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DOI
10.1016/j.chbah.2023.100020

Publication date
2023

Document Version
Final published version

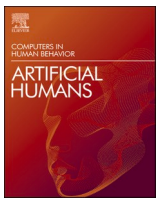
Published in
Computers in Human Behavior: Artificial Humans

Computers in Human Behavior: Artificial Humans 1 (2023) 100020

Contents lists available at ScienceDirect

Computers in Human Behavior: Artificial Humans

journal homepage: www.journals.elsevier.com/computers-in-human-behavior-artificial-humans



Can non-humanlike avatars induce the Proteus effect? The roles of avatar identification and embodiment in influencing social participation

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ARTICLE INFO

Keywords:
Proteus effect
Non-humanlike avatars
Avatar identification
Embodiment
Virtual reality (VR)

ABSTRACT

In virtual environments, people tend to behave in line with the virtual avatars they embody. For example, when an individual embodies an attractive and physically fit avatar, they might show an increase in self-esteem. This phenomenon is called the Proteus effect. While prior research shows support for this effect with humanlike avatars, it is unclear whether non-humanlike avatars can also induce it. In this study, we examine the Proteus effect in the context of non-humanlike avatars and test whether the level of attractiveness of a non-humanlike avatar affects social participation. Two underlying mechanisms of the Proteus effect are considered: the mediating role of avatar identification and the moderating role of level of embodiment. To test our hypotheses, a 2 x 2 between-subjects lab experiment ($N = 134$) was conducted. Participants were randomly assigned to one of two non-humanlike avatars differing in level of attractiveness (attractive vs. unattractive) and one of two levels of embodiment (head-mounted display VR vs. desktop). The results showed that participants embodying the attractive non-humanlike avatar perceived higher levels of avatar identification via self-similarity, which increased social participation. Also, this study found that level of embodiment did not moderate the effect of attractiveness of the non-humanlike avatar on social participation.

Avatars, defined as virtual characters controlled by humans, play an important role in how users experience video games and virtual worlds. They serve as a digital self-representation of the user through which users act and interact in virtual space. Prior research (Yee & Bailenson, 2007) shows that attributes of embodied avatars' can influence individuals' behaviors in simulated environments. For example, when a player embodies an attractive and physically fit avatar, the player might show an increased self-esteem, integrating their avatar's attributes into their self-concept. This phenomenon is better known as the Proteus effect.

The Proteus effect is grounded in the self-perception theory (Bem, 1972), which posits that individuals make inferences about their attitudes and beliefs by observing their own behaviors. This means that, for example, after noticing they spent a lot of time playing strategy video games, an individual might deduce that they enjoy strategic and tactical challenges. Recently, a meta-analysis of a decade's work of research on the Proteus effect showed the effect is consistent for the embodiment of humanlike avatars (Ratan et al., 2020). What remains unclear, however, is whether the effect also hold up for non-humanlike avatars (e.g., virtual characters that do not resemble human beings), given that self-perception theory implies a human self. This is particularly relevant, because, contemporary virtual world platforms (e.g., Mozilla Hubs & VRchat) offer users a wide variety of avatars—some humanlike, yet many non-humanlike. They can take, for example, the form of an animal, object, or any other type of non-human entity. Investigating the effect with non-humanlike avatars may thus shed light on whether the Proteus effect is contingent upon avatar type.

In the current study, we aim to test the Proteus effect in a non-humanlike avatar context and further investigate its underlying mechanisms. We do this by examining whether people who embody an attractive (vs. unattractive) non-humanlike avatar show increased levels of social participation. This work builds directly on the work by Bian et al. (2015), who examined the influence of avatar appearance on social interaction behavior in a humanlike avatar context. Also, we will examine the roles of avatar identification as a mediator and level of embodiment as moderator. Avatar identification refers to the temporal mental fusion between the perception of the self and the avatar (Klimmt et al., 2010) and embodiment refers to a psychological state that is characterized by believing a virtual body is one's own (Kilteni et al., 2012).

