

A Virtual Reality System for Gender Swapping to Increase Empathy Against Stereotype Threats in Computer Science Job Interviews

Zahra Borhani*
Colorado State University

Francisco R. Ortega†
Colorado State University



Figure 1: The virtual reality environment Scene

ABSTRACT

There is a gender gap in computer science education. Stereotypes associated with women could be potential barriers that increase this gap. This project aims to introduce a tool that can potentially increase empathy using avatar gender-swap in a Virtual Reality (VR) setting that simulates a job interview experience. VR environment includes a full-body tracked avatar that represents the interviewee. The objective is to explore how gender swapping affects empathy towards the opposite gender. The job interview will be conducted under three conditions: microaggression stereotype threat, direct stereotype threat, and no threat. This study will showcase all the necessary tools to accomplish this goal and provide a path forward for a qualitative user experiment.

Index Terms: Virtual Reality—Avatar Gender Swapping—Stereotype Treats—Gender Gap

1 INTRODUCTION

The term stereotype threat has been introduced in [4] as the phenomenon in which members of negatively stereotyped groups underperform in stereotype salient situations. This has been observed in various contexts, such as the underperformance of females in STEM fields. Stereotype threats can be categorized into two main groups: first, Microaggressions Stereotype Threats (MST) encompass threats that might be very subtle and implicit, and they are often unintentional. Second, Direct Stereotype Threats (DST) involve stereotypes that are explicit, intentional, and more offensive.

The existing gender gap in Science, Technology, Engineering, and Math (STEM) majors, especially in Computer Science, is a challenge that threatens 49 percent of the world's population. Stereotypes associating this area with men is a significant barrier that prevents female students from developing interests in this field [2]. The effects of a virtual gender swap illusion on the working memory of participants have confirmed the adverse effects of stereotype threats [2, 3].

*e-mail: zahra.borhani@colostate.edu

†e-mail: f.ortega@colostate.edu

The main contribution of this research lies in developing a VR system that can potentially enhance empathy towards female students in computer science by employing gender-swapped avatars in a simulated programming job interview. The motivation behind considering this scenario is that the presence of stereotype threats has an adverse effect on the feedback from the female employees and the hiring outcome. This might result in fewer female students finding the motivation in approaching these careers. This simulation includes understanding the required tools and design guidelines to develop these types of systems and a pilot study that provides additional design criteria. Finally, we conducted two questionnaires to verify the system's design. This system is completed and ready for an experimenter to be used for human-subject studies.

2 SYSTEM DESIGN

The objective of the design was to develop a System for interviewing participants with a gender-swapped avatar to increase empathy.

Initial Design: The initial design of the VR environment was slightly different than the current version. The interview room included furniture, a mirror, a male avatar as the interviewer, and an upper half-body avatar as the interviewee avatar using Oculus Rift S. To evaluate the system, we conducted a pilot study and gathered participants' feedback.

Updated Design: We applied participants' feedback from the pilot study to improve the final VR environment. The new environment includes two mirrors (one, in front of the interviewer's view and one on the right-hand side) to ensure participants can see their avatar's body during the interview and a full-body avatar tracing the interviewee's movements (Figure 1). The purpose it to increase the feeling of embodiment for the participant.

Avatars' Design: In our experiment, the avatars play a crucial role as users primarily interact with them. To create a truly immersive virtual experience, the user's and interviewer's avatars must exhibit humanoid behavior. To achieve this, various features are incorporated into the avatars based on their roles (interviewer and interviewee). These features encompass animations, eye contact, lip-syncing, audio, and facial expressions for the interviewer avatar, while interviewee avatars are equipped with full-body movements and calibrations of height and arm length.

The system utilized six emotions for facial expressions and stereotyped behavior, as depicted in Figure 2. Additionally, 42 pre-recorded audio recordings were utilized for the speech of the inter-

viewer's avatar (including condition-dependent interview statements which were based on the gender stereotyped questionnaire). Some of these pre-recorded audio were integrated into the lip-syncing module to synchronize the movements of the avatar's lips. The interviewee's avatar in our system incorporates full-body tracking, which enables it to mirror the participant's movements. We utilized an HTC Vive Head Mounted Display, two controllers, and three trackers to achieve this. Figure 3 illustrates how the interviewee avatar tracks the user's motions precisely. In addition, we implemented a calibration process to adjust the height and arm length of participants.

A Wizard-of-Oz System: Employing a wizard-of-oz system allows the experimenter to control the interviewer's avatar (the facial blendshapes and speech). To ensure consistency across various runs of the experiment, we grouped the blendshapes used for each question which allows triggering of them sequentially by pressing designated keys on the keyboard.

3 EXPERIMENT DESIGN

A between-subject experiment was designed with a stereotype threat condition as the independent variable to investigate the effect of gender-swapping on empathy. The stereotype threat conditions included a male avatar without any threat (MNT), a female avatar subjected to a microaggression stereotype threat (FMST), and a female avatar facing a direct stereotype threat (FDST). In the stereotype threat conditions, the interviewer exhibits sexist behavior, which manifested in two different ways: microaggression stereotype threats and direct stereotype threats. Sexist behavior is demonstrated through the interviewee's statements and the facial expressions displayed during the interview.

4 VERIFICATION OF SYSTEM DESIGN

Pilot study: A total of 7 male participants with an average age of 25.9 experimented with the initial design. Their feedback was gathered to evaluate the feeling of embodiment and empathy induced by the system. Precipitants' feedback showed no agreement on the feeling of avatar embodiment by the users, but results confirmed the emergence of empathy in the users. The updated design introduced in section 2 was based on feedback received from participants from the pilot study.

Facial expressions questionnaire: This questionnaire was created to assess the accuracy of seven facial expressions. In total, 64 participants (20f and 44m, with an age average of 25.5) were asked to assign an expression to the different images of the interviewer's avatar with varying facial expressions. Our results showed that, with the exception of the "Fearful" facial expression, the agreement rate consistently exceeded 80%, leading to the selection of six facial expressions.

Gender stereotyped questionnaire: This questionnaire aimed to evaluate the suitability of interview statements for each of the three experimental conditions. As there was not a standardized questionnaire for this purpose, we gathered statements from different stereotype-related papers and modified them to be applicable to our experiment (e.g., "My wife had difficulty in coding, too, but she worked hard to get ahead in her work") [1]. In total, 56 participants (15f and 41m, with an average age of 25.7) answered 35 interview phrases to evaluate the stereotype degree of each phrase (out of 5) and the frequency of encountering that question in the real world. Our results confirmed participants felt a higher stereotype degree for the DST questions (female avg of 4.42 and male avg of 4.33) and less for the MST questions (female avg of 3.75 and male avg of 3.67). In addition, the analysis showed that for each of the conditions, female participants felt a higher degree of stereotyping compared to male participants. Finally, phrases with a higher frequency of appearing in real word situations were selected for the interview conditions.

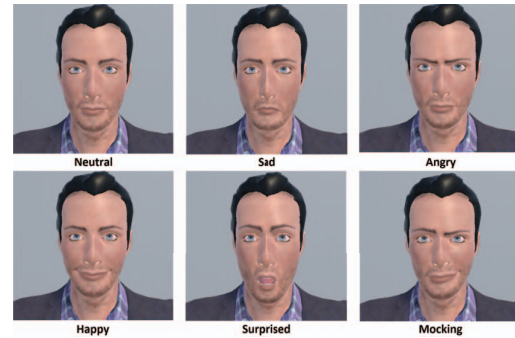


Figure 2: Facial expressions designed for the interviewer's avatar (Neutral, sad, angry, happy, surprised, and mocking)

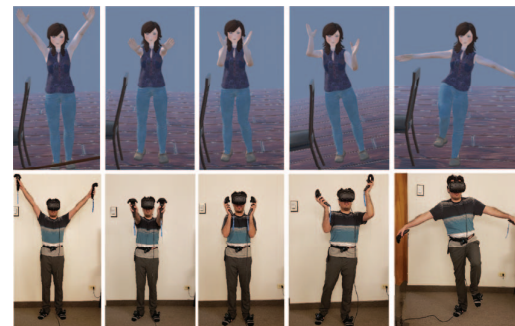


Figure 3: Full body tracking. The above row shows the avatar as the user sees it in the mirror.

5 CONCLUSION AND FUTURE RESEARCH

This study introduces VR tool that has the potential to enhance empathy among users in the field of computer science through the use of avatar gender swapping. Also, two surveys were used to verify the appropriateness of the interview questions and the correctness of facial expressions of the interviewer's avatars, alongside an initial pilot study to improve the environment.

As a further step, we plan to conduct a human-centric experiment with the verified environment to evaluate the effect of the proposed system in terms of enhancing the feeling of embodiment and empathy in the participants.

ACKNOWLEDGMENTS

This work was supported by NSF under Grants 2327569, 2238313, 2223432, 2223459, 2106590, 2016714, 2037417, and 1948254.

REFERENCES

- [1] M. G. Constantine, L. Smith, R. M. Redington, and D. Owens. Racial microaggressions against black counseling and counseling psychology faculty: A central challenge in the multicultural counseling movement. *Journal of Counseling & Development*, 86(3):348–355, 2008.
- [2] T. C. Peck, M. Doan, K. A. Bourne, and J. J. Good. The effect of gender body-swap illusions on working memory and stereotype threat. *IEEE transactions on visualization and computer graphics*, 24(4):1604–1612, 2018.
- [3] T. C. Peck, J. J. Good, and K. A. Bourne. Inducing and mitigating stereotype threat through gendered virtual body-swap illusions. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, pp. 1–13, 2020.
- [4] C. M. Steele and J. Aronson. Stereotype threat and the intellectual test performance of african americans. *Journal of personality and social psychology*, 69(5):797, 1995.