How humanlike is enough?: Uncover the underlying mechanism of virtual influencer endorsement

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ABSTRACT

Social media and computer-mediated communication technologies have given rise to the emergence of virtual influencers and created a new digital landscape for online interactions. Although an increasing number of virtual influencers - computer-generated agents are developing partnerships with organizations and brands to connect with social media users, there is a paucity of research exploring the mechanism underlying the endorsement of virtual influencers. With an online experiment ($N = 320$), this study investigated the effects of using virtual influencers in branding. Particularly, we examined how variations in humanlike appearances affect two-dimensional anthropomorphism and para-social interaction in the communication process. In general, results showed that respondents perceived higher levels of mindful anthropomorphism and stronger para-social interactions with virtual influencers that had a more humanlike appearance, leading to more favorable brand attitudes and higher purchase intentions. No significant difference in branding effects was found between a highly humanlike virtual influencer and a real human. Additionally, the branding effects were not different between using a moderately humanlike virtual influencer and a highly humanlike one or a real human endorser via mindless anthropomorphism. Findings provide both theoretical and practical insights into using virtual influencers in branding.

1. Introduction

The rapid evolvement in digitalization has given rise to a novel type of social media influencer, known as virtual influencers (VI). They are computer-generated virtual agents built on computer vision-oriented graphic technologies and artificial intelligence (Park et al., 2021; Thomas & Fowler, 2021). As virtual influencers emerge, new opportunities are opened for advertisers and marketers to reach their consumers. Similar to the strong impact of using human influencers, virtual influencers could also produce positive and negative brand attitudes (Li & Ma, 2023; Thomas & Fowler, 2021) and potentially bring brand values and drive sales. For example, many virtual influencers have already collaborated with brands such as Chanel, Burberry, and Prada to reach Gen Z social media users (Drenten & Brooks, 2020). Despite increasing attention and deployment of virtual influencers, the underlying mechanisms of their endorsement effects are marked by conflicting results and arguments (Appel, Grewal, Hadi, & Stephen, 2020; Moustakas, Lamba, Mahmoud, & Ranganathan, 2020). Scholars and practitioners

are calling for research into virtual influencers, including their characteristics as endorsers, endorsement effectiveness, and the underlying mechanism of their interactions with followers, as well as the comparison with human influencers (Appel et al., 2020; Thomas & Fowler, 2021).

Scholars concur that humans can anthropomorphize nonhuman agents, attributing human-like qualities to them (Epley et al., 2007; Fink, 2012; Tan et al., 2018), which can facilitate the judgment of and foster social connections to such nonhuman agents. Indeed, many virtual influencers, while non-humans by nature, often have humanlike representations and socially interact with their followers. Some have even attracted a sizable number of followers on social media and achieved remarkable commercial success, such as Lil Miquela on Instagram (@lilmiquela). While existing virtual influencers active on social media present various degrees of human likeness, little is known about how people perceive anthropomorphism based on levels of human likeness, which are cues to assess those influencers. In addition, many researchers in human-computer interactions conceptualized anthropomorphism

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from a multidimensional perspective (Epley et al., 2007; Kühne & Peter, 2023; Kim & Sundar, 2012), yet, the majority of studies on how people perceive virtual influencers have been overly focused on anthropomorphism through the lens of humanlike appearance (i.e., mindful anthropomorphism). Given the dynamic landscape of social media, where virtual influencers can frequently interact with consumers, it is imperative to understand not only how they look like humans, but also how they are perceived to socially engage. Thus, exploring 'mindless anthropomorphism' provides a lens to examine how individuals unconsciously perceive the sociability of these influencers.

Extant literature on influencer marketing highlights social interactions between influencers and followers positively affect advertising and marketing (e.g., Lee & Watkins, 2016). It is notable that virtual influencers interact more with their followers than their human counterparts, and VI-generated content attracts four times more followers (Baklanov, 2019), which enables the success of VI advertising. However, there is a lack of clarity on how social interaction between human and virtual influencers affects advertising. On the other hand, scholars raised concerns about the limited or counter effects of using virtual influencers (e.g., Franke, Groeppel-Klein, & Müller, 2022; Lou et al., 2023). The opposing implications of using VI in advertising from current research suggest a poor understanding of social interaction fostered by perceptions of VIs and their subsequent outcomes.

To fill the aforementioned research gaps, this study attempts to investigate the underlying process of endorsement effects across virtual influencers with various degrees of humanlike appearances vs. human influencers. Specifically, our study investigates two important mediating variables: perceived (mindful and mindless) anthropomorphism and para-social interaction, both of which have been proven to play a significant role in explaining the advertising effects of human influencers and digital agents (Gong & Li, 2017; Hwang & Zhang, 2018; Keeling, McGoldrick, & Beatty, 2010; Lin, Crowe, Pierre, & Lee, 2021; Liu, 2019; Sokolova & Kefi, 2020), and may play a key role in the endorsement activities of virtual influencers as well.

2. Literature review

2.1. Virtual influencers in branding

With the rise of social media and technological advancement, an increasing number of computer-generated images (CGIs) mushroomed as influencers on social media platforms worldwide. Apart from virtual influencers in the US, such as Lil Miquela, China also launched its first meta-human virtual influencer named Ayayi in May 2021 on Xiaohongshu (also known as RED, a social media and e-commerce platform), acquiring nearly three million views on her first post and around 40,000 new followers overnight (Chen, 2021). The virtual influencer phenomenon has gone global platforms like Instagram, featuring a diverse range of races and nationalities, including e.g., from South Korea's Rozy (@rozy.gram), South Africa's Shudu (@shudu.gram), and Brazil's Lu of Magalu (@gamazinluiza).