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https://doi.org/10.1016/j.chbah.2023.100020
Received 21 April 2023; Received in revised form 6 October 2023; Accepted 7 October 2023
Available online 9 October 2023

1. Theoretical background

1.1. Research on the Proteus effect

The Proteus effect was first introduced by Yee and Bailenson (2007) in their research studying how people adapt their behaviors to the appearance of embodied avatars in virtual worlds. They found that people who embodied attractive (vs. unattractive) avatars behaved more intimately when interacting with confederates in self-disclosure and interpersonal distance tasks. This meant that individuals who were embodying an attractive avatar were found to stand closer to the confederates. Moreover, participants with taller avatars displayed greater confidence and boldness in a negotiation task, in contrast to those with shorter avatars. Concretely, people embodying a taller avatar were more likely to offer an unfair split when negotiating how to divide a reward. Notably, at the same time, participants embodying a shorter avatar were more likely to accept an unfair split. Since then, dozens of studies have been conducted on the Proteus effect concerning avatars with different avatar characteristics–such as age (e.g., Hershfield et al., 2011; Reinhard et al., 2020; Van Gelder et al., 2013; Yee & Bailenson, 2006), race (e.g., Ash, 2016; Groom et al., 2009; Peck et al., 2013), and gender (e.g., Palomares & Lee, 2010).

Overall, most research on the Proteus effect has focused on human-like avatars (e.g., Ash, 2016; Hershfield et al., 2011; Palomares & Lee, 2010). A notable exception is the work by Oyanagi and Ohmura (2019). In their paper, the authors examine whether embodying a bird avatar can reduce people's subjective fear of heights. No decrease was found for people who embodied the bird avatar. However, this study was a pilot study and had a small sample size of only 12 participants. This restricts the generalizability of the findings and means that the statistical power of the study was limited. As a result, there is an increased risk that any observed effects or associations in the study might be due to random chance rather than reflecting true underlying patterns.

1.2. Theoretical foundation of the Proteus effect

Over the years, there have been ongoing discussions regarding the underlying mechanisms of the Proteus effect, and both self-perception theory and priming have been proposed as drivers of this effect.

Originally, the Proteus effect is rooted in self-perception theory, suggesting that people draw inferences about their attitudes and beliefs from observing their behaviors (Bem, 1972). Yee and Bailenson (2007) first explained the Proteus effect as being driven by deindividualization, which refers to the phenomenon that individuals lose their identity and become assimilated into a large group (Ziller, 1964). They suggested that deindividualization, occurs in the virtual setting due to increased anonymity and reduced social cues (Kiesler et al., 1984; McKenna & Bargh, 2000). Since avatars are the primary identity cues in the virtual environment, they argue that individuals tend to make inferences about themselves (e.g., attitudes, beliefs, and dispositions) through observing their avatars. This, subsequently, can further lead to confirmation of the expectations or stereotypes associated with the avatars.

Another explanation was proposed by Peña et al. (2009), who showed that priming can also explain the Proteus effect. Based on the automaticity model, they suggested that external cues (e.g., avatar features) in the virtual environment activate associated memories or stereotypes and lead to cognitive or behavioral responses following those associations (Bargh et al., 1996). This means that, for example, when an individual selects an elderly-looking avatar, the avatar's age-associated features (e.g., grey hair) are expected to activate related stereotypes (e.g., wisdom or slowness), leading the person to unconsciously adopt behaviors and interactions consistent with these stereotypes while navigating the virtual space. The work by Peña et al. (2009) was in line with prior research, which showed that external cues activate related concepts and inhibit inconsistent concepts (Anderson & Spellman, 1995; Bargh et al., 1996; Dijksterhuis & van Knippenberg, 1998).

Yee and Bailenson (2009) in turn, argued that there is a conceptual difference between self-perception and schema activation through priming in explaining the Proteus effect. Self-perception emphasizes how attitudes and behavior are changed to align with the characteristics of the observed avatar, when individuals perceive the avatar as a manifestation of their self. However, priming focuses on how external cues activate associated concepts and influence attitudes and behavior, which does not necessarily include the sense of the self as an avatar. Therefore, they argued that seeing an avatar and being an avatar would show a different impact on attitudes and behavior, which was supported by the results of their experiments (Yee & Bailenson, 2009). By manipulating the level of embodiment using immersive virtual environment technology, they found greater behavior changes resulting from embodying an avatar than simply viewing it.

More recently, a theoretical approach that combines self-perception and priming was proposed (Ratan & Dawson, 2016; Ratan & Sah, 2015). Previous research indicated that an individual's perception of the self will be associated with the avatar's features when using the avatar (Chandler et al., 2009; Klimmt et al., 2010). Hence, this combined theoretical approach suggests that when individuals employ an avatar, they infer how to behave through self-perception. In this process, individuals are more likely to conform to the stereotypes of the avatar's features if the more activated self-related schema is associated with the avatar-related schema. This argument was supported by the meta-analysis (Ratan et al., 2020), which showed that factors that could build close associations between the self and the avatar (e.g., self-similarity, customization, and embodiment) are important factors moderating the Proteus effect. This proposed approach also prompts questions about whether non-humanlike avatars can induce the Proteus effect, as they may have weaker associations with the users' self, compared to human-like avatars.

