Overall, both manipulations were successful.

5.2.2 | Hypothesis testing

A two-way ANCOVA analysis was performed to test the main and interaction effects of anthropomorphism (animate-like coded as 0 vs. human-like coded as 1) and racial homophily (foreign-like coded as 0 vs. local-like coded as 1) on trust in the virtual influencer. The same control variables as Study 1, three demographic and two continuous variables, were included as co-variables. The results showed that the main effect of anthropomorphism on trust was significant ($M_{\text{Animate}} = 4.596$, $M_{\text{Human}} = 5.086$, $F = 22.170$, $p < 0.001$, $\eta^2 = 0.045$) in which high level of anthropomorphism (human-like virtual influencer) elicited a higher level of trust than low level of anthropomorphism (animate-like virtual influencer). Thus, H1 was supported. However, the main effect of racial homophily was insignificant ($M_{\text{Foreign}} = 4.947$, $M_{\text{Local}} = 4.736$, $F = 3.469$, $p = 0.063$, $\eta^2 = 0.009$). This suggested that the racial homophily did not lead to significant difference on trust in the virtual influencers. Furthermore, the interaction effect was significant ($F = 4.096$, $p < 0.05$, $\eta^2 = 0.010$). Further pairwise comparisons showed that the human-foreign condition elicited a higher level of trust than human-animate condition ($M_{\text{Animate-Foreign}} = 4.588$, $M_{\text{Human-Foreign}} = 5.306$, $p < 0.001$). This provided further insights on the main effect of anthropomorphism that virtual influencers in high level of anthropomorphism (human-like) elicited stronger trust than virtual influencers in low level of anthropomorphism (animate-like) when racial homophily was low. In addition, participants in human-foreign condition reported a higher level of trust than those in human-local condition ($M_{\text{Human-Foreign}} = 5.306$, $M_{\text{Human-Local}} = 4.866$, $p < 0.01$). This supported H3b that, in the context of high-cost pro-

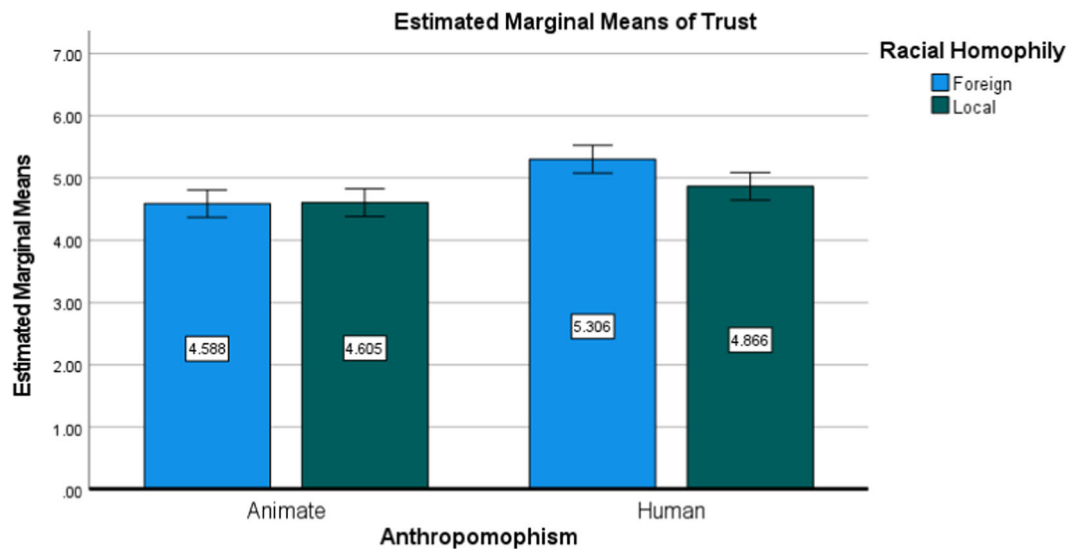


FIGURE 3 Effect of anthropomorphism and racial homophily on trust in virtual influencers (Study 2).

environmental behaviors, virtual influencers in low level of racial homophily (foreign-like) generated a higher level of trust than those in high level (local-like) when anthropomorphism was high. The graphical presentation of these results is shown in Figure 3.

