# It's in Their Eyes: A Study on Female and Male Virtual Humans' Gaze

Philipp Kulms[1], Nicole C. Krämer[1], Jonathan Gratch[2], and Sin-Hwa Kang[2]

[1] University of Duisburg-Essen, Forsthausweg 2, 47048 Duisburg, Germany
philipp.kulms@stud.uni-due.de, nicole.kraemer@uni-due.de
[2] Institute for Creative Technologies, 12015 Waterfront Drive, Playa Vista, CA 90094, USA
{gratch,kang}@ict.usc.edu

**Abstract.** Social psychological research demonstrates that the same behavior might lead to different evaluations depending on whether it is shown by a man or a woman. With a view to design decisions with regard to virtual humans it is relevant to test whether this pattern also applies to gendered virtual humans. In a 2x2 between subjects experiment we manipulated the Rapport Agent's gaze behavior and its gender in order to test whether especially female agents are evaluated more negatively when they do not show gender specific immediacy behavior and avoid gazing at the interaction partner. Instead of this interaction effect we found two main effects: gaze avoidance was evaluated negatively and female agents were rated more positively than male agents.

**Keywords:** female & male virtual agents, eye contact, gender differences, gender stereotypes, empirical evaluation.

## 1 Introduction

The effects of virtual agents have been analyzed in numerous evaluation studies [1, 2]. The influence of various agent characteristics such as [nonverbal] behavior and appearance on acceptance, perceived and actual efficiency as well as on their power to elicit social reactions on the part of the user has been established empirically. However, one of the most important categories of human everyday life and the question whether its effects are also transferrable to the interaction with agents has not been studied in depth: Gender. While studies of course frequently assess and consider whether female users' reactions differ from those of male users [3], the systematic manipulation of the agent's gender has not received sufficient attention (for an exception see [4]). To have knowledge on the differential effects of female and male agents, however, is all the more important as the agent's gender might not only have an influence per se but might also affect how the agent's behavior is perceived and evaluated. Here, social psychological research has demonstrated that the same nonverbal behavior will elicit different attributions, judgements and reactions depending on whether it is shown by a man or a woman. In a seminal study, Deutsch et al. [5] provided evidence that women who do not smile are socially less accepted than men if they do not smile: they are associated with less happiness and carelessness compared to men. The authors explain

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their finding with the fact that – due to gender stereotypes and due to the fact that women indeed show more smiles and immediacy behavior in everyday life – women clearly are expected to smile whereas for men, smiling and other immediacy behaviors are positive deviations from the norm. The objective of the present study is to test whether this pattern can also be observed for female and male virtual agents. The nonverbal cue we use here is gaze. Like smiling, gaze is a fundamental cue for intimacy [6] and immediacy [7] and is also shown more frequently by women than by men.

In order to gain insights into gender specific perception of virtual humans we used our well established framework that has already been capable of showing the potential of Embodied Conversational Agents to establish rapport [8, 9]. The Rapport Agent framework draws on psychological findings, identifying mutual attentiveness, positivity (mutual friendliness) and coordination as key elements for facilitating rapport [10]. To rely on these principles allowed us to vary two different forms of gaze of the Rapport Agent while maintaining a basic level of fluent interaction. Additionally, we varied the agent's gender, so that in a 2x2 experimental setting we were able to test whether the evaluation of specific behaviors is dependent on the agent's gender.

## 2 Theoretical Background

**Gaze.** During nonverbal communication, it is the face that strongly stands out from the rest of our body and that plays the most important role [11]. Facial expressions serve a variety of purposes: they coordinate social interactions, reflect a person's emotional state and his or her behavioral intentions [12]. Among the facial parts that are involved in these expressions, a lot of attention is allocated to the eyes [7, 13]. People are highly accurate when it comes to interpreting direction and target of gaze [14] and they have almost no problem in telling whether they are looked at [15]. Why is gaze decisive in the context of interpersonal communication? According to Richmond et al. [13], the characteristics of gaze are salience, arousal and involvement. In a face-to-face situation the gaze draws the interlocutor's attention, because it is a vital source for information (e.g., by providing feedback and signalling if the channel is open [6]). It does not matter whether the relation between two communicators is positive or negative: when their eyes meet, both feel arousal as a direct result. Also, gaze is an important feature for facilitating immediacy and rapport [7, 10].

