

Investigating the Relation Between Gender Expression of Mixed Reality Avatars and Sexuality of Male Users

Anish Kundu*
Keio University Graduate
School of Media Design

Yun Suen Pai†
Keio University Graduate
School of Media Design

Kouta Minamizawa‡
Keio University Graduate
School of Media Design

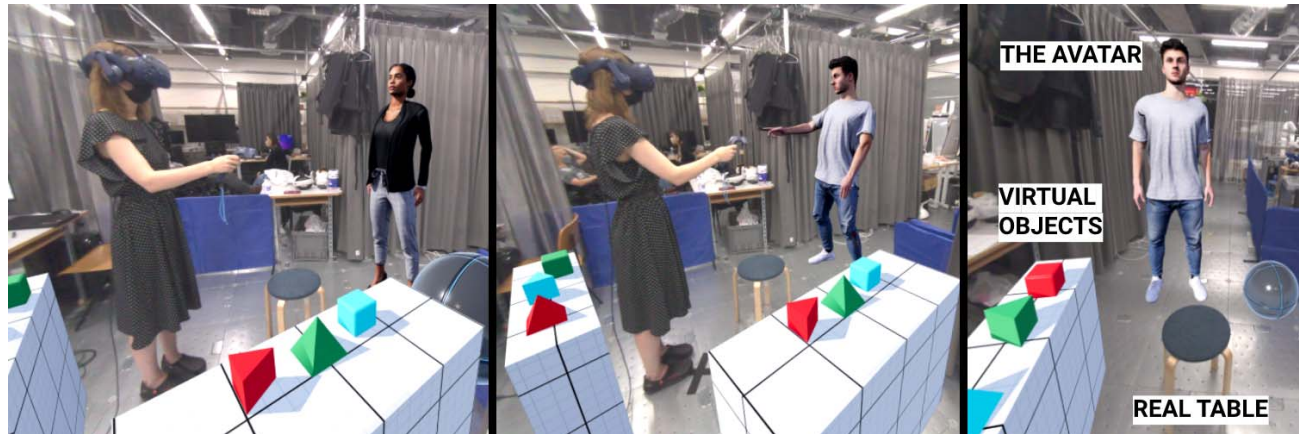


Figure 1: Overview of the collaborative mixed reality system and the virtual avatars

ABSTRACT

Mixed reality environments are the next step in remote collaboration, yet there has been little attention towards avatar design for the enjoyability and efficiency of diverse users, particularly for the lesbian, gay, bisexual, transgender and queer (LGBTQ+) community. We believe that it is important to adapt the design of virtual avatars users collaborate with depending on not only the users gender but also their sexuality. In this study, we focus on examining the relationship between the sexual orientation of male users with the gender expression of virtual avatars, while they perform a collaborative task in mixed reality. We analyzed the perception of straight cisgender men and gay cisgender men in relation to the gender expression of the above mentioned agents and find differences that might affect design decisions for creating user-base specific avatars. We found that Female avatars tend to have a more positive perception when it comes to gay men. And for mixed reality, gay men also tend to have both negative and positive experiences more intensely than straight men.

Index Terms: Mixed Reality—Sexual Orientation—Gender—Collaborative Agents—User-centred Design—;

1 INTRODUCTION

As the era of the Metaverse is becoming more mainstream, mixed reality (MR) as a social platform is becoming increasingly feasible. MR, unlike augmented reality (AR) and virtual reality (VR), aims to accurately integrate the virtual with the physical world. Paul Milgram first defined MR as “anywhere between the virtuality continuum” [18]. Though the terminologies have become muddled in

recent years, we look at MR as strong AR, that is, an advanced AR system capable of environmental tracking and realistic rendering bound by the hardware we chose [22]. This is achieved by having the system detect and recognize the physical world through cameras and use this information to render virtual content in such a way that it can interact with the physical space itself. This creates an experience where users are able to perceive virtual content indistinguishably from the physical space. In a social context, this includes perceiving and interacting with virtual avatars of each other as well.

