Towards Virtual Humans without Gender Stereotyped Visual Features

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ABSTRACT

Animations have become increasingly realistic with the evolution of Computer Graphics (CG). In particular, human models and behaviors have been represented through animated virtual humans. Gender is a characteristic related to human identification, so virtual humans assigned to a specific gender have, in general, stereotyped representations through movements, clothes, hair, and colors in order to be understood by users as desired by designers. An important area of study is determining whether participants' perceptions change depending on how a virtual human is visually presented. Findings in this area can help the industry guide the modeling and animation of virtual humans to deliver the expected impact to the public. In this paper, we reproduce using an animated CG baby, a previous perceptual study conducted in real life aimed to assess gender bias about a baby. Our research indicates that simply textually reporting a virtual human's gender may be sufficient to create a perception of gender that affects the participant's emotional response so that stereotyped behaviors can be avoided.

CCS CONCEPTS

• **Computing methodologies** → *Perception*; *Human-Computer Interaction*; *Animated Virtual Humans.*

KEYWORDS

human perception, virtual humans, virtual baby, gender bias

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1 INTRODUCTION

Computer Graphics (CG) has evolved in recent years and helped develop realistic CG characters. According to the Uncanny Valley theory [Mori et al. 2012], the more realistic an artificial human is, the more likely it is to cause discomfort to the observer. The discomfort is related to the perception of human likeness, being an identification issue, i.e., the humans perceive realistic characteristics in the virtual humans [Kätsyri et al. 2015]. For example, according to [Scott 2007; Wallach Scott 2010], gender characteristics are related to social and cultural constructions about "appropriate roles" for women and men. Regarding the scientific community of CG, there is much evidence of gender bias, skin color, etc [Dodik et al. 2022; Kim et al. 2022]. In [Draude 2011], authors claimed that simulated human likenesscould utilize human self-reliability, turning something abstract into comfortable. In this sense, the work of [Araujo et al. 2021]showed that women feel more comfortable with realistic female CG characters than with male characters, while men feel comfortable similarly with female and male characters. The characters were visibly male and female but would these results be similar if the virtual human had no gender identification? Still in relation to gender categorization [Draude 2011], a studied question is: Has Computer Science the potential to deconstruct the gender binary with virtual humans?

According to [Condry and Condry 1976], hypothetically, the chances of observing stereotypes in young children are lower than in adults. With this, babies are accepted as naturally "genderless", so the human bias measure can be considered with less interference. In the movies industry, specifically cartoons, female characters are usually more stereotyped [Garza et al. 2019] both in terms of visuals [1] and movement. Are these stereotypes positive? Are these exaggerations necessary for the recognition of a female character? Therefore, this work replicates and expands the work of [Condry and Condry 1976], in which the authors measured the perception of men and women about a video containing a real baby reacting to different stimuli. The authors separated the participants into two groups, one receiving the video of the baby with a male name and the other receiving the baby with a female name. The results showed that the indication of gender influences people's perception

[1] https://thedissolve.com/news/655-disney-animator-says-women-are-hard-to-draw-becaus/

through the name. We also expand the experiment using a third group of people who receives the unnamed virtual baby. Therefore, the following hypotheses are created and discussed in this text: *i)* $H0_1$ defining that women and men perceive emotions similarly in female, male, and unnamed animated virtual babies; and *ii)* $H0_2$ defining that the unnamed baby is recognized as genderless.

The main contributions are the investigation of human bias attributing gender to virtual humans and its impact on the perceived emotions. We use virtual babies because they are easily perceived as genderless [Condry and Condry 1976], and there is literature on gender bias observed in real life that can be used as a comparison.