A moderated mediation analysis utilizing PROCESS MACRO v4.2 Model 7 (Hayes, 2018) was conducted (95% CI; 10,000 bootstrap samples) was conducted in testing the effect of all manipulated and measured variables. Anthropomorphism (0 = animate-like; 1 = human-like) was included as independent variable, racial homophily (0 = foreign-like; 1 = local-like) as a moderator, trust as mediator, and pro-environmental behavior (0 = not buy; 1 = buy) as dependent variable. The control variables were the same as previous analyses. The index of moderated mediation was significant (Index = -0.5349, SE = 0.2975, CI = [-1.1939, -0.0208]) indicating that the effect of anthropomorphism on pro-environmental intention via trust was conditional on racial homophily.

Specifically, the results showed anthropomorphism had a significant positive relationship with trust ($\beta = 0.7180$, SE = 0.1598, $p < 0.001$, CI = [0.4039, 1.0321]), this suggested that a higher level of anthropomorphism leads to a higher level of trust in the virtual influencer. Thus, H1 was supported. However, the effect of racial homophily was insignificant ($\beta = 0.0170$, SE = 0.1589, $p = 0.9146$, CI = [-0.2954, 0.3295]). There was a negative significant interaction effect of anthropomorphism and racial homophily on trust ($\beta = -0.4565$, SE = 0.2255, $p < 0.05$, CI = [-0.8999, -0.0130]). By examining the conditional effect of anthropomorphism at different values of racial homophily, the effect of anthropomorphism on trust was positive and significant ($\beta = 0.7180$, SE = 0.1598, $p < 0.001$, CI = [0.4039, 1.0321]) when racial homophily was low (i.e., foreign-like virtual influencer). This implied that the trust level of a foreign-like virtual influencers can be enhanced by utilizing anthropomorphic (i.e., more human-like) features. However, the effect of anthropomorphism on trust was insignificant when racial homophily was high (i.e., local-like virtual influencer) ($\beta = 0.2615$, SE = 0.1599, $p = 0.1027$, CI = [-0.0529, 0.5759]). H3b was supported as trust level was highest when the virtual influencer had a high level of

anthropomorphism and a low level of racial homophily (i.e., human-foreign virtual influencer). Regarding the outcome variable, the direct effect of anthropomorphism on the pro-environmental behavior was insignificant ($\beta = -0.4689$, SE = 0.2648, $p = 0.0766$, CI = [-0.9880, 0.0501]). However, the relationship between trust and pro-environmental behavior was significant ($\beta = 1.1718$, SE = 0.1443, $p < 0.001$, CI = [0.8889, 1.4547]) and thus H2 was supported. The results also indicated a significant conditional indirect effect of anthropomorphism on pro-environmental intentions at low level of racial homophily ($\beta = 0.8413$, SE = 0.2372, CI = [0.4531, 1.3734]) but not at high level ($\beta = 0.3065$, SE = 0.1954, CI = [-0.0678, 0.7022]).

The key findings of both Studies 1 and 2 are presented in Figure 4.

6 | GENERAL DISCUSSION

6.1 | Theoretical implications

This research makes a twofold contribution to academic literature. First, this research advances the understanding of virtual influencers by examining the interaction effect of anthropomorphism and racial homophily. Prior studies often examined how the level of anthropomorphism influencer customer perception and engagement and these studies often compared human influencers, human-like virtual influencers, and animate-like virtual influencers with markedly different appearances (e.g., Arsenyan & Mirowska, 2021; Jiang et al., 2024). Drawing upon the social identity theory (Tajfel, 1978), this study extends the current research on virtual influencers by examining the moderating role of racial homophily. Prior studies often examined the concept of homophily based on appearance and attitude similarity between influencers and their audiences (e.g., Bu et al., 2022; Gupta et al., 2023), this research provides a novel perspective in virtual influencer marketing. Second, the two

