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Investigating the Effects of Two Virtual Reality Types on Individual Self-Perception and User Experience in Adults: Realistic Humanoid vs Fantastical Animated Avatars

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Investigating the Effects of Two Virtual Reality Types on Individual Self-Perception and User Experience in Adults: Realistic Humanoid vs Fantastical Animated Avatars

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Abstract

Investigating the Effects of Two Virtual Reality Types on Individual Self-Perception and User Experience in Adults: Realistic Humanoid vs Fantastical Animated Avatars

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Avatars, in the virtual world, have transformed our ways of interaction and experience. This study investigated the impact of avatar types in VR technologies on adults' perception, focusing on realistic humanoid and fantastical animated entities. We explored how embodying these two avatars in a basic virtual room affect participants' emotions, self-perception, and behaviors while taking into account their tendency to anthropomorphize non-human entities. Participants engaged in movement activities and a tiny human-like game using head-mounted displays (HMD) in a simulated environment. From 14 interviews, we identified trends in avatar type and anthropomorphism's effects on perception shifts, emotional responses, and behavior changes related to avatar embodiment. Our findings offer valuable insights for future avatar design and research, with potential enhancements in healthcare, education, and collaborative technologies, contributing to a deeper understanding of VR embodiment and user engagement.

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Chapter 1: Introduction

This chapter discusses the 1. background of virtual reality and avatars, 2. avatar's effect on perceptions, emotions, and behaviors, and initial questions.

1.1 Background

Virtual reality (VR) has emerged as a transformative technology that has profoundly impacted both our interactions with the real world and our experiences in virtual environments. This groundbreaking innovation has revolutionized the way we engage and represent ourselves within the digital world, showing immense promise in domains such as healthcare and medical treatment (Riva, 2002), mental wellness and psychiatry (Pensieri & Pennacchini, 2014), education and innovative learning (Radianti et al., 2020) and the collaborative technologies like collaborative learning and working environment (Monahan et al., 2008).

One established, industrialized, and proven approach to experiencing VR is through using a head-mounted displays (HMD), which immerse users in a simulated sensory environment (Anthes, García-Hernández, Wiedemann, & Kranzlmüller, 1970). Currently, most of the research and application development in VR focuses on optimizing the immersive potential of HMDs (Gugenheimer et al., 2017). Until now, Various consumer-oriented mixed reality devices, including Oculus Quest 2, HTC Vive, and Steam VR, have been introduced, typically featuring an optical display in front of the user's eyes, and using handheld controllers or joysticks for navigation and interaction within the virtual space (Anthes et al., 2016).

In the past few years, VR has led a trend in the research domain on exploring the experience enhanced technology and other public applications. Traditionally, VR users have been limited to experiencing virtual environments with low-cost headset (Castelvecchi, 2016) and without other self-representation technique. They put on a headset and become immersed in a digital world, where their experiences are highly dependable on the levels of immenseness for the systems, from non-immersive system of reproducing realistic images to immersive system with a complete simulated experience (Cipresso et al., 2018). Research has shown that even a limited level of embodiment, which has an unviewable self-representation can significantly enhance the user's overall experience (Castelvecchi, 2016).

In the real world, our experience is anchored in our physical bodies, which act in accordance with our intentions and the physical environment (Gonzalez-Franco & Peck, 2018). Traditionally, digital representation within games is often limited to either an unviewable or partial body. Virtual reality avatars represent an innovative approach with the potential to significantly impact various domains. They offer users a wide range of immersive and interactive experiences, both mirroring real-life situations and enabling exploration of scenarios that are unattainable in the physical world.

1.2 AVATAR'S EFFECT ON PERCEPTIONS, EMOTIONS, AND BEHAVIORS

Overview of avatars in virtual worlds. Avatars are central to virtual worlds and online gaming. The term derives from Hinduism to define the descent of a deity to the Earth in an incarnate form or some manifest shape (Bailenson & Blascovich, 2004). Human beings have the nature of transforming their self-representation, from minor alterations of changing hair style and cloth, to totally change to an extreme condition of being a creature or God (Yee & Bailenson, 2007). While now avatars, as the digital self-representation in the virtual world, has provided far more flexible transformative ability (Yee & Bailenson, 2007) and enable people to explore more possibilities of themselves. In digital realms, an avatar mirrors its human user's actions in real-time, distinct from algorithm-driven embodied agents (Bailenson & Blascovich, 2004). This study examines how these digital self-representations influence self-perception, emotions, and behavior in virtual environments.

Embodying avatars can influence people's perceptions. Research shows the bond users form with avatars can mirror real-world interactions, affecting their virtual and potentially real-world perceptions (Bailenson, Blascovich, Beall, & Loomis, 2003). Freeman and Maloney (2021) interviewed 30 adults and concluded that participants felt more engaging, intimate, and personal with their self-presentation in social VR compared to traditional virtual worlds and online games. Park and Ogle (2021) researched on the virtual avatar experience of 18 females embodying anthropometric 3D models, showing that after the experience, participants gained more self-acceptance. Banakou et al. (2013) and Tajadura-Jimenez et al. (2017) discovered that when adults embody a 4-year-old child avatar, they tend to overestimate object sizes, with estimates approximately twice as large as when embodying an adult, and they also start identifying with child-like attributes.

Measuring people's connections to their avatars. In VR, the user experience is often evaluated through the concept of presence, or the feeling of "being there" (Lee, 2004; Slater & Wilbur, 1997), assessed typically through self-report questionnaires. Self-presence, feeling united with an avatar, is a crucial aspect of VR connection. This concept encompasses how people perceive themselves online, the impact of immersive qualities, contextual differences, and individual psychological traits (Oh et al., 2018). Aseeri and Interrante (2021) researched how embodying avatars can enhance confidence and trustworthiness in interpersonal communication. Ogawa et al. (2020) found that embodying full-body avatars positively impacted self-presence, evidenced by participants' task completion in walking past a wall. Freeman and Maloney (2021) found that 30 adults felt more engaged, intimate, and personally connected with their self-presentation in social VR than in traditional virtual worlds and online games. Park and Ogle (2021) showed that 18 women who embodied anthropometric 3D models in a virtual avatar experience gained more self-acceptance.

The emotional impact of avatars on users. The type of avatars that users embody can impact their emotions. For example, Waltemate et al. (2018) showed that adults felt more positive emotion when using a realistic avatar. Diemer et al. (2015) concluded that participants with immersive avatar experience have a significant positive relationship between presence and positive emotions, like happiness, joy.

VR avatars affect people's behavior. VR interaction via avatars enhances user experience through, influencing behavior as demonstrated by the Proteus Effect (Yee & Bailenson, 2007), which people conform their behaviors to the type of avatar they embody, such as their appearance. Embodying avatars encourages proactive engagement in unique activities, benefiting education, therapy, and entertainment (Rosenberg et al., 2013). Bailenson et al. (2006) proposed a method to have embodied real-time avatar do two levels of behavioral realism tasks and concluded that more realistic avatars can lead to deeper emotional engagement and more effective communication in the virtual world, which is beneficial in future therapy.