2 RELATED WORK

According to [Scott 2007; Wallach Scott 2010], gender is a social and cultural construction built on stereotypes. For example, a pink shirt is assigned to a girl, while a blue shirt is assigned to a boy. So, a woman's self-identify as female had the construction of her feminine self based on a social standard of femininity. In this sense, in the work of [Will et al. 1976], the authors carried out a perceptual experiment with two groups of mothers, one group receiving a male baby with a male name and wearing an outfit considered male, and the other group receiving the male baby with a female name and dressed in clothing considered feminine. In one of the results, the group that received the baby with a female name presented more a doll than a train. Human perception is essential for the design of virtual humans [Zell et al. 2019]. In the two work by [Zibrek et al. 2013, 2015], the authors investigated the perception of gender of virtual humans about different emotional feelings and measured the effect on people's perceptions. The results indicated that participants classify the gender according to the emotion shown by the character. In this case, it was more evident when the motion had a stereotyped gender movement than when the character walked based on real human motion. In the work of [Bailey and Blackmore 2017], the authors assessed gender differences in the perception of avatars, and the results indicated that gender is relevant in the perception of emotions. Similar to the work of [Nag and Yalçın 2020], where the authors conducted a study to assess people's perception of male, female, and androgynous virtual humans, the authors evaluated the stereotyped assumptions of gender traits and roles in virtual humans. Results showed that gender stereotypes in the virtual humans were not perceived, and the androgynous virtual humans were perceived as a middle ground between gender stereotypes. It is important to emphasize that this work used other cues to present the gender, such as hair and neck size. On the other hand, the work by [Garza et al. 2019] presented a methodology to perform content analysis on the representation of characters in children's 3D animation movies. The authors noted that female characters and their emotional expressions are still developed to fit into patterns of social stereotypes, which are "easier" to introduce into 3D animated children's movies.

3 PROPOSED METHODOLOGY

First, explaining Condry and Condry's experiment, the authors presented to participants a video of a real 9-month-old baby sitting in a baby chair facing a mirror (with a camera mounted behind the mirror) and reacting to some objects. The baby had neutral clothes and no accessories to avoid gender stereotypes. Then, the authors separated the participants into two groups: a group receiving the baby with a female name and the other group receiving the baby with a male name. Thus, the authors asked the participants to use predefined scales to assess the baby's emotional levels. The main goals of the authors were to know whether the baby's gender influenced the perception of participants' emotions.

In the present work, we used a 3D model of a baby purchased on website [2] to replicate the previous work conducted in real-life. The model has animations of crawling, walking, and playing with a ball. In the original work, the authors reported that the baby reacted positively (smiled, laughed, reached out) to two objects and reacted negatively (turned away, stared, cried) to other two objects. Three stimulus objects were used for our virtual baby to interact. Firstly, the animation of the baby playing with a ball, which in our hypothesis was perceived as a positive reaction from the baby. Secondly, the possible negative reaction was hypothetically created using the same object as in the original work, i.e., a virtual model of a jack-in-the-box [3], which contains an animation of "Jack" jumping out of the box and back into the box. The crawl animation was used for the virtual baby to reach the jack-in-the-box, and a simple facial animation (mouths opened as in a surprise facial expression) was created (using the facial blendshapes of the baby). Regarding a object that caused a hypothetically neutral reaction, a 3D model of a colored unicorn[4] was used, and the virtual baby's reaction was to crawl in the opposite direction to the unicorn (without interest). The objects used in this work can be seen in Figure 1. Three videos as stimuli were created, each video for each object, to present to the participants. A virtual room was created to put context in the scene, and can be seen in Figure 1. The camera always remains in the same position, pointed at the window. At the beginning of the videos, the virtual baby always starts facing the camera and objects. The videos' duration is between 6 and 19 seconds and were sent to YouTube to be added to the questionnaire.

First, the participants (volunteers) were presented with the consent form approved by a Ethics Committee[5]. The questionnaire was created on the Qualtrics platform[6], distributed on social networks, and also had demographic information: age, educational level, gender, and familiarity with CG (games, movies, simulations etc). After this, three copies of the questionnaire were created, one containing the baby with a female name, and the others containing the baby with a male name, and the unnamed baby. We randomly selected one of the questionnaires for each participant. In an introductory text block, we presented the baby with the name[7], age and gender (or no name and gender). For each video, the participants were instructed to rate, on 11-Likert Scales (as in the original study), the pleasure, anger, and fear felt by the baby. This step aims to test the $H0_1$ hypothesis, and it provides a 2 (Women and Men responses) x 3 (Ball, Jack-in-the-box, and Unicorn) x 3 (Pleasure, Anger, Fear) x 3 (Female name, Male name, and Unnamed virtual baby) design structure. Finally, three questions about name, age and gender were

[2] https://www.cgtrader.com/3d-models/character/child/game-ready-baby
[3] https://www.blendswap.com/blend/27680
[4] https://free3d.com/3d-model/unicorn-doll-772526.html
[5] Research Ethics Committee of Pontifical Catholic University of Rio Grande do Sul, Brazil - Project Number: 46571721.6.0000.5336
[6] https://www.qualtrics.com
[7] We chose two popular names: Helena and Miguel.