Avatars and agents in MR space is an important consideration in a Metaverse future because it encompasses the possibilities of a platform that caters to diverse users. Diversity can refer to several contexts: cultural, racial, and physical disabilities are among some examples of diversity that are all equal in terms of the importance of consideration when designing a social platform for an inclusive future. When an avatar represents a user, they have the freedom to either have it portray them as they do in the physical world [10], or as a form of self expression beyond what is normally possible [4]. Additionally, the interaction with these avatars delivering a comfortable and safe social environment also becomes a main priority.

In this study, we focus our efforts on diversity towards the lesbian, gay, bisexual, transgender and queer (LGBTQ+) community. It is important to support the community through design, considering the significant amount of identifiable stress that the community faces in online and virtual worlds. [20] Especially in VR and by extension in MR, because perceived social cues and touch can be explored realistically even though they are in essence virtual interactions. [8] As this is a broad topic, we focus our efforts on cisgender homosexual and heterosexual male users of MR. Specifically, we explore the effects of different MR avatar gender representation towards male users of the above mentioned sexuality in terms of agent perception and enjoyability. We used two realistic virtual avatars represented as male and female, and rendered them using a high-fidelity MR platform for the users to interact with. In our initial study, we performed a mixed factorial experiment where the users performed a simple object sorting task as directed by the avatars while their responses

*e-mail: anish@kmd.keio.ac.jp

†e-mail: pai@kmd.keio.ac.jp

‡e-mail: kouta@kmd.keio.ac.jp

to questionnaires regarding enjoyability and avatar perception were recorded. The contributions of this work are threefold:

1. We performed an initial experiment to understand the effects of virtual avatar gender representation towards male users of two different sexuality.
2. We evaluated the participants' feedback on the MR experience based on enjoyability and the agent perception of the two different avatars.
3. We discuss our preliminary findings and propose the future works of our research.

2 RELATED WORKS

We looked into avatar and agents gender representation in online and virtual reality environments for an idea of the current gender related research, and explored the current status of research that contributes towards the LGBTQ+ community, which turned out to be quite low in number. There is past research on how sexuality is related to avatars as well, which we have discussed briefly. We propose our research as a bridge between these three separate research fields.

2.1 Avatars and Agents

Findings suggest that MR has the potential to support dynamic collaborative activities, and several factors like appearance and gestures of the avatars become important [13]. In a social AR, VR or MR scenario, the aesthetics, gender, race and age are four important aspects in designing social avatars [7]. Gonzales et al. [9] found that an expert/credible looking avatar is more attractive and likable over a common/basic-looking avatar when a certain task is presented. And depending on the realism and anthropomorphism of the avatars faces, perception changes drastically, and can even be the opposite of avatars which are portrayed more realistically. [6] Since gender stereotypes are a key factor in interpersonal communications [1, 11], they significantly influence avatar perception as well.

2.2 LGBTQ+ Community in Contemporary Research

There are only a handful of guidelines, mostly theoretical, when it comes to supporting the LGBTQ+ community through research, more so due to the methodological issues that need to be considered very carefully [28]. Especially in VR, where the freedom of expression related to gender identity can be both liberating and restricting depending on the system and the design of it [23]. There are measurable differences between reactivity of people of different genders and sexual orientations in VR in relation to the perception of touch in the virtual world [8]. Acena et al. [1] interviewed 8 LGBTQ participants in popular VR social platforms like VRChat¹ and AltSpaceVR² and found that a VR platform allows them to have a face-to-face interaction even when they are within areas that do not accept them, it allows for more confidence since they are free to portray themselves as any gender, and it fosters a safe space. However, they did not investigate a specific gender, nor any cognitive or emotional changes.