Avatar types, ranging from realistic to fantastical, impact users' perceptions, emotions, and behaviors in virtual experiences. Yoon et al. (2019) and Latoschik et al. (2017) concluded that the physical embodiment of realistic avatars enhances the sense of presence, influencing social interactions and satisfaction in virtual spaces. Ogawa et al. (2020) observed that participants embodying realistic full-body avatars were less likely to walk through a virtual wall, implying a stronger sense of physical presence. Additionally, advancements in motion tracking and avatar-user synchronicity further improve the realism of virtual experiences (Cummings & Bailenson, 2016). While Lin and Wang, (2014) and Jo et al. (2017)'s studies showed that users' choices of avatars, driven by various motivations, affect perceptions of body ownership and presence, with cartoon-like avatars notably impactful. Koulouris et al. (2020) found that idealized avatars increased wishful identification but reduced performance in exercise games compared to realistic ones. Additionally, avatar customization has also been researched and found to have impacts on perceptions, emotions, and behaviors. You and Sundar (2013) research indicates that customized avatars, as opposed to pre-assigned ones, enhance participants' visual perceptions and feelings of effort and calorie burn. Avatar customization plays a key role in enhancing presence (Freeman & Maloney, 2021). Lastly, there is also research on the how anthropomorphism impact the avatar realism on the illusion of virtual body ownership (Lugrin, 2015).

This study narrows its focus on how avatars influence self-perception, emotions, and behaviors in VR, exploring key factors that enhance self-perception and user experience, building upon prior research in avatar realism, social aspects, and technical elements of virtual environments.

Chapter 2: Method

This chapter discusses the research method of this project by elaborating on 1. study aim and overview; 2. participant, 2. procedure, 3. equipment and virtual environment, 4. procedure, 5. measures, 6. analysis approach.

2.1 Study Aim and Overview

This project is part of a broader research study on examining adults' and children's perceptions when embodying different types of avatars. This study examined how the type of avatar (i.e., level of fantasy) during a VR experience impacted users' behaviors, emotions, and perceptions (i.e., presence, usability, and design preferences). Participants were randomly assigned to one of two distinct VR avatars: (a) realistic humanoid avatar (human, i.e. a toon teen model), or (b) fantastical avatar (non-human, i.e., a blue Muppet). Each avatar represents a different level of fantasy. The realistic humanoid avatar closely resembled the participant in both age and appearance, representing the low fantasy level (i.e. more humanness), and the fantastical avatar bared no physical resemblance to the participant, embodying a high level of fantasy (i.e. less humanness).

For this exploratory study, we explored the boundaries of VR experiences with avatars, aiming to enhance psychological immersion and user engagement of VR experiences. This study delves into how adults' user experience, immersion, emotions, and behaviors are affected by embodying different types of avatars. In addition, this study examined participants' tendency to anthropomorphize non-human entities (Waytz et al., 2010) as it might influence how people see their avatars as themselves and its broader effect on other measures as well. Finally, we examined the implications for avatar design in the future use of VR technology to benefit diverse groups of people in domains such as medical, mental healthcare, education, working, etc.

2.2 Participants

2.2.1 Participants Description

The study recruited 14 participants, aged over 18 from the greater Austin area, including both University of Texas at Austin (UT) students and non-students. Furthermore, all adult participants received a consent form which stated that individuals with epilepsy, seizure disorders, or conditions predisposing them to dizziness, disorientation, or nausea would be excluded from the study. No adults reported they had any of these conditions. They reported their age (ranging from 18 to 33, mean = 24.57 years, *SD* = 3.63 years), =10 females and 4 males, race/ethnicity (11 Asian, 2 Latino/Hispanic, and 1 North African), and their previous 6 months' VR and gaming experience with responses as no experience at all, a little as less than once per month, some as more than once per month, a lot as several days or weeks per month (Table 1). The results show the participants for gaming experience (no = 0, a little = 1, some = 12, a lot = 0), VR experience (no = 8, a little = 6, some = 0, a lot = 0), avatar experience (no = 4, a little = 6, some = 1, a lot = 3). In addition, Participant codes are sorted by the gender groups. The participant ID and avatar type codes were given before each test by the associated researcher.

Table 1: Participants Description

Participant	Gender	Avatar Type	Age	Ethnicity	Gaming/VR/Avatar Experience
P1	Female	Human	25	Asian	Some/No/No
P2	Female	Human	25	Asian	Some/A little/A little
P3	Female	Non-Human	33	Asian	Some/A little/A lot
P4	Female	Non-Human	30	Asian	A little/No/A little
P5	Female	Non-Human	25	Asian	Some/No/No
P6	Female	Human	24	Asian	Some/No/A little
P7	Female	Non-Human	22	Latino /Hispanic	Some/A little/No
P8	Female	Non-Human	21	Asian	Some/No/Some

P9	Female	Human	23	Asian	Some/A little/A little
P10	Female	Human	24	Latino/ Hispanic	Some/No/No
P11	Male	Non-Human	18	Asian	Some/No/A little
P12	Male	Human	25	Asian	Some/A little/A little
P13	Male	Human	23	North African	Some/A little/A lot
P14	Male	Non-Human	26	Asian	A lot/No/A lot

The participant ID is ordered by the gender groups.

2.2.2 Recruitment of Participants

Initially, we created a recruitment online form using UT Qualtrics and distributed the form to the iSchool email lists and put it on social media like Discord across the UT campus. In the form, we asked the potential participants their past gaming or VR experience, if they had conditions that would make them susceptible to dizziness, disorientation, or nausea, if they had a seizure disorder or epilepsy, and if they would be interested in participating in an in-person interview at the iSchool later. Then, based on their responses, the researcher sent out invitations to schedule interview sessions with prospective participants.

Due to the limitation on the time of recruitment, we set a baseline of recruiting ten participants as the minimum. We commenced by generating a list of subjects, each assigned an avatar type and a unique participant code, utilizing a computer-based randomization algorithm within an Excel spreadsheet. This randomization was designed to evenly distribute participants across avatar types. If participant enrollment exceeds ten individuals, we employ a predefined sequence (A, B, B, A, B, A, A, B, A, B; A being avatar type human, and B being avatar type non-human) to ensure an evenly distributed list within each set of ten participants. Our methodology prioritized time and participants' mobility to be engaged at iSchool; thus, we minimized exclusion during the recruitment phase, ensuring every eligible participant was included in the offline interviews and participated in the entirety of the study.

The study was sponsored by the School of Information Immersive Human Development Lab which was founded by Dr. Jakki Bailey, and the whole research procedure took place in the lab room.

2.3 Equipment and Virtual Environment

2.3.1 Equipment and Virtual Environment Overview

We used the Oculus Quest 2 (head-mounted device) to connect to the virtual environment. Oculus Quest 2 equipment included the headset and two controllers, one for left hand and one for right hand. The headset enabled quest link with a cable linked to a desktop computer to realize real-time communication between the headset and the computer. The virtual environment was built and programmed in Unity using its inner tools and C# programming languages. The virtual environment served as the main experience that participant engaged with.

Participants came to the lab with the equipment and virtual environment already set up correctly. After they have signed consent forms and filled out a pre-test questionnaire, they stood on a set of footprints laid on the physical floor of the lab room, and then complete the whole VR experience. As Figure 1 (left) shows, it is the front view of the experience setting, which consists of (1) VR experience location (footprint), (2) VR experience terminal (desktop computer), (3) participant. During the test session, adults were asked to stand on the (1) footprint as the starting point. On the other side, the researcher set up VR experience and input ID, avatar type that the participants had been assigned at (2) VR experience terminal, the responsible researcher also took in charge of the experience flow control, scenes transitional actions and other activities. Then, in the center (Figure 1, left), it is the (3) participant that has been fully prepared to experience. As the Figure 1 (right) shows, it is the rear view of the experience setting, which consists of (4) VR Quest link, (5) self-report workstation (laptop computer), (6) webcam. Firstly, before and after the VR experience, adults were asked to fill out consent forms, pre-test questionnaire, and post-test questionnaire at (5) self-report workstation where they were provided with the lab laptop computer to complete the online forms. Also, during the VR experience, the (6) webcam connected to the (2) laptop computer was started by the researcher to record the participants' physical activities inside the lab room during the whole VR experience.

