The Effects of Anthropomorphic Avatars vs. Non-Anthropomorphic Avatars in a Jumping Game

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ABSTRACT

Avatar identification is a topic of increasingly intense interest. This is largely because avatar identification can promote a wide variety of outcomes: game enjoyment, intrinsic motivation, quality of made artifacts, and more. Yet we still understand very little about how different avatar *types* affect users. Here, we contribute one of the few highly controlled studies of this nature (N=1074). Specifically, we compare three avatar types in a jumping game: 1) Human (high anthropomorphism), 2) Block-like (low anthropomorphism), and 3) Robot (high anthropomorphism). We find that players randomly assigned to the Robot condition have significantly higher player experience. We find that both Robot and Human conditions lead to higher avatar identification. Finally, using linear hierarchical regression, we find that avatar identification significantly promotes player experience (29.8% variance) and time played (3.5% variance). Our study demonstrates the importance of considering avatar type in designing virtual systems.

CCS CONCEPTS

• **Applied computing** → **Computer games**; • **Human-centered computing** → *Empirical studies in HCI*;

KEYWORDS

Anthropomorphism; Anthropomorphic; Avatar Type; Jumping; Virtual Identity; Avatars

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1 INTRODUCTION

Avatar identification has been shown to promote game enjoyment [36], intrinsic motivation [6], quality of made artifacts [21], and more. Anthropomorphism (or lack thereof) is also a topic of increasing interest in immersive virtual environments [27]. However, there is both a lack of highly controlled studies in this domain, as well as a lack of consensus on whether anthropomorphism positively affects experience-related outcomes. Here, we conduct a randomized controlled study (N=1074) that contrasts two anthropomorphic avatars with a non-anthropomorphic avatar in a jumping game: 1) Human (high anthropomorphism), 2) Block-like (low anthropomorphism), and 3) Robot (high anthropomorphism). Our research questions were:

RQ1. Do anthropomorphic avatars improve player experience?
RQ2. Do anthropomorphic avatars improve avatar identification?
RQ3. Do anthropomorphic avatars improve performance?
RQ4. Does avatar identification improve player experience?
RQ5. Does avatar identification improve performance?

We find that:

- Robot participants have higher player experience.
- Robot & Human participants have higher avatar identification.
- There were no significant differences in performance.
- Avatar identification improves player experience.
- Avatar identification improves play time.

2 RELATED WORK

2.1 Avatar Identification

Avatar identification, as defined by Klimmt et al., is a *temporary alteration of media users' self-concept through adoption of perceived characteristics of a media person* [11]. Avatar identification is sometimes called "character identification" [34], "player-avatar identification" [25], or "avatar-self connection" [17]. Avatar identification can improve game enjoyment [7, 24, 29, 36], intrinsic motivation [6, 37], flow [34], trust in others [22], learning interest [2], game appreciation [9], and more. Avatar identification can even lead to higher quality of made artifacts [21].

Moreover, a body of work has demonstrated that avatars that are similar to users are more influential and linked to better outcomes [3, 5, 15, 23, 36, 38]. The most prevalent theory for why this occurs is similarity-attraction—people are attracted to similar others [10, 16]. We therefore predict that more highly anthropomorphized avatars will lead to improved experience-related outcomes.

2.2 Anthropomorphism

Anthropomorphism is the *tendency to imbue the real or imagined behavior of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions* [13]. Anthropomorphic agents give us greater trust [12, 39], can elicit greater social response [14], and increase self-awareness [32]; however, they can also lead to feelings of unease through the phenomenon known as the *uncanny valley* (when the avatar is weirdly *almost* human) [28]. In marketing, imbuing products with human-like features (e.g., perceiving the car's