2.3 Sexuality and Gender

There has been several past research that looked into the effect of perceived avatar gender on the user. For example, Lee et al. [16] and Yee et al. [27] looked into how avatar gender assignment effects a user's behavior and saw that gender stereotypes are subconsciously enforced in virtual spaces regardless of the actual gender of the users. Lehdonvirta et al. [17] also found that female avatars are more likely to help in terms of material and labor compared to male avatars. The same paper also found that emotional help is not stereotyped to

¹<https://hello.vrchat.com/>

²<https://altvr.com/>

gender roles. Androgynous avatars on the other hand, can further help reduce these stereotypes for gender roles in work places [19]. Suzuki et al. [24] previously explored how changing an avatar's voice effected male user's efficiency in a task by alleviating their boredom and found that they enjoy the task more and are more efficient when the avatars they interact with are female. However, they focused on the tactile sensation and audio feedback of the avatar. The factors which have been explored in avatars related to gender stereotypes are conformity [26], the role of the avatar [2, 5] and proximity to the user [29].

From these related works, we establish that there has been little to no study regarding effects of avatar gender representation on male users of varying sexuality in terms of their perceived agent perception and enjoyability. To that end, we designed a preliminary experimental procedure to explore this research question.

3 INITIAL EXPERIMENTAL SETUP

The initial experiment is designed as a high-fidelity MR experience that the participants interact with inside a lab environment. The participants perform a simple task involving interactions in MR while collaborating with the virtual avatar.

3.1 System Description

The MR experience is achieved with the Varjo XR-3 mixed reality headset³, with the environment developed in Unreal Engine 4.27⁴. The application uses a single Vive Pro controller to interact with the virtual objects for the task inside the MR environment, the participants had to physically move to and touch the objects with the virtual counterpart of the controller to be able to interact with them. Our experiment was running on a Windows PC with an Intel i9-11900F, 32 GB RAM and an Nvidia GeForce RTX 3080.



Figure 2: A participant in MR interacting with the avatar

3.2 Study Design

The aim of this experiment is to analyze the effects of two different MR avatar gender representations (male and female), towards cisgender heterosexual and cisgender homosexual male users in terms of their perceived agent perception and enjoyability. We use a mixed factorial design with the within-subjects variable *avatar gender representation* and the between-subjects variable *sexuality of the participant*. Participants answered quantitative questionnaires and provided feedback for perceived emotions and avatar perception. The experiment had been approved by the relevant ethics committee of the institution.

³<https://varjo.com/products/xr-3/>

⁴<https://www.unrealengine.com/en-US/>

Avatars

We used two realistic pre-programmed avatars (see Figure 1), with their gender representation being stereotypically male and female. The male avatar was caucasian, dressed in a casual tshirt and jeans, while the female avatar was a person of color, dressed in a casual shirt, coat and jeans. The avatars and the gestures they were programmed with were taken from free assets available on the Unreal Engine marketplace on the Epic Games Store digital distribution service. Both the avatars were programmed with exactly the same set of gestures since they can also influence the perception of users in several ways [11].

Interaction Design

We developed a task which was used to ensure that the participants interact closely with the avatars. We facilitated an immersive MR experience by making the participants interact with both real and virtual objects while doing the task. Three virtual tables were placed around the participant (left, right and back of the participant), with a real world table and the virtual avatar in front of the participant. The task was to pick one correct object from three virtual objects on each virtual table and put it on the real world table. The avatar would do a yes/no gesture ('no' gesture being a waving hands animation, while 'yes' being a thumbs-up animation) depending on whether the object is correct or not. After the participant finds the three correct objects, the avatar would do a 'cheering' gesture indicating that the participant has completed the experience.

The participants performed the task six times in total, divided into three rounds each. Each round had a different random combination of the correct objects. Three rounds were with the male avatar and three more with the female avatar, order balanced between participants. A short break was provided to the participants between the two rounds to fill up an avatar perception questionnaire.

Participants

Our sample was drawn from 7 cisgender men who were invited to do the experiment. A pre-survey based on the "Self Assessment of Sexual Orientation" scale [21] was conducted to investigate the participants sexuality. The data of 6 participants (mean:28, SD:5.68), 3 being 'exclusively heterosexual' and 3 being 'exclusively homosexual' according to the above scale were selected for analysis. The data of one participant indicated that he was asexual and being out of scope of this experiment, was not used for the analysis. None of the participants had prior experience in MR.

Questionnaires

There are 3 total questionnaires that had been prepared for the participant. The pre-survey was based on the "Self Assessment of Sexual Orientation" scale as stated before, which is an improved version of the Kinsey scale of sexuality. [15] The avatar perception survey, filled up by the participant twice, one for the male and one for the female avatar, was based on the standardized questionnaire for likeability of avatars, also called the Godspeed Questionnaire series. [3] The final post-experiment questionnaire is designed to understand the users overall experience of the experiment, based on the Game Experience Questionnaire (GEQ) and a paper which combines multiple surveys related to and UX for use in VR specific questionnaires. [12,25]

3.3 Procedure

After signing the consent form, the participant was asked to fill up a pre-survey questionnaire to identify their background and sexuality. We presented all the devices and explained the procedure of the experiment. After setting up the HMD, the participants did 1-2 trials of the task with the default white Unreal Engine mannequin as the avatar to get them familiarized with the MR environment and their interactions. Then the participants wear the wearable sensor

device and start the actual experience. After 3 rounds with the male avatar, a short break is taken while they fill up a survey on avatar perception. Then they go through the last 3 rounds with the female avatar, and again fill up the avatar perception survey. As long as the participants asked for no break, they remained in MR for the 3 rounds. Lastly, they fill up the post-survey on the experience. All of the questionnaires were filled up by the participant on the desktop. We asked for comments about their concerns, what they liked about the experience and what they would like to improve.

4 RESULTS AND DISCUSSION

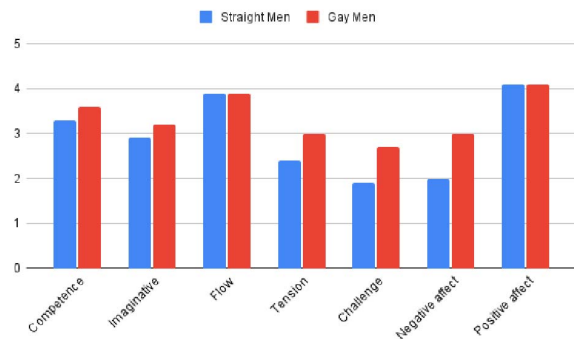


Figure 3: Experience Feedback differences

From the post-experiment questionnaire, the seven quantified data were Competence, Imaginative Immersion, Flow, Tension, Challenge, Negative Affect and Positive Affect. Figure 3 shows that both sexuality enjoyed the experience equally in terms of Flow and Positive Affect. However, even though gay men have higher Competence and Immersion, they have significantly more intense negative experiences (Tension, Challenge and Negative Affect) compared to straight men ($t(4) = 4.38178, p = 0.005929$).

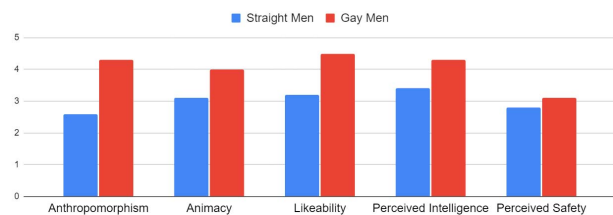


Figure 4: Five factor differences for Female Avatars

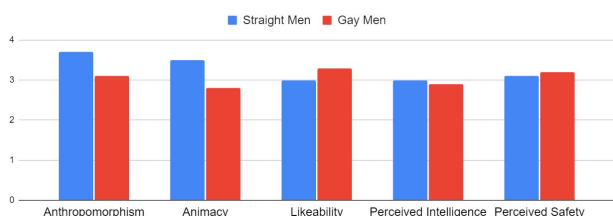


Figure 5: Five factor differences for Male Avatars

Figure 4 and 5 base avatar perception on five factors, Anthropomorphism, Animacy, Likeability, Perceived Intelligence and Perceived

Safety. We found that avatar perception of the female avatar for gay participants was significantly more positive compared to the straight participants ($t(8) = 3.562, p = 0.00369$). However, when it came to male avatars, there was no significant difference between participants of either sexuality ($t(8) = -1.17041, p = 0.137759$).

5 CONCLUSION AND FUTURE WORKS

Gender is a complex and multi-layered construct. It can be defined in multiple configurations and identities [14]. As a consequence any research on gender should be and is controversial at best, and unintentionally or intentionally silencing / propagating inequality at worst. The initial results show that female avatars tend to have a significantly more positive perception when it comes to gay men. And for mixed reality, gay men also tend to have both negative and positive experiences more intensely than straight men. In the future, we plan to collect and analyze physiological signals as well to understand these differences more.

6 ACKNOWLEDGEMENTS

This work was supported by JST Moonshot RD Program “Cybernetic being” Project (Grant number JPMJMS2013).

REFERENCES

- [1] D. Acena and G. Freeman. “in my safe space”: Social support for lgbtq users in social virtual reality. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, pp. 1–6, 2021. doi: 10.1145/3411763.3451673
- [2] J. D. Bailey. Avatar and participant gender differences in the perception of uncanniness of virtual humans. In *2017 Seventh International Conference on Affective Computing and Intelligent Interaction (ACII)*, pp. 571–575. IEEE, 2017. doi: 10.1109/ACII.2017.8273657
- [3] C. Bartneck, D. Kulić, E. Croft, and S. Zoghbi. Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots. *International Journal of Social Robotics*, 1(1):71–81, Jan. 2009. doi: 10.1007/s12369-008-0001-3
- [4] G. Bernal and P. Maes. Emotional beasts: visually expressing emotions through avatars in vr. In *Proceedings of the 2017 CHI conference extended abstracts on human factors in computing systems*, pp. 2395–2402, 2017. doi: 10.1145/3027063.3053207
- [5] A. Brown, J. Bailey, K. Blackmore, S. Boogaard, and K. Nesbitt. Gender differences when adopting avatars for educational games. In *2021 Australasian Computer Science Week Multiconference*, pp. 1–10, 2021. doi: 10.1145/3437378.3442691
- [6] Y. Ferstl, E. Kokkinara, and R. McDonnell. Do i trust you, abstract creature? a study on personality perception of abstract virtual faces. In *Proceedings of the ACM Symposium on Applied Perception*, pp. 39–43, 2016. doi: 10.1145/2931002.2931014
- [7] G. Freeman and D. Maloney. Body, avatar, and me: The presentation and perception of self in social virtual reality. *Proceedings of the ACM on Human-Computer Interaction*, 4(CSCW3):1–27, 2021. doi: 10.1145/3432938
- [8] M. Fusaro, M. P. Lisi, G. Tieri, and S. M. Aglioti. Heterosexual, gay, and lesbian people’s reactivity to virtual caresses on their embodied avatars’ taboo zones. *Scientific reports*, 11(1):1–12, 2021. doi: 10.1038/s41598-021-81168-w
- [9] M. A. Gonzales-Chávez and N. Vila-Lopez. Designing the best avatar to reach millennials: gender differences in a restaurant choice. *Industrial Management & Data Systems*, 2020. doi: 10.1108/IMDS-03-2020-0156
- [10] D. Gul Unlu. Determining gender stereotype based on physical appearance expectations in interpersonal communication process: An intercultural comparison between turkey and portugal. *Online Journal of Communication and Media Technologies*, 11(1):e202102, 2021. doi: 10.30935/ojcm/9576
- [11] D. Gul Unlu. Determining gender stereotype based on physical appearance expectations in interpersonal communication process: An intercultural comparison between turkey and portugal. *Online Journal of Communication and Media Technologies*, 11(1):e202102, 2021. doi: 10.30935/ojcm/9576
- [12] W. IJsselsteijn, Y. de Kort, and K. Poels. *The Game Experience Questionnaire*. Technische Universiteit Eindhoven, Eindhoven, 2013.
- [13] B. Jones, Y. Zhang, P. N. Wong, and S. Rintel. Belonging there: Vroom-ing into the uncanny valley of xr telepresence. *Proceedings of the ACM on Human-Computer Interaction*, 5(CSCW1):1–31, 2021. doi: 10.1145/3449133
- [14] O. Keyes, C. May, and A. Carrell. You keep using that word: Ways of thinking about gender in computing research. *Proceedings of the ACM on human-computer interaction*, 5(CSCW1):1–23, 2021. doi: 10.1145/3449113
- [15] A. C. Kinsey, W. B. Pomery, and C. E. Martin. Kinsey scale. *Personality and Social Psychology Bulletin*, 1948.
- [16] J.-E. R. Lee, C. I. Nass, and J. N. Bailenson. Does the mask govern the mind?: Effects of arbitrary gender representation on quantitative task performance in avatar-represented virtual groups. *Cyberpsychology, Behavior, and Social Networking*, 17(4):248–254, 2014. doi: 10.1089/cyber.2013.0358
- [17] M. Lehdonvirta, V. Lehdonvirta, and A. Baba. Prosocial behaviour in avatar-mediated interaction: The influence of character gender on material versus emotional help-giving. *On the Horizon*, 2011. doi: 10.1108/10748121111163878
- [18] P. Milgram and F. Kishino. A taxonomy of mixed reality visual displays. *IEICE TRANSACTIONS on Information and Systems*, 77(12):1321–1329, 1994.
- [19] P. Nag and Ö. N. Yalçın. Gender stereotypes in virtual agents. In *Proceedings of the 20th ACM International conference on intelligent virtual agents*, pp. 1–8, 2020. doi: 10.1145/3383652.3423876
- [20] K. Saha, S. C. Kim, M. D. Reddy, A. J. Carter, E. Sharma, O. L. Haimson, and M. De Choudhury. The language of lgbtq+ minority stress experiences on social media. *Proceedings of the ACM on human-computer interaction*, 3(CSCW):1–22, 2019. doi: 10.1145/3361108
- [21] R. L. Sell. The Sell Assessment of Sexual Orientation: Background and Scoring. *Journal of Gay, Lesbian, and Bisexual Identity*, 1(4):295–310, Oct. 1996. doi: 10.1007/BF03372244
- [22] M. Speicher, B. D. Hall, and M. Nebeling. What is mixed reality? In *Proceedings of the 2019 CHI conference on human factors in computing systems*, pp. 1–15, 2019.
- [23] L. Staniukynas. “Impact Of Virtual Reality On The Expression Of Gender Identity”. doi: 10.13140/RG.2.2.32802.45769
- [24] K. Suzuki, M. Yokoyama, Y. Kionshita, T. Mochizuki, T. Yamada, S. Sakurai, T. Narumi, T. Tanikawa, and M. Hirose. Gender-impression modification enhances the effect of mediated social touch between persons of the same gender. *Augmented Human Research*, 1(1):1–11, 2016. doi: 10.1007/s41133-016-0002-y
- [25] K. Tcha-Tokey, E. Loup-Escande, O. Christmann, and S. Richir. A questionnaire to measure the user experience in immersive virtual environments. In *Proceedings of the 2016 Virtual Reality International Conference, VRIC ’16*. Association for Computing Machinery, New York, NY, USA, 2016. doi: 10.1145/2927929.2927955
- [26] S. Wijenayake, N. van Berkel, V. Kostakos, and J. Goncalves. Measuring the effects of gender on online social conformity. *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW):1–24, 2019. doi: 10.1145/3359247
- [27] N. Yee, N. Ducheneaut, M. Yao, and L. Nelson. Do men heal more when in drag? conflicting identity cues between user and avatar. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pp. 773–776, 2011. doi: 10.1145/1978942.1979054
- [28] M. C. Zea, C. A. Reisen, and R. M. Díaz. Methodological issues in research on sexual behavior with latino gay and bisexual men. *American journal of community psychology*, 31(3-4):281–291, 2003. doi: 10.1023/a:1023962805064
- [29] K. Zibrek, B. Niay, A.-H. Olivier, L. Hoyet, J. Pettre, and R. McDonnell. Walk this way: Evaluating the effect of perceived gender and attractiveness of motion on proximity in virtual reality. In *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)*, pp. 169–170. IEEE, 2020. doi: 10.1109/VRW50115.2020.00036