Many virtual influencers, akin to their human counterparts, have distinct personalities, generate media content, attract a substantial follower base and actively interact with their followers (Lou et al., 2022; Miyake, 2023). With increasing popularity, brands and organizations are now collaborating with virtual influencers and seeking more opportunities to partner with prominent virtual influencers. For example, Hatsune Miku, one of the first globally recognized cartoon-like virtual celebrities (Hoang & Su, 2019), has not only released songs, photo books and magazines but also held offline concerts and endorsed several brands (e.g., BMW, Google and McDonald's) (Black, 2006). Likely, Lil Miquela, a renowned human-like virtual influencer, has collaborated with brands such as Calvin Klein, Dior and Prada.

Despite the huge potential, concerns about virtual influencers endorsements have surfaced among scholars. Indeed, there are competing arguments and findings on virtual influencer advertising. On the one hand, scholars suggested that due to their humanlike features, virtual influencers could foster more positive brand attitudes or purchase intentions, much like human influencers (Thomas & Fowler, 2021). On the other hand, research revealed that endorsement from virtual influencers yields less positive advertising attitudes than human ones (Franke, Groeppel-Klein, Müller, 2022), and virtual influencers are perceived as uncannily and authentically fake (Lou et al., 2022). While both lines of research have their merits in understanding the impact of virtual influencers, the underlying mechanism of how people perceive virtual influencers remains unclear.

2.2. Anthropomorphism, perceived anthropomorphism and human likeness

Given the proliferation of the application of artificial intelligence, scholars have been paying increasing attention to the concept of anthropomorphism and human likeness imbued in technology. Despite scholars delving into how anthropomorphism affects users' perceptions and behaviors, there is no consistent definition of anthropomorphism. Thus, we first sort out the relationships between different definitions of anthropomorphism by examining how each defines the concept, in order to better understand our approach to it.

From a social-psychological perspective, anthropomorphism describes a process whereby people attribute human characteristics, including appearances, emotions, or behaviors, to non-human entities such as animals, artificially intelligent computers, or robots (Epley et al., 2007). Although the definitions of anthropomorphism from a perception and a technological design approach have their own merits, we argue that there are better terms to fit those definitions. Specifically, from the approach of mental perception, anthropomorphism was termed as individuals' "thoughtful, sincere belief that an object has human characteristics" (Nass & Moon, 2000). However, when operationalizing such perception, scholars often use measures to capture "the degree to which the users perceive the agent to be human-like" (e.g., Bartneck et al., 2009; Kiesler et al., 2008; Moussawi & Koufaris, 2020), which is also better defined as perceived anthropomorphism (Moussawi & Koufaris, 2020). From the design of agents or stimuli, scholars explain anthropomorphism as "the degree to which a character has the properties of human appearance or behavior" (Kim et al., 2023; Murphy et al., 2021). In such a domain, a technology agent with more humanlike features including voice, motion, and appearance is described as more anthropomorphism (e.g., Gong, 2008; Kim, Lee, & Kang, 2023). We believe that the level of human likeness is a more straightforward way to explain the degree a character has attributes of a human, which is also frequently used in existing research (Gammoh, Jiménez, & Wergin, 2018; Tsai, Liu, & Chuan, 2021).

It is notable that perceived anthropomorphism and human likeness can be mapped onto the concept of anthropomorphism from the social phycological scheme. Epley and his colleagues (2007) proposed the theory of anthropomorphism and identified three determinants including elicited agent knowledge as a cognitive factor and two motivational factors - effectance and sociality. Elicited agent knowledge is the information about humans in general, that is readily accessible for induction when processing information about non-human agents (Epley et al., 2007). When facing virtual influencers, human likeness can serve as the base knowledge for active individuals' cognitive mechanisms. Effectance describes the motivation of people to effectively interact with non-human agents (White, 1959), which entails "understanding and predicting about one's environment and the agents that inhabit it" (Epley et al., 2007). Thus, perceived anthropomorphism, a way to measure people's understanding of non-human agents, predominates effectance motivation. However, the majority of studies on virtual influencers have primarily focused on mindful perceived anthropomorphism, which refers to the user's conscious perception of the human features of the virtual agents ((i.e., human-like/machine-like, natural/unnatural, or lifelike/artificial-like; Araujo, 2018; Kim & Sundar,

2012). It is worth noting that such perception can hardly capture whether the perception of which people can interact with these agents effectively. More importantly, researchers have suggested examining perceived anthropomorphism from a multidimensional perspective. Indeed, people can unconsciously apply human attributes to computers (Epley et al., 2007; Nass & Moon, 2000), and form mindless perceived anthropomorphism - seeing virtual agents as likable, sociable, personal, etc. (Kim & Sundar, 2012). Therefore, by combining mindful and mindless perceived anthropomorphism, we can gain a more comprehensive insight into people's perception of virtual agents.

2.3. Human likeness of AI, perceived anthropomorphism, and the uncanny valley theory

Scholars suggest that humanlike cues, including visual appearances, facial expressions, languages, and social behaviors, are strong antecedents of the perceived anthropomorphism in consumers' responses to physical robots, chatbots, and other AI (Blut, Wang, Wünderlich, & Brock, 2021; Epley et al., 2007). Virtual influencers are designed with humanlike features in various ways, including appearances and behaviors (e.g., generating and posting content, and interacting with followers in a social and emotional manner) (Lou et al., 2022; Thomas & Fowler, 2021). Users are likely to perceive virtual influencers as anthropomorphic when they exhibit humanlike characteristics, despite being fictional computer-generated figures.(Fink, 2012; Groom et al., 2009; Nass, C., Steuer, J., & Tauber, 1994). For example, Lil Miquela (@lilmiquela), one of the most popular virtual influencers on Instagram with 2.9 million followers to date, is perceived as anthropomorphic in both appearance and behavior (Ahn, Cho, & Sunny Tsai, 2022). However, many studies showed that presenting human features among virtual agents results in higher levels of mindful anthropomorphism (e.g., Oh, Bailenson, Krämer, & Li, 2018). It is also worth noting that influencers' success, whether virtual or not, is often tied to their interactivity with users. Users' willingness to interact with influencers typically comes from whether they perceive influencers as likable, sociable, friendly, or personal. In the context of virtual influencers, such perception can be encapsulated through mindless anthropomorphism. Scholars suggested that displaying human features enhances people's perception of virtual entities as sociable or personal (e.g., Nass, Moon, & Green, 1997). It is likely degrees of human likeness will also affect how people mindlessly perceive anthropomorphism. However, people can mindlessly anthropomorphize technologies (Epley et al., 2007; Kim & Sundar, 2012), even when no humanlike appearances are presented (e.g., website; Liu & Wei, 2021). Thus, it is unclear whether there is a linear positive relationship between the level of human likeness and perceived mindless anthropomorphism.

With the evolution of CG (computer-graphic) technology, the appearances of virtual influencers are becoming more and more humanlike. This progression brought the uncanny valley theory to the forefront and sparked controversy over the level of human likeness in virtual influencers. The uncanny valley theory hypothesized a nonlinear relation between a virtual agent's degrees of human likeness and people's responses toward it. Particularly, it stated that an increase in humanlike appearance and motions of a robot or animated character could augment people's positive emotional responses, until a point where an extremely high level of human likeness makes the figure appear creepy and unnatural (Mori, MacDorman, & Kageki, 2012). Indeed, some studies examined virtual influencer phenomena and the similarities and differences between virtual and human influencers in advertisements (e.g., Ahn et al., 2022; Franke, Groeppel-Klein, 2022; Park et al., 2021; Stein, Linda Breves, & Anders, 2022; Thomas & Fowler, 2021) and claimed the uncanny valley theory was validated the. Yet, to our best understanding, the very humanlike figure employed in many studies was not extremely humanlike that is indistinguishable from real humans. Some virtual influencers active on social media appear with stunning realism, making it difficult for users to determine whether a figure is a real human or an artificial one. In turn, people may mindfully attribute the same level of perceived anthropomorphism to it as they would a human influencer.

Following this line of research and reasoning, it is necessary to address the fact that existing virtual influencers vary by the degrees of human likeness, their variance in human likeness may influence their perceived anthropomorphism.

Therefore, we utilized three existing virtual influencers with different levels of human likeness (i.e., high, moderate, and low) and one human influencer in our experiment to explore the relationship between the level of human likeness of virtual influencers and their perceived anthropomorphism. Because mindful anthropomorphism focused more on the attributes of human cues, we proposed the following hypotheses:

H1. The more humanlike a virtual influencer is, the higher levels of perceived mindful anthropomorphism they will be perceived. Specifically,

H1a. A human influencer will be perceived as more mindful anthropomorphic than virtual influencers with moderate and low levels of human likeness.

H1b. A virtual influencer with a high level of human likeness will be perceived as more mindful anthropomorphic than those with moderate and low levels of human likeness.

H1c. A virtual influencer with a moderate level of human likeness will be perceived as more mindful anthropomorphic than one with a low level of human likeness.

Due to the unclear relationship between human likeness and mindless anthropomorphism, and the nuance between a highly humanlike figure and a real human, we proposed the following research questions:

RQ1. Does mindless anthropomorphism differ across virtual influencers with different levels of human likeness?

RQ2. Do a highly humanlike virtual influencer and a human influencer differ in perceived mindful and mindless anthropomorphism with a ceiling effect?

2.4. Para-social interaction and anthropomorphism

Para-social interaction (PSI) was originally defined as a "one-way imaginative relationship that an audience develops with a media character" (Horton & Richard Wohl, 1956). Over time, with continuing encounters with media characters, audiences develop an illusive feeling of actual psychological engagement and mutual awareness with media characters (Hartmann & Goldhoorn, 2011), much as they might perceive a close or remote friend in the real world (Eyal & Dailey, 2012; Giles, 2002). As para-social interaction is frequently measured with questions asking the intention to interact with a character, it can explain the desire people like to establish social connections, which can also describe the sociality motivation of anthropomorphism.

Recent research on PSI has extensively centered on online environments, including social media platforms. Social media, in particular, by creating a digital culture of interaction and participation, intensifies PSI (Kim & Kim, 2021). Influencers on social media, as one type of media character, are proven to be highly effective in fostering PSI with followers (Gong, 2020; Labrecque, 2014). Specifically, influencers and followers can communicate with each other directly, timely, and consistently. For example, followers use functions like instant comments, likes, and retweets/shares to interact with influencers, thereby feeling a personal connection with them (Song & Zinkhan, 2008).

Although limited research looked at how virtual influencers fostered PSI, its significant role has been studied with other non-human virtual agents, including social media bots (Liu, 2019; Yuksel & Labrecque, 2016), chatbots (Tsai et al., 2021) and avatars in video games (Jin & Park, 2009). For example, Jin and Park (2009) found that users formed a

para-social relationship with their virtual selves through a video game avatar. Giles (2002) addressed that the key element in PSI was the extent to which the audience automatically responded to the human features of media characters. Even though virtual agents and figures may not be humanlike in appearance, they could be perceived as anthropomorphic due to other humanlike characteristics (e.g., voice, language), therefore fostering PSI. Indeed, scholars have found that humanlike features encourage users' interaction with chatbots (Dowling, 2000; Walker, Sproull, & Subramani, 1994) and other non-human virtual avatars (Guadagno, Blascovich, Bailenson, & Mccall, 2007, 2011). For example, Tsai et al. (2021) found that the anthropomorphic profile design of chatbots could improve consumers' evaluation via the mediating process of para-social interaction. Giles (2002) found that non-humanlike virtual agents, such as cartoon characters, also elicited PSI. Notably, higher levels of perceived anthropomorphism of non-human agents led to stronger PSI with users (Bond & Calvert, 2014; Giles, 2002; Stein et al., 2022).

As underscored by the previous research on PSI in both human influencers and non-human virtual agents, virtual influencers with human features are also expected to foster effective PSI with their followers. Indeed, scholars suggested that humanlike appearances, presences, and behaviors embedded in virtual influencers allow audiences to interact with them in a social and emotional manner (Andersson & Sobek, 2020; Park et al., 2021; Thomas & Fowler, 2021). However, there are competing results regarding this relationship. Lou et al. (2022) discovered that most interviewees had difficulty building strong para-social relations with virtual influencers. By contrast, one study has revealed a highly humanlike virtual influencer could increase PSI as effectively as a human one (Stein, Breve, & Anders, 2022). To better understand these conflicting findings, we investigate whether mindful and mindless anthropomorphism affect the underlying process of perceiving virtual influencers.

Given the positive relationship between the level of human likeness and PSI in virtual agents, including virtual avatars (Guadagno et al., 2007, 2011), chatbots (Tsai et al., 2021) and voice assistants on websites (Whang & Im, 2021), we expect that as both mindful and mindless anthropomorphism increase, PSI also increases. Therefore, we hypothesize as follows:

H2a. Perceived mindful anthropomorphism will be positively associated with para-social interaction.

H2b. Perceived mindless anthropomorphism will be positively associated with para-social interaction.

As previously mentioned, scholars have raised concerns that extremely humanlike appearances may have a counterproductive effect due to the uncanny valley phenomenon. For example, some scholars have found that extremely humanlike virtual agents are more negatively evaluated by consumers compared with less humanlike ones (Groom et al., 2009), and may create a feeling of unease when they become too humanlike (Schmitt, 2020; Thomas & Fowler, 2021). Thus, it is possible that PSI, as one of the users' responses to virtual influencers, may decrease at some point, particularly when the virtual influencer resembles a human influencer too closely. However, there has been scant research examining the extent to which the human likeness of virtual influencers triggers in a boomerang effect on PSI. Therefore, we will also examine whether seeing a highly humanlike influencer decreases PSI through perceived anthropomorphism.

2.5. Anthropomorphism, parosocial interaction and endorsement effects

Beyond the direct positive and negative effects of endorsements by virtual influencers, research also suggests that perceived anthropomorphism positively shapes perceptions while having an insignificant or negative impact on perceptions and behavioral intentions (Li & Suh, 2021). Yet, there is a consensus that the success of using social media

influencers, including virtual ones, is largely attributed to the PSI between influencers and consumers. Corporations increasingly favor social media influencers due to their power of influence to lead the opinion, driving consumers' brand attitude and purchase intention (Schouten, Janssen, & Verspaget, 2020). As underscored by previous research, users with higher levels of PSI exhibit more positive attitudes toward the endorser and the advertisement (Gong & Li, 2017; Lueck, 2015), the endorsed product or brand (Gong, 2020; Gong & Li, 2017; Lee & Watkins, 2016), which consequently boosts their purchase intention (Hwang & Zhang, 2018; S. V. Jin & Ryu, 2020; Lin et al., 2021; Sokolova & Kefi, 2020). Likewise, PSI developed between audiences and non-human virtual agents in online environments can also improve consumers' brand attitude (Jin & Lee, 2010; Labrecque, 2014) and purchase intention (Zheng, Men, Xiang, & Yang, 2020). Particularly, the humanlike features of virtual agents positively affect consumers' brand attitude and purchase intention (Choi, 2019; Keeling et al., 2010; Liu, 2019). Therefore, we hypothesize:

H3. PSI will increase positive brand attitude (a) and the likelihood of purchase intention (b).

Along with the effects of PSI on endorsements, we delve into how virtual influencers affect attitudes and purchase intentions with PSI as a mediator. In addition, given that more humanlike features in virtual agents may increase perceived anthropomorphism (Blut et al., 2021), and that human likeness can elevate PSI (Tsai et al., 2021), which in turn could affect brand attitude and purchase intention (Hwang & Zhang, 2018; Jin & Ryu, 2020; Sokolova & Kefi, 2020), we propose a mediation effect of seeing virtual influencer endorsements through anthropomorphism and PSI. Fig. 1 presents a conceptual model integrating perceived anthropomorphism and PSI as mediators. The model specifies that virtual influencers with various degrees of human likeness could affect mindful and mindless perceived anthropomorphism differently compared to a human influencer. As perceived anthropomorphism and PSI are positively associated with each other, they will increase brand attitude and purchase intention by sequence.

3. Methods

3.1. Participants

An online experiment ($N = 320$) was conducted via Prolific using four Instagram image messages of an advertisement. Each participant was compensated with $1.0. A total of 298 participants in the United States completed the survey and passed the attention check questions. 47.3% of the participants were female. The age of the participants ranged from 18 to 81 ($M = 39.1$, $SD = 13.66$, $Median = 36.5$). The majority of the participants were White (72.1%). Over half of the participants (52%) have received a four-year college degree. The medium annual income of the participants was between $50,000–79,000 (See Table 1).

3.2. Stimuli

This study used one factor (4 levels: 1 human influencer, 3 virtual influencers with a high vs. moderate vs. low level of human likeness) between-subject experimental design. A graphic designer on behalf of the research created a set of Instagram advertisements with four different influencers. These images have the same background, product, and layout. The images of influencers were selected from real Instagram posts (See Appendix A). Participants were randomly assigned to one of the conditions and presented with an Instagram advertisement. A set of univariate analysis of variance indicated that there were no significant differences between conditions in respondents' age, ($F (1, 297) = 0.44$, $p = 0.73$), gender ($\chi2(1) = 2.65$, $p = 0.00.1$), education ($F (1, 297) = 1.11$, $p = 0.34$), and annual household income ($F (1, 297) = 1.35$, $p = 0.26$). Therefore, random assignment was successful. In the subsequent
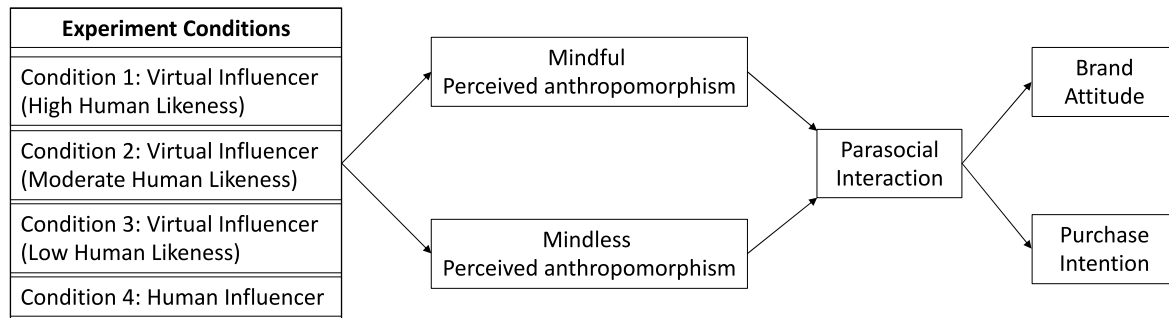
Fig. 1. The Conceptual model.

online survey, participants were asked to report on the same measures.

3.3. Measures

Perceived Anthropomorphism. Mindful perceived anthropomorphism was measured by 3 items on a 10-point semantic differential scale adapted from an existing scale (Powers & Kiesler, 2006). Participants were asked to report whether they perceived the influencer/celebrity from the advertisement as being "cartoon-like/humanlike," "unnatural/natural," or "artificial/lifelike" ($M = 4.81$, $SD = 3.03$, $\alpha = 0.94$, *Skewness* = 0.18, *Kurtosis* = −1.35). Mindless perceived anthropomorphism was measured by 4 times (i.e., likable, sociable, friendly, and personal) on a 7-point scale using an existing scale (Kim & Sundar, 2012) ($M = 3.55$, $SD = 1.46$, $\alpha = 0.92$, *Skewness* = 0.10, *Kurtosis* = −0.51).

Para-social Interaction (PSI). The original PSI scale consists of 20 items (Rubin, Perse, & Powell, 1985). Recent research has employed different forms of PSI scale using 6 items (e.g., Tsai & Men, 2017), 8 items (Lee & Watkins, 2016), or 15 items (Dibble, Hartmann, & Rosaen, 2016). To adapt this scale to an online Instagram post with influencers, we utilized 11 items from the original index and removed 9 items that were not applicable. These items were measured on a 7-point scale (1 = strongly disagree, 7 = strongly agree). Sample items include "I like seeing more of the influencer/celebrity when I use social media" and

Table 1
Descriptive statistics of demographics.

Variables	M(SD) or Sample percentage	Skewness (Std. Error)	Kurtosis (Std. Error)
Age	39.10(13.66)	0.63(0.14)	−0.41 (0.28)
18–20	3.7%		
21–29	27.5%		
30–39	26.5%		
40–49	18.1%		
50–59	10%		
>60	11.1%		
Income	3.11(1.65)	0.36(0.14)	−1.03 (0.28)
Less than $25,000	19.8%		
$25,000-$49,999	24.5%		
$50,000-$74,999	16.1%		
$75,000-$99,999	14.1%		
$100,000-$149,999	15.8%		
$150,000 or more	8.4%		
Education	4.14(1.36)	−0.23(0.14)	−1.27 (0.28)
Less than high school	0.3%		
High school diploma/GED	14.1%		
Some college, but no degree	25.2%		
Associates or technical degree	8.4%		
Bachelor's degree	35.6%		
Graduate or professional degree (MA, MS, MBA, PhD, JD, MD, DDS etc.)	16.4%		

"The influencer/celebrity from the advertisement makes me feel comfortable, as if I am with friends." The average score of 11 items yields the PSI index ($M = 2.61$, $SD = 1.47$, $\alpha = 0.97$, *Skewness* = 0.81, *Kurtosis* = −0.26).

Brand Attitude. Brand attitude was assessed with 5 items on a 7-point semantic differential scale based on Schouten et al. (2020). Participants were asked to report whether they think of the brand in the advertisement as "unappealing/appealing," "bad/good," "unpleasant/pleasant," "unfavorable/favorable," and "unlikable/likable" ($M = 4.01$, $SD = 1.75$, $\alpha = 0.97$, *Skewness* = −0.25, *Kurtosis* = −0.88).

Purchase Intention. Purchase intention was measured by 7 items on a 7-point scale (1 = strongly disagree, 7 = strongly agree). Five items were adapted from existing research (Lee & Watkins, 2016; Shoenberger, Kim, & Jonson, 2020), such as "I am going to purchase this product after viewing this advertisement." And "If I were going to purchase a luxury product, I would consider buying the brand shown in the advertisement." Two items were added based on the feature of Instagram advertisement, including "I may click the link of the product to get more information" and "I would like to search this product." Responses of 7 items were averaged to the index of purchase intention ($M = 2.43$, $SD = 1.49$, $\alpha = 0.93$, *Skewness* = 0.96, *Kurtosis* = 0.04).

4. Results

To examine H1 and answer RQ 1& 2, we conducted an ANOVA test with a post-hoc analysis to see how people perceived anthropomorphism after seeing different influencers. The results showed that the effect of experimental conditions on mindful anthropomorphism was significantly different ($F (3,294) = 55.76$, $p < 0.001$, $\eta2 = 0.36$). Due to the violation of homogeneity of variances, a Games-Howell post-hoc analysis was utilized to examine all pairwise differences. The results showed that people mindfully perceived the human ($M = 6.33$, $SD = 2.34$) and the highly humanlike influencer ($M = 6.71$, $SD = 2.63$) as more anthropomorphic compared to the virtual influencers with a moderate ($M = 3.90$, $SD = 2.60$, $p < 0.001$) and a low level of human likeness ($M = 2.26$, $SD = 2.12$, $p < 0.001$). In addition, seeing a moderately humanlike influencer ($M = 3.90$, $SD = 2.60$) resulted in a higher level of mindful anthropomorphism compared to a low humanlike one ($M = 2.26$, $SD = 2.12$, $p < 0.001$). Thus, H1a-c were supported. However, no significant difference was found between a highly humanlike and a human influencer on mindful anthropomorphism. That is, seeing a real human influencer ($M = 6.33$, $SD = 2.35$) or a virtual influencer with a high level of human likeness ($M = 6.71$, $SD = 2.63$) did not differ significantly in mindful anthropomorphism ($p = 0.79$). Regarding mindless anthropomorphism, there is a significant difference in mindless anthropomorphism across four conditions ($F (3, 294) = 12.16$, $p < 0.001$, $\eta2 = 0.11$). Specifically, the human influencer ($M = 3.81$, $SD = 1.28$) did not differ from the highly ($M = 4.11$, $SD = 1.25$, $p = 0.49$) or the moderate ($M = 3.37$, $SD = 1.53$, $p = 0.46$) humanlike virtual influencer in mindless anthropomorphism. However, seeing the highly humanlike virtual influencer ($M = 4.11$, $SD = 1.25$) resulted in a higher

Table 2
Relationships between anthropomorphism, PSI, brand attitude and purchase intention (conditions were dummy coded with the human influencer as the reference group).

	Mindful Anthropomorphism	Mindless Anthropomorphism	Para-social Interaction	Brand Attitude	Purchase Intention
			B(SD)	B(SD)	B(SD)
Intercept	6.33(0.28)***	3.81(0.16)***	−0.16(0.22)	1.72(0.23)***	0.42(0.21)*
High human likeness	0.38(0.40)	0.29(0.23)	−0.14(0.17)	−0.12(0.18)	0.06(0.17)
Moderate human likeness	−2.42(0.40)***	−0.34(0.23)	0.17(0.19)*	−0.70(0.20)***	−0.19(0.18)
Low human likeness	−4.07(0.40)***	−1.01(0.23)***	0.57(0.20)***	−0.63(0.22)**	−0.08(0.20)
Mindful Anthropomorphism	–	–	0.08(0.03)*	−0.02(0.04)	−0.03(0.03)
Mindless Anthropomorphism	–	–	0.63(0.06)***	0.60(0.07)***	0.12(0.07)+
Para-social Interaction	–	–	–	0.33(0.06)***	0.79(0.06)***
Model Fit Indices	$F(3,294) = 55,76\ p < 0.001$ $R^2 = 0.36$	$F(3,294) = 12.16\ p < 0.001$ $R^2 = 0.11$	$F(5,292) = 56.07\ p < 0.001$ $R^2 = 0.49$	$F(6,291) = 67.47\ p < 0.001\ R^2 = 0.58$	$F(6,291) = 74.74\ p < 0.001$ $R^2 = 0.61$

Note $^+p<0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

score on mindless anthropomorphism compared to the ones with moderate ($M = 3.37$, $SD = 1.53$, $p < 0.05$) and the low level ($M = 2.80$, $SD = 1.73$, $p < 0.001$) of human likeness. Similarly, the moderate humanlike virtual influencer has a higher score compared to the lower one ($p < 0.05$).

To test the direct effects of seeing different influencers on para-social interaction, brand attitude and purchase intentions, we conducted a set of ANOVA tests with post-hoc analyses. Results showed no significant differences between seeing four influencers on parasocial interaction (F (3, 294) = 1.64, $p = 0.18$, $\eta2 = 0.76$) and purchase intention (F (3, 294) = 1.93, $p = 0.13$, $\eta2 = 0.02$). However, brand attitude was significant different across four conditions (F (3, 294) = 39.27, $p < 0.001$, $\eta2 = 0.29$). The results indicate that para-social interaction could be affected by four conditions via perceived anthropomorphism.

Moving on to examine H2 and H3 to better understand the relationships between anthropomorphism, PSI, brand attitude and purchase intention with different influencers in the picture, we dummy-coded the four experiment conditions into three variables and used the human influencer condition as the reference group. From two stepwise regression analyses, we found that higher levels of mindful ($B = 0.08$, $SE = 0.03$, $p < 0.05$) and mindless ($B = 0.63$, $SE = 0.06$, $p < 0.001$) anthropomorphism increased para-social interaction. People who reported higher levels of PSI were likely to show a more positive brand attitude ($B = 0.33$, $SE = 0.06$, $p < 0.001$) and a higher likelihood to purchase the product ($B = 0.79$, $SE = 0.06$, $p < 0.001$) (See Table 2). Therefore, H2 and H3 were supported.

Proceeding to the full model on the mediation effects of anthropomorphism and para-social interaction on brand attitude and purchase intention, we performed two sets of path analyses with Process Macro