**Gender and Gender Stereotypes.** As Duncan states, the most important variable with an influence on gaze appears to be gender [16]. Women establish more eye contact than men [17, 18] and they look at their interlocutor more often while listening and speaking [13]. Exline et al. [18] explain their findings with females' stronger need for inclusion and affection in interpersonal relations. Here, support is provided by same-sex interaction patterns, identifying females to be more likely to show affectionate behavior such as involvement and immediacy through gaze, gesture and body orientation [19]. This is in line with findings that women in general show more nonverbal immediacy cues (such as e.g. smiling [17]).

Women do not only show more immediacy, e.g. by means of smiling or gaze, they are also expected to show immediacy to a larger extent, whereas male communicators are seen as less skilled [20]. However, if women's nonverbal behavior is not congruent with the stereotypes that society holds about them, women are faced with rather harsh judgements. Deutsch, LeBaron and Fryer [5] showed that the examination of non-smiling female faces displayed on photographs evoked more negative evaluations than non-smiling male faces. Men, as opposed to women, do not have to fulfill comparable behavioral expectations, because they are nonexistent in their case. Thus, men are not perceived to reveal a negative emotional state if they do not smile, as non-smiling men are seen as the norm, whereas women are perceived to deviate from the norm when they are not smiling [5]. This means that the same behaviour is judged differently dependent on whether it is shown by men or women. This has also been demonstrated for gaze behaviour: In a job interview setting that incorporated different levels of gaze and changing reward values through applicants' status, judgements of female applicants differed significantly from judgements of male applicants. When the applicants were presented as high status, high gaze rates led to attributing submissiveness to females and dominance to males. When the status of applicants was low, the pattern was reversed: high gaze females were perceived as dominant, whereas high gaze males were seen as submissive [7]. What has not been analyzed so far is whether similar to the study of Deutsch et al. [5], who demonstrated this for the immediacy cue smiling, women will also be penalized when they do not show the immediacy behaviour of frequent gaze.

The results depicted above have been explained by the ubiquitousness of gender categories in social cognition [21] and the fact that (gender) stereotypes are activated automatically and are hard to suppress [22]. Given that it has already been shown that gender stereotypes are applied in human computer interaction even when gender is manipulated rather superficially by using male versus female voices [23] our objective here is to analyse whether gendered virtual humans evoke gender-related attributions and whether, more importantly, this leads to a differential evaluations of the same behaviour.

Based on the considerations presented above, we first expect gendered female and male agents to evoke gender-specific attributions (H1). Given the results on gaze behavior in previous studies we expect agents who gaze at the interaction partner to be evaluated more positively than agents who avoid looking at the human interlocutor (H2). Additionally, an interaction between the agent's gender and its gaze should occur: Eye contact avoiding behavior leads to significantly more negative judgements of the female agent, whereas normal gaze will not result in any differences between the male and the female agent (H3).

## 3 Method

### 3.1 Experimental Design

The study was based on a 2x2 factorial design (N = 72), with two conditions for each factor. The first factor, gaze of the agent, determined the behavior of the Rapport Agent and was added to its rapport engine. The second factor, gender of the agent,

manipulated the Rapport Agent's gender. Participants were assigned randomly to one of the four conditions.

### 3.2 Participants and Procedure

74 participants were recruited from the Greater Los Angeles Area. Due to software issues, two sessions were declared invalid, resulting in 72 valid sessions that were entered into the final dataset (40 female, 32 male). The mean age of the sample was 35.03 (*SD* = 12.11), the range between 19 and 59 years. Recruitment of participants was conducted online via Craigslist.com. After a one hour session, each participant received $20 for compensation.

Participants were led to the laboratory at the ICT facility, starting with the pre-questionnaire that included demographic data and the explanatory variables. Next, they were seated in front of a 34" monitor. Below the monitor, a camcorder and a stereo camera system were fitted to record the participant during his/her interaction with the Rapport Agent. In order to be able to talk to the agent and to hear its voice, participants wore a headset with two headphones and one microphone. The investigator monitored the interaction from an adjacent room. Next, the Rapport Agent asked five questions to establish an interview-like conversation that required self-disclosure by the participant [24]. Prior to the actual questions, the agent itself revealed somewhat personal information according to the degree of intimacy of the subsequent question to support self-disclosure answers [25]:

1. I was designed and built by ICT researchers here in Marina del Rey. What is your hometown?
2. When I don't interact with people, I usually study them so I can better communicate with them. What are your favorite things to do in your free time?
3. I like to listen to what people say. I have lots of patience for listening, even if you have a lot to say. What characteristics of yourself are you most proud of?
4. I feel furious when people treat me as if I was just a machine without any thinking of feeling. What are some of the things that make you furious?
5. My abilities are somewhat limited. For example, I can speak and listen to what you say, but I can't walk down a street in your world. What are some of the things you hate about yourself?
6. That's all I have, thank you.

