Social evaluations of embodied agents and avatars

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\title{ABSTRACT}

The purpose of this study was to examine social evaluations (i.e., perceptions of empathy and positivity) following peoples’ interactions with digital human representations. Female research participants engaged in a 3-min interaction while immersed in a 3-D immersive virtual environment with a “peer counselor.” Participants were led to believe that the peer counselor was either an embodied agent (i.e., computer algorithm) or an avatar (i.e., another person). During the interaction, the peer counselor either smiled or not. As predicted, a digitally-rendered smile was found to affect participants’ social evaluations. However, these effects were moderated by participants’ beliefs about their interaction partner. Specifically, smiles enhanced social evaluations of embodied agents but degraded them for avatars. Although these results are consistent with other findings concerning the communicative realism of embodied agents and avatars they uniquely demonstrate that people’s beliefs alone, rather than actual differences in virtual representations, can impact social evaluations.

1. Introduction

Facial expressions play an important role in communication and social interaction. Facial displays express participants’ emotional states, involvement, responsiveness, understanding, and validate their thoughts and feelings (Bavelas, Black, Lemery, & Mullett, 1986; Fridlund, Ekman, & Oster, 1987). As a pervasive facial expression, smiling has received considerable attention in the literature. The ability to smile and to recognize a smile is well-developed early in life (Srofe & Waters, 1976). Moreover, a smile is a readily understood gesture of friendliness (Thompson & Meltzer, 1964) and is an important antecedent to interpersonal attraction (Byrne, 1971). Smiling affects the ways individuals are perceived and evaluated by others (Lau, 1982; Reis et al., 1990). There are many types of smiles and subtly different ones are associated with different feelings and functions. Ekman and Friesen (1982), for example, distinguished between Duchenne (i.e. genuine) and non-Duchenne (i.e. false) smiles and noted that Duchenne and non-Duchenne smiles involve different facial muscles. Although research examining the effect of different kinds of smiles on social evaluations is limited, Frank, Ekman, and Friesen (1993) found that individuals can reliably distinguish between Duchenne and non-Duchenne smiles and that Duchenne smiles are associated with more positive impressions and evaluations of others.

In the current study, female research participants engaged in a short session with a peer counselor within an immersive virtual environment. Participants’ beliefs about their interaction partner were manipulated. Half were told that they were interacting in real-time with a digital representation of one of our undergraduate research assistants. In this condition, both the participant and research assistant were represented by a 3-dimensional virtual human or avatar, which is a digital representation of another actual person in real time. The other half were led to believe that their peer counselor was a computer-generated “embodied agent” (a digital representation of a computer algorithm designed to look like a person; Blascovich et al., 2002). During the interaction, the digital peer counselor either smiled when it was socially appropriate to do so, or never smiled. The digitally rendered smiles were animated so as to approximate a Duchenne smile. Following the interaction, research participants evaluated their peer counselor on a number of dimensions including perceived empathy and positivity.

1.1. Study goals

Although there is much research examining how communicative realism – the extent to which a virtual human acts like a real person – affects the way people evaluate and respond to virtual humans (Bailenson, Blascovich, Beall, & Loomis, 2003; Bailenson et al., 2005; Baylor & Soyoung, 2009; Blascovich, 2002; Blascovich & Bailenson, 2011; Fridlund, 1991; Garau, 2003; Guadagno, Blascovich, Bailenson, & McCall, 2007; Von der Pütten, Krämer, Gratch, & Kang, 2010), most previous research examining communicative realism has focused on the role of eye gaze or head movements. Much less is known about how the inclusion of facial non-verbal
behaviors affect evaluations of embodied agents compared to avatars. Thus, this study adds to the existing literature by examining a socially-important non-verbal behavior, namely smiling, and compares people's reactions to identical digitally-rendered smiles that are exhibited by embodied agents and avatars.

1.2. Predictions

Based on previous research examining the effect of smiling on social evaluations (Lau, 1982; Reis et al., 1990; Srofe & Waters, 1976; Thompson & Meltzer, 1964), we expected participants to evaluate virtual humans more positively when the latter smiled than when they did not. We also expected an interaction between the presence of smiles on the part of virtual humans and participants' beliefs regarding the virtual humans with whom they interacted.