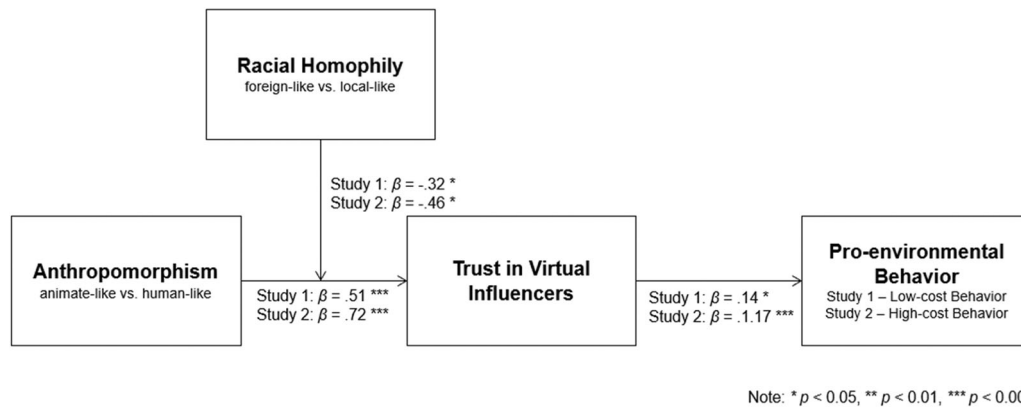


FIGURE 4 The key findings in Studies 1 and 2.

experimental studies examined the research model in the context of low-cost and high-cost pro-environmental behaviors respectively. Although several studies have examined the role of virtual influencers in promoting pro-environmental behaviors (e.g., Gerrath et al., 2024; Guo et al., 2023), these studies did not adequately examine the perceived costs to the audiences that could potentially influence their willingness to engage in the respective pro-environmental behaviors (Huang et al., 2020; Uren et al., 2021). Drawing upon the low-cost hypotheses by Diekmann and Preisendörfer (2003), our study explores how perceived costs for engaging in a pro-environmental behavior may call for tailored design approaches for virtual influencers.

The findings of the two experimental studies demonstrated that the impact of anthropomorphism is dependent upon racial homophily. Building upon prior sociological studies (e.g., Antonoplis & John, 2022) and match-up hypothesis (Kamins, 1990), racial homophily is considered as a mental shortcut for decision making and this is often useful for quick and impulsive decisions. Nevertheless, racial heterophily between the message sources and their audiences appears to be an effective option in the context of celebrity endorsement for symbolic products (Schouten et al., 2021; Tong & Su, 2021; Yu & Hu, 2020). Consistent with prior studies (Blut et al., 2021; So et al., 2023), both studies in this research confirmed that the level of anthropomorphism enhances the level of trust in virtual influencers by comparing animate-like and human-like virtual influencers generated by artificial intelligence. Additionally, our study specifically demonstrated that level of trust would be further diminished when an animate-like (low in anthropomorphism) and foreign-like (low in racial homophily) virtual influencer is employed, particularly in the context of low-cost pro-environmental behaviors. Nevertheless, in high-cost pro-environmental behavior, human-like (high in anthropomorphism) and foreign-like (low in racial homophily) virtual influencer is the most effective in eliciting trust from the audiences. These findings extend the current research on virtual influencers by not only investigating their potential in promoting pro-environmental behaviors, but also their racial homophily to the audiences and its influence on both low-cost and high-cost pro-environmental behaviors. To the best of our knowledge, this is the

first empirical investigation in virtual influencer research to examine the interaction effect of anthropomorphism and racial homophily on pro-environmental behaviors at different cost levels.

6.2 | Managerial implications

Our findings offer valuable insights for businesses and marketers promoting pro-environmental behaviors. Virtual influencers with human-like traits can effectively encourage sustainable practices and lifestyles among social media audiences. Therefore, the anthropomorphic characteristics of virtual influencers should be carefully considered and designed for enhancing trust and subsequently motivating pro-environmental actions.

Racial homophily, that is, whether the virtual influencers look ethnically similar to the audiences, should also be thoroughly evaluated in pro-environmental campaigns. For low-cost and straightforward pro-environmental behaviors, such as recycling, reusing shopping bags, virtual influencers should not possess characteristics of an animated character resembling a foreigner. In high-cost pro-environmental behaviors, such as changing transportation means, purchasing carbon offsets, virtual influencers with human-like characteristics resembling a foreigner are the most effective. Therefore, businesses and marketers are suggested to first assess the costs associated with the target pro-environmental behaviors before designing virtual influencers or considering potential collaborations with them. Artificial intelligence has the potential to assist marketing activities on digital channels, such as crafting promotional messages and monitoring customer behaviors and sentiment (Karnouskos, 2020; Kietzmann et al., 2018). This technological approach can create highly effective pro-environmental messages that influence audiences' behaviors (Cooper, 2023).