Question #5 was added starting with the eighth participant to lengthen the total answer time. When the participants felt their answer on a question was complete, they were instructed to press the space bar on the keyboard to indicate that they are ready for the next question. The investigator then triggered the next question. The investigator's role, however, was not evident to the participants. After the interaction, participants completed the post-questionnaire and with that, finished the experiment. They were fully debriefed and thanked for their participation.

### 3.3 Measures

**Independent Variables.** We manipulated gaze (*low gaze* vs. *high gaze*) and gender of the agent (*female* vs. *male*). In the *low gaze* condition, the agent looked at the speaker only very few times while listening to her or him, resulting in little overall eye contact, whereas in the *high gaze* condition, eye contact was held most of the time.[1] To ensure that the measured judgements and the participant's behavior are not based solely on the agent's optical appearance and voice, two female and two male versions were employed, each with unique graphical designs and voices.

**Quantitative Measures (post-questionnaire).** We assessed participants' emotional state with the Positive And Negative Affect Scale (PANAS) [26], consisting of 10 items for positive and 10 items for negative emotions, rated on a 5-point Likert scale (e.g. nervous, excited, distressed). Person perception of the agent was assessed with a semantic differential that incorporated 26 bipolar adjectives (e.g. arrogant – modest, unfriendly – friendly), rated on a 7-point scale [27]. The Bem Sex Role Inventory (BSRI) [28] was used to measure whether participants ascribed rather feminine or masculine attributes. Accordingly, the BSRI incorporates a femininity (e.g. yielding, affectionate, understanding) and a masculinity dimension (e.g. forceful, dominant, analytical), 20 items each, as well as 20 filler items (e.g. conventional, inefficient, truthful).

Participants also rated the social presence of the agent. We used the 5-item social presence survey by Bailenson, Blascovich, Beall and Loomis [29] (e.g. I feel that the person is watching me and is aware of my presence) and the Networked Minds Questionnaire (NMQ) [30]. As for the NMQ, we used five subscales: Empathy (four items, e.g. I was influenced by my partner's moods), Mutual awareness (two items, e.g. The other individual didn't notice me in the room), Attention allocation (four items, e.g. I paid close attention to the other individual), Mutual understanding (three items, e.g. My opinions were clear to the other) and Behavioral interdependence (four items, e.g. The behavior of the other was in direct response to my behavior). The social presence scales were rated on 7-point Likert scales.

**Qualitative Measures.** Participants' answers to the Rapport Agent's questions were subject of a qualitative analysis. We used a coding scheme to identify different degrees of intimacy within the answers to question 4 ("What are some of the things that make you furious?") and 5 ("What are some of the things you hate about yourself?"): (a) No intimacy answer: the infuriating aspect or the personal characteristic has not affected the private or business life of the participant, (b) Low-intimacy answer: the infuriating aspect or the personal characteristic has somewhat affected the private or business life of the participant, (c) High-intimacy answer: the infuriating aspect or the personal characteristic has strongly affected the private or business life of the participant. We counted the number of times that each category occurred. Moreover, we counted the times that participants verbally referred to what the agent told them, e.g. by saying "I agree", "Probably the same thing", "Thank you", "I also think I'm a good listener" etc.

[1] We are aware of the fact that a reliable manipulation of eye contact cannot be accomplished by only manipulating the Rapport Agent's gaze, as the participant's gaze clearly holds the second prerequisite for the occurrence of eye contact.

**Explanatory Variables.** Because the participants are to some extent asked about intimate information by the Rapport Agent, we measured shyness [31]. Empathy was assessed with the Interpersonal Reactivity Index [32], since empathic persons often are interpersonal sensitive towards nonverbal cues [33]. Moreover, we looked at emotional sensitivity, by means of the corresponding subscale of the Social Skills Inventory [34]. Emotional sensitivity can be described as the ability to associate nonverbal cues correctly with underlying emotions [33].