Previous research has shown that communicative realism manipulations such as mimicry (Bailenson, Yee, Patel, & Beall, 2008; Stel et al., 2010) sometimes affect people's perceptions and evaluations of embodied agents and avatars differently (Bailenson et al., 2003; Guadagno et al., 2007). As a result of these prior research findings, we were interested in examining the effect of smiling and agency beliefs (i.e., beliefs about whether one's virtual partner was a human or computer) on social evaluations such as perceived empathy and positivity. Given its social nature (Fridlund, 1991), smiling may have a greater impact on people when they believe they are interacting with another person, an avatar, relative to a computer, an agent. Thus, we might expect smiling to result in more positive evaluations for avatars. However, research has also shown that the fidelity of representations of actual others enters the mix (Slater & Steed, 2001). Because people may be more sensitive to the slightest imprecision in animations of avatars compared to agents, we might expect even slightly imperfect renderings of avatars' facial expressions to elicit less positive or even negative feelings. Given these competing hypotheses that we examined in the interaction between smiling and agency beliefs without making an a priori directional hypothesis in terms of smiling effects on interactants by avatars vs. agents.

2. Method

2.1. Participants

Participants were 38 undergraduate women whose average age was M = 20.2 (SD = 1.55). They received psychology course credit or were paid for their participation. Owing to women's greater sensitivity to non-verbal behavior (Hall, 1978), we only used female participants. This provided us with a methodologically cleanest test of our hypotheses.

2.2. Design

A 2 (Type of Interaction Partner: agent vs. avatar) X 2 (Smile Condition: present vs. absent) between-subjects factorial design was employed. Type of interaction partner referred to participants' beliefs about whether their interaction partner was a computer algorithm (embodied agent) or an actual person in real time (avatar). The smile condition, reflected whether the virtual peer counselor smiled (smiles present) or not (smiles absent).

2.3. Procedure

Participants were greeted by a female experimenter, blind to condition, and escorted to a private room. After providing consent, participants completed the first part of the study on a desktop computer. Participants read information on the computer research involving digital virtual humans and the difference between an avatar and an embodied agent was explained. They were also informed that immersive virtual environment technology (IVET) had advanced such that it was difficult for people to tell whether they were interacting with a computer or another person.

Participants were told that they would be discussing a personal topic with a digital representation of a peer counselor in an immersive virtual world and that following their interaction they would provide feedback about their partner and the interaction. They were presented with three discussion topics (aspects of yourself that make feel you uncomfortable or embarrassed; an event that damaged your sense of self-worth; or problems with a past or current relationship) and were asked to rank them in the order of discussion preference. Everyone discussed her second-choice topic. Next, participants were given 3 min to prepare by identifying their discussion points.

Participants assigned to the avatar condition were told that their peer counselor, “Beth,” was an undergraduate research assistant who would join them in a virtual world and that both of them would be represented by a 3-dimensional virtual human during their real-time interaction. Participants in the embodied agent condition, were told that they would be interacting with a peer counselor named “Beth” and they were asked to imagine what it would be like visit a counseling-oriented website to discuss their thoughts and feelings with a computer-generated counselor who looked and acted like Beth. Regardless of condition, all participants actually interacted with a human research assistant, blind to condition, who was trained to respond in a consistent manner during the interactions.

After the partner type manipulation, participants were brought into another room for the peer counseling session. To provide the participant with privacy, the experimenter left the room after helping her don a head-mounted display. During the session, the research assistant “smiled” via the digital representation when it was socially appropriate to do so by pushing gamepad button. In the smiles enabled condition, the button triggered a smile response on the virtual human. In the smile disabled condition, nothing happened when she pushed the button. After the interaction, participants filled out post-interaction measures using RiddleMeThis (Loewald, 2009), were debriefed, and released.

2.4. The virtual environment

All participants were immersed in the same 3-dimensional virtual world for their interaction and they all interacted with the same peer counselor. The virtual environment and virtual human bodies were created using 3D Studio Max and Blaxxun Avatar Studio, respectively (see Fig. 1). The heads and faces of the virtual humans were created using 3D Me Now Software (see Fig. 2). The selected face was rated as above average on a variety of interpersonal traits (i.e., warm, kind, supportive, open-minded, attractive, intelligent, etc.) during pre-testing.

2.5. Equipment

Participants and the research assistant donned Virtual Research V8 stereoscopic head mounted displays (HMDs). The HMDs featured dual 680 horizontal by 480 vertical pixel resolution LCD panels that refreshed at 60 Hz. The display optics presented a visual field subtending approximately 50 degrees horizontally by 38 degrees vertically. Perspectively correct stereoscopic images were rendered by a 450 MHz Pentium III dual processor computer with an Evans & Sutherland Tornado 3000 dual pipe graphics card and were updated at an average frame rate of 36 Hz. The simulated viewpoint was continually updated as a function of the
participants’ head movements. The orientation of the participant’s head was tracked by a three axis orientation sensing system (Inter-sense IS300, update rate of 150 Hz). The system latency was 65 ms. The software used to render and track was Vizard 2.0.