(a) Ball (b) Unicorn (c) Jack-in-the-box

Figure 1: Environment and three objects that the baby interacts with: (a) the baby plays with the ball; (b) the baby crawls in a direction opposite to the unicorn; (c) the baby has a negative emotion seeing Jack jump out of the box (Jack-in-the-box).

asked to the participants (also based on the original work). However, only the question "What was the baby's gender?" is evaluated in this work, with "Female", "Male", and "I do not know" as possible answers, as it aimed to test hypothesis $H0_2$. This step was 2 (Women and Men responses) x 3 videos x 3 (questions about name, age, and gender) x 3 (Female name, Male name, and Unnamed).

4 RESULTS

The questionnaire was answered by 148 volunteers, being 79 women (25 received the female name baby, the male name had 24, and the unnamed had 30), 66 men (23 in female name, 23 in male name, and 20 in unnamed group) and three people who chose another option. [8] Regarding age, from 145, 105 people were younger than 36 years old. About education, 105 people completed undergraduate studies. 130 responded that they were familiar with CG. In the statistical analyses[9][10], we used the nonparametric tests: *Kruskal-Wallis*, *Mann-Whitney*, and *Chi-Square*, with 5% of significance.

Explaining the results related to hypothesis $H0_1$, Table 1 presents the averages of the emotional rating scales (11-Likert Scales) for all videos (Ball, Unicorn, and Jack-in-the-box). The columns represent the separate emotional scales (Pleasure, Anger, and Fear), and all emotions together[11]. The first four data columns refer to the answers of the participants who received the virtual baby with the female name, followed by the virtual baby with the male name, and the unnamed baby. Therefore, the first lines refer to women's answers, and the last lines refer to men's answers.

Concerning women population, in general, the emotional perception was higher for the female name than for the other groups in most cases. We found significantly different values in pleasure (.006) and global analysis (Avg Emotions) (.03). Furthermore, using a *Dunn* test as a *post hoc* with a *Bonferroni* correction, the women's perception of emotion (.03) and pleasure (.004) had the most significant difference in the comparison between the group that received the female name and the group that received the unnamed baby. Therefore, **we can say that the women perceived that the baby with a female name was more emotional, in general, and felt more pleasure than the baby with a male name and the unnamed baby. About the results of men**, the opposite happened, i.e., in most cases, the mean values were lower for participants who received the virtual baby with a female name. The *p*-values were significant in fear and in relation to all emotions "Avg Emotions" (.01). Regarding the *post hoc*, in the perception of all emotions (.01) and in the perception of fear (.03), the most different groups were the ones who received the groups of female and male names. Therefore, **we can say that the men perceived both the baby with a male name and unnamed as more emotional and feeling more fear than the female named baby. In general, it was more evident when we compared men's perceptions of the baby with male and female names.** Bearing in mind that the baby is the same for both women and men groups, only the name was changed. Comparing women and men, regarding emotions in general, we found significant values in the three groups (.006, .01, .01, respectively for female, male names, and unnamed). With this, we can say that **women perceived more emotion in the babies with a female name than men, and men perceived more emotion in the babies with a male name and unnamed than women**.

In relation to the name question, when the baby was not assigned a gender, 18 women (60% from the total) and 11 men (55%) responded that the baby was male. We compared the correct answers, i.e., "female" for who received the female name (88% for women and 86.95% for men), "male" for the male name (91.66% for women and 100% for men), and "I do not know" for without name (30% for both, women and men). We found no significant results, that is, **women and men were similarly correct when the babies were assigned a gender (female and male names), and were wrong in a similar way when the baby was not assigned a gender (unnamed baby). Even if the baby does not have visual gender stereotypes, people will still point out that it is male.**

4.1 Discussions

Concerning $H0_1$, our results indicate that the baby's gender through only a gendered name can impact how people perceive emotions, even if that baby does not have behavioral gender stereotypes. Our results agree with the work of [Condry and Condry 1976], who studied gender bias in real life. So, it is interesting to note that, apparently, we maintain our bias in virtual environments. It can be related to gender identification [Scott 2007], for example, women identify more with female virtual humans. This indicates that it

[8] We removed these three participants because this group was very small.
[9] https://www.statsmodels.org/dev/index.html
[10] https://docs.scipy.org/doc/scipy/index.html
[11] Note: The global analysis of emotions was also based on the original paper.

Table 1: The first four data columns correspond to the participants who received the questionnaire containing the baby with a female name, followed by the columns of the groups that received male, and unnamed names. In addition, "Avg Videos" states the average emotional rate value of the three videos together (Ball+Unicorn+Jack-in-the-box), and "Avg Emotions" presents the average value of all emotions together (Pleasure+Anger+Fear). The first three lines refer to women's data, and the last three refer to men's data.

Women												
	Female Name				Male Name				Unnamed			
Stimuli	Pleasure	Anger	Fear	Avg Emotions	Pleasure	Anger	Fear	Avg Emotions	Pleasure	Anger	Fear	Avg Emotions
Avg Videos	5.18	0.98	1.65	2.60	4.40	0.66	1.38	2.15	3.51	0.84	1.44	1.93
Men												
	Female Name				Male Name				Unnamed			
Stimuli	Pleasure	Anger	Fear	Avg Emotions	Pleasure	Anger	Fear	Avg Emotions	Pleasure	Anger	Fear	Avg Emotions
Avg Videos	4.34	0.54	0.98	1.96	4.94	1.04	1.85	2.61	5.11	0.88	2.03	2.67

is possible to deconstruct gender stereotypes through virtual humans, as mentioned by [Draude 2011]. In our opinion, this could mean the industry does not need to create stereotyped animated virtual humans to convey gender. About the $H0_2$, most participants who received the unnamed baby defined the virtual baby as male, i.e., there is a gender bias, both in the real-life and virtual experiments. In the work of [Nag and Yalçın 2020], men and women participants had similar successes and errors concerning female, male, and androgynous characters' gender classification. In our case, most participants were more wrong than correct when trying to guess the gender of the unnamed baby compared to the other groups. While we only informed (textually) the gender of a virtual human without visual identifications, i.e., our virtual human was always the same, in [Nag and Yalçın 2020], the authors used visual identifications to differentiate the virtual humans. It shows that in both cases, the cues (textual or visual) impact the participants' answers, creating gender determination, as expected. On the other hand, the errors obtained in our work to guess the gender of the unnamed baby seem consistent with a gender bias in the participants' answers. Therefore, in our opinion, the CG community can revisit the stereotypical visual aspects and propose different ways of modeling and animating virtual humans, perhaps deconstructing the binary gender or reinforcing it, if desired. The most important thing is that all people have good experiences with virtual humans.

5 FINAL CONSIDERATIONS

This work evaluated whether human perception is influenced by virtual humans assigned gender. We recreated the work of [Condry and Condry 1976], but using a virtual baby. Our results were similar to the original paper, that is, women perceived more emotions in a baby named female, and men perceived more emotions in babies with a male name and unnamed babies. Furthermore, the participants who received the unnamed baby defined that this baby was male, even though the baby did not have gender stereotypes. We believe this subject has relevant material for the CG community. Suppose a designer wants to represent a specific gender. In that case, he/she can avoid building strong gender animated stereotypes and use more neutral animations since gender can be inferred based on other aspects, like names and visual cues. It can also impact the rendering and the models themselves because, as our method discusses, some of our perception processes are due to human conventions and bias. It is important because stereotyped animations can sometimes reinforce negative aspects, so avoiding stereotypes and, at the same time, keeping the designers' intentions can be very relevant. This discussion can help build a CG that is more inclusive and representative of people's diversity.

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