### 3.4 The Rapport Agent

The Rapport Agent captures real-time audiovisual data to show nonverbal backchannel behavior. A signal processing package analyzes pitch and intensity of the speaker's speech signal [8] and an image-based tracking library [35] uses the stereo images that are captured by a Videre Design Small Vision Stereo Camera System which is placed in front of the speaker. Watson detects the speaker's upper-body movement. Combined with the voice features input, the Rapport Agent is able to produce listening behaviors like head nods and mirrored posture shifts [8].

Next to the stereo camera, also in front of the speaker, a high-definition camcorder was positioned. The sessions were videotaped to assess the participant's behavior. The animated Rapport Agent was displayed on a 34" monitor. Audiovisual monitoring of the sessions was ensured by means of an Internet camera.

In order to alter the Rapport Agent's gaze in a way that it shows eye contact avoiding behavior it was necessary to design cues that communicate avoidance in a salient way yet do not fall outside norms of conversational behavior. The choice of 0% eye contact in the *low gaze* condition and 100% eye contact in the *high gaze* condition would surely have maximized the manipulation's effect on the measured dimensions, but such an approach does not resemble natural social interactions [36]. Instead, empirical research has identified patterns of gaze behavior of speaker as well as listener (e.g., the listener looks more at the speaker than the other way round, gaze is used to indicate the yielding of a turn [37, 38].

These considerations made it necessary to implement dynamic patterns of the Rapport Agent's gaze instead of scripted or randomly triggered behavior. Because we were able to detect rich and elaborate data from the speaker's voice, we decided to use the participant's verbal utterances as key trigger. In the *low gaze* condition we used some of those cues that in the normal version of the Rapport Agent are used as triggers for backchannel behavior as triggers for avoiding gaze instead. Additionally, in the *low gaze* condition, the agent's focus already drifted away while asking the questions. Shortly before finishing the questions, the agent looked back at the speaker in order to yield the turn. Gaze aversion not only included eye movement to an alternative target in the virtual environment, but also head motion towards the same target. Figure 1 shows an example. The eyes were configured to reach the target shortly before the head, not simultaneously, to increase naturalness.

In the *high gaze* condition, the agent's head was kept steady, except for head nods. Gaze aversion during the questions was reduced to a minimum and the gaze only incorporated one target, whereas, in the *low gaze* condition, there were two targets in a row. In the *high gaze* condition, the agent gazed away once after several seconds had passed, in order to not show 100% eye contact.

**Fig. 1.** Four different appearances of the Rapport Agent in the *low gaze* condition, after gaze aversion has been triggered. Eyes and head are moved towards an alternative target.

**Adequate Gaze Behavior.** In order to avoid a simple stimulus response pattern as foundation of the whole interaction and to minimize predictability, we included a natural temporal element given by an exponential distribution that reflects the variable probability of a given event over time [39]. As a result, the agent did not gaze away instantly when the participant's cue occurred.

**Pretest.** Since we used four different appearances of the Rapport Agent, many of which were previously unevaluated, we conducted a pretest with the BSRI. It was assumed that for the female agents, femininity ratings are significantly higher than masculinity ratings and vice versa for male agents. In a within-subjects design, participants were asked to look at four 7" x 9" color photographs, each showing the frontal view of a different agent as participants in the main experiment would look upon them, and to rate the displayed agents on the BSRI. 14 participants completed the task. Their age ranged between 23 and 45 years ($M$ = 31.14, $SD$ = 8.00).

## 4 Results

Based on the BSRI, we evaluated the stereotyped gender that was attributed to the agents. We calculated femininity and masculinity scores for the agents and compared them with one another. The reliability of the two subscales was very high, as the results for Cronbach's α in the main experiment indicate: α = .93.

**Pretest.** After combining the BSRI ratings to a female and a male agents' dataset, a Repeated Measures Analysis of Variance (RM-ANOVA) was calculated. We found a significant overall effect ($F(3,39) = 40.13$, $p < .001$, part. $\eta^2 = .76$). Pairwise comparisons with Bonferroni correction showed that the male agents ($M = 5.24$, $SD = .66$) were judged to be more masculine than the female agents ($M = 3.5$, $SD = .67$), $p < .001$, and that the female agents were judged to be more feminine ($M = 4.42$, $SD = .51$) than the male ones ($M = 3.31$, $SD = .40$), $p < .001$. Hypothesis 1 was confirmed in the pretest.

**Main Experiment.** We calculated a Multivariate Analysis of Variance (MANOVA) with the BSRI femininity and masculinity scores as dependent variables and gender of the agents and, additionally, gaze as independent variables. The effect that we found in the pretest was not replicated in the main experiment. Here, the assignments of female and male attributes were not influenced by the agent's gender. Thus, hypothesis 1 was not confirmed. There was, however, a significant effect for gaze ($F(1,68) = 10.44$, $p < .01$, part. $\eta^2 = .13$): In the *high gaze* condition ($M = 4.78$, $SD = 1.05$), the agents were judged as more masculine (that is, e.g., more forceful, assertive and independent) than in the *low gaze* condition ($M = 3.94$, $SD = 1.15$).

We conducted factor analyses (principal components, varimax rotation) for all dependent measures except for the social presence survey that only included five items. Person perception ratings resulted in three factors: *Negative evaluation* (α = .921, explains 28.49% % of the variance), *Positive evaluation* (α = .810, 15.26%) and *Weakness* (α = .828, 14.09%). See Table 1 for factor loadings and communalities. The PANAS factor analysis also led to three factors of which only two were consistent: *Positive emotions* (α = .88, 23.74%) and *Negative emotions* (α = .79, 15.88%). The factors *Consciousness of the partner* (α = .80, 20.03%), *Influence of the partner* (α = .74, 16.96%) and *Influence on the partner* (α = .74, 16.54%) resulted after the NMQ factor analysis.

Therefore, a total of nine dependent variables, eight factors and the mean values of the social presence survey, were entered into a MANOVA. The independent variables again were gender and gaze behavior of the agent. There were two main effects for gender: First, results of the person perception factor *Positive evaluation* indicate that the female agents ($M = .29$, $SD = 1.01$) were judged more positively than the male ones ($M = -.28$, $SD = .93$): $F(1,67) = 5.67$, $p < .05$, part. $\eta^2 = .08$. The second main effect was only marginal and referred to the social presence dimension. During the interaction with the male agents ($M = 3.16$, $SD = .97$), the feeling of communicating with a self-conscious partner was marginally higher compared to the female agents' sessions ($M = 2.69$, $SD = .98$), $F(1,67) = 3.77$, $p = .052$, part. $\eta^2 = .06$.

There was also one main effect for the gaze condition that confirmed hypothesis 2: The agents in the *low gaze* condition ($M = .19$, $SD = .88$) were judged more negatively than in the *high gaze* situation ($M = -.27$, $SD = .98$), with respect to the

**Table 1.** Factor loadings and communalities based on a principal components analysis with varimax rotation for the 26-items semantic differential (person perception)

*Note.* Factor loadings < .400 are suppressed.

| Item | *Negative evaluation* | *Positive evaluation* | *Weakness* |
|---|---|---|---|
| Aloof | .811 | | |
| Unapproachable | .749 | | .412 |
| Unsympathetic | .738 | | |
| Unpleasant | .723 | -.416 | |
| Callous | .700 | -.404 | |
| Unfriendly | .696 | | |
| Detached | .672 | | |
| Sleepy | .669 | | |
| Mature | -.640 | | |
| Dishonest | .590 | | |
| Unintelligent | .590 | | |
| Modest | | .778 | |
| Soft | | .768 | |
| Not conceited | | .652 | |
| Non-threatening | | .636 | |
| Permissive | | .562 | |
| Nervous | | | .862 |
| Shy | | | .726 |
| Relaxed | | | -.652 |
| Cheerful | -.488 | | -.603 |
| Naive | .526 | | .556 |

factor *Negative evaluation* ($F(1,67) = 3.78$, $p < .05$, part. $\eta^2 = .06$). No interaction effect emerged. Therefore, hypothesis 3 was not supported.

In the next step, we entered the ratings for *shyness*, *empathy* and *emotional sensitivity* as covariates into a Multivariate Analysis of Covariance (MANCOVA). We also added gender of the participants as third independent variable into these analyses. Scores for empathy and emotional sensitivity were calculated according to the scale instructions. Both scales correlated significantly with each other ($r = .55$, $p < .001$). A factor analysis led to one consistent *Shyness* factor ($\alpha = .73$, 30.44% of variance explained).