1.2.1. Attractiveness and social participation

An important avatar characteristic that has previously been studied in the context of the Proteus effect is the attractiveness of an avatar. For example, Bian et al. (2015) examined the influence of the attractiveness of humanlike avatars on individuals' intention to participate in a social scenario. They found that participants who embodied an attractive avatar were more likely to show intention to participate in a social scenario than those who embodied an unattractive avatar.

According to self-perception theory (Yee & Bailenson, 2007), individuals infer their identities by observing their avatars in the virtual setting. This means that individuals embodying an attractive (or unattractive) avatar are expected to perceive themselves as more (or less) attractive as a result of self-perception. Since attractive people are generally perceived as more sociable than unattractive people (Langlois et al., 2000), individuals may further conform to this expectation of being sociable—ultimately resulting in higher levels of social participation. In sum, we hypothesize that:

H1. Embodying an attractive (vs. unattractive) non-humanlike avatar leads to higher levels of social participation.

1.2.2. Avatar identification in the Proteus effect

Another important variable to consider when discussing the workings of the Proteus effect is avatar identification (Ratan et al., 2020). Avatar identification can be defined as the temporal mental fusion between the perception of the self and the avatar (Klimmt et al., 2010). Research has shown that our behavior can shift due to our self-perception, but this shift can be swayed by how closely our self-view (self-schema) is linked with our digital avatar's traits (avatar-schema). In other words, when the traits people associate with themselves are actively linked with those of an avatar, they are more prone to altering their behavior based on their self-perception.

Praetorius and Görlich (2020) analyzed how past findings on the Proteus effect could be connected to the avatar identification model by

Van Looy et al. (2012). They suggested that avatar characteristics may affect individuals' level of avatar identification, and ultimately influence an individual's behavior. In particular, the Proteus effect can be influenced by avatar identification via self-similarity. When there is a high similarity between the self and the avatar, the self-relevance of the avatar increases, making it easier for individuals to conform to the expected behavior associated with the avatar's features. Another dimension of avatar identification that could explain the Proteus effect is wishful identification. Despite being dissimilar, the desirable feature of the avatar can also result in behavior change as individuals identify with the avatar to erase the discrepancy between the image of themselves and the desirable feature of the avatar. All in all, we expect that avatar identification explains the effect of embodying an attractive (vs. unattractive) non-humanlike avatar on social participation. The following mediation hypothesis is proposed:

H2. Avatar identification mediates the effect of embodying an attractive (vs. unattractive) non-humanlike avatar on social participation.

1.2.3. Embodiment in the Proteus effect

The association between the activated self-related and avatar-related schema can also be affected by the levels of embodiment (Ratan et al., 2020). A higher level of embodiment suggests a greater feeling of being the avatar, indicating more association between the self-related and avatar-related schema. Past research shows that embodying an avatar results in stronger behavioral change than merely presenting visual stimuli (Yee & Bailenson, 2009). Other studies also suggested the level of embodiment as a potential moderator for explaining the Proteus effect (Ash, 2016; Ratan et al., 2020).

Level of embodiment can be manipulated by using different equipment (head-mounted display VR vs. desktop). The head-mounted display VR is believed to generate a higher level of spatial presence than a desktop monitor (El Ali et al., 2023; Hruby et al., 2020), and subsequently a higher level of embodiment. Spatial presence, which refers to the feeling of 'being there' (Biocca, 1997), is an important predictor of the levels of embodiment in the virtual environment (Reinhard et al., 2020; Van Berlo et al., 2020). In addition, past research also showed that using VR can facilitate the level of embodiment compared to non-immersive virtual environments (Ahn et al., 2016; Yee & Bailenson, 2009). Therefore, we propose the following moderation hypothesis:

H3. The effect of embodying an attractive (vs. unattractive) non-humanlike avatar on social participation is moderated by the level of embodiment.