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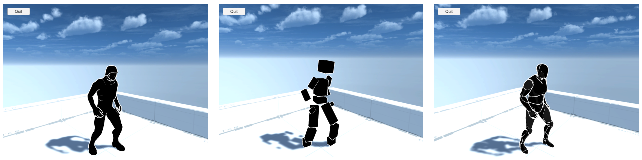
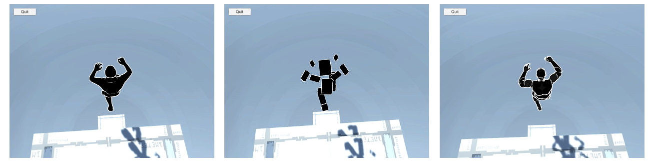


(a) Human avatar. **(b) Block-like avatar.** **(c) Robot avatar.**

Figure 1: Avatars.



(a) Human jumping. **(b) Block-like jumping.** **(c) Robot jumping.**

Figure 2: Avatars jumping.

headlights as eyes, and the grille as a smile) has been seen to produce positive perceptions [1, 35].

2.3 Avatar Type

Although studies exist on avatar type, this is a relatively new research area. Some researchers have contrasted well-known scientists, with well-known athletes, with geometric shapes, finding that scientists can lead to higher engagement in a STEM learning game [18]. Another topic has been the *successful likeness* avatar, in which the avatar transforms between a geometric shape (when the player is failing) to player likeness (when the player is succeeding), shown to improve play time and performance [19]. Researchers in virtual reality (VR) have found that both a machine-like avatar and a cartoon-like avatar gave users *better* illusion of virtual body ownership than realistic human avatars. The researchers hypothesized that this was due to the uncanny valley effect. Finally, other researchers have found that having either a stick-man avatar or a realistic avatar had no difference on influencing people's perceptions of whether they can step off a virtual ledge [8].

3 THE GAME

Infinite Jumper was created by the author, specifically for this experiment. *Infinite Jumper* is a game that involves WASD to move, and space to jump. The only game mechanic is to jump off one platform to another. There are an infinite number of platforms, as each subsequent platform is programmatically generated as the player lands. Moreover, it is impossible to miss a platform when jumping—we adjust the position of the platform to match the player's position. (See Figures 1a, 1b, and 1c.)

4 METHODS

4.1 Avatar Types

The three avatar types we tested were:

(a) Human Avatar
(b) Block-like Avatar
(c) Robot Avatar

To control for potential color effects [20], all avatars were made black. A white outline was added to the avatar for clarity. All avatars used an identical walk animation and jump animation. Therefore, only the visual appearance of the avatar differed across conditions. (See Figures 2a, 2b, and 2c.)

4.2 Validating Anthropomorphism

To ensure that avatars had the perceived anthropomorphism we expected, we ran a validation study (N=333). Participants were asked to play *Infinite Jumper* three times, each time with a different avatar. Participants played the three avatars in a randomized order. After playing at least one minute of each game, they could exit the game at any time. After each game, they filled out the *anthropomorphic autonomy* sub-scale of a validated scale [4]. This scale consists of seven questions relating to anthropomorphism of the avatar (e.g., "This avatar is like a human being") on a scale of (1:*Strongly Disagree*) to (7:*Strongly Agree*).

Intraclass correlation was ICC = 0.98 (one-way random, average measures [33]), indicating high agreement of ratings. A repeated measures ANOVA found that there was a statistically significant effect of avatar type on anthropomorphism, $F(2, 664) = 33.49$, $p < .001$. Both Human (M=2.65, SD=0.33) and Robot (M=2.61, SD=0.34) had a significantly higher anthropomorphism score than Block-like (M=2.31, SD=0.21) $p < .001$. These differences were as expected. However, there are two things to note. The first is that the mean differences between conditions is (descriptively speaking), not large. We expected this, since our experimental manipulation involved only visual changes, whereas the majority of scale questions relate to tangential anthropomorphic characteristics (e.g., "This avatar has its own thoughts and ideas", "This avatar has its own feelings", "When I log out of the game, this avatar has its own life"). Alternately, the question "This avatar is like a human being", elicited greater differences: Human (M=3.28, SD=2.1) and Robot (M=3.2, SD=2.0) were significantly higher than Block-like (M=2.54, SD=1.88) $p < .0001$. Moreover, all avatars were made to have identical skeletal rigs and identical animations for greater experimental control (for example, a sphere without a humanoid structure would likely feature lower anthropomorphic scores, but at the cost of potential confounds such as less animations/movement, etc.). Secondly, the overall anthropomorphic scores are low on the 7 point scale. This was also expected because: 1) Avatars were made to be dark shadows with white outlines and minimal discernible features in order to have consistent style across avatar types, and 2) Avatars were missing additional anthropomorphic indicators such as voice and facial expression which would add significant complexity and confounds. For greater experimental control, this was an unavoidable trade-off.