We found one main effect for gender of the participants. Among female participants ($M = -.20$, $SD = .15$), less positive emotions were elicited than among male ones ($M = .34$, $SD = .17$), with respect to the factor *Positive emotions*: $F(1,57) = 4.21$, $p < .05$, part. $\eta^2 = .08$. The covariates empathy ($F(1,57) = 2.71$, $p = .079$, part. $\eta^2 = .05$) and emotional sensitivity ($F(1,57) = 3.12$, $p = .06$, part. $\eta^2 = .06$) marginally explained this effect.

Because the data we gained through the qualitative analysis did not qualify for T tests, we conducted Mann-Whitney U tests for the independent variable gaze. In the *high gaze* condition (Mean rank = 40.71, Sum of ranks = 1465.50), participants uttered significantly more verbal references to the agent, e.g. by saying “You’re welcome”, “It’s been fun” etc. ($U = 496.50$, $p < .05$), compared to the *low gaze*

condition (Mean rank = 32.29, Sum of ranks = 1162.50). Mann-Whitney U tests for the independent variable gender of the agent did not show any significant results.

## 5 Discussion

Instead of observing the expected interaction of gaze and gender, we only found several main effects for gender and gaze. This might indicate that actual behavior and its evaluation is more important for evaluation than gender stereotypes. This is supported by the result that – as opposed to the pretest that used still pictures – in the main experiment, participants neither ascribed more masculine attributes to the male agents nor more feminine attributes to the female agents. This means we must consider the nature of a real interaction that features enhanced communicative cues. In such a context, there are a lot more influences on gender typing processes. Stereotyped attributions become less important as the perceiver now can interpret the actual behavior, which, in our case, was shaped by gaze aversion.

Our result may serve as an indicator for a rather moderate prevalence of social stereotypes in human computer interaction. The experiment conducted by Nass et al. [23] which showed an activation of gender stereotypes even in a cue reduced setting may have benefited from the absence of actual nonverbal behavior.

Our experiment documents negative evaluations that virtual humans receive if they show a lack of immediacy that can also be described as a lack of interest. Higher ratings were especially found for masculinity of the BSRI which is known for the fact that masculine and socially desirable attributes are confounded. Interestingly, however, these evaluations were limited to a person perception dimension and were not accompanied by negative emotional reactions, by low perceptions of social presence or by fewer intimate answers. The connection between these three dimensions and person perception appears not to be very close in the context of immediacy. Apparently, participants did not feel constrained while answering the Rapport Agent's intimate questions in the *low gaze* condition, probably as a result of the backchannel behavior that was still used in order to facilitate rapport. These backchannel behaviors may also have provided a basic level of mutual understanding and behavioral interdependence from the participants' perspective. Despite the missing role of emotions, and in line with previous results that women are less experienced with computer technology and show different reactions [3], there were overall less positive emotions among female participants. We found somewhat weak indicators that women's higher sensitivity for nonverbal behaviors is responsible for this finding. Accordingly, it seems more important for women to communicate with an agent that facilitates immediacy, especially in a self-disclosure setting, but then again, the explanatory result needs more support.

The seemingly low prevalence of emotions and social presence appears to only hold for the emotional dimension, as our analysis of the users' behavior indicates reactions among participants that do reflect social presence of the agent in the *high gaze* condition. In this condition, we found significantly more verbal responses to the agent, even when the agent did not explicitly expect a response. The connection between immediacy and social presence, was, however, not evident with regard to the self-report data.

The gaze pattern that was shown by the Rapport Agent in the *low gaze* condition resembles the submissive gaze pattern that was used by Kipp and Gebhard [40]. The authors showed that if their avatar averted eye contact most of the time, for example immediately after it had been established, the avatar was perceived as submissive. It was, however, not judged more negatively in terms of likability or naturalness, which means that submissiveness seems not to be an explanatory variable for our person perception results.

Not only did we not find any support for a gender induced disadvantage for female agents as a result of their nonverbal behavior – in fact, they were able to overall receive more positive judgements than the male agents. This is interesting from an applied perspective and might be used for future design decisions. Further studies should investigate whether female virtual humans indeed have the potential of being more desirable communicators in specific contexts.

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