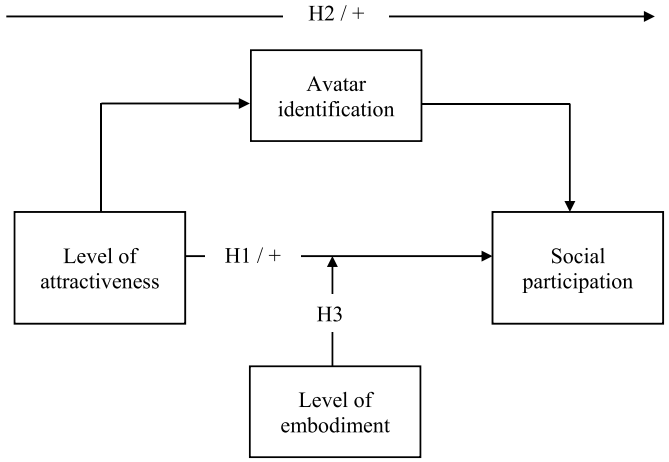

Fig. 1. Conceptual model.

1.2.4. Conceptual model

A visual overview of the conceptual model is shown in Fig. 1.

2. Methods

2.1. Participants and procedure

To test the hypotheses, a 2 x 2 between-subjects experiment was conducted. Participants were randomly assigned to one of two non-humanlike avatars differing in level of attractiveness (attractive vs. unattractive) and one of two levels of embodiment (head-mounted display VR vs. desktop). The current study received ethical approval from the ethical review board of the Department of Communication Science, University of Amsterdam, and was preregistered via AsPredicted (under register number: 115815).[1]

A total of 135 participants were recruited via the panel of the Behavioural Science Lab of the University of Amsterdam. Each participant received either research credit or monetary compensation for their participation. We aimed for a sample size of at least 128. This was based on the power analysis for an expected Cohen's f effect size of 0.25, suggested by past research that indicated a small to medium effect size of the Proteus effect (Ratan et al., 2020), with α level of 0.05 and power of .80. One participant was excluded from the data analysis due to technical issues which resulted in questionnaire data completed after the virtual experience not being saved.

Overall, data from 134 participants were analyzed for the current study. The participants ranged in age from 18 to 66 (M = 21.75, SD = 5.89) and were majority female (77.6%). Among these participants, 66 people were randomly assigned to the head-mounted display VR condition, with 33 participants randomly assigned to the attractive non-humanlike avatar and 33 participants to the unattractive non-humanlike avatar. The remaining 68 participants took part in the desktop condition, with 35 participants randomly assigned to the attractive non-humanlike avatar and 33 participants to the unattractive non-humanlike avatar.

Upon entering the laboratory, participants were asked for informed consent. Then, brief introductions about the experiment procedure and instructions about the VR controllers or keyboard controls were provided. Subsequently, participants interacted through their assigned avatar in a virtual environment that differed in the level of embodiment: either via head-mounted display (HMD) VR, using Meta Quest 2 with two hand-held controllers, or via a desktop computer, using a keyboard and mouse. The avatar and the levels of embodiment were randomly assigned before the participants entered the lab. During the virtual experience, participants visited two rooms. In the first room, participants were asked to complete four tasks. After finishing all the tasks, participants went to the second room and later reported their level of social participation by filling out a questionnaire embedded in the scene. After the experience, participants were asked to complete a questionnaire on a desktop computer that measured avatar identification, level of embodiment (manipulation check), and several control variables (e.g., mood, previous VR experience, cybersickness, and demographics). The whole experiment took about 30 to 45 min.

[1] The conceptual model that was tested in this study differed from the preregistered model in that the preregistered model also included a moderation of the effect of level of attractiveness on avatar identification by level of embodiment. To make the model more parsimonious, we decided to remove this moderation effect in the tested model. Notably, this difference did not influence the findings and conclusions of our current study in any substantive way. The moderated-mediation results for the exact preregistered model are available upon request.

2.2. Stimulus material

2.2.1. The virtual environment

The platform Mozilla Hubs (www.hubs.mozilla.com), a free VR chatroom designed for headsets and browsers, was used to create two virtual rooms for this study. The first room was designed for participants to finish four tasks (e.g., explore the room and get comfortable with the controls, observe themselves through the mirror, take a picture, and draw a self-portrait) that helped them to better observe their assigned avatar. The room was empty save for a mirror, a blank poster for painting, and posters of control instructions and task instructions. The second room created a pub scene, in which different avatars were chatting, drinking beers, and playing pool, with a video playing on the wall as a background, simulating a television in a real bar.

2.2.1.1. The non-humanlike avatar. Similar to prior studies that investigated the influence of non-humanlike avatars (e.g., Dujmović & Valerjev, 2018; Wang et al., 2019), we used two dog-like avatars as non-humanlike avatars. The two models were customized by a professional 3D developer based on the results of a pretest assessing people's perceptions of cartoon dogs with different levels of attractiveness. In a pretest ($N = 56$), we asked participants to evaluate 20 images of cartoon dogs in terms of how attractive they perceived them. Also, they were asked to choose their top three most attractive and least attractive dogs from the 20 images. The resulting avatars were designed based on the images that were picked as the most attractive and the least attractive. The final designs of the avatars can be found in Fig. 2.