2.6. The interaction

Once immersed in the virtual environment, the participant was introduced to her peer counselor who was seated in the virtual world facing her. The peer counselor greeted her by name and informed her that she could begin talking about her topic when she was ready. The participant then talked about her thoughts and feelings about her topic for 3 min. During the interaction, the lips of the virtual humans moved in sync with the participant’s and peer counselor’s speech and the eyes blinked in a realistic manner. Their head movements were veridically rendered based on their actual head movements. Other facial expressions (i.e., mouth and eye area movements) were explicitly manipulated. The peer counselor maintained eye contact throughout the interaction, nodded encouragingly, and provided verbal feedback (e.g., “I see”: “go on”). If necessary, minimal additional verbal prompts facilitated further self-disclosure (e.g., “how did that make you feel?”).

2.7. The smile manipulation

Smiles were animated so that they had a gradual onset and offset and lasted for 1 s. On average, the research assistants smiled three times per interaction. The smiles were programmed to be as realistic and natural as possible since the goal was to create a Duchenne smile. Thus, the corners of the mouth were pulled upwards, mimicking the movement of the zygomatic major muscle, and the eyes narrowed slightly to approximate the movement of the orbicularis oculi muscle (see Fig. 3).

2.8. Dependent measures

2.8.1. Social evaluations

Participants evaluated the peer counselor on 19 interpersonal traits using a 7-point scale where −3 = strongly disagree and +3 = strongly agree. An exploratory factor analysis revealed that the 19 traits loaded onto two factors, thus two composite scales were created which we labeled: counselor empathy and general positivity. Counselor empathy was comprised of 12 items: supportive, responsive, warm, sympathetic, caring, open, accepting, genuine, distant, uninvolved, judgmental, and cold, $\alpha = .90$. General Positivity was comprised of 7 items: friendly, attractive, intelligent, professional, polite, likeable, and open-minded, $\alpha = .82$.

2.8.2. Other dependent variables

Participants also rated the peer counselor along a number of other dimensions on a 7-point scale where −3 = strongly disagree and +3 = strongly agree. Four items ( $\alpha = .86$) assessed the peer counselor supportiveness. Two items ( $\alpha = .83$) assessed peer counselor likeability. Three items ( $\alpha = .88$) assessed comfort with the interaction. Interaction satisfaction and interaction enjoyableness were both assessed by 1 item. Six items ( $\alpha = .86$) assessed social presence. Nine items ( $\alpha = .90$) peer counselor trustworthiness. Four items ( $\alpha = .86$) assessed participants’ satisfaction interaction mode.

3. Results

All of the dependent variables showed strong, positive correlations with one another (see Table 1). We first examined our dependent measures to determine whether topic discussed or research assistant acting as the peer counselor differed by session and experimental condition. There were no significant differences by condition or session for the topic discussed or the research assistant portraying the peer counselor. Thus, we were assured that there were no experimenter effects or differential discussion topics across the experimental design.

3.1. Social evaluations

In order to examine the impact agency and smiling behavior on social evaluations, we conducted a multivariate analysis of variance (MANOVA) using interaction partner type and smile condition as the independent variables and counselor empathy and general
positivity as the dependent variables. Results of this analysis revealed no significant main effects for either interaction partner type or smile condition. The interaction of partner type by smile condition was significant, Wilks’ \( \lambda = .78, F(2, 33) = 4.55, p < .05, \eta_p^2 = .22 \). In addition, there was a significant univariate interaction for counselor empathy, \( F(1, 34) = 6.82, p < .05, \eta_p^2 = .16 \), but not positivity.

Because counselor empathy and general positivity were strongly correlated with one another, follow-up tests to compare the effect of interaction partner type and smile condition on counselor empathy were conducted controlling for general positivity. As with the MANOVA results, a univariate analysis of covariance (ANCOVA), with general positivity as the covariate, revealed a significant interaction partner type by smile condition interaction for counselor empathy, \( F(1, 33) = 8.36, p < .01, \eta_p^2 = .21 \). As seen in Table 2, simple effects comparing the effect of smiling on counselor empathy separately for avatars and embodied agents revealed that when participants thought that they were interacting with another actual person, the peer counselor was viewed as more empathic when she did not smile (\( M = .72, SD = .86 \)) compared to when she did smile (\( M = .13, SD = .85 \)). For participants who thought they were interacting with a computer, the peer counselor was seen as somewhat more empathic when she smiled (\( M = .30, SD = .83 \)) than when she did not (\( M = .25, SD = .85 \)), \( F(1, 33) = 2.73, p = .11, \eta_p^2 = .08 \). Thus, the same digitally rendered smile enhanced social evaluations of empathy for embodied agents, but inhibited them for avatars.