4.3 Quantitative and Qualitative Measures

4.3.1 Player Experience of Need Satisfaction. We use the 21-item Player Experience of Need Satisfaction (PENS) scale [31].

4.3.2 Player Inventory Scale. The Player Inventory Scale (PIS) measures avatar identification [38], which consists of three second-order factors: 1) Similarity identification (e.g., My character is similar to me); 2) Embodied identification (e.g., In the game, it is as if I become one with my character); 3) Wishful identification (e.g., I would like to be more like my character).

4.3.3 Performance. We directly measure the amount of time spent playing the game. We also measure the number of platforms jumped.

4.4 Participants

A total of 1074 (522 male, 552 female) participants were recruited through Mechanical Turk. Participants were between the ages of 18 and 73 (M = 36.1, SD = 11.3), and were all from the United States.

4.5 Design

A between-subjects design was used: avatar type was the between-subject factor. Participants were randomly assigned to a condition.

4.6 Protocol

Prior to starting the game, players were informed that they could exit the game *at any time* via the quit button in the corner of the screen. When participants were done playing, participants returned to the experiment instructions, which then prompted them with the PIS, PENS, and then a demographics survey.

4.7 Analysis

We use multivariate analysis of variance (MANOVA). Separate MANOVAs are run for each separate set of items—*PIS, PENS*; with the independent variable—*avatar type*. These results are reported as significant when $p<0.05$ (two-tailed). Finally, we use ANOVAs for comparing performance measures.

To measure the predictive capacity of avatar identification, we used linear hierarchical regression using similarity identification, embodied identification, and wishful identification as individual predictors. Since age and sex have been shown to affect need satisfaction, intrinsic motivation, and other avatar identification-related outcomes during game play [26, 30, 31], we entered age and sex in the first block of the regressions. We use avatar identification to predict PENS scores and performance.

5 RESULTS

RQ1. Do anthropomorphic avatars improve player experience?

Summary: Robot participants have higher player experience overall. Robot participants have significantly higher autonomy and significantly higher intuitive controls. The MANOVA was statistically significant across badge conditions in the editor, F(10, 2134) = 2.29, p <0.05; Wilk's λ = 0.979, partial η^2 = 0.01. Univariate testing found this effect to be significant for *autonomy* (F(2, 1071) = 3.51; p <0.05; partial η^2 = 0.007) and *controls* (F(2, 1071) = 3.06; p <0.05; partial η^2 = 0.006). Post-hoc testing (LSD) found that for autonomy, Robot > Human, p <0.05; and Robot > Block-like, p <0.05. For controls, Robot > Human, p <0.05. (See Figure 3.)

RQ2. Do anthropomorphic avatars improve avatar identification?