2.3. Measures

An overview of all scales can be found in Appendix A.

2.3.1. Social participation

Social participation refers to the intention that people participate in a social scenario in this study, which was measured by five items using a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*). These items were adapted from Bian et al. (2015), who used one question with four categorical choices to measure social participation. The current study modified it to five items to measure participants' average intention to engage with others in the given social scenario.

Fig. 2. The non-humanlike avatars with attractive (left) and unattractive (right) appearance.

Notably, however, a factor analysis with direct oblimin rotation showed that the scale explained two factors. The first factor had an eigenvalue of 3.19 and accounted for 63.76% of the variance, with three items measuring the intention to engage in social interactions. The second factor had an eigenvalue of 1.07 and accounted for 21.35% of the variance, with two items measuring intention to stay in a social scene. Although people's intention to stay in a social scene may be an indicator of their future social engagement, it does not directly reflect on people's intention to socialize with others. Therefore, in this study, we decided to only focus on the first factor ($EV = 2.52$, $R^2 = 0.84$, Cronbach's alpha = .90), which included the three items accessing people's intention to engage in social interactions ($M = 4.74$, $SD = 1.51$): "I would like to take the initiative to introduce myself to others in the room.", "I would like to try to participate in the conversations others currently were having in the room.", "I would like to interact and make friends with others in the room.

2.3.2. Avatar identification

Participants' overall avatar identification was measured using a scale developed by Van Looy et al. (2012). Specifically, two dimensions of the scale, similarity identification, and wishful identification, were used to provide an average indication of how strongly participants identified with the avatar. Six items ($EV = 8.20$, $R^2 = 0.48$, Cronbach's alpha = .93) from the similarity identification ($M = 2.64$, $SD = 1.35$) and five items ($EV = 1.33$, $R^2 = 0.08$, Cronbach's alpha = .91) and from the wishful identification ($M = 2.31$, $SD = 1.23$) were rated on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

2.3.3. Manipulation checks

To check the manipulation of different levels of embodiment (head-mounted display VR vs. desktop), avatar embodiment was assessed on a six-item embodied presence scale ($EV = 3.06$, $R^2 = 0.18$, Cronbach's alpha = .92; $M = 4.23$, $SD = 1.45$) by Van Looy et al. (2012). Participants indicated their responses on a 7-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Moreover, the attractiveness of the avatars was also checked by asking the participants to describe their assigned avatar and evaluate its attractiveness ($M = 4.00$, $SD = 1.60$, with two items ($EV = 1.68$, $R^2 = 0.84$, Cronbach's alpha = .91) on a 7-point numerical scale from 1 (*very unattractive or uncharming*) to 7 (*very attractive or charming*).

2.3.4. Control variables

The pretest indicated that people may perceive the manipulated avatars as either a happy or sad dog. Previous research has suggested that a happy mood increases positive testing in social interaction more than a sad mood (Dardenne, 2011). To account for this potential influence, participants were asked to indicate their mood ($M = 4.92$, $SD = 1.25$) on a single-item 7-point scale ranging from 1 (*sad*) to 7 (*happy*). Past research has shown a negative relationship between presence and cybersickness in VR (Breves & Stein, 2023; Weech et al., 2019). To determine the potential impact of cybersickness, experience of cybersickness ($M = 2.86$, $SD = 1.50$) was measured on a four-item scale (EV = 2.73, $R^2 = 0.68$, Cronbach's alpha = .84) from the negative feelings sub-scale of the ITC-sense of presence inventory (Lessiter et al., 2001). Lastly, the demographic information, including age and gender, and information regarding prior VR experiences was collected.

3. Results

3.1. Randomization check

Randomization checks were performed with several variables to check whether the sample data were distributed equally across conditions. The mean scores between conditions for age (F (3,129) = 0.56, p

= .640) and mood (F (3,129) = 1.60, p = .193) were compared. Moreover, two chi-square tests were conducted to compare the distribution of gender (χ^2 (6, 134) = 5.00, p = .547) and previous VR experience (χ^2 (3, 134) = 2.45, p = .485) between conditions. No significant differences in these variables were found between conditions, suggesting that participants were randomly assigned to the four conditions.