Similarly, simple effects comparing avatars and embodied agents separately within each smile condition revealed that when smiling was disabled, avatars were viewed as significantly more empathic relative to embodied agents, \( F(1, 33) = 7.36, p < .01, \eta_p^2 = .18 \). When smiling was enabled, however, embodied agents were viewed as somewhat more empathic than avatars, \( F(1, 33) = 1.76, p = .19, \eta_p^2 = .05 \).

### 3.2. Other dependent measures

Results of a MANOVA using interaction partner type and smile condition as the independent variables and the remaining eight interaction outcome measures as the dependent variables revealed no significant main effects or interactions.

### 3.3. Counselor empathy

Next, a series of hierarchical linear regressions examined the effect of counselor empathy and general positivity on the remaining eight dependent variables by entering general positivity in Step 1 followed by empathy in Step 2. As seen in Table 2, general positivity towards the counselor was significantly related to the eight dependent variables. Except for liking, adding counselor empathy at Step 2 resulted in a significant increase in the \( R^2 \) and reduced the effect of general positivity non-significant. Thus, perceptions of counselor empathy explained a significant proportion of the variance for seven of the eight dependent variables, even after controlling for general positive feelings towards the counselor. Moreover, the only unique effect for these seven variables was for counselor empathy. Thus, greater perceptions of empathy led participants to view their counselor as more supportive, they were more comfortable and satisfied with their interaction, they enjoyed their interaction with her more, they experienced greater copresence with her, they enjoyed interacting using immersive virtual environment technology more, and they felt more trusting and open in their interaction. Interestingly, although participants’ beliefs about their partner and whether she smiled or not did not have any direct effect on any of the interaction outcome variables, the amount of perceived empathy did vary as a function of both whether participants thought they were interacting with another person or not and the nonverbal behavior of their partner. Empathy then predicted participants’ evaluation of their partner and their feelings about their interaction (see Fig. 4).

On the other hand, general positivity explained the majority of the variance in liking and adding counselor empathy in Step 2 resulted in only a marginal \( \Delta R^2 \) while general positivity remained uniquely related to liking. The interpersonal traits comprising the general positivity scale (i.e., friendly, attractive, intelligent, professional, polite, likeable, and open-minded) might all be viewed as tapping general liking for the counselor, thus their strong association with participants’ liking ratings is not surprising. Moreover, the pattern of results for general positivity with the remaining dependent variables mirrored those for liking.

### 4. Discussion

Overall, the results of this study indicate that choosing to render a basic nonverbal behavior such as a smile can have a profound impact on how people experience their virtual interactions with others. Smiling increased perceptions of counselor empathy and empathy was positively associated with people’s evaluation of their peer counselor and their interaction. Specifically, higher empathy was associated with more positive counselor impressions, a greater
sense of connection with and trust for the counselor, and more comfort, enjoyment, and satisfaction with the interaction.

Importantly, however, the effect of rendering a smile on counselor empathy was impacted by whether people thought they were interacting with another person (i.e., an avatar) or a computer (i.e., an embodied agent). Rendering a digital smile enhanced perceived empathy for embodied agents, but doing so decreased perceived empathy for avatars. In fact, an avatar who did not smile was perceived as significantly more empathic than one who did.

Previous research has shown that the effect of the communicative realism of virtual humans on a variety of social outcomes is complex and not necessarily intuitive (Bailenson et al., 2005; Fox & Bailenson, 2009; Garau, 2003; Garau et al., 2003; Guadagno et al., 2007; Yee & Bailenson, 2007; Yee, Bailenson, & Ducheneaut, 2009). While it might seem that increasing the extent to which an embodied agent or avatar possesses the verbal and non-verbal capacities of humans should increase its social influence, this does not seem to always be the case. For example, Bailenson et al. (2005) demonstrated that although communicative realism affects perceptions of copresence and various social responses to embodied agents, the effect of communicative realism varies as a function of the extent to which the embodied agent looks like a real human being.

Others have found similar effects such that the effect of an avatar’s realism depends on the extent to which the avatar looks like a real person (Garau, 2003; Garau et al., 2003). For example, Garau found that interactions with realistic-looking avatars were viewed as more natural (i.e., more like a face-to-face interaction), they elicited greater copresence, and interaction partners were evaluated more positively when avatars exhibited inferred eye gaze rather than random eye gaze. In contrast, interