

# Reducing Implicit Gender Bias Using a Virtual Workplace Environment

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## ABSTRACT

Implicit gender bias has costly and complex consequences for women in the workplace. We present an online desktop virtual environment that follows the story of a male or female self-avatar from the first-person perspective, who either experiences a positive or negative workplace scenario. Participants who experienced negative workplace experiences with a female self-avatar had significantly decreased levels of implicit gender bias compared to those who had a male self-avatar with evidence of perspective taking. Experiences of a positive workplace scenario showed no significant decreases in implicit gender bias regardless of self-avatar gender. We discuss the implications of these findings and make recommendations for virtual environment technologies and scenarios with respect to the reduction of implicit biases.

## CCS CONCEPTS

• **Human-centered computing** → **Interaction paradigms.**

## KEYWORDS

Implicit Gender Bias, Virtual Environments, Avatar, Implicit Association Test, IAT, Gender.

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## 1 INTRODUCTION

There is evidence to support that a person can consciously believe that they would never willingly discriminate against others, but still unconsciously have implicit biases that can affect their behavior [4, 8, 10]. As a society, we have come a long way in recognizing explicit biases, however, we are all unwitting victims of social conditioning that imbues us with biased implicit attitudes. There has been a call to action from the CHI community on Feminist HCI [6], Queer(ing) HCI [62], and Critical Race Theory in HCI [46] to integrate concepts such as these into HCI research. In addition, the principle of gender equality is viewed as a topic of global importance [49], however, 42% of women in the United States say they have faced gender discrimination in their workplace [50]. These numbers are much higher in STEM settings where men outnumber women (78%), women in computer jobs (74%), and women in STEM with a postgraduate degree (62%) [51]. Research has shown that implicit gender biases have complex and costly consequences on women in the workplace [11, 13, 15, 18, 24, 31, 33, 55, 56, 59].

In this paper, we examine the use of desktop virtual environments to reduce implicit gender biases, through the adoption of self-avatars being placed in negative and positive workplace scenarios. While this was originally meant to be an in-person study with full body visuomotor synchrony akin to [5, 26, 32, 37, 45, 47] we pivoted to an online desktop virtual environment as a result of the COVID-19 pandemic. This had the added benefit of opening the study up to a much broader demographic of participants who would not normally have the resources or access to virtual reality equipment. We found that participants who experienced a negative workplace scenario using gender microaggressions as a female self-avatar had a significant decrease in implicit gender bias compared to a male self-avatar. We found no significant differences in implicit gender bias in a positive workplace environment.

## 2 RELATED WORK

### 2.1 Gender Microaggressions

Microaggressions have been defined as “*the brief and commonplace daily verbal, behavioral, and environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative racial, gender, sexual-orientation, and religious slights and*

*insults to the target person or group*” [64, 66]. Gender microaggressions devalue women and dismiss many of their accomplishments. They can occur frequently, thereby limiting women’s effectiveness in professional environments [3, 9]. In the workplace, many women have reported being overlooked, disrespected, or dismissed by male colleagues. A classic example is that of a female employee contributing an idea during a meeting, which a male superior may not respond to or seemingly not hear. However, when a male coworker suggests the same idea, it is recognized and praised by colleagues [64]. Other examples of gender microaggressions in the workplace include exclusion from formal and informal meetings, lack of effective mentorship compared to men, male mentors mistaking their interactions as a sexual invitation, and over 60% of women reporting sexual harassment at the workplace in the form of sexist jokes and unwanted sexual attention [38, 52]. Taxonomies of gender microaggressions have been researched and identified [12, 44, 64, 65] into the following categories: Sexual Objectification, Second-Class Citizenship, Use of Sexist Language, Assumptions of Inferiority, Denial of the Reality of Sexism, Traditional Gender Role Assumptions, Invisibility, Denial of Individual Sexism, and Sexist Humor/Jokes (further information in Supplementary Materials).

## 2.2 Perspective Taking and Self-Avatars in Virtual Environments

Perspective taking is the process of putting oneself into the shoes of another person and imagining the other person’s situation and point of view. Perspective taking has been used in social psychology to reduce stereotype activation and reduce biases between groups [20–22]. Davis et al. [16] showed that perspective taking creates an overlap between the self and other, where the observer’s thoughts and feelings about the target become more “self-like”. The observer’s two mental representations of the self and target come to share more features in common, creating a merging of the self and other. Perspective taking has been explored in virtual environments in order to place users in another person’s shoes. Virtual environments<sup>1</sup> allow users to inhabit an avatar of a different race [5, 30, 47], gender [26, 35, 37, 43, 45, 58], age [32, 70], or even a different species [2]. First person perspective taking in virtual simulations can be used as a powerful tool to decrease implicit bias [5, 26, 47], decrease negative stereotyping [70], increase empathy [2, 32, 43, 58], and decrease conflict in negotiations [23].

## 2.3 Crowdsourcing and Online Virtual Reality

Recent research has investigated crowdsourcing and conducting online virtual reality (VR) experiments outside the laboratory [34, 39, 42, 57, 63]. Huber and Gajos [34] studied unpaid and unsupervised online virtual environments across different devices with 91% of their users working from desktop devices. They were able to replicate the results of two VR studies, and found no effect of device type on place illusion and embodiment illusion, suggesting that it is an equally effective mechanism independent of the device. These findings are backed up by other studies that have utilized desktop virtual environments such as Gehlbach et al. [23] who recruited AMT workers and carried out perspective taking successfully. Pena

et al. [48] showed that negative priming of avatars can affect user attitude and cognition using desktop virtual settings. While there is great potential for crowdsourcing VR studies, very few participants had devices at home that allowed hand movement tracking and no devices for full body tracking [34, 39, 57, 63].

## 3 MATERIALS AND METHODS

### 3.1 Virtual Environment

Before beginning the workplace scenarios, participants were given time to get accustomed to their self-avatar with in a room with a virtual mirror in front and left of the self avatar. Participants were asked to press keys to move the avatar’s body and look around the room for several minutes akin to [37]’s introductory scene. In each of the workplace scenes, participants actively spoke the lines of their self-avatar and recorded their voice when prompted. Figure 2 shows the recording interface and progressions. There were five scenes in each workplace scenario (Figure 1). The story was told from the first-person perspective of either a male (Kevin) or female (Kate) self-avatar, who interviews for a position at a company and gets the job (scene 1), has their first day at the office and meets their supervisor (scene 2), has a standup meeting with three male colleagues (scene 3), has a follow-up talk with their supervisor (scene 4), and after some time has passed has a chat with a same-sex colleague in the breakroom about their experiences in their job. Prior to the first scene, the participant was presented with text on the screen giving some background on their self-avatar and details on the job interview. There was transition text prior to each scene to update the participant on the situation of their self-avatar and explain any passage of time. The full script of both experiments can be found in Supplementary Table 1.

*Experiment 1:* For the negative scenario, we used the taxonomy of gender microaggressions [12, 44, 64, 65]: Sexual Objectification, Second-Class Citizenship, Use of Sexist Language, Assumptions of Inferiority, Denial of the Reality of Sexism, Traditional Gender Role Assumptions, Invisibility, Denial of Individual Sexism, and Sexist Jokes. (Please see supplementary material for full list of gender microaggressions used and their categorizations.) The same experiences were created for both the female and male self-avatar. In the negative scenario, the self-avatar is not given the position that they applied and are qualified for, their ideas are not listened to in the meeting, they are not invited to further meetings, their work is not acknowledged and praised, and they are not put up for promotion. The last scene allows the user to explicitly express the difficult experiences of the microaggressions to a sympathetic same-sex colleague who has also experienced similar treatment.

*Experiment 2:* In the positive scenario, none the gender microaggressions were included. Instead, the self-avatar is given the position that they applied and are qualified for, their ideas are listened to in the meeting, they are welcome to further meetings, their work is acknowledged and praised, and they are put up for promotion. The last breakroom scene allows the user to explicitly express the how well the work has been going to a same-sex colleague who praises them.

<sup>1</sup>For the purposes of this paper, the term virtual environment (VE) includes fully immersive virtual environments as well as desktop virtual environments.



Figure 1: Scenes from the workplace simulation.

### 3.2 Experimental Design

We conducted two experiments to address whether implicit gender bias could be reduced by experiencing negative (Experiment 1) and positive (Experiment 2) workplace scenarios in a desktop virtual environment. Each experiment was between-subjects and had two conditions: experiencing a female self-avatar versus a male self-avatar (control).

Participants were recruited using Prolific [53] as several multi-part studies. The first study verified users were using the Chrome on a desktop and could hear and record audio. Users that passed the systems checks were administered a gender-career Implicit Association Test (IAT) (*preIAT*) [28, 29]. After 48 hours, users that successfully completed the *preIAT* were invited to take part in the virtual workplace simulation and followup post simulation gender-career IAT (*postIAT*) and questionnaires. Participants were compensated for each study and awarded a bonus for completing all parts of the study. The studies used Qualtrics [54] to collect data. The system checks used built-in metadata to check for mobile devices and browsers, an embedded audio player widget from Google Drive to test the audio setup, and an embedded Unity WebGL widget from Simmer [60] to record audio and display the workplace simulation. Counterbalancing was used to assign an equal number of participants to the study conditions based on gender. We used the IATGEN tool [14] to conduct the pre and postIAT in Qualtrics. Before starting, participants were given time to adjust to their self-avatar in front of a virtual mirror. During the workplace scenario, participants actively spoke with the other avatars by recording their voice when prompted by their self-avatar’s lines (Figure 2). Participants went through an audio and microphone check to ensure that they could hear the dialogue and record their voice before starting. We removed participants who failed engagement checks (questions about appearance of self-avatar and virtual environment and lack of transcribed audio).

We measured the difference in the pre and postIAT in the same way as [5, 37, 47]:  $\Delta IAT = \text{postIAT} - \text{preIAT}$ <sup>2</sup>. Table 1 shows the questions we used to measure levels of embodiment and body ownership [25, 61] including the control question [42, 63] (‘Outdoor Park’). Ninety participants took part in the negative workplace

<sup>2</sup>A positive  $\Delta IAT$  indicates an increase in implicit gender bias. A negative  $\Delta IAT$  indicates a decrease in implicit gender bias.



Figure 2: The recording interface and progression.

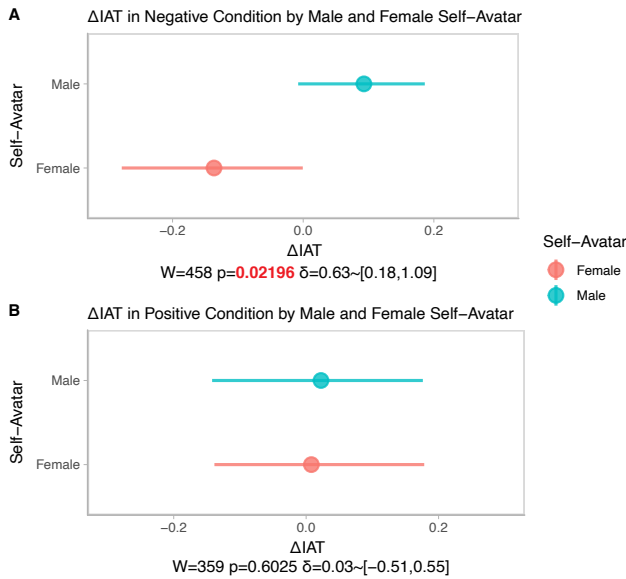
scenario (Experiment 1) aged 18 to 63 (mean age of 32.0, SD of 11.2; 38 female, 50 male, 2 non-binary). Sixty-six took part in the positive workplace scenario (Experiment 2) aged 18-66 (mean age of 29.2, SD of 10.5; 35 female, 31 male). The avatar gender was assigned to participants (all genders) randomly. All of the participants were White in order to control for race, as carried out by [5, 37, 47]. All participants had English as their first language to ensure that the interactive dialogues were understood at the same level.

### 3.3 Technical Setup

**3.3.1 Virtual Avatar Creation and Animation.** We used Unity [67] to build the virtual environment and deployed the build via the WebGL platform [69] which was deployed on Simmer.io [60]. We used Adobe Fuse CC [1] to create the avatar models using stock faces for the third party avatars. For the male and female self-avatars, we used faces and body types that were piloted to demonstrate neutral physical attractiveness and likeability (citation omitted for anonymity). The models were exported into Mixamo [41] for rigging and some animation before being imported into Unity. We used voice recordings to act out the parts of the third party avatars and used LipSync Pro, a third-party Unity asset, to animate speech articulations performed by the avatars [36]. We were not able to record full body motion capture as originally intended for avatar animation due to social distancing requirements, we therefore used a combination of Mixamo animations, FinalIK (Inverse Kinematics third party Unity Asset [19]), and LipSync Pro. This allowed us to supplement animations with custom movement not reflected in an animation. We used Microphone WebGL Library [40], a Unity third-party asset, to communicate with the microphone from the WebGL build. Completed recordings were sent to Google’s Speech-To-Text service. Google Cloud Speech Recognition Pro [27], a third-party Unity asset, was used to access Google’s Cloud Speech REST API from within the Unity WebGL build.

### 3.4 IAT

The IAT is a measurement of implicit bias which relies on people making decisions without time for conscious introspection. It measures reaction times and accuracy in associating a target group with positive and negative qualities [28, 29]. In this paper, we used the Gender-Career IAT which requires users to quickly associate words



**Figure 3:  $\Delta$ IAT across Negative and Positive scenario experiments in Male/Female Self-Avatars. Results indicate a significant difference in the Negative scenario (Experiment 1), in contrast to similar  $\Delta$ IAT values in the Positive scenario (Experiment 2).**

into the the Female-Male and Career-Family categories. We used the IATGEN tool [14] which integrates the IAT with the Qualtrics survey software. A positive IAT score indicates a Male-Career and Female-Family association, a negative IAT score indicates Male-Family and Female-Career association, and a zero indicates no bias. The IATGEN tool uses the improved IAT algorithm by [29] over the conventional algorithm by [28] (please see Table 4 in [29] for a comparison of the two algorithms). The new algorithm is less sensitive to prior IAT experience, particularly for postIAT-preIAT study designs [29]. However, prior IAT experience effect is not completely eliminated by the new algorithm and the order that the association pairings are presented in need to be counterbalanced, as they were in this paper.

## 4 RESULTS EXPT 1: NEGATIVE SCENARIO

### 4.1 IAT Data

In both experiments, primary statistical results are reported using bootstrapped 95% confidence intervals for means and effect sizes, following recent calls for more transparent statistical reporting in human-computer interaction [17]. Traditional comparison metrics such as non-parametric Wilcoxon tests are also included for context.

Shown in Figure 3.a, the  $\Delta$ IAT was significantly lower ( $W = 458, p = 0.02196$ ) in participants who experienced female self-avatars ( $M = -0.14 [-0.27, 0], d = 0.63 [0.15, 1.05]$ ) compared to male self-avatars ( $M = 0.09 [0, 0.19]$ ). This finding demonstrates that in the negative scenario participants who experienced a female self-avatar had a significant decrease in implicit gender bias compared to participants who experienced a male self-avatar.

| Label          | Question   |
|----------------|--|
| Virtual Body   | I felt like the virtual body representing me was my own.   |
| Two Bodies     | I felt as if I had two bodies.   |
| Outdoor Park   | During the experience, I recall visiting an outdoor park.  |
| Attracted      | I was physically attracted to the virtual body that was representing me.                               |
| Movements      | I felt that the movements of the virtual body were caused by my own movements.                         |
| Resembled      | I felt that my virtual body resembled my (real) body in terms of shape, skin tone, or visual features. |
| Office         | I felt as if I were located in the office environment.   |
| Fairly         | I felt that my virtual character was treated fairly in the workplace.                                  |
| Listened       | I felt that my virtual character's ideas were listened to.   |
| Discrimination | I felt that my virtual character experienced gender discrimination.                                    |
| Better         | This experience will affect the way I act towards others in the workplace for the better.              |

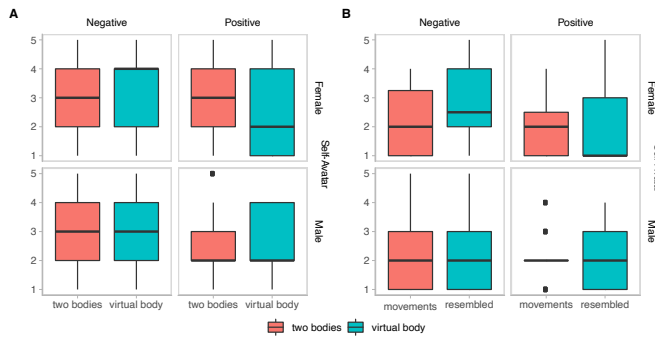
**Table 1: Questions were rated on a 5-point Likert scale from Strongly Disagree to Strongly Agree [25, 61, 63].**

### 4.2 Questionnaire Data

Results showed that there was some embodiment in the negative condition (Virtual Body), particularly for the female self-avatar (Figure 4.a). There was no sense of control over the movements (Movements) of the self-avatar (Figure 4.b). Participants did feel that they were in an office environment (Figure 5.b). Interestingly, while almost all participants felt that the female self-avatar experienced gender discrimination, they did not feel that way about the male self-avatar (Figure 5.d), although the male self-avatar experienced the same events and participants felt both avatars were equally not treated fairly (Figure 5.c) nor listened to (Figure 5.e). Participants did not feel attracted to the self-avatar (Figure 5.a). This is beneficial as it avoids objectification of the self-avatar, which would obstruct perspective taking.

### 4.3 Comments From Participants

**4.3.1 Perspective Taking.** Sixteen out of 19 male participants and 13 out of 16 female participants commented on the fact that having a female self-avatar in the negative scenario helped them experience her point of view and/or that they were affected in some way. Comments such as these examples below help illustrate this: *-After the first or second question by the CEO I guessed what was going to be the theme of this simulation. I have personally witnessed gender discrimination against my colleagues and whilst I can empathise to a degree I do recognise its not something I'll ever experience. It was quite a clever simulation, and echoes what I've seen in the past and often the stories I hear from my partner. I'd be bitterly disappointed if I ever raise a son to behave like that in the workplace.* [FN condition,



**Figure 4: Embodiment questions (Table 1) all rated on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree).**

male participant,  $\Delta IAT = -0.0362599$

*-I think the virtual body was a really interesting idea to try and understand the viewpoint of someone being discriminated in a workplace situation. Although I was aware gender discrimination is a huge issue, experiencing it in person (albeit virtually) made me feel uncomfortable and forced me to consider my positionality. I really enjoyed the study and hope you find some useful results!* [FN condition, male participant,  $\Delta IAT = -0.1984775$ ]

**4.3.2 Technology.** The fidelity of the virtual environment can stand to be improved:

*-I enjoyed the experience in general, though the animation seemed like Xavier: Renegade Angel style or late 90s. I did appreciate the study and certainly support the message behind it.* [FN condition, male participant,  $\Delta IAT = -0.1111981$ ]

*-I enjoyed the experience in general, though the animation seemed like Xavier: Renegade Angel style or late 90s. I did appreciate the study and certainly support the message behind it.* [FN condition, male participant,  $\Delta IAT = -0.1111981$ ]

## 5 RESULTS EXPT 2: POSITIVE SCENARIO

### 5.1 IAT Data

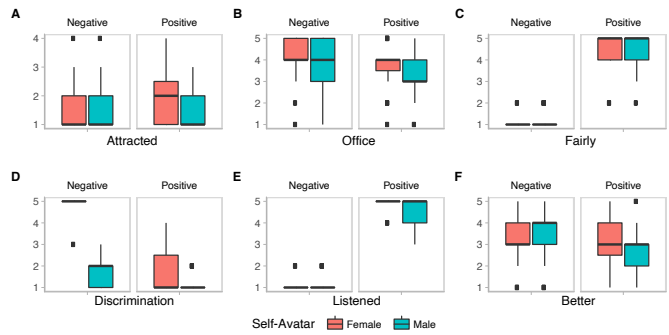
Shown in Figure 3.b, there was no significant difference in  $\Delta IAT$  ( $W = 359, p = 0.6025$ ) among participants who experienced a female self-avatar ( $M = 0.01 [-0.13, 0.19], d = 0.03 [-0.47, 0.57]$ ) compared to a male self-avatar ( $M = 0.02 [-0.13, 0.18]$ ). These results demonstrate that there was no decrease in implicit gender bias between the female and male self-avatars in a positive scenario.

### 5.2 Questionnaire Data

Shown in Figure 4, participants did not feel embodied in the self-avatars in the positive scenario. Participants felt that their self-avatars were fairly treated (Figure 5.c), listened to (Figure 5.e), and did not experience gender discrimination (Figure 5.d). They did not feel attracted to the self-avatar (Figure 5.a).

### 5.3 Participant Comments

**5.3.1 Perspective Taking.** Three out of 12 male participants and seven out of 15 female participants commented on the fact that the positive scenario was “unrealistic” and/or they had a difficult time



**Figure 5: Questions (Table 1) all rated on a 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree).**

identifying with it.

*-I expected the virtual body to experience discrimination and for her ideas to be dismissed as she was a female, but was pleasantly surprised by the fact that she was so well treated. I can see a lot of effort went into the simulation, so I commend everyone involved in creating the study.* [FP condition, female participant,  $\Delta IAT = -0.3266387$ ]

This participant felt that the scenario was “too nice” to perhaps be reflective of real life.

*-It felt like the people inside the workplace were too nice.* [FP condition, male participant,  $\Delta IAT = 0.52409966$ ]

There was also a sense of unreality from this female participant who had a male self-avatar:

*-I feel like it would be better if it were tailored to the gender we submitted. For example, as a woman I know that I'd face a lot more discrimination in this workplace than just being “the new guy,” so it was hard to relate to the virtual character.* [MP condition, female participant,  $\Delta IAT = 0.05095463$ ]

**5.3.2 Technology.** There was important feedback on the avatar and audio recordings related to embodiment:

*-Actual direct control could have made the virtual body feel more realistic than what amounts to random button presses. Even if we never moved Kate, giving mouse control to her head and allowing us to look around to a certain degree would have made the whole thing easier to “buy” into.* [IAT data too fast - rejected by algorithm]

*-I was a little nervous about speaking words that weren't my own but I got into it and tried to convey emotion as I talked.* [FP condition, female participant,  $\Delta IAT = -0.441932$ ]

## 6 DISCUSSION

The findings showed that participants who experienced a negative workplace scenario with a female self-avatar had significantly decreased implicit gender bias compared to those with a male self-avatar (Figure 3.a). This is the first time that we know of that implicit gender bias has been decreased, as measured by the IAT, in a desktop virtual environment. This is also the first time that implicit gender bias has been reduced across male and female participants, although the effect of participant gender should be further investigated. The results suggest that perspective taking took place in users who experienced negative workplace experiences and gender microaggressions with a female self-avatar.

We make three recommendations for the development of the workplace scenarios with respect to the reduction of implicit gender biases. Firstly, avoiding the automaticity of stereotype activation [7] was key in order to allow perspective taking to take place. Unintentional stereotype activation can occur in first-person perspective studies in race [30] and gender [37, 45]. Secondly, we carefully provided a back story and information on the self-avatar through text both as an introduction and as transitions between scenes. This is consistent with Gehlbach et al. [23]’s findings who argued that when individuals are asked to take the perspective of another person, but are given no or little information about that person, there is actually no perspective to be taken. Lastly, the type of scenario (positive, negative, or neutral) was vital, as demonstrated here and by others (e.g., [5, 26, 30, 37, 47]). We suggest investigating negative scenarios for the reduction of implicit gender biases.

We will improve the fidelity of the virtual environment in future work by deploying to a standalone platform, with real-time lighting and a build running natively as opposed to streaming. WebGL only supports non-directional Baked Global Illumination [69]. Performance of the build was also likely hindered by delays in loading, skipping of render frames, and unforeseen bugs which could lower the fidelity of the virtual environment [68]. Moving forward, we would also like to give participants direct control over the movement of their avatar’s head and body using key presses and mouse movements. We had originally planned to use motion capture for all avatar animations but were not able to due to COVID-19 social distancing rules and therefore pivoted to a mixture of animations from Mixamo and Unity. Increasing the fidelity and performance of the virtual environment, along with giving the user more control, will likely increase the user’s sense of embodiment and have an effect on the levels of perspective taking and implicit bias.

## 7 CONCLUSION

Participants who experienced a negative scenario in a desktop virtual workplace environment as a female self-avatar had significantly decreased implicit gender bias compared to participants who experienced a male self-avatar. We recommend pursuing this exciting avenue due to its accessibility to a broad audience.

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