3.2. Manipulation checks

To check whether the manipulations of the avatar's attractiveness (attractive vs. unattractive) and level of embodiment (head-mounted display VR vs. desktop) were successful, two independent sample *t*-tests were conducted. The participants who embodied the attractive non-humanlike avatar (M = 4.59, SD = 1.47) perceived the avatar as more attractive compared to those who embodied the unattractive non-humanlike avatar (M = 3.30, SD = 1.60), t (132) = 4.84, p = .006. In addition, participants assigned to the VR condition showed higher embodied presence (M = 4.55, SD = 1.40) compared those assigned to the desktop condition (M = 3.92, SD = 1.44), t (132) = 2.57, p = .011. These results indicated the variables, attractiveness of the non-humanlike avatar and level of embodiment, were manipulated successfully.

3.3. Hypothesis testing

Hayes' (2013) Macro PROCESS model 5 was used to test the moderated-mediation model, with the attractiveness of the non-humanlike avatar as the independent variable, social participation as the dependent variable, the two dimensions of avatar identification as (parallel) mediators, and level of embodiment as the moderator. The model was estimated with heteroscedasticity-consistent standard errors and covariance matrix estimators (HC3). To facilitate the interpretation of the tested model, the mean and standard deviation estimates (per *attractiveness* condition) for the dependent variable social participation, and the mediator avatar identification were presented in Table 1.

3.3.1. The effect of level of attractiveness on social participation

The results shown in Table 1 indicate that there was no direct effect of the level of attractiveness of the non-humanlike avatar on social participation, suggesting that participants who embodied the attractive non-humanlike avatar showed similar intentions to participate in a social scenario compared to those who embodied the unattractive non-humanlike avatar. The data did not support Hypothesis 1.

3.3.2. Avatar identification as mediator of the effect of level of attractiveness on social participation

Overall, there was a significant total indirect effect of the level of attractiveness on social participation via avatar identification (b = 0.22, 95% CI [0.01, 0.49]). The attractiveness of the non-humanlike avatar was positively associated with avatar identification, and greater avatar identification was associated with higher levels of social participation. This implied that participants tended to identify with the avatar more when embodying the attractive non-humanlike avatar compared to the unattractive non-humanlike avatar, which further led to a higher intention to participate in a social scenario (see Table 2).

Specifically, there was an indirect effect of the level of attractiveness on social participation through similar identification (b = 0.18, 95% CI [0.00, 0.44]. The attractiveness of the non-humanlike avatar was positively associated with similar identification, which was further positively associated with social participation. This implied that participants who embodied the attractive non-humanlike avatar identified with the avatar more as they perceived it more similar to themselves than participants who embodied the unattractive non-humanlike avatar. Subsequently, this increased their intention to participate in a social scenario.

However, no indirect effect of the level of attractiveness on social participation was found via wishful identification (b = 0.03, 95% CI [-0.10, 0.21]). Although the attractiveness of the non-humanlike avatar was positively associated with wishful identification, wishful identification was not associated with social participation. This implied that even though participants embodying the attractive non-humanlike avatar showed higher wishful identification than those embodying the unattractive non-humanlike avatar, it did not lead to any difference in their intention to participate in a social scenario. All in all, the data support Hypothesis 2.

3.3.3. Level of embodiment as moderator of the effect of level of attractiveness on social participation

Finally, as is shown in Table 2, no interaction effect was found between the attractiveness of the non-humanlike avatar and the level of embodiment on social participation. This suggested that the level of embodiment did not strengthen the effect of the attractiveness of the non-humanlike avatar on social participation. The data do not support Hypothesis 3.

Table 1
Means and standard deviation estimates of key variables per attractiveness condition.

Measure	Attractive Non-Humanlike Avatar (n = 66)		Unattractive Non-Humanlike Avatar (n = 68)		t (1, 132)	Cohen's d
	M	SD	M	SD		
Social participation	4.63	1.57	4.84	1.46	0.78	-0.14
Avatar identification						
Similarity identification	2.88	1.37	2.39	1.30	**2.14**	0.37
Wishful identification	2.57	1.28	2.05	1.12	**2.47**	0.43

Note. *t*-values in bold are significant at $p < .034$.

4. Discussion

The aim of the current study was to test the Proteus effect and further investigate its underlying mechanism, particularly with the role of avatar identification and level of embodiment in a non-humanlike avatar context. In line with our expectations, we found that the effect of the attractiveness of a non-humanlike avatar on social participation was mediated by avatar identification. However, no evidence was found for the moderating role of the level of embodiment in the Proteus effect.