model 80 in SPSS. With *dummy coding* methods, three variables were created with the human influencer as the reference group. Results revealed three sets of significant indirect effects. Specifically, an ad with a moderately humanlike virtual influencer led to a more negative brand attitude via lowered mindful anthropomorphism and decreased para-social interaction compared to the same advertisement with a human influencer (*point estimate* = −0.06, *95% CI*: [−0.13, −0.01]), but not via mindless anthropomorphism (*point estimate* = −0.07, *95% CI*: [−0.18, 0.02]). Similarly, people who viewed the advertisement with a low humanlike virtual figure compared to those viewed a human influencer reported lower levels of both mindful (*point estimate* = −0.11, *95% CI*: [−0.21, −0.02]) and mindless (*point estimate* = −0.21, *95% CI*: [−0.33, −0.10]) anthropomorphism and para-social interaction, which further led to a less positive brand attitude. The indirect effects of experimental conditions on purchase intention via anthropomorphism and para-social interaction showed a similar pattern. That is, individuals who watched a virtual influencer with a moderate level of human likeness (*point estimate* = −0.15, *95% CI*: [−0.30, −0.03]) decreased their intention to purchase the advertised product via lower levels of mindful anthropomorphism and para-social interaction compared to those who were presented with a human influencer in the advertisement. Seeing a virtual influencer with a low level of human likeness has a more negative indirect effect on purchase intention via both mindful (*point estimate* = −0.26, *95% CI*: [−0.48, −0.05]) and mindless (*point estimate* = −0.50, *95% CI*: [−0.77, −0.27]) anthropomorphism and para-social interaction compared to a human one (See Table 3, Fig. 2).
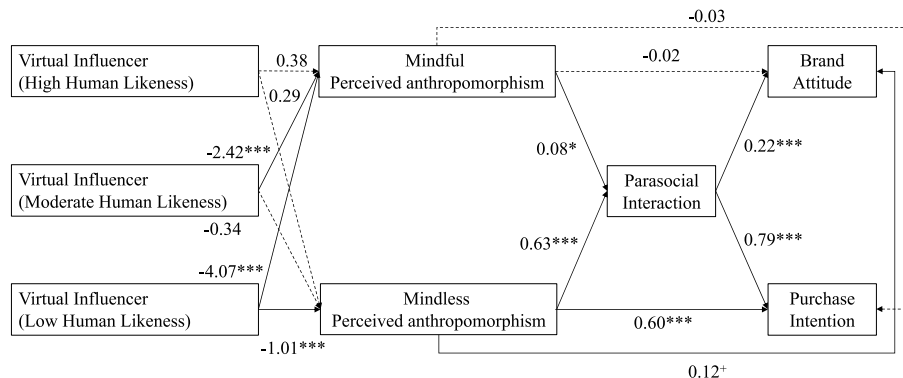

Fig. 2. Serial mediation model. *Note.* The condition with human influencer is the reference group. The statistics represent unstandardized regression coefficients. $^+p<0.1$, *$p<0.05$, **$p<0.01$, ***$p<0.001$. Dash lines = Non-significant relationship.

Table 3
Indirect effects from experimental conditions to brand attitude and purchase intention.

Reference group: Human Influencer	B(SE)	Lower level 95% CI	Upper level 95% CI	B(SE)	Lower level 95% CI	Upper level 95% CI
	Mindful Anthropomorphism→Brand Attitude			Mindful Anthropomorphism→Purchase Intention		
High Human Likeness→	0.01(0.01)	−0.01	0.04	0.02(0.03)	−0.03	0.09
Moderate Human Likeness→	**−0.06(0.03)**	**−0.13**	**−0.01**	**−0.15(0.07)**	**−0.30**	**−0.03**
Low Human Likeness→	**−0.11(0.05)**	**−0.21**	**−0.02**	**−0.26(0.11)**	**−0.48**	**−0.05**
	Mindless Anthropomorphism→Brand Attitude			Mindless Anthropomorphism→ Purchase Intention		
High Human Likeness→	0.06(0.05)	−0.02	0.16	0.15(0.10)	−0.05	0.35
Moderate Human Likeness→	−0.07(0.05)	0.18	0.02	−0.17(0.12)	−0.41	0.05
Low Human Likeness→	**−0.21(0.06)**	**−0.34**	**−0.10**	**−0.50(0.13)**	**−0.77**	**−0.27**

Note. SE = standard error, CI = confidence interval.

5. Discussion

With the burgeoning controversies surrounding the use of virtual influencers, it is paramount to elucidate the underlying mechanism of how consumers respond to VI endorsements. This study sheds light on the effects of existing virtual influencers with their varying degrees of human likeness. By clarifying the concept of anthropomorphism, we mapped human likeness, perceived anthropomorphism and para-social interaction to cognitive and motivational schemes from the theory of anthropomorphism. Moreover, this study extends the work on the roles of two-dimensional perceived anthropomorphism and para-social interaction in evaluating the effects of influencer endorsement in virtual entities. In general, our results showed that respondents perceived virtual influencers with higher levels of human likeness as more mindful perceived anthropomorphic. However, when virtual influencers attained a moderate level of human likeness, no significant difference was found in mindless perceived anthropomorphism between these figures and a real human influencer. Moreover, increased perceived anthropomorphism enabled individuals to form stronger para-social relationships with these influencers, leading to more positive attitudes toward the endorsed brand and higher purchase intention. Interestingly despite both dimensions of anthropomorphism increased para-social interaction, mindless anthropomorphism has a stronger effect ($B = 0.08$, $SE = 0.03$, 95% CI: [0.01, 0.15]) than the mindful one ($B = 0.63$, $SE = 0.06$, 95% CI: [0.54, 0.75]). Additionally, a comparison between a highly humanlike virtual influencer and a human influencer revealed that they did not significantly differ in perceived mindful and mindless anthropomorphism and indirect advertising effects. Although we compared three ordinal levels of human likeness in the analysis, these results suggested a linear relationship between human likeness and other concerned variables. That is, the more humanlike virtual influencers triggered stronger para-social interactions, more positive brand attitude and purchase intention.

Our study contributes to the extant literature on influencer marketing and human-computer interaction in the following three aspects. First, our study is one of the few exploratory empirical studies directly looking into existing active virtual influencers on social media and their influence on consumers' brand attitudes and purchase intention. Integrating research on the humanlike features of non-human digital agents, we used virtual influencers with different degrees of human likeness and examined consumers' responses. Particularly, we include a virtual influencer that is extremely humanlike. Aligning with current literature, this study proves a positive association between human likeness and perceived mindful anthropomorphism. However, the increasing mindful perceived anthropomorphism stops when the level of human likeness of VI is extremely high. Additionally, when the VI reached a moderate level of human likeness, users attribute similar levels of mindless perceived anthropomorphism as they do to a human influencer. In other words, human likeness, as the elicited agent knowledge, can lead to perceived anthropomorphism, which can serve as effectance motivation, with a ceiling effect.

Second, our study extends the literature by arguing para-social

interaction is the sociality motivation and examining its mediation effects on advertising. Existing research has identified PSI as a strong predictor for human influencers' advertising effectiveness (Chen & Lin, 2021; Gong, 2020; Jin & Ryu, 2020). Similarly, this study replicates the positive influence of PSI on advertising in a virtual context. Our study also connects perceived anthropomorphism with PSI and offers insights into them as important mediators in understanding the advertising effects of virtual influencers. Indeed, increased human likeness in virtual influencers positively affects consumers' brand attitude and purchase intention via their perceived anthropomorphism and para-social interactions, especially via mindless anthropomorphism. Previous studies on uncanny valley theory suggested that highly humanlike robots could elicit negative responses (Mori et al., 2012). One of the recent studies showed that human influencers outperformed virtual ones regarding attitudes toward advertisement (Franke, et al., 2022). Indeed, our results partially supported this finding by showing that virtual influencers with a moderate and low level of human likeness had lower levels of brand attitudes and purchase intention compared to a human one through mindful anthropomorphism. However, our study also showed that a highly and a moderately humanlike virtual influencer did not differ from a human influencer in advertising effects through mindless anthropomorphism. This suggests that consumers could socially connect with virtual influencers as long as their appearance has moderate humanlike features. Indeed, some scholars validated the uncanny valley effect with respect to virtual influencers (e.g., Franke et al., 2022), while others have proved that the uncanny valley effects still remain unstable and inconsistent in many empirical studies (Kätsyri, Förger, Mäkäräinen, & Takala, 2015). Such competing results can be explained by the present study with a thorough examination on the parasocial interaction through mindful and mindless perceived anthropomorphism. It is worth noting that most virtual influencers disclose their non-human identity in their social media profiles and actively interact with users, which may decrease users' negative perceptions (Ahn et al., 2022; Block & Lovegrove, 2021). More importantly, although scholars suggest that cognitive and motivational factors work in concert in anthropomorphizing non-human agents (Epley et al., 2007), our model provided a sequence of those factors with elicited agent knowledge triggers effatance motivation leading to sociality motivation, and established their effects on advertising endorsement.

Finally, this study can benefit practitioners in understanding the underlying mechanism in which consumers see virtual influencers of different levels of human likeness in appearance, and how these perceptions lead to different advertising outcomes. With mindless perceived anthropomorphism has a stronger effect on advertising, practitioners can work more on the sociality of VIs. Beyond beauty product advertising, future research can also look at how this mechanism works in other contexts such as marketing different products.

This study also has a few limitations. First, this study distinguishes the human likeness of the virtual influencer mainly by its artificial appearance. However, human-computer interaction research suggests that the visual and mental properties of a digital entity should be investigated separately (Ferrari, Paladino, & Jetten, 2016; Stein et al.,

2022). Future studies could investigate virtual influencers' strategies in crafting their socialness (e.g., expressing political opinions, attitudes, and emotions), and other characteristics embodying mental human likeness. This could be valuable in understanding how two dimensions of perceived anthropomorphism, especially mindless perceived anthropomorphism play a role in consumers' interaction with virtual influencers. Second, this study only investigates static pictures posted on Instagram. However, many virtual influencers are active on various video platforms (e.g., Tik Tok, Twitch). Users' evaluation of virtual influencers may differ across social media platforms, and forms of presentations (e.g., static pictures and dynamic videos). Future studies could explore virtual influencers with various representations and content on different media platforms. Many Esports activities are using virtual live streamers to co-host with humans, and future studies could investigate how audiences react to virtual influencers working with humans on the screen. Third, our study only focuses on one beauty and fashion brand. Therefore, future studies could investigate how this idea can apply to virtual influencers' endorsements of different product categories.

6. Conclusion

This study is one of the first exploratory studies to directly investigate the effects of virtual influencers endorsements and their humanlike characteristics through the lens of two dimensional anthropomorphism and PSI. Our results showed that respondents perceived higher levels of anthropomorphism seeing more humanlike virtual influencers, leading to stronger para-social interactions, more positive brand attitudes and higher purchase intention. Our study implies that virtual influencers of higher human likeness are likely to bring more positive brand values and stronger persuasiveness than less humanlike ones. When a virtual influencer is highly humanlike, people do not respond differently compared to a real human influencer. It offers practitioners a feasible option to partner with highly humanlike influencers in endorsement. Additionally, when partnering with moderate humanlike virtual influencers, practitioners may work on the sociability of those figures to increase mindless anthropomorphism. Regarding the increasingly diverse landscape of virtual influencer profiles, future studies could look into virtual influencers across different media formats (e.g., videos, photos, and livestreams) and their endorsement of different product categories and pro-social activities.
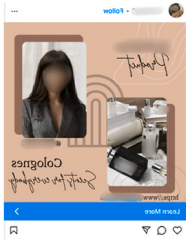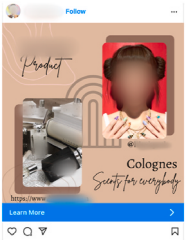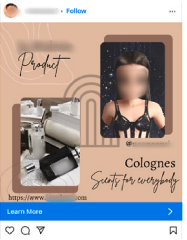
Ethical approval and informed consent

This study was approved by the institutional review board of Oregon State University (approval number IRB-2022-1597). All participants provided informed consent prior to data collection

Declaration of competing interest

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

Appendix A. Stimuli Design

Virtual influencer (High human likeness)	Virtual influencer (Moderate human likeness)	Virtual influencer (Low human likeness)	Human influencer

Faces and products are blurred for legal and copyright reasons.

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