Summary: Robot and Human participants have higher avatar identification overall. Robot and Human participants have significantly higher similarity identification, and significantly higher wishful identification. The MANOVA was statistically significant across badge conditions in the editor, F(6, 2138) = 2.14, p <0.05; Wilk's λ = 0.988, partial η^2 = 0.006. Univariate testing found this effect to be

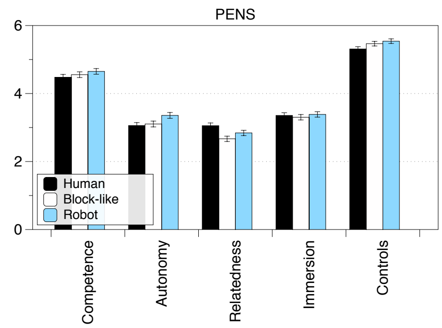


Figure 3: For both autonomy and controls, Robot has significantly higher scores on the PENS scale. Error bars show standard error of the mean (SEM).

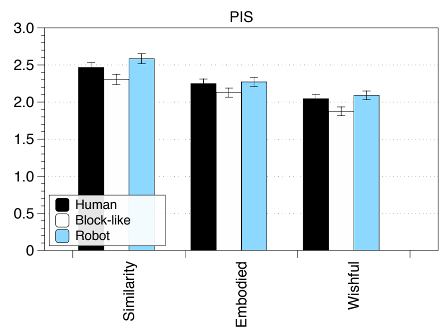


Figure 4: Human and Robot score significantly higher than Block-like on similarity identification and wishful identification. Error bars show SEM.

significant for *similarity identification* (F(2, 1071) = 4.24; p <0.05; partial η^2 = 0.008) and *wishful identification* (F(2, 1071) = 3.77; p <0.05; partial η^2 = 0.007). Post-hoc testing (LSD) found that for similarity identification, Robot > Block-like, p <0.005. For wishful identification, Human > Block-like, p <0.05; and Robot > Block-like, p <0.01. (See Figure 4.)

RQ3. Do anthropomorphic avatars improve performance?

Summary: There were no significant differences in performance. The one-way ANOVA found no significant difference in play time across avatar types (F(2,1071) = 0.501, p = .606). Similarly, the one-way ANOVA found no significant difference in platforms jumped across avatar types (F(2,1071) = 0.033, p = .967).

RQ4. Does avatar identification improve player experience?

Summary: All types of avatar identification (Similarity / Embodied / Wishful) significantly improve player experience (29.8% variance). From the hierarchical regression in Table 1, avatar identification significantly improves need satisfaction. Avatar identification significantly improves competence, autonomy, relatedness, presence/immersion, and intuitive controls. R^2 values (as a result of adding identification) explain 29.8% of variance in need satisfaction.

	Similarity Identification					Embodied Identification					Wishful Identification				
	β	R^2	$R^2(c)$	$F(c)$	$p(c)$	β	R^2	$R^2(c)$	$F(c)$	$p(c)$	β	R^2	$R^2(c)$	$F(c)$	$p(c)$
Player Experience of Need Satisfaction (PENS)															
Competence	0.27	0.092	0.073	86.0	**0.00**	0.33	0.127	0.108	132	**0.00**	0.26	0.083	0.064	74.8	**0.00**
Autonomy	0.65	0.420	0.410	755	**0.00**	0.66	0.435	0.425	804	**0.00**	0.66	0.438	0.427	813	**0.00**
Relatedness	0.66	0.429	0.422	790	**0.00**	0.62	0.387	0.380	664	**0.00**	0.69	0.475	0.468	951	**0.00**
Immersion	0.73	0.529	0.518	1175	**0.00**	0.78	0.606	0.595	1614	**0.00**	0.75	0.560	0.549	1334	**0.00**
Intuitive Controls	0.08	0.027	0.006	6.13	**0.01**	0.14	0.040	0.019	20.8	**0.00**	0.05	0.024	0.003	2.97	0.09
Behavior															
Time Played	0.17	0.103	0.030	35.2	**0.00**	0.19	0.109	0.036	42.8	**0.00**	0.20	0.112	0.038	45.7	**0.00**
Platforms Jumped	-0.08	0.008	0.007	7.44	**0.01**	-0.04	0.002	0.001	1.28	0.26	-0.06	0.004	0.003	3.32	0.07

Table 1: Regression properties β, R^2, change in R^2, F, and p from adding identification. Change statistics are marked (c). Significant results are bold.