To enhance trust, businesses can consider collaborating with well-known and successful local or foreign virtual influencers to raise awareness about climate changes and environmental causes and promote pro-environmental behaviors. However, as discussed above, the targeted pro-environmental behaviors should be carefully evaluated in terms of the costs to the audiences. For example,

marketers can collaborate with Lil Miquela, Liu Yexi, or Imma, who are well-known virtual influencers from America, China, and Japan respectively (Yu et al., 2024; Zhou et al., 2023). These collaborations can involve sharing promotional messages to their followers on social media regarding adopting pro-environmental behaviors in daily life.

6.3 | Study limitations and future research

While this study provides insights into the critical aspects of virtual influencers in the context of pro-environmental behaviors, it is essential to acknowledge its limitations. First, all the studies were based on the responses from Chinese customers, which calls for future research to verify the findings of this research in other cultural contexts, particularly the impact of racial homophily. Second, cross-sectional studies were conducted in this research; the continuance of pro-environmental attitudes and behaviors influenced by virtual influencers may be investigated using a longitudinal research design. Third, the research employed the virtual influencer avatar and messages generated by specific generative artificial intelligence platforms, future research may investigate the outputs of different artificial intelligence technologies and platforms for business and marketing purposes. The messages generated for this research included emoji that may be a factor influencing message persuasiveness and warrants further investigation in future studies (Baek et al., 2022). Lastly, this research examined the pro-environmental behaviors of opting-out cutlery in food delivery and purchasing carbon offsets, future studies may attempt to investigate other types of pro-environmental behaviors and prosocial behaviors. This helps understand the potential or limitations of virtual influencers for the greater good.

7 | CONCLUSIONS

In summary, this study examined how anthropomorphism and racial homophily of virtual influencers in motivating pro-environmental behaviors. Our research revealed the effectiveness of human-like virtual influencers in encouraging pro-environmental actions. Moreover, the moderating role of racial homophily in low-cost and high-cost pro-environmental behaviors was examined. The results showed that low racial homophily (foreign-like virtual influencer) diminishes the trust level when a virtual influencer with low anthropomorphism (animate-like virtual influencer) is employed. By contrast, the trust level is enhanced by utilizing a virtual influencer with high anthropomorphism and low racial homophily (human- and foreign-like virtual influencer) for promoting high-cost pro-environmental behaviors. These findings contribute to the theoretical understanding of the two key visual traits of virtual influencers. Third, our study applied generative artificial intelligence in creating virtual influencers' images and crafting messages. This research utilized images generated by artificial intelligence and this helps ensure consistency across virtual influencers used in different conditions, with only the relevant

differences highlighted for the tested conditions (Kim et al., 2024) and suggested a promising avenue for methodological development in future studies (Qasem, 2023; Rahman et al., 2023).

This study provides valuable insights for businesses and marketers and the potential of using virtual influencers to drive sustainability practices. Marketers can create human-like virtual influencers or collaborate with established ones to develop their pro-environmental campaigns to foster consumers' pro-environmental behaviors. Marketers should carefully assess the costs associated with the target pro-environmental behaviors before designing virtual influencers' racial homophily or considering potential collaborations with them. By leveraging virtual influencers and messages generated by artificial intelligence to promote sustainability practices, businesses and marketers can potentially convey effective pro-environmental messages to their intended audience.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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APPENDIX A: MEASUREMENT ITEMS

Constructs	Items	Source(s)
Trust	The virtual influencer can be relied upon on her content. I trust the virtual influencer is an environmentalist. I trust the virtual influencer shares truthful experience.	Guo et al. (2021), Kim and Kim (2021), Wongkitrungrueng and Assarut (2020)
Pro-environmental Intentions (Study 1 only)	I intend to use reusable cutlery in the next takeaway purchase. I intend not to use single-use cutlery next time I purchase takeaway. Using reusable cutlery will be my preference over single-use cutlery in the future.	Ajzen (1991), Tonglet et al. (2004), Wan et al. (2014)
Control variables		
Environmental identity	Acting environmentally friendly is an important part of who I am. I am the type of person who acts environmentally friendly. I see myself as an environmental-friendly person.	Truelove et al. (2016), van der Werff et al. (2013)
Perceived behavioral control ¹	If I want to, I could avoid using single-use cutlery. Whether I avoid single-use cutlery or not is completely up to me. I have no difficulty using reusable cutlery. Whether I use reusable cutlery or not is completely up to me.	Raimondo et al. (2022)

¹In Study 2, the wordings on cutlery were changed to carbon offset for aligning with the study context.