4.1. The role of attractiveness in driving social participation

The results of the study show that embodying an attractive non-humanlike avatar does not result in a higher intention to participate in a social scenario than embodying an unattractive non-humanlike avatar. This is not in line with the work by Bian et al. (2015) who found that attractiveness had a positive effect on social participation in a human-like avatar context. The discrepancy could potentially be explained by the less clear association between the activated self-related and avatar-related schema (Ratan & Dawson, 2016; Ratan & Sah, 2015). Participants may find it hard to connect the non-humanlike avatar to themselves, as its overall characteristics are fundamentally different from human beings. Therefore, they are less likely to adopt the expected behavior corresponding to the avatar's features. This argument is further supported by the mediation effect of avatar identification via self-similarity.

4.2. The mediating role of avatar identification

Avatar identification is found to mediate the effect of the attractiveness of the non-humanlike avatar on social participation in this

Table 2
Results moderated-mediation analysis.

Predictors	Similarity Identification				Wishful Identification			
	b	*SE*	*t*	95% CI	*b*	*SE*	*t*	95% CI
Level of attractiveness	0.49	0.23	**2.12**	[0.04, 0.95]	0.51	0.21	**2.45**	[0.10, 0.93]
Constant	2.39	0.16			2.05	0.14		

	Social Participation			
	b	*SE*	*t*	95% CI
Level of attractiveness	-0.68	0.34	**-2.02**	[-1.16, -0.02]
Similarity identification	0.37	0.14	**2.63**	[0.09, 0.65]
Wishful identification	0.06	0.14	0.46	[-0.22, 0.35]
Level of embodiment	-0.94	0.37	**-2.55**	[-1.66, -0.21]
Level of attractiveness x level of embodiment	0.51	0.50	1.02	[-0.48, 1.51]
Constant	4.29	0.33		

Note. *t*-values in bold are significant at $p < .045$.

study. Individuals embodying an attractive (vs. unattractive) non-humanlike avatar show higher levels of avatar identification, which further led to a higher intention to participate in a social scenario.

When separately examining the two dimensions of avatar identification (i.e., similarity identification & wishful identification), the findings show that participants tend to identify with the avatar both in terms of similarity identification and in terms of wishful identification. However, the effect on social participation is only mediated via similarity identification. Concretely, this means that individuals who identify the non-humanlike avatar as more similar to themselves, are expected to have found it more personally relevant and therefore more likely to adopt the feature of attractiveness and conform to the corresponding behavior. Contrary to the findings by Praetorius and Görlich (2020), people did not show higher levels of social participation as a result of identifying with the avatar through wishful identification. This mediated effect was expected, because attractiveness is a generally positive trait that people may wish to possess and further conform to the expected behavior of the avatar.

Past research on wishful identification suggested that similarities to the characters in fundamental traits (e.g., gender, race, and age) facilitate people's desire to become more like them, as these similarities may indicate it is possible and appropriate to become like them in other ways (Hoffner & Cantor, 2005). In the current study, the non-humanlike avatar (i.e., dog) shared little similarity with human beings. This lack of similarity could have made it more difficult for participants to find a reason or desire to become like the non-humanlike avatar, despite the presence of a desirable trait (i.e., attractiveness). Furthermore, it should be noted that the attractiveness levels of the two avatars, though distinct, were generally low and could explain why we did not find an effect on social participation. A reason for the lower levels of attractiveness could be the fact that attractiveness is a feature typically associated with humans (rather than with dogs).

4.3. The moderating role of embodiment

Contrary to past research that found a stronger Proteus effect for people experiencing greater embodiment (Ash, 2016; Yee & Bailenson, 2009), this study did not find any moderating role of the level of embodiment in the effect of attractiveness on social participation. The inconsistent findings in the current study may also result from the weak connection between the self and the avatar. Past research suggested that a higher level of embodiment indicates a stronger sense of being the avatar, which increases the likelihood for people to adopt the expected behaviors consistent with the identity cues through self-perception (Yee & Bailenson, 2009). However, in the current study, the significant dissimilarities between the non-humanlike avatar and the participants themselves may hinder the effect of the level of embodiment. In other words, although they may experience a greater feeling of being the non-humanlike avatar, they may not perceive the avatar as being similar to themselves, leading to no observed behavior changes. This argument is supported by the observation during the experiment that some participants in the VR condition did not draw their assigned non-humanlike avatars but the actual self when asked to draw a self-portrait. Meanwhile, the overall avatar identification was relatively low, indicating that participants may not view the assigned avatar as a representation of themselves in the virtual environment.

