# Addressing Sexist Attitudes on a College Campus through Virtual Role-Play with Digital Doppelgangers

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## ABSTRACT

Digital doppelgangers are virtual humans that highly resemble the real self but behave independently. Digital doppelgangers possess great potential to serve as powerful models for behavioral change. An emerging technology, the Rapid Avatar Capture and Simulation (RACAS) system, enables low-cost and high-speed scanning of a human user and creation of a digital doppelganger that is a fully animatable virtual 3D model of the user. We designed a virtual role-playing game, DELTA, that implements a powerful cognitive dissonance-based paradigm for attitudinal and behavioral change, and integrated it with digital doppelgangers to influence a human user's attitude towards sexism on college campuses. In this paper, we discuss the design and evaluation the RACAS system and the DELTA game-based environment. Results indicate the potential impact of the DELTA game-based environment in creating an immersive virtual experience for attitudinal change.

## CCS CONCEPTS

• **Computing methodologies** → **Intelligent agents**; • **Applied computing** → *Psychology*; • **Software and its engineering** → *Interactive games*;

## KEYWORDS

virtual role-play, simulation game, digital doppelganger, cognitive dissonance

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## 1 INTRODUCTION

Everyday sexism is defined as minor sexist incidents or microaggressions that occur in everyday interactions [43], such as gender-typed expectations, stereotypic comments, and language that excludes women. The harm of everyday sexism is difficult to recognize, because the effects tend to be distal and cumulative, meaning that not every minor sexist incident has immediate observable consequences. Over time, however, these incidents accumulate to negatively affect the psychological well-being and material outcomes of women [43, 45].

While recognizing everyday sexism and acknowledging its harm can be the first steps towards addressing the problem, teaching individuals about everyday manifestations of sexism can be challenging. Individuals may be reluctant to accept the uncomfortable information and/or may have low self-efficacy to effect change. Two theories in social psychology offer insight toward solutions for these two challenges: cognitive dissonance theory and social cognitive theory.

Cognitive dissonance is a state of mental discomfort that arises from conflicting attitudes or beliefs within an individual [17]. Such dissonance motivates the individuals to restore internal consistency by changing their attitude and behavior [17]. To create such a dissonance state, one either makes counterattitudinal statements, or first makes proattitudinal statements but is then reminded of times in the past when one failed to live up to these advocated standards [20]. Both ways are potentially effective in bypassing the issue of reluctance to accept uncomfortable information about sexism, by asking people to make statements that they believe will have a positive impact on others and that they are thus less resistant to making.

Social cognitive theory, on the other hand, states that people do not need to experience rewards or punishments themselves in order to learn behaviors, but rather they can learn behaviors through the observation of models [6]. Greater similarity and identification with a model lead to more imitation of the modeled behaviors. Based on this theory, providing an environment that allows someone to observe modeled behaviors can help one learn such behaviors, potentially addressing the issues of self-efficacy.

Traditionally, dissonance-based interventions are carried out in person and are both time- and resource-intensive (e.g., [41]), limiting access to this effective attitudinal and behavioral intervention. Internet-based interventions reduce the cost and broaden the access (e.g., [40]). However, such interventions often fail to create the same level of presence as face-to-face sessions, which can potentially impact the participants' engagement in the intervention. In this

paper, we discuss the design of a role-playing game, called DELTA[1], to create an immersive virtual environment for inducing cognitive dissonance. In addition, a novel avatar capture and animation system, called RACAS, is used to enhance the social cognitive process in the DELTA game by increasing similarities between the users and their models. We conducted a large-scale evaluation of the DELTA game on its efficacy to address sexist attitudes on college campuses. We discuss the outcome of the study and its implication on future directions in game-based behavioral interventions.

## 2 RELATED WORK

While there has been a great deal of effort in addressing sexist attitudes, sexual harassment, and assault, including ones with technological solutions, not just for colleges but across diverse settings, the work that is most relevant here is the use of games with virtual role-play for training and attitudinal and behavioral intervention. For example, in education, game-based learning environments have been researched extensively to study the potential to help students gain foreign-language skills and cultural awareness [24], cultivate scientific-inquirer skills [25, 27, 36], and improve problem-solving capabilities [7, 23], just to name a few.

Another line of work that is relevant is the design and application of digital doppelgangers. Digital doppelgangers are virtual humans that highly resemble the real self but behave independently[4]. Because digital doppelgangers possess a strong resemblance to the physical self—as they are actually a digital copy of the physical body—they have great potential to serve as powerful models [5, 19]. Human reactions to doppelgangers have been observed to induce behavior changes in many areas, including promoting healthy lifestyles (e.g. routine exercise and better eating habits [19]), becoming more future-oriented (e.g. increasing retirement savings [22]), altering consumer behavior [1], and alleviating public speaking anxiety [3], among others. However, the digital doppelgangers used in previous work were either static renderings (either 2D or 3D) of the human counterpart and not animatable characters. Additionally, the similarity in appearance between users and their avatars have shown to increase presence in the virtual immersive games [34]. Thus the use of digital doppelgangers can potentially impact presence virtual environment as well.

Creating a virtual character from a particular subject is not a trivial task and usually requires extensive work from a 3D artist to model, rig, and animate the virtual character. The first step of avatar creation requires reconstruction of a 3D model from either a set of images or depth range scans. With the availability of low-cost 3D cameras (Kinect and Primesense), many inexpensive solutions for 3D human shape acquisition have been proposed. The work by [44] employs three Kinect devices and a turntable. Multiple shots are taken and all frames are registered using the Embedded Deformation Model [42]. The work done in [49] utilizes two Kinect sensors in front of the self-turning subject. The subject stops at several key poses, and the captured frame is used to update the online model. More recently, solutions which utilize only a single 3D sensor have been proposed, and this allows for home-based scanning and applications. The work in [47] asks the subject to turn in front of a fixed 3D sensor, and four key poses are uniformly sampled to perform shape reconstruction. To improve the resolution, KinectAvatar [13] considers color constraints among consecutive frames for super-resolution. More recently, the work in [29] asks the subject to come closer and obtains a super resolution scan at each of eight key poses. The second step is to create an animated virtual character from the scanned 3D human model. A 3D model needs to be rigged with a skeleton hierarchy and appropriate skinning weights. Traditionally, this process needs to be done manually and is time consuming even for an experienced animator. An automatic skinning method is proposed in [8] to reduce the manual efforts of rigging a 3D model. The method produces reasonable results but requires a connected and watertight mesh to work. The method proposed by [9] complements the previous work by automatically skinning a multi-component mesh. It works by detecting the boundaries between disconnected components to find potential joints. Such a method is suitable for rigging mechanical characters that consist of many components. Other rigging algorithms can include manual annotation to identify important structures such as the wrists, knees, and neck [31].

In recent years, video-based methods have enabled the capture and reconstruction of human motions as a sequence of 3D models [39]. Such methods, which are capable of reproducing surface and appearance details over time, have been used to synthesize animations by the combination of a set of mesh sequences [11]. This results in a novel motion that preserves both the captured appearance and actor style, without the need of a rigging step. However, current approaches have demonstrated successful results for only basic locomotion motions such as walking, jogging, and jumping. The complexity of the movements needed in this work would still require the video-based 3D models to be rigged.

## 3 RACAS: RAPID AVATAR CAPTURE AND SIMULATION

Rapid Avatar Capture and Simulation (RACAS) is a virtual avatar generation system based on a 3D body scan. Recent advances in scanning technology have enabled the acquisition of human models through a variety of photogrammetry methods using RGB cameras, as well as through the use of commodity RGB-D sensors, such as the Microsoft Kinect. Such human 3D models can be used as static imagery in a 3D simulation or as a printed model [29]. However, the use of such 3D models as dynamic 3D characters requires additional effort to properly rig the model in order to provide the control mechanism and deformation behavior.

The RACAS system has two main capabilities: automatic rigging transfer, and interactive avatar reshaping [15, 38]. RACAS takes scans of a user from the front, back, left, and right sides using an RGB-D sensor. These scans are "stitched together" to create a 3D model. The 3D model is then enhanced by inferring a skeletal and muscular structure, as well as generating a model for the deformation of the skin and clothes (see Fig. 1). To do so, RACAS first utilizes SCAPE [2] to build a morphable human model from a 3D human model database. In order to allow pose deformations via linear blend skinning, RACAS researchers also manually rigged a template mesh from the database. Therefore, given a 3D human body scan, RACAS can fit the morphable human model produced by SCAPE onto the input scan and establish mesh correspondences between them. Once RACAS establishes such correspondences, they can be

[1]DELTA: Digital Embodiment for Learning Transfer Acceleration

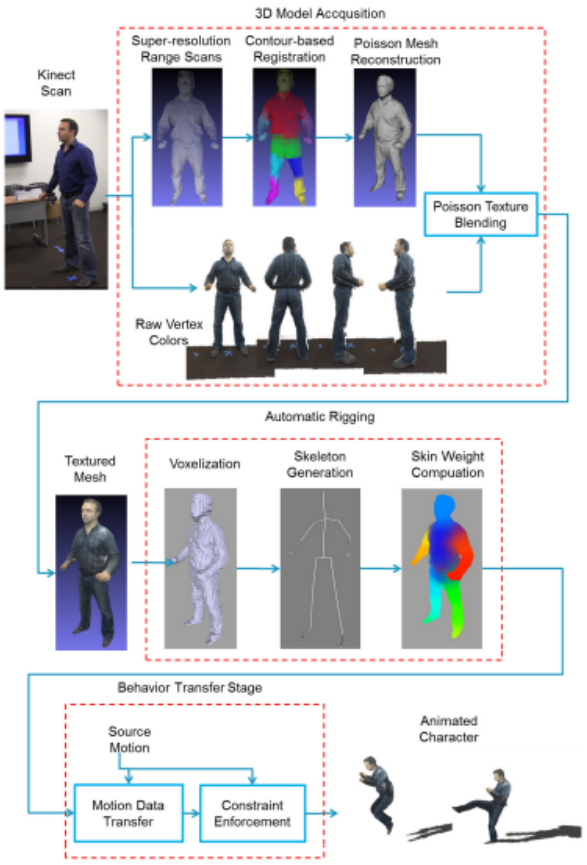


**Figure 1: The Rapid Avatar Capture and Simulation (RACAS) system.**

used to transfer both skeleton and skin binding weights from the template mesh onto the input scan to generate a 3D virtual avatar. The users of RACAS can also interactively adjust semantic body attributes of the fitted model by exploring the body shape space generated from the database. Such body shape deformations can then be transferred to the aforementioned 3D scan to further create various virtual avatars with different body sizes and proportions. The resulting virtual avatars can then be animated in a simulation environment to execute various behaviors using animation retargeting. SmartBody, a character animation system, drives the animation of the 3D virtual character [37]. Using RACAS, researchers can easily create a digital doppelganger that serves as an ideal model for maximizing feelings of similarity, enabling the demonstration of a wide range of rewards and punishments, and customizing the virtual self's behavior to portray an optimal performance that the physical self cannot yet achieve.

## 4 COGNITIVE DISSONANCE THROUGH DELTA

We designed a virtual role-playing game, DELTA, integrated with digital doppelgangers, to influence a human user's attitude toward sexism on college campuses (Fig. 2). In DELTA, human users guide digital doppelgangers of themselves created by RACAS to navigate

**Figure 2: A screenshot from the DELTA game environment.**

through various scenarios where their doppelgangers encounter sexist attitudes on a virtual college campus. To induce cognitive dissonance in the users, we designed a series of dialogue-based game scenarios to imitate the process of inducing dissonance traditionally used in laboratory settings. In a traditional approach, participants were given a description of an undesirable behavior (e.g., a sexist comment) and were asked to use their own words to counter it by either writing an essay, making a recorded speech, etc. In the DELTA game environment, users witness the use of sexist comments and are asked to use their own words to counter such comments. The current implementation of DELTA includes five scenarios on a college campus, with topics ranging from women's sports, to balancing between family and career, to objectification of women. DELTA is developed with Unity3D. The in-game characters from different scenarios carried out conversations with the human users. The in-game characters are integrated virtual humans [21] with speech prerecorded using actors in sound studios and speech gestures generated using Smartbody [37] and Cerebella [28]. Since the scans captured using the RACAS system presented in this paper do not have an animatable face, user characters do not have facial expressions or lip-syncing with the speech. The user characters speech gestures are limited to head, body and limbs. The in-game characters are fully animated, e.g, has facial expressions and lip-syncing.

## 5 EVALUATION

### 5.1 Design

To evaluate the impact of the DELTA game with digital doppelgangers on attitudinal and behavioral change, we conducted a study with the digital doppelganger serving as the player avatar in the DELTA role-playing game. To tease apart the impact of virtual role-play and the use of RACAS avatars, we designed four experiment conditions for the evaluation study.

- **Baseline**: In this condition, participants read an essay about sexist attitudes. The essay is adopted from [14]. No avatar was used in this condition.
- **Traditional-CD**: In this condition, participants were presented the sexist comments on a web page and asked to use their own words to counter such comments. The sexist comments were embedded in the text descriptions of the same

scenarios implemented in the DELTA game. No avatar was used in this condition.

- **DELTA-Only**: In this condition, participants interacted with the DELTA game. In the game, a virtual human with photo-realistic appearance, not based on any resemblance to the participant, served as the avatar controlled by the participants. To control the realism of the virtual human used in this and the DELTA-DD condition, the agent in this condition was generated using captures of non-participants obtained with RACAS through the same process used in the DELTA-DD condition.
- **DELTA-DD**: In this condition, participants interacted with the DELTA game. In the game, the participants controlled their digital doppelgangers, captured and generated at the beginning of the study using RACAS.

We hypothesize that:

- **H1:** The interactions in the DELTA-Only condition create a higher level of immersion and presence, compared to the Baseline and Traditional-DD conditions.
- **H2:** The DELTA game environment with Digital Doppelgangers creates a higher level of immersion and presence, compared to the other three conditions.
- **H3:** The DELTA game environment with Digital Doppelgangers is more effective in inducing attitude and behavioral change, compared to the other conditions.

## 5.2 Population

Because the scenario implemented in the current version of the DELTA game is geared towards heterosexual males, we recruited 132 male heterosexual participants from the student population of a university located in North America. Participants were recruited either from the Psychology Department subject pool or via fliers posted on campus. Participants recruited from the subject pool received course credit for their participation, while participants recruited through the fliers received $10 for their participation.

## 5.3 Procedure

Participants first read and signed an informed consent form. Then the experimenter completed a full-body scan using an iPad Pro (2015) attached to an Occipital structure sensor. The scans were taken in a lab fitted with an array of LED lights to provide even lighting. The scans were transmitted wirelessly to a DELL XPS Workstation in real-time. Participants from all conditions were scanned. Next, the participants filled out a Background Survey, while the RACAS system completed the generation of the 3D model of the participants. Next, the participants sat in front of a 30-inch computer monitor and completed a task according to the condition they were randomly assigned to, as described in Section 5.1. Next, the participants filled out a Post-Survey. Before participants left the lab, they were offered a choice of free deodorant, as a behavioral measure of their sexist attitude (see Section 5.4). Each study session in the lab was designed to last one hour. Six weeks after the in-lab session, the participants filled out a Follow-Up survey online. At the end of the survey, the participants were asked to choose between two online gift-cards as their compensation for filing out the survey, as a second behavioral measure of sexist attitudes. The Follow-Up survey was designed to be completed in no more than 10 minutes.

## 5.4 Measures

The Background Survey included demographic information, such as education. The Rosenberg Self-Esteem Scale [35], Adolescent Body Image Satisfaction Scale (ABISS) [26], and Anxiety scale [33] were also included, because such individual differences may impact particpants' reactions to seeing their own avatars in the virtual environment. The Background Survey also included a 15-item measure of Attitude Toward Women on College Campus (specific to the university where the study was carried out) and an 11-item Attitude Toward Women in Society Scale. Both were designed by the research team. Finally, the Social Desirability Scale [12] was included to gauge any such bias within the responses to measures of Attitude Toward Women.

The Post-Interaction Survey included measures of Presence (constructed using items from [48] and [18]), Avatar Similarity ("To what extent do you feel that the virtual avatar resembled you?"), Desired Avatar Similarity ("If you had to design your own avatar for this task, how similar to your real appearance would you make your avatar?"), and the Attitude Toward Women on College Campus and Society scales.

The Follow-Up survey contained the Attitude Toward Women on College Campus and Society scales. The three versions of these two scales (in the Background, Post, and Follow-Up surveys) contained items drawn from two pools of items (30-item and 22-item pools for Attitude Toward Women on College Campus/Society). Thus each scale contained both overlapping and distinct items as they appeared on different surveys.

Two behavioral measures were used. One was the choice of free deodorant at the end of the lab session. Deodorants similar in scent and packaging from two brands, Degree and Axe, were offered as choices. The second behavioral measure was the choice of gift-card as a compensation for the Follow-Up survey. Gift-cards from two clothing companies, American Apparel and Urban Outfitters, were offered as choices. Axe deodorant and American Apparel feature advertising campaigns exhibiting a more sexist attitude than those of Degree and Urban Outfitters. The gift-card behavioral measure was validated in an unpublished study prior to the study discussed here. While the study was ongoing, American Apparel went out of business and stopped selling and redeeming gift-cards. Gift-cards from two different clothing companies, Abercrombie & Fitch and American Eagle, were offered as choices instead.

# 6 RESULTS

Data from 132 participants were included in the analysis. The participants had an average age of 21.8 and came from majors ranging from psychology, to business administration and biology. Participants were randomly assigned to one of the experiment conditions. 33 participants were assigned to each experiment condition.

## 6.1 Manipulation Check

We first performed a "manipulation check" on the perceived resemblance of the player-controlled avatar to the participants. We expect Avatar Similarity to be lower in the DELTA-Only condition,

**Table 1: Ratings on Avatar Similarity and Desired Avatar Similarity measures (7-point Likert scale). For each column, items sharing the same superscript are significantly different from each other, based on Tukey HSD post-hoc analysis.**

| | Avatar Similarity | Desired Avatar Similarity |
|---|---|---|
| Baseline | NA | $2.848^{abc}$ |
| Traditional-CD | NA | $4.636^{ad}$ |
| DELTA-Only | $2.67^{a}$ | $5.667^{b}$ |
| DELTA-DD | $4.45^{a}$ | $6.091^{cd}$ |

which integrates the participants' 3D avatar in the DELTA game, compared to the DELTA-DD condition. Data from the Baseline and Traditional-CD condition were excluded for this analysis, because no avatars were used. An ANOVA test revealed that participants indeed perceived the avatar they controlled in the DELTA game to be much more similar to themselves when the digital doppelgangers were used ($p < .0001, F = 16.266$).

We then included data from all the conditions and performed an ANOVA test on Desired Avatar Similarity—how much participants would like the avatar to look like them for this specific task (e.g., learning about the issue of sexist attitudes on college campus and how to address it). Results show that there is a significant difference between all four conditions $p < .001, F = 20.571$. Means from both tests are shown in Table 1. The results suggest that when virtual role-playing is used, whether through text description, a 3D simulation game, or a 3D simulation game with digital doppelgangers, participants had a much higher desire to have their own avatar visually represent them in the role-play, compared to when the task was not framed as role-play.

## 6.2 Presence

We also hypothesized that the DELTA game and digital doppelganger would impact participants' immersion in the role-playing simulation, which could in turn potentially impact the efficacy of the intended attitudinal and behavioral change. There are three sub-scales of Presence included in the Post-Survey: Involvement, Immersion, and Avatar. The Involvement sub-scale includes items such as "How involved were you in the virtual environment experience?". The Immersion sub-scale includes items such as "How completely were your senses engaged in this experience?" The Avatar sub-scale includes items such as "To what extent do you feel the avatar is an extension of yourself?" and "To what extent do you feel you embodied the avatar?" ANOVA tests show that there are significant differences between the conditions for all three sub-scales ($p < .001$ for all three measures). Table 2 shows the means from the sub-scales across conditions. The data suggest that the DELTA game, whether a digital doppelganger is used or not, is much more effective in creating immersion and presence in the role-play scenario, compared to reading essays or engaging in the role-play scenarios in a text-only environment. However, the use of digital doppelgangers in the DELTA game did not significantly increase the participants' sense of immersion, compared to the DELTA game without the digital doppelganger.

**Table 2: Ratings on Presence, including involvement, immersion, and avatar (5-point Likert scale). For each column, items sharing the same superscript are significantly different from each other, based on Tukey HSD post-hoc analysis.**

| | Involvement | Immersion | Avatar |
|---|---|---|---|
| Baseline | $1.606^{abc}$ | $2.152^{abc}$ | $1.588^{abc}$ |
| Traditional-CD | $2.985^{ade}$ | $4.212^{a}$ | $3.1^{a}$ |
| DELTA-Only | $4.349^{bd}$ | $4.742^{b}$ | $4.036^{b}$ |
| DELTA-DD | $3.902^{ce}$ | $4.667^{c}$ | $3.883^{c}$ |

## 6.3 Reliability Analysis

The Attitude Toward Women scales (ATW) are 5-point Likert scales. Because they were designed by the research team, a factor analysis was first conducted to test the scales' reliability. The Cronbach's Alpha for ATW-College is .736 in the Background Survey, .818 in the Post Survey and .764 for the Follow-up Survey. The Cronbach's Alpha for ATW-Society is .779 in the Background Survey, .765 in the Post Survey, and .756 for the Follow-up Survey.

In the Background Survey, we included a 33-item Social Desirability scale, which assesses whether or not respondents are concerned with social approval ($Mean = 15.23, Min = 6, Max = 30$). Such individual differences may impact one's response to statements on Attitude Toward Women. We conducted Pearson correlation tests on the Social Desirability scale and the ATW scales. Results show that there were significant correlations of responses to the Social Desirability scale and the ATW-USC scales ($r = -.271$ for the ATW-USC in the Background Survey, $r = -.335$ in the Post Survey, and $r = -.217$ for the Follow-up Survey). This means that participants who are more concerned about social approval gave answers that indicate less sexist attitude toward women on college campuses. There was no significant correlation between the Social Desirability scale and the ATW-Society scales. This suggests that participants' concern for social approval had no relationship with whether their answers indicated less sexist attitude toward women in society at large. This could be due to fact that the participants, who were college students, had an easier time figuring out the socially desirable answers to questions on the ATW-College scale, but not so much on the ATW-Society scale. Thus, for this paper, we included analysis on only the ATW-Society scale.

## 6.4 Attitude Toward Women

We first conducted an analysis of variance test with the scores on ATW-Society from the Background and Post Survey as a repeated measure and the experiment conditions as the Between-Subject factor (Fig. 3). The result shows that there was a significant within-subject effect from the Background to the Post Survey[2] ($M_pre = 1.649, M_post = 1.576, p = .032, F = 4.715$). This means that, overall, sexist attitudes reduced right after the study.

The between-subject effect due to the experiment manipulation was not statistically significant ($p = .156, F = 1.772$). This means

[2]Close examination of Figs. 3 and 4 seems to suggest that there may be a difference in the participants' attitude toward women *prior to* the study. An ANOVA test shows that such differences on the ATW-Society scale from the Background survey are not statistically significant.

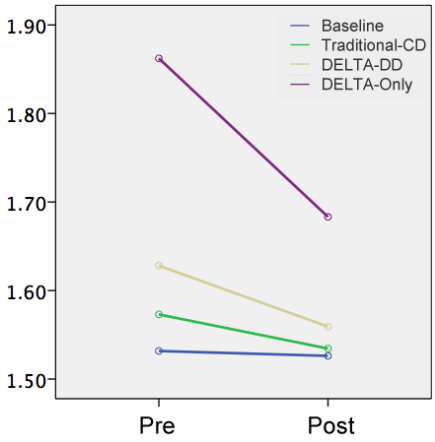


**Figure 3: Comparison of Attitude Toward Women (Society) before and immediately after the study across experiment conditions.**

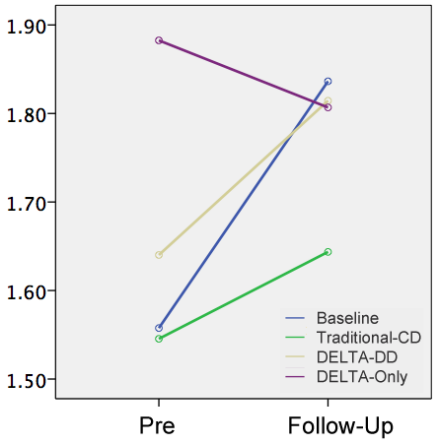


**Figure 4: Comparison of Attitude Toward Women (Society) before and 6 weeks after the study across experiment conditions.**

that there was no significant difference in the way ATW-Society changed from pre- to post-study between conditions. Subsequently, we compared the changes on ATW-Society from the Background to the Post Survey *separately* for each condition. Because the overall within-subject effect was significant, we wanted to test whether any such significant change exists in only some conditions but not others. Paired Sample T-Tests show that in the DELTA-Only condition (without the Digital Doppelganger), the decrease in sexist ATW in society (ATW-Society) is statistically significant ($M_{pre} = 1.862, M_{post} = 1.683, p = .009, t = 2.762$). We did not find any significant change in the ATW-Society in the other conditions, including the DELTA-DD condition. This suggests that using role-playing simulation to implement the cognitive dissonance paradigm reduced sexist attitudes by itself, while the other approaches, such as the use of essay, did not. And the use of digital doppelganger in the DELTA game did not have an added impact and may have even detracted from the effect.

We then conducted an analysis of variance test with the scores on ATW-Society from the Background and the 6-week Follow-Up Survey as a repeated measure and the experiment condition as the Between-Subject factor (Fig. 4). The follow-up survey was solicited through follow-up email and filled out by the participants remotely online. Not all the participants filled out the follow-up survey. A total of 86 (out of 132) participants filled out the follow-up survey (14 from the the Baseline, 24 from the Traditional-CD, 24 from the DELTA-Only, and 24 from the DELTA-DD conditions). Results show that there is a significant within-subject effect ($M_{pre} = 1.656, M_{follow-up} = 1.775, p = .026, F = 5.107$). The between-subject effect is not statistically significant ($p = .407, F = 0.979$). Subsequently, we compared the changes on ATW-Society from the Background to the Follow-Up Survey *separately* for each condition and found no statistically significant difference on the change of ATW-Society from Follow-Up to Pre-study for any of the conditions. This indicates that, overall, the sexist ATW on society was significantly higher when participants answered the survey outside the lab 6 weeks after the study, compared to before in the lab. However, none of the conditions alone contributed to such significant difference.

## 6.5 Behavioral Measures

In addition to the self-report measures, we also designed post-study and follow-up behavioral measures. Right after the study, we used the participant's choice of deodorant brand as a behavioral measure. And 6 weeks after the study, participants indicated their choice of gift card as their compensation for filling out the Follow-Up survey. Overall, participants who chose the deodorant from a brand that has a history of sexist advertisements (e.g., Axe) scored higher on the ATW-Society scale on the Post Survey ($N_{Axe} = 57, N_{Degree} = 54, M_{Axe} = 1.652, M_{Degree} = 1.465, p = .024, F = 5.260$). Additionally, participants who chose the gift card from brands that have a history of sexist advertisements (e.g., American Apparel and Abercrombie & Fitch) scored higher on the ATW-Society scale on the Follow-Up Survey ($N_{AA/AF} = 29, N_{UO/AE} = 57, M_{AA/AF} = 1.903, M_{UO/AE} = 1.652, p = .001, F = 11.547$). A non-parametric test (Chi-square) was conducted on the choice of deodorant but showed no significant difference between the conditions ($p = .852$). The same test on the choice of gift-card indicated at the end of the Follow-Up survey did not show any significant difference between conditions either ($p = .456$).

# 7 DISCUSSION

In this paper, we discussed the design of a virtual role-playing game, DELTA, and an auto-rigging character simulation system, RACAS, and the integration of the two systems for addressing sexist attitudes on a college campus. A large-scale study was carried out to evaluate the efficacy of the DELTA game, integrated with digital doppelgangers created by RACAS, in creating an environment conducive to immersion and presence, and reducing sexist attitudes. Data on various measures of presence indicates that the DELTA game alone, without the integration of digital doppelganger, is just as effective in immersing participants in the virtual environment

and making the participants feel that their embodied avatar was an extension of themselves. Interestingly, results on the Desired Avatar Similarity measure suggest that, for this task, participants preferred to see an avatar share their own appearance, as long as the task was set in role-playing scenarios. And no significant difference was found on the Desired Avatar Similarity in DELTA games with and without digital doppelgangers. However, the application of digital doppelgangers is task dependent and may be sensitive to the context. For example, the digital doppelgangers have also been used in a different setting, where students are tasked to teach their virtual avatars, verbally and face-to-face [46]. In this setting, participants who taught their digital doppelganger reported much lower desire for such resemblance, compared to participants who taught an avatar that did not share their appearance.

The main objective of the DELTA game is to create a virtual environment to role-play interactions in the cognitive dissonance paradigm to induce behavioral and attitudial change. The use of digital doppelgangers is aimed at enhancing one's social cognition to align with the advocacy of prosocial behavior in the cognitive dissonance paradigm. With respect to these goals, the DELTA game was successful in reducing sexist attitudes right after the intervention, as the results show. Interestingly, such significant impact on sexist attitude was not observed in a "traditional" implementation of the cognitive dissonance paradigm through web forms, nor in the use of the DELTA game integrated with digital doppelgangers. This result has two implications. First, virtual role-play through simulation games seems to be an effective means to realize the cognitive dissonance paradigm for remote access. Decades of research on in-person dissonance-based interventions have indicated the efficacy of such an approach on behavioral and attitudinal change. However, in-person interventions are resource intensive. Virtual role-play through simulation games can be an alternative to reduce the cost by supporting remote access. Second, the integration of digital doppelgangers not only did not add to the efficacy of the DELTA game, but also failed to produce the significant impact on attitudinal change. This could be due to the distractions created by artifacts in the scans acquired through RACAS (Figure 5). New methods to create higher fidelity and more accurate 3D scans at even higher speed are already under way [16] and offer opportunities to improve the quality of the digital doppelganger for future implementations. However, other studies on digital doppelgangers created using RACAS also found that having avatars that look like the participants improved subjective experience, but made no difference on performance measures (e.g., running in a virtual maze with mines) [30].

Results on the behavioral measures (e.g., choice of deodorant and gift card) did not replicate the same trend as self-reported measures. While these measures are designed to offer participants comparable choices that only differ in the dimension of sexist attitude, in reality, other factors may have interfered with the participants' behavior. For example, differences in packaging of the deodorant, or convenience of shopping with the gift cards. Other types of behavioral measures are already under discussion. For example, participants can play the role of an investigator of a sexual harassment case. The questions asked by the participants during their interview of the defendant/victim can indicate a sexist attitude, such as victim blaming.

**Figure 5: Screenshots of the participants' digital doppelgangers acquired through RACAS in DELTA game.**

Additionally, the efficacy of the DELTA game in reducing sexist attitudes disappeared in the 6-week follow-up. This is consistent with decades of research on dissonance-based intervention that creating lasting long-term attitude and behavioral change remains a challenge to this day. Recent large-scale longitudinal studies have indicated the efficacy of repeated interventions on changes in ones' body image [41]. To reduce the cost of repeated interventions, internet-based intervention is being experimented with as well [40]. The DELTA game can be a potentially effective and low-cost means to deploy such repeated interventions remotely.

There are several limitations to the current work. The animation of the RACAS characters is limited to head, limbs and torso, while the face of the character is not animatable. This limited the application of such characters to dialogues in games, e,g., no lip syncing with speech. While the RACAS characters can be animated to show realistic human speech gestures, such as beat hand gestures, such behavior did not resemble the behavioral profile of a specific speaker, even though the appearance did. Research on methodologies to allow the face to be animated in addition to the body [10], and to create behavioral resemblance in addition to the appearance resemblance [32], are already underway. These advances provide great promise for future studies on the integration of digital doppelgangers with DELTA games to address other problematic behaviors.

In the mean time, virtual-role play simulation can be a useful tool for creating immersion, presence, and attitude change.

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