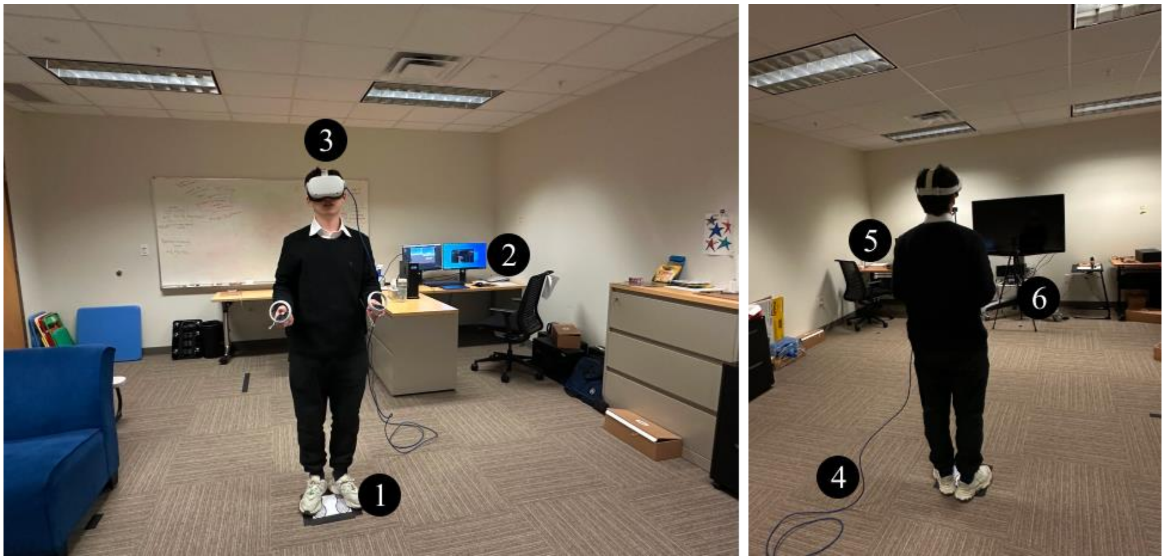

Figure 1. Front and Rear Views of The Lab Setting

2.3.2 Virtual Environment

Unity VR used two scenes: 1. preparation scene, 2. game Scene. In the 1. preparation scene, the participant entered the default world of Unity connected through the Quest link platform. And on the desktop computer side, the researcher was responsible to guide the participant through the navigation of VR, also to input coded ID and the assigned avatar type to launch the VR experience so that each participant would be experiencing the programmed and scripted experience prepared for their routes.

Entering the game scenes, participants engaged with three stages of experiences: 1. orientation (figure 2, left), 2. mirror (figure 2, right), 3. ask-and-answer questions. Figure 2 (left) shows the orientation phase of game when adults are asked to confirm if they have seen the colored balls, and Figure 2(right) shows when the participant have the avatar's body and stand in front of a mirror.

Figure 2. Two Phases of The Game Scene

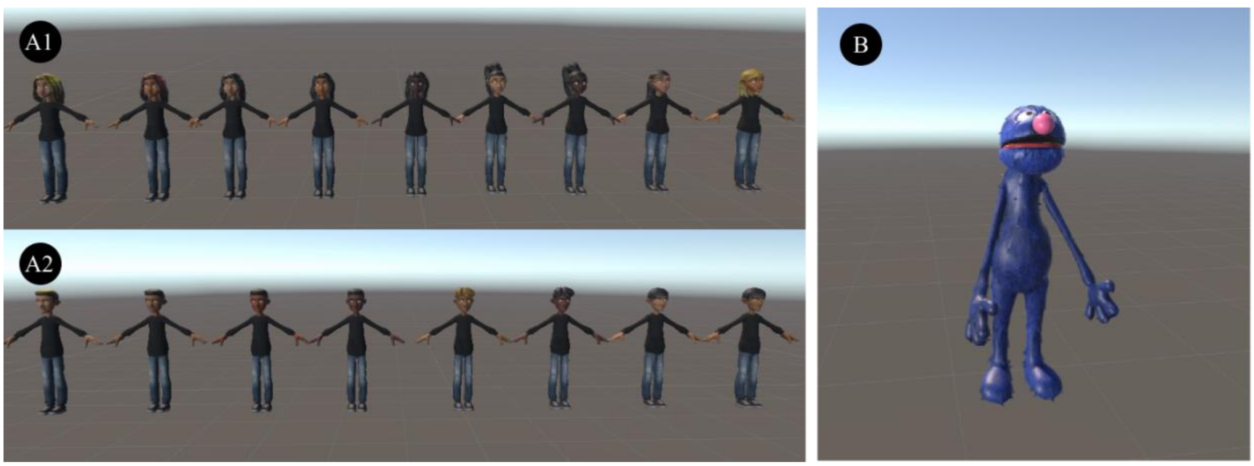

Figure 3. Two Types of Virtual Avatars

2.3.3 Virtual Characters

In order to achieve the goals of the study to investigate how avatar types can affect the perceptions, emotions, and behaviors of adults, two avatar types were created, and programmed to enable a first-person perspective of the experience: 1. human (i.e. the animated humanoid character), as shown in Figure 3 (left top and left bottom, A1 as females, A2 as males), 2. non-human (i.e. blue Muppet, Grover), as shown in Figure 3 (right, B).

Human (i.e. humanoid) avatars are generated from Unity store asset Toon Teen package. Edits from the default Toon Teen models, to incorporate potential diverse demographics of adult participants, customization of the Toon Teen avatars has been executed. As Figure 3 (A1) shows there are 9 different female human avatars (F1-F9) being created. Customized parts include skin tone, hair style and color, while the clothe outfit and other settings remain the same for all female avatars to ensure consistency. Same applies for the 8 male human (figure 3, A2) avatars (M1-M8), customized parts include skin tone, hair style and color, while other settings remain the same and consistent. Second type of avatar is the non-human one, which is Grover (figure 3, B), the blue Muppet model provided by Sesame Street Workshop. Every participant embodies the same non-human model to ensure the experience consistent across all individuals. Grover has blue skins and fluffy creature characteristics that makes it different from human avatars. In the experience, participants controlled same features embodying either one of these avatar types, with same animation clips, hand and leg movement programmed to the utmost extent eliminate the irrelevant factors that can potentially affect the results.

2.4 PROCEDURE

Semi-Structured Interview Process. Participants visited VR lab to engage in the semi-structured interview process with a pre-test check and the experimental test.

Pre-test session. Before the experiment, the researcher presented the consent form to the participant with details of the nature of this study, the study aims, the reimbursement method, the participant's acknowledgment of personal health condition, and how we keep the data and use them in the future to receive approval of continuing the study.

Entering the experiment and VR experience. Firstly, before putting on the headset and having the participant experience the VE, the participant was asked to fill out a pre-test questionnaire which consists of some more detailed demographic information, gaming/VR experience, Individual Differences in Anthropomorphism Questionnaire (IDAQ), emotional levels, and simulator sickness. Secondly, after the recording on the physical space and the virtual environment, was turned on, the researcher introduced the HMD and hand controllers to the participant, the game basics, and how to play the game later. Then, the researcher asked the participant to stand on the footprint at the center of the room facing toward the webcam that the study used to capture the physical movements of the participant. The participant was tethered to the local desktop computer Unity scene via the quest link. After the headset, hand controllers, and cable link were set up, the researcher launched the Unity scene to enter the participant ID, the pre-determined embodying avatar type.