4.4. Limitations and future research

Although this study sheds light on the Proteus effect and its underlying mechanisms in a non-humanlike avatar context, there are some limitations and suggestions for future research. Firstly, the current study shows that embodying an avatar might elicit avatar identification, which further influences conforming to the behavior consistent with the avatar's features. However, an alternative interpretation is plausible. Specifically, the lower avatar identification in the current study may have caused the attractiveness feature of the avatar to become essentially irrelevant to the scenario. Instead, individuals might express a greater inclination to socialize as an avatar they perceive to be resembling themselves. People generally prefer avatars that are similar to themselves and feel more at ease socializing as themselves.

Secondly, it's important to note that this study exclusively utilizes a dog as the non-human-like avatar, while there is a vast array of alternative non-humanlike avatars. When examining non-humanlike avatars that share human-like traits (e.g., elves or humanoid robots), the perception of feature attractiveness may become more pronounced, subsequently influencing behavior to align with these characteristics. Therefore, in future research investigating the Proteus effect in non-humanlike avatar contexts, it would be advisable to consider the level of anthropomorphism in avatars as an influential factor.

Third, the social scene created in this study lacks interactivity due to technical limitations. Participants were not able to interact with non-player characters in the scene. This may decrease the scene's authenticity and have further influenced participants' responses to the questionnaire assessing their level of social participation. For future research, a more interactive virtual environment should be created that allows conversations between the user and non-player characters.

Finally, we did not find any moderating effects of the level of embodiment and attributed this to the lack of self-similarity between the non-humanlike avatar and the participants. However, there is a lack of evidence in the current and previous studies to support this argument. Future research can further investigate the influence of self-similarity by testing the currently proposed model with both non-humanlike avatars and humanlike avatars. If the moderating effect of the level of embodiment is found in the humanlike avatar context but not in the non-humanlike avatar context, it may indicate that self-similarity is an important factor for the level of embodiment to moderate the Proteus effect. Moreover, comparing humanlike avatars with non-humanlike

avatars could also provide insights into whether humanlike avatars can have more influence on individuals' behavior than non-humanlike avatars.

4.5. Implications for theory and practice

This study offers an important theoretical implication by demonstrating that the Proteus effect is mediated by avatar identification. Although past studies suggested that avatar identification can be an important factor influencing the Proteus effect (Praetorius & Görlich, 2020; Ratan et al., 2020), the role of avatar identification in the Proteus effect was not previously specified and tested. The current study shows that embodying an avatar can elicit avatar identification, which further influences conforming to the behavior consistent with the avatar's features. In addition, this finding further supports the theoretical approach that combines self-perception and priming in explaining the Proteus effect (Ratan & Dawson, 2016; Ratan & Sah, 2015).

Finally, this study reveals the importance of self-similarity for the Proteus effect to occur in a non-humanlike context. The low similarity between the avatar and the self indicates less self-relevance of the avatar, decreasing the likelihood for individuals to behave in alignment with the avatar's characteristics. This also provides an implication in practice that non-humanlike avatars may be less likely to have an impact on individuals' behavior due to the lack of self-similarity. Therefore, for designers and policymakers, non-humanlike avatars could be considered if one's goal is to create a virtual environment where individuals are not meant to be influenced by the avatar's appearance.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Xinmiao Lan reports financial support was provided by Digital Communication Methods Lab.

Appendix A

Table A1
Items of the scales used in the study

Scale	Item
Social participation	I would like to stay in the room for a longer time.
	I would like to leave the room immediately.
	I would like to take the initiative to introduce myself to others in the room.
	I would like to try to participate in the conversations others currently were having in the room.
	I would like to interact and make friends with others in the room.
Wishful identification	If I could become like my character, I would
	I would like to be more like my character
	My character is an example to me
	My character is a better me
	My character has characteristics that I would like to have
Similarity identification	My character is like me in many ways
	My character resembles me
	I identify with my character
	My character is an extension of myself
	My character is similar to me
	I resemble my character
Embodied presence	When I am playing, it feels as if I am my character
	I feel like I am inside my character
	When playing in the game, it is as if I become one with my character
	When I am playing I am transported into my character
	When playing, it feels as if my character's body becomes my own
	In the game, it is as if I act directly through my character
Negative feelings sub-scale of the ITC-sense of presence inventory	I felt dizzy
	I felt nauseous
	I felt I had a headache
	I had eyestrain

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