APPENDIX B: STUDY 1 MATERIALS

Messages generated by artificial intelligence

Platform	ChatGPT 3.5
Prompt	As a social media influencer, you wanted to encourage pro-environmental behaviors. Write a social media post of 50 words to encourage people to use reusable cutlery when they order food delivery. Provide the outputs in both English and Simplified Chinese
Output	<p>English:  Make your food delivery eco-friendly!  Opt for reusable cutlery and cut down on waste.  Together, we can make a positive impact on the environment, one meal at a time.  Let's dine sustainably and protect our beautiful planet!  #GoGreen #ReduceWaste #SustainableLiving #ReuseCutlery</p> <p>Simplified Chinese:  让你的外卖环保起来!  选择可重复使用餐具, 减少浪费。  一起为环保出一份力, 从每一餐开始。  让我们可持续用餐, 保护美丽地球!  #绿色生活 #减少浪费 #可持续生活 #可重复使用餐具</p>
Avatar of virtual influencer generated by artificial intelligence	

Platform	NightCafe
Model	SDXL BETA
Preset Style	Photo (for human-like virtual influencers) CGI Character (for animate-like virtual influencers)
Prompt	3D, virtual influencer, female, Asian/American, young, smile, blue shirt, headshot Note: after the 1st image was generated, the other three images were "evolved" from the 1st one.

Output



Social Media Posts (English Version for Illustrative Purpose)

Green Guardian Follow

🌱 Make your food delivery eco-friendly!

🌍 Opt for reusable cutlery and cut down on waste. ❤️ Together, we can make a positive impact on the environment, one meal at a time. 🗑️ Let's dine sustainably and protect our beautiful planet! 🌱

#GoGreen #ReduceWaste #SustainableLiving #ReuseCutlery

👍 100+ 🌟 10+ 💬 10+

	Local	Foreign
Human-like		
Animate-like		

Social Media Posts (Chinese Version used in Study 1)

绿色守护者 关注

🌱 让你的外卖环保起来!

🌍 选择可重复使用餐具, 减少浪费。❤️ 一起为环保出一份力, 从每一餐开始。🗑️ 让我们可持续用餐, 保护美丽地球! 🌱




#绿色生活 #减少浪费 #可持续生活 #可重复使用餐具

👍 100+ 🌟 10+ 💬 10+

	Local	Foreign
Human-like		
Animate-like		

APPENDIX C: STUDY 2 MATERIALS

Messages generated by artificial intelligence

Platform	ChatGPT 3.5
Prompt	The monthly per capita carbon emission in China is 0.65 tons, it requires approximately ¥40 to offset the carbon emission. As a social media influencer, you wanted to encourage people to pay for carbon offset programmes, for example, tree planting, green energy, etc. Write a social media post of 50 words to encourage people to purchase carbon offset credits. Provide the outputs in both English and Simplified Chinese.
Output	<p>English:  Let's offset our carbon footprint together! For just ¥40, you can neutralize 0.65 tons of monthly per capita carbon emissions in China. Invest in carbon offset programs today and support initiatives like tree planting and green energy. Together, we can make a difference for our planet! 🌍,💚 #CarbonOffset</p> <p>Simplified Chinese:  让我们一起抵消碳足迹吧！只需40元，你就可以抵消中国每人每月的0.65吨碳排放量。立即投资于碳排放抵消计划，支持树木种植和绿色能源等倡议。一起为我们的地球做出改变！🌍💚 #碳排放抵消</p>
Avatar of virtual influencer generated by artificial intelligence	
Platform	NightCafe
Model	SDXL 1.0
Preset Style	Photo (for human-like virtual influencers) CGI Character (for animate-like virtual influencers)
Prompt	3D, virtual influencer, female, Asian, young, smile, gray shirt without logo, headshot <i>Note: after the 1st image was generated, the other three images were "evolved" from the 1st one.</i>
Output	

Social Media Posts (English Version for Illustrative Purpose)

	Local	Foreign
Human-like		
Animate-like		

Social Media Posts (Chinese Version used in Study 1)

	Local	Foreign
Human-like		
Animate-like		