During-test session. In the VR experience, the participant went through a process to orient to the VR, warm-up avatar phase, a Go/No Go activity (Won et al., 2015), and answering questions. The virtual environment was designed to be a simple room with three colored balls on the ground being placed at the position of left, center, and right. In the orientation phase, the participant was asked to confirm with the researcher that he had seen the red/blue/yellow ball on the ground. The orientation was designed to help participants establish a basic understanding of the virtual environment and help them get familiar with the equipment. Then, in the warm-up phase, the participant became the avatar which was pre-designed in the library that was most similar to him/her in appearance. The type of humanoid or fantastical was predetermined in the randomized list. The participant saw their body in the virtual space and after five seconds, a mirror would appear in front of the participant. Furthermore, the second step for them was they were asked to freely explore the space and their body for at least 30 seconds. After that, the researcher continued to ask them to complete the warm-up session.

The third step of the virtual reality experience was to have the participant play a Go/No Go task (Won et al., 2015) where the participant was asked to touch certain colored cubes. Blue and purple, touch; yellow and orange, don’t touch. A practice was introduced first, and then the real test began, the researcher recorded how participants scored on the Go/No Go task.

After the game, the researcher provided participants at least 30 seconds to explore the virtual space their avatars. Finally, the researcher asked participants about their self-presence, and their tendency to do certain activities in the virtual space.

Post-test session. After completing the VR experience, the participant completed a post-experience online questionnaire by filling out questions on emotional levels, simulator sickness, usability, self-perception, and social perception and open-ended questions.

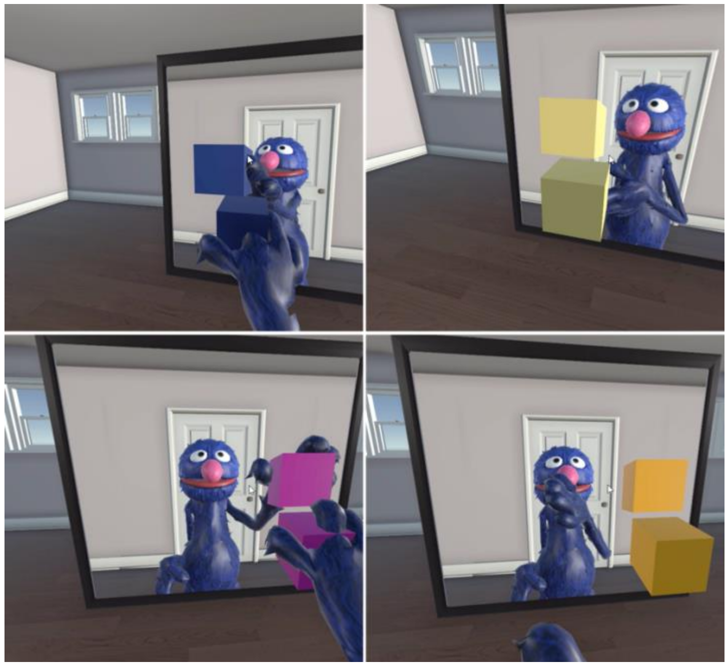

Figure 4. Go/No Go Test. On the left are blue and purple cubes that participants were asked to touch; While on the right are the yellow and orange cubes that they shouldn't touch.

2.5 Measures

2.5.1 Demographic Information

Demographic information was collected in the pre-test session. Participants answered questions about their (a) age, (b) gender (female, male, non-binary, self-described), (c) sex they were born, (d) race/ethnicity, and (e) previous experience with gaming, with VR, and with avatars in the past 6 months. The demographic information will be valuable for later analysis to understand the background, diversity, and experience of the participant groups, and the information will be utilized to investigate potential effect as factors in adults' perception, emotions, and behaviors change.

2.5.2 Individual Differences in Anthropomorphism Questionnaire (IDAQ)

Individual Differences in Anthropomorphism (IDAQ) responses were collected in the pre-test session. IDAQ, which comprises 30 questions, was designed to assess how strongly a person is prone to attribute human-like characteristics to non-human entities (Waytz et al., 2010).

The IDAQ is used to gauge the adults' behavioral tendency to anthropomorphize, which can be described as the propensity to give inanimate objects or animals with human qualities, feelings, or intentions. (Epley & Waytz, 2007). Participants filled out the IDAQ-30 items via an electronic form provided via the lab laptop. From the provided original question list, 15 items are IDAQ, and 15 are nonanthropomorphic items (IDAQ-NA), which are used to distinguish anthropomorphism from general dispositional attribution (Waytz et al., 2010). All items are rated on a scale of 10, from 0 being not at all/strongly disagree to 10 being very much. Collecting IDAQ aims to grasp the individuals and general trend of participants' tendency to anthropomorphize.

2.5.3 Emotional Distress

Emotional distress responses were collected in the pre-test and post-test sessions. In these sessions, adults were provided with digital online form where they could respond to three questions that gauge their current feelings of fear, sadness, and worry. These measures are based on the PedsQL 4.0 emotional functioning items (Varni et al., 2001). While the original PedsQL 4.0 was designed for healthy pediatric populations and included a provision for parental proxy reporting, this study utilized the same questions for adults, to enable direct comparison of emotional experience change across children and adults. This approach follows the precedent studies in the field (Schloss et al., 2021; Bailey & Schloss, 2023). The simulator sickness questions are based on a scale of 5, with options that include 1 – Not at all, 2 – Slightly, 3 – Moderately, 4 – Strongly, 5 – Very strongly. Collecting emotional distress responses aims to evaluate if there is an emotion difference between before and after the VR experience for adults.

2.5.4 Simulator Sickness

Simulator sickness responses was collected in the pre-test session and post-test session. Adults answered four questions adopted from simulator sickness questionnaire (Kennedy et al., 1993) regarding their stomach, head, eyes, and feeling of dizziness before and after the VR avatar experience. For this study, the researcher asked participants to fill out simulator sickness questionnaires online themselves via a laptop themselves. Simulator sickness questions are based on a scale of 5, with options ranging from 1 (Not at all) to 5 (Very strongly). Collecting simulator sickness responses aims to evaluate the one part of participants' experience after the avatar experience.

2.5.5 Self-Presence

Self-presence responses were collected during the test session. The self-presence questions, derived from the self-presence question list (Won, Bailenson & Lanier, 2015; Won, Bailenson, Lee, & Lanier, 2015), include items 1, 2, 3, and 5. These items inquire whether participants perceive the virtual character's body movements as their own, identify as the virtual character, feel present in the character's body, and consider the character's body as their own. These questions had been customized for our study, as outlined by Gold et al. (2021), and Witmer and Singer (1994). During the VR experience, researchers verbally asked participants these self-presence questions while they were engaged as the virtual character and observing themselves in a virtual mirror Through the communication, researcher took notes on the participant's responses and recorded any additional information if needed. Additionally, participants were asked to rate how much or to what extent they feel their avatar represents them during the experience. The responses to the self-presence questions are measured on a 5-point scale, with options ranging from 1 (Not at all) to 5 (Very strongly). The objective of collecting these self-presence responses is to evaluate differences in self-perception during the VR experience in adults.