RQ5. Does avatar identification improve performance?

Summary: All types of avatar identification (Similarity / Embodied / Wishful) significantly improve time played (3.5% variance). From the hierarchical regression in Table 1, avatar identification significantly improves time played. Avatar identification has a slightly negative effect on platforms jumped, with only similarity identification being a significant predictor. R^2 values (as a result of adding identification) explain 3.5% of variance in time played. R^2 values (as a result of adding identification) explain 0.4% of variance in platforms jumped.

6 DISCUSSION

In this paper, we have conducted a randomized controlled study (N=1074) with three avatar types: 1) Human (high anthropomorphism), 2) Block-like (low anthropomorphism), and 3) Robot (high anthropomorphism). We find that:

- Robot participants have higher player experience.
- Robot & Human participants have higher avatar identification.
- Avatar identification improves player experience.
- Avatar identification improves play time.

Interestingly, avatar identification had a slightly negative effect on platforms jumped. That higher identification leads to less jumping behavior is somewhat counterintuitive. It's possible that jumping was viewed as a dangerous behavior, and therefore participants that more highly identified with their avatars were hesitant to jump. However, this was an extremely small effect.

This is in stark contrast to the effects of avatar identification on need satisfaction. Our R^2 values are commonly in the 40%–55% range, indicating effect sizes well beyond the standard cutoff for large effect size (25%). Previous work using a timed infinite runner game found that avatar identification had effect sizes on the order of 5%–10% [6]. Our extremely large effect sizes might be a result of inducing highly variable levels of avatar identification through the Block-like and anthropomorphic conditions. Yet even despite these conditions, the effect sizes are remarkably large. Another reason might be the type of game played. Specifically, our avatar was directly controlled by the player at all times using the WASD and space bar keys. This finer-grained control may create stronger relationships between the level of avatar identification and virtual experiences. Here, the virtual experience is jumping from a high vertical height, which is a specific mechanic whose vicarious experience may benefit from avatar identification.

We contribute one of the few large-scale controlled studies on avatar types. Our results suggest greater anthropomorphism of the avatar can improve player experience and avatar identification. Avatar identification, in turn, improves player experience and increases time played. This study has high relevance to virtual systems containing avatars more generally. For example, VR often allows you to see your own avatar: as a reflection, directly by looking downwards, or indirectly through customization. We provide a concrete study demonstrating that anthropomorphic avatars can have important and tangible effects in virtual worlds. These studies are increasingly important for designers, developers, and researchers.

7 LIMITATIONS

One limitation is the number of avatar types studied. Here, we contrasted two anthropomorphic avatars with one non-anthropomorphic avatar. Although we found that anthropomorphism led to higher avatar identification, it's possible that other types of avatars would instead lead to different results. For example, consider an avatar of a person's favorite animal, toy, or memento. These types of avatars may invoke greater avatar identification than the specific form of non-anthropomorphism found here. Nonetheless, even this argument should be critiqued, as an emotionally equivalent anthropomorphic avatar might be a best friend or family member. Additional studies, with additional avatar types and additional game types, would help to fill in the gaps in the literature.

8 CONCLUSION

Our study finds that avatars with higher anthropomorphism led to higher player experience. Avatars with higher anthropomorphism also led players to identify more highly with their avatars. Independent of avatar type, we find avatar identification significantly promotes player experience. Finally, avatar identification significantly promotes time played.

As one of the few highly controlled studies on avatar type, we shed further light on the effects of anthropomorphic vs. non-anthropomorphic avatars. We also show extremely large effect sizes for the promotion of need satisfaction through avatar identification. Further work is needed to unpack why these effect sizes are much larger than those previously found in the literature [6, 21], such as additional studies on avatar identification and game type. We provide a contribution in the domain of avatar research: on avatar type, anthropomorphism, and identification. This work informs the design and creation of future virtual worlds.

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