2.5.6 Usability and Acceptability (ACT)

Usability and acceptability responses were collected in the pre-test session and post-test session. Participants completed a questionnaire about the overall experience by answering scaled usability questions adopted from system usability scale of 8 items and with a quick and dirty method (Brooke, 1996). Besides, a scaled ACT questions was adopted from Grip inventory immersion item 1 and 16 (Gold et al., 2021) to evaluate how usable and acceptable the virtual reality experience that includes the avatar embodiment is to adults after they experience it. For system usability scale, the 8 items are rated on 1 – Strongly disagree, 2 – Disagree, 3 – Cannot tell, 4 – Agree, 5 – Strongly agree. The calculation follows the method that Brooke (1996) introduced. For ACT, the two items are rated on a 5-point scale, with options ranging from 1 (Not at all) to 5 (Very strongly). Collecting usability and acceptability responses aims to assess the user experience of the overall VR and avatar game avatar for adult people.

2.5.7 Avatar Design Preference

Avatar design preference responses were collected in the post-test session. Participants answered questions about their future design preferences of the avatars. And the questions have been grouped to three categories. 1. realism and customization preference (Won, Bailenson & Lanier, 2015; Won, Bailenson, Lee, & Lanier, 2015). In the future avatar experience, how does the participant think of avatar resemblance appearance (e.g. how important is it for the avatar to resemble you?). These questions are rated on a 5-point scale, with options ranging from 1 (Not at all) to 5 (Very strongly). 2. body parts and features preference. In the future avatar experience, what body parts and features matter most? These questions were free-text fields where participants input values themselves. In addition, 3. open-ended questions, which are regarding how they think of customization of their avatars. The objective of collecting these avatar design preference responses is to evaluate and explore trends or patterns in adults thought about future avatar research and applications.

2.5.8 Social and Behavioral Perception

Social and behavioral perception responses were collected in the post-test session. Observational notes were taken on participants' verbal and non-verbal behaviors as reviewed by the researcher. A 5-point scaled questionnaire regarding social perception was asked to gather exploratory data on participants' social perception. In addition, participants' head and hand movements were tracked by the VR equipment, measuring their actions during the VR experience. However, the video raw data was not analyzed in this initial study.

2.6 Analysis Approach and Techniques

This study examined how the type of avatar embodiment (i.e., level of fantasy or non-humanness) during a VR experience impacts users' behaviors, emotions, and perceptions (i.e., presence, usability, design preferences). Participants were randomly assigned to one of two distinct VR avatars: (a) realistic humanoid avatar (i.e. toon teen), (b) fantastical avatar (i.e. a blue Muppet). In the result section, the 2 avatars are coded as (a) human and (b) non-human. Overall, this study takes a mixed research method with a combination of qualitative, quantitative methods to interpret the results or findings.

First and foremost, the measures are coded as: (1) tendency to anthropomorphize (i.e. IDAQ), (2) emotional levels, (3) simulator sickness, (4) self-presence, (5) avatar design preference, (6) usability, (7) acceptability (ACT), (8) subjective perception of embodying avatars (9) Social perception and behaviors.

The majority parts of this study collect adults' responses via scaled questions, typically a scale of 5. Analyzing approach calculated the mean scores, standard deviations of the average responses that adults provided: (1) (2) (3) (4) (5) (6) (7) (9); Then, we utilized the statistical methods, either logistic regression or linear regression to test the relationship between factors and how robust the relationships are. For (4) (5) (6) (7), linear regressions tested the preliminary relationship between avatar types and measures scores considering tendency to anthropomorphize as a covariate (Draper & Smith, 1998).

In addition, another analytical approach used was the thematic analysis (Braun & Clarke, 2012), combination of inductive and deductive methods was applied to evaluate the responses of adults' thinking on (5) (8). For (5), participants' responses were firstly categorized to the pre-defined groups, and each matched answer was numbered and counted into the coded groups, for example how many times they mentioned upper body or lower body. This provides a ranking of importance for avatar design preference; For (8), adults were asked how they feel and perceived themselves in the virtual environment embodying a type of virtual body. Their responses were collected and categorized into positive, neutral, and negative. Each participant's response was counted as potential once for each group. Furthermore, (9) had only been analyzed through an exploratory approach with further qualitative analysis to be included.

Chapter 3: Results

This chapter reports the results and findings we analyze and conclude from the study, including 1. IDAQ, 2. emotional distress, 3. simulator sickness, 4. self-presence, 5. avatar design preference, 6. usability, 7. acceptability, 8. subjective perception, 9. social perception and behaviors.

3.1 Individual Difference In Anthropomorphism Results

The below Table 2 displays the sum scores of IDAQ as "IDAQ" and the average (mean) scores of IDAQ as "mean IDAQ" for all the adults. The table shows the mean (standard deviation), max, and min scores of the IDAQ (mean = 60.07, *SD* = 21.91 max = 116.00, min = 33.00), Mean IDAQ (mean = 4.00, *SD* = 1.46, max = 7.73, min = 2.20), IDAQ-NA (mean = 85.79, *SD* = 14.00, max = 107.00, min = 63.00), Mean IDAQ-NA (mean = 5.72, *SD* = 0.93, max = 7.13, min = 4.20). These scores were used for the further analysis of user trends, tendency, and relationships with other factors. "Mean IDAQ" is the score that was used for the following analysis.

Table 2: IDAQ and IDAQ-NA by Individuals

Category	Mean	Max	Min
IDAQ	60.07(±21.91)	116.00	33.00
Mean IDAQ	4.00(±1.46)	7.73	2.20
IDAQ-NA	85.79(±14.00)	107.00	63.00
Mean IDAQ-NA	5.72(±0.93)	7.13	4.20

Scores in parentheses show the standard deviations of the mean scores.

3.2 Emotional Distress

Before and after the VR experience (in the pre- and post-test session), participants provided responses to the emotional distress levels questions on a scale of 5. The results, including mean scores and standard deviations, have been computed and categorized into three different group types (All participants, participants with human avatars, participants with non-human avatars).

Before the VR experience, the calculated results for three different groups: all (*n* = 14, mean = 1.40, *SD* = 0.42), human (*n*=7, mean = 1.62, *SD* = 0.49), and non-human (*n* = 7, mean = 1.19, *SD* = 0.18). After the VR experience, the calculated results for three groups: all (*n* = 14, mean = 1.33, *SD* = 0.47), human (*n*=7, mean = 1.52, *SD* = 0.57), and non-human (*n* = 7, mean = 1.14, *SD* = 0.26). Comparing scores before and after the experience shows that the average (mean) change in values was a decrease of 0.07 all, a decrease of 0.10 for human avatars, and a decrease of 0.05 for non-human avatars.

3.3 Simulator Sickness

Before and after the VR experience (in the pre- and post-test session), participants provided responses to the simulator questions on a scale of 5. The results, including mean scores and standard deviations, have been computed and categorized into three different groups: All participants, participants with human-avatar embodiment, participants with non-human avatar embodiment.

Before the VR experience, the calculated results for three groups: all (*n* = 14, mean = 1.21, *SD* = 0.44), human (*n*=7, mean = 1.18, *SD* = 0.31), and non-human (*n* = 7, mean = 1.25, *SD* = 0.58). After the VR experience, the calculated results for three groups: all (*n* = 14, mean = 1.32, *SD* = 0.35), human (*n*=7, mean = 1.50, *SD* = 0.38), and non-human (*n* = 7, mean = 1.14, *SD* = 0.20). Comparing scores before and after the experience shows that the average (mean) change in values was an increase of 0.11 all, an increase of 0.25 for human avatars, and a decrease of 0.04 for non-human avatars.

3.4 SELF-PRESENCE

3.4.1 Self-Presence Results

Adults' self-presence during VR experience is divided by avatar type. Table 3 shows the mean (standard deviation) score of the self-presence for all participants, participants embodying a human avatar, participants embodying the non-human avatar. The minimum score is 1 being not at all, and the maximum score is 5 being very strongly. Based on the scores, all participants experience a slightly high self-presence in the VR experience with a mean score of 3.23 (*SD* = 0.76); participants with humanoid avatars have slightly lower self-presence in the VR experience with a mean score of 2.82 (*SD* = 0.28); participants with fantastical avatars have higher self-presence in the VR experience with a mean score of 3.64 (*SD* = 0.88). This indicates that adults embodying the non-human avatar are more prone to gain higher self-presence during the experience.

Table 3: Means and Standard Deviations of Self-Presence Score by Avatar Type

	All	Human	Non-Human
Self-Presence	3.23(±0.76)	2.82(±0.28)	3.64(±0.88)

Values in parentheses mean standard deviation.

3.4.2 The Impact of Avatar Types on Self-Presence Score: Considering Tendency to Anthropomorphize

Although the mean self-presence scores of three different groups as of values can draw to a potential conclusion that adults experiencing non-human avatar gains higher score than people experiencing human avatars, the underlying relationship between IDAQ, avatar type, and self-presence scores. Below is the figure plotting the box graphs of self-presence and IDAQ scores by the two avatar types (Figure 5). Figure 5 indicates potential relationship and impact that avatar type can influence the outcome of self-presence and IDAQ. But still, further analysis is needed.

Table 4 shows the key indicators and values of the figure 4's box graphs that self-presence score and mean IDAQ divided by the two avatar types. In Table 4, the mean, SD (standard deviation), min (minimum), max (maximum), 25% (25th percentile), 50% (median, 50th percentile), and 75% (75th percentile) scores for self-presence and mean IDAQ are presented.

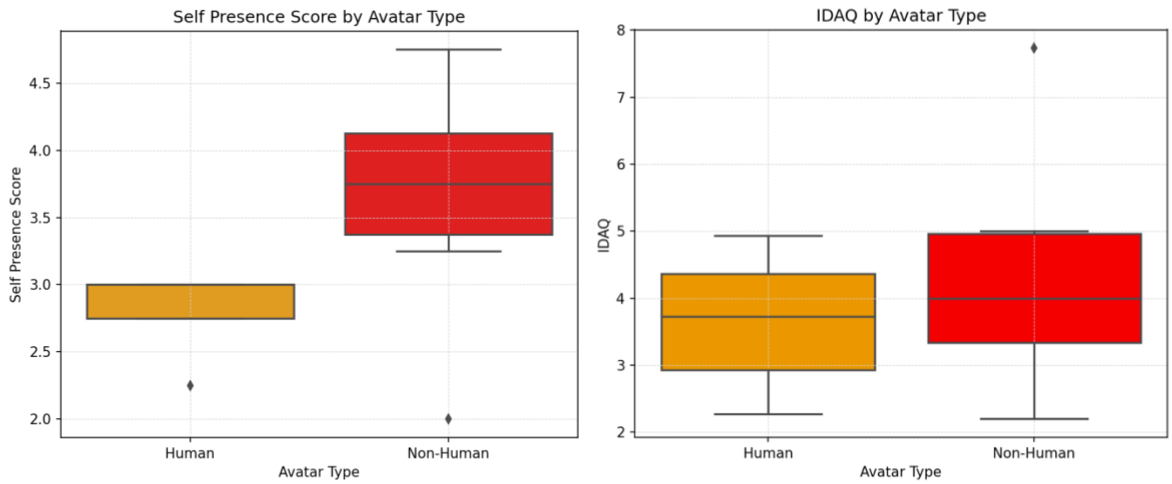

Figure 5: Box Graphs of Self-Presence and IDAQ by Avatar Type

Table 4: Box Graphs Values in Figure 5

Measures	Avatar Type	Mean	SD	Min	25%	Median	75%	Max
Self-Presence	Human (n=7)	2.82	0.28	2.25	2.75	3.00	3.00	3.00
	Non-Human (n=7)	3.64	0.88	2.00	3.38	3.75	4.13	4.75
Mean IDAQ	Human (n=7)	3.65	1.06	2.27	2.93	3.73	4.37	4.93
	Non-Human (n=7)	4.36	1.79	2.20	3.34	4.00	4.97	7.73

After the exploratory analysis of the scores is completed, a potential linear relationship between avatar types, IDAQ and self-presence score needs to be investigated more. The basic set up for the linear regression is x = mean IDAQ, y = self-presence, type 1 = human (encoded as 0), type 2 = non-human (encoded as 1). As figure 6 shows below, two separate regression lines indicate the fitting model of the human and non-human linear relationships. The preliminary regression analysis used Python packages and the ordinary least squares regression (OLS) method. R-squared is 0.415, mean IDAQ (*coef* = 0.17, *SD* = 0.12, $t = 1.36$, $p = 0.202$), avatar type (*coef* = 0.70, *SD* = 0.35, $t = 2{,}02$, $p = 0.068$). The results suggest that avatar type's p has slightly above the conventional 0.05 threshold for statistical significance, suggesting marginal significance, while IDAQ is not statistically significant at the conventional 0.05 level. And the regression analysis should be treated cautiously due to the limited sample size.

Figure 6: Mean IDAQ on Linear Regression with Self-Presence

3.5 Avatar Design Preference

3.5.1 Avatar Design Preference Results

Adults' perception of avatar design preference is analyzed by avatar type after VR experience. Table 5 shows the mean (±standard deviation) scores of the Usability and ACT by avatar types. The scores indicate that participants with the non-human avatar have a higher usability and acceptability on the VR experience. And overall, the experience is slightly satisfying for participants.

Question 1 (Q1): To what extent is it important for your avatar to resemble you?

Question 2 (Q2): To what extent is it important for your avatar to have a unique appearance?

Table 5: Scores and Counts of Individuals' Responses Towards Avatar Design Questions

Avatar Type	Question Number	Mean	>3 Percentage & Count	<3 Percentage & Count
All (n = 14)	Q1	3.71(±1.07)	64% (9)	7% (1)
	Q2	4.14(±0.86)	71% (10)	0% (0)
Human (n = 7)	Q1	4.00(±0.82)	72% (5)	0% (0)
	Q2	3.71(±0.95)	43% (3)	0% (0)
Non-Human (n = 7)	Q1	3.43(±1.27)	57% (4)	14% (1)
	Q2	4.57(±0.53)	100% (7)	0% (0)

Values in parentheses with ± mean standard deviation, without ± mean counts. >3 means in the scale of 5, the response is selected as 4 or 5; <3 means in the scale of 5, the response is selected as 1 or 2.

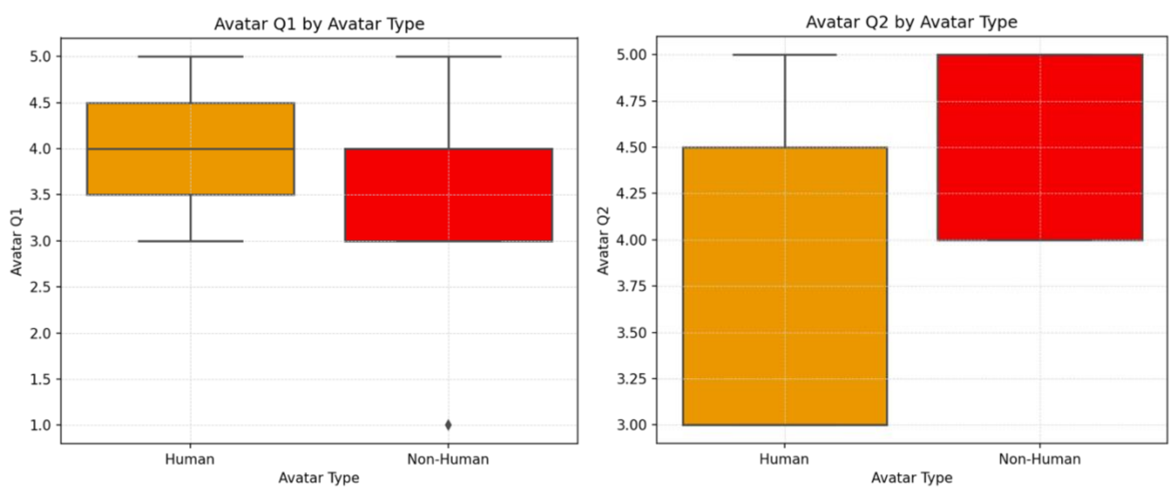

Figure 7: Box Graphs of Avatar Q1 and Q2 by Avatar Type

Table 6: Box Graphs Values in Figure 7

Question Number	Avatar Type	Mean	SD	Min	25%	Median	75%	Max
Q1	Human (n=7)	4.00	0.82	3.00	3.50	4.00	4.50	5.00
	Non-Human (n=7)	3.43	1.27	1.00	3.00	4.00	4.00	5.00
Q2	Human (n=7)	3.71	0.95	3.00	3.00	3.00	4.50	5.00
	Non-Human (n=7)	4.57	0.53	4.00	4.00	5.00	5.00	5.00

SD means standard deviation, 25%, Median and 75% mean percentile.

Table 5, figure 7 and table 6 show the different perspectives of values that describe the scores of the avatar design preference Q1 and Q2.

Preliminary linear regression analysis was done, setting mean IDAQ as x viable, avatar type as covariate, and avatar Q1 and Q2 as y variable. For Q1: R-squared is 0.382, mean IDAQ (*coef* = 0.397, *SD* = 0.184, *t* = 2.162, *p* = 0.054), avatar type (*coef* = -0.856, *SD* = 0.517, *t* = -1.655, *p* = 0.126). For Q2: R-squared is 0.382, mean IDAQ (*coef* = -0.034, *SD* = 0.158, *t* = -0.216, *p* = 0.833), avatar type (*coef* = 0.882, *SD* = 0.444, *t* = 1.984, *p* = 0.073). The R-squared indicate that these models have a low to moderate level of explanation of the variability, there is a marginal significance between mean IDAQ and Q1, and a marginal significance between avatar type and Q2. However, the preliminary result should be treated cautiously due to the small sample size.

In conclusion, for Q1, there is a potential relationship that embodying human avatars will lead to a higher score on the importance of similarities between the avatar the participants themselves. For Q2, there is a potential relationship that embodying the non-human avatar will lead to a higher score on the importance of unique appearance that the participants want for their avatars.

3.5.2 Adults' Preference of Avatar Body Parts

Besides Q1 and Q2 that adults answered questions regarding how important they think in the future, avatar’s similarities with them. The study also gathered their responses to and coded with deductive descriptions from the raw data. Question 3 (Q3): Which body parts matter most to you? As Table 7 shows, descriptions of responses have been categorized, each description will be counted for each participant and can have multiple counts if responses go to different groups. Face, hand, arm, hair, legs are the descriptions that participants explicitly respond in the raw data, while upper-body, lower-body, and upper and lower are the groups summarize the descriptions. Face as the most mentioned in the descriptions, all has 8, while human (face = 5) and non-human (face = 3) has a slight difference.

Table 7: Counts of Matched Description for Avatar Q3

Description of Responses	All (n = 14)	Human (n = 7)	Non-Human (n =7)
Face (i.e. facial expression, face characteristics)	8	5	3
Hand (i.e. hands, hand movement)	4	2	2
Arm (i.e. arms, arm movement)	3	0	3
Hair (i.e. hair color, hair style)	2	1	1
Legs (i.e. legs, leg movement)	5	3	2
Upper-Body (i.e. face, hand, arm, hair)	13	7	6
Lower-Body (i.e. leg, foot)	5	3	2
Upper and lower (mentioned together)	4	3	1

Face, hand, arm, hair, legs are counted as if responses included them as actual words, while upper-body, lower-body, and upper and lower as counted as if the responses have words meaning by the group.

3.6 Impact of Avatar Type on User Usability and Acceptability

After the VR experience (in the post-test session), participants provided responses to the usability questions on a scale of 5. The results, including mean scores and standard deviations, have been computed and categorized into three different types: all (n = 14, mean = 57.32, SD = 8.57), human (n=7, mean = 56.07, SD = 9.99), and non-human (n = 7, mean = 58.15, SD = 7.48). By comparing the mean scores of these three groups, the ranking of usability is below: 1. non-human (58.15), 2. all (57.32), 3. Human (56.07). This indicates that adults embodying the non-human avatar (i.e. Muppet) generally claim to gain better usability system score than adults embodying the human avatar. A preliminary linear regression analysis was done, setting mean IDAQ as x viable, avatar type as covariate, and usability as y variable: R-squared is 0.041, mean IDAQ (*coef* = 0.809, SD = 1.793, t = 0.451, p = 0.661), avatar type (*coef* = 1.921, SD = 5.046, t = 0.381, p = 0.711). The result suggests that mean IDAQ and avatar type are not significant predictors of usability.

After the VR experience (in the post-test session), participants also provided responses to the acceptability (ACT) questions on a scale of 5. The results, including mean scores and standard deviations, have been computed and categorized for three different types: all (*n* = 14, mean = 3.75, *SD* = 0.78), human (*n*=7, mean = 3.36, *SD* = 0.85), and non-human (*n* = 7, mean = 4.14, *SD* = 0.48). By comparing the mean scores of these three groups, the ranking of usability is below: 1. non-human (4.14), 2. all (3.75), 3. Human (3.36). This indicates that adults embodying the non-human avatar generally claim to gain higher ACT score than adults embodying the human avatar. A preliminary linear regression analysis was done, setting mean IDAQ as x viable, avatar type as covariate, and ACT as y variable: R-squared is 0.382, mean IDAQ (*coef* = 0.181, *SD* = 0.131, *t* = 1.381, *p* = 0.195), avatar type (*coef* = 0.657, *SD* = 0.368, *t* = 1.785, *p* = 0.102). The R-squared indicates that this model has a moderate level of explanation of the variability, but there the mean IDAQ and avatar type are not significant predictors of ACT.

3.7 Subjective Perception of Adults on Embodying Avatars

During the VR experience (in the during-test session), participants provided responses to the researcher verbally regarding their subjective perception of "How they feel being the character?" and "What is it like to be this character?" The researcher analyzes the qualitative raw data by identifying and grouping similar responses, assigning codes to categorize these responses, and extracting unique insights from the raw data.

The coding method is to find positive, neutral, negative responses or descriptions from the raw data. Table 8 categorizes the response counts for first and second impressions into groups of codes or descriptions. The initial reaction to embodying avatars among adults was generally positive, with non-human avatars receiving more favorable results (*n* = 7, all positive) compared to human avatars (*n* = 7, positive = 3). Upon second impression, the perception of human avatars improved slightly (positive = 4, negative = 0), whereas for non-human avatars, there was a minor decrease in positive responses (positive = 5, negative = 1).

Table 8: Counts of Matched Response Code for Subjective Perceptions

	1st Impression			2nd Impression		
Response Code	All	Human	Non-Human	All	Human	Non-Human

Positive	10	3	7	9	4	5
Neutral	3	3	0	4	3	1
Negative	1	1	0	1	0	1

1st impression is provided after participants embody avatars and complete warm-up activity; 2nd impression is provided after participants complete Go/No Go activity.

3.8 SOCIAL PERCEPTION AND BEHAVIORS

Social Observations. Adults' perception of social perception is gathered and verbally responded in the during-test session is analyzed by avatar type. The results are listed below:

Question 1 (Q1): If you were going to play games with your friends, to what extent would you want to be this character?

Question 2 (Q2): If you were sad and wanted to feel better, to what extent would you want to be this character?

Question 3 (Q3): If you wanted to talk to a friend about how you feel, to what extent would you want to be this character?

Question 4 (Q4): If you were talking to someone you didn't know very well, to what extent would you want to be this character?

Mean scores and standard deviation are calculated and have been categorized into three different groups as the below Table 5 shows.

Behavioral Observations. Most of the participants were able to complete the full Go/No Go activity with 100% accuracy (n = 10), but a few participants completed with 94% accuracy (n = 4). General observations of participants behaviors have been analyzed but no significant patterns have been discovered so far. Further analysis needs to be completed in the future.

Table 9: Means and Standard Deviation of Social Perception by Avatar Type

Question Number	Avatar Type	Mean	SD
	All (n = 14)	3.07	1.14
Q1	Human (n = 7)	2.57	0.98
	Non-Human (n = 7)	3.57	1.13

	All (*n* = 14)	2.43	1.28
Q2	Human (*n* = 7)	1.71	0.76
	Non-Human (*n* = 7)	3.14	1.35
	All (*n* = 14)	2.21	1.37
Q3	Human (*n* = 7)	1.71	0.76
	Non-Human (*n* = 7)	2.71	1.70
	All (*n* = 14)	3.50	1.29
Q4	Human (*n* = 7)	2.86	1.35
	Non-Human (*n* = 7)	4.14	0.90

Chapter 4: Discussion

This chapter discusses 1. implications of results that avatar type and IDAQ in different directions affect measures, 2. limitations and areas for future research.

4.1 IMPLICATIONS OF RESULTS

As discussed earlier in the introduction, this research serves as an exploratory study which is an initial attempt to investigate how people's avatar type embodiment and tendency to anthropomorphize impact their perceptions, emotions, and behaviors. Due to the limited sample size ($n = 14$), regression and preliminary model fits should be treated cautiously. Therefore, in this study, we mainly discuss the implications of the mean, standard deviation scores, and how qualitative analyzed data infer findings.

Across different measures and the manipulation of avatar type, we observed that participants who embody the non-human avatar (i.e. a blue Muppet) in general has more positive and higher self-perception, user experience, subjective and social perception. Specifically, adults embodying non-human avatars gain higher mean scores in self-presence, usability, acceptability, avatar design preference question 2 (i.e. unique appearance), and social perception questions 1-4. In addition, non-avatar embodiment results in a higher decrease in emotional distress and simulator sickness after the VR experience. Despite considering the individual differences in anthropomorphize tendency, non-human avatars provide users' better experience. However, as Figure 5 shows, the initial participants pool who later embodied the blue Muppet has a higher IDAQ score (mean IDAQ = 4.36) compared to those embodied the human avatar (mean IDAQ = 3.65). Due to the non-significant statistical reason, IDAQ as a factor does not indicate clear relationship with these measures. But some of them do show low potential relationships, which is needed to be analyzed further to reinforce and confirm the effect of non-human positive effects.

On the other hand, there are several findings that infer adults who embody the human avatar will have more sense of the virtual body and act similarly to themselves. To be more specific, human avatar embodiment made participants more prone to notice themselves and cared more about the virtual body details like face, hand, legs. It was also observed that they are more prone to prefer a realistic avatar after being one and based on their open-ended responses, they would like to do body movements after the experience like dance, run, walk etc.

To conclude, non-human, and human avatars do indicate different levels of perceptions inside the virtual environment. The implications can draw some design recommendations in future VR applications that if developers and designers plan a game to do diverse kinds of things that need to have a robust immersion, self-presence, and user experience, choosing a fantastical avatar would potentially level up experiences. While selecting a human avatar in some design scenarios, for example, as a person to meditate or as a person to do sports, would potentially help with level up users' self-awareness and help them achieve their goals.

Another key factor that this study wants to explore is how tendency to anthropomorphize (i.e. IDAQ) would affect people's perceptions and behaviors. We ran some preliminary regression analysis on the setting IDAQ as x viable and other measures as y viable, including self-presence, usability, ACT, avatar Q1 and Q2. The analysis should be treated carefully since the small sample size, but as an exploratory analysis, there might be a potential relationship between IDAQ and avatar type 1 ($p = 0.054$). But again, these analysis needs to be further conducted in the future with a larger sample size.

Regarding the qualitative analysis, this study minimized on the searching and grouping patterns for communicational raw data and physical video recordings as the focus is analyzing the scores and values of scaled measures that potentially can provide fundamental insights at this stage. A simplified qualitative research process was finished throughout the study on people's reactions, subjective perceptions, talked-aloud responses, and physical behaviors. These were used in supporting the analysis with measures.

Furthermore, there are some other factors that need to be discussed. Firstly, the study has strictly followed the randomization of assignment of avatar types to participants, as total number of participants being 14 and divided into human (n=7) and non-human (n=7). Also, the same distribution method was applied for females (n=10, human = 5, non-human = 5), and males (n=4, human = 2, non-human = 2). This ensures consistency across the whole analysis although the gender factor cannot be excluded.

In conclusion, this study highlights notable associations between avatar type and various aspects of perception, emotions, and behaviors. It also suggests a potential link between IDAQ scores and certain metrics within the study. These findings provide a valuable foundation for ongoing research into avatars in the scientific community and offer insightful guidance for the development of virtual avatar designs in the industry. This work paves the way for more in-depth exploration into how avatars can impact user experiences and outcomes in virtual environments.

4.2 Limitations and Areas for Future Research

The study initially takes a random recruiting method mainly in the UT Austin school of information; therefore, the demographic information lacks certain levels of diversity in the gender and ethnicity. This may affect the implication of the study results that could suit to a broader audience. Another limitation of this study is the participant number is limited to 14 adults. This leads to a less robust result of the logistic regression or linear regression. This study is more of a pilot study which will be used to combine with a later study to draw insights for the similar questions. Adding sample size for the future research will help to establish more statistically significant model predictions in the future. Next, further research on qualitative data of the social and behavioral notes and videos could help identify find potential patterns. The current study only provides an initial analysis of how people react and provide social responses but amount of raw data needs to be analyzed carefully to consider if the effects of avatar type and IDAQ will impact how adults behave and interact in the virtual space. Finally, further research on demographic information (e.g. gender and VR experience) and its impacts on the measures could provide additional insights on the impact of individual differences on users' experiences of avatars in VR. Current study does not provide analysis on the relationship between demographic information and measures, although it is observed that there are differences in different groups of perceptions and behaviors. Further analysis is needed to investigate into these areas.

Appendix

Measurements and coding techniques:

Below is the list of measurements done throughout the whole in-person study. There are three main measurement scales:

A. Likert of 5, 1 - Not at all; 2 – Slightly; 3 – Moderately; 4 – Strongly; 5 – Very strongly to answer questions with “To what extent do you feel?”, including emotional levels, self-presence, acceptability, avatar design preference, and social perception.

B. Likert of 5, 1 – Strongly disagree; 2 – Disagree; 3 – Cannot tell; 4. Agree; 5. Strongly agree to answer questions with a claim, including the usability.

C. Likert of 10, 0 – Not at all; 10 – Very much to answer questions with a claim, including Individual Differences in Anthropomorphism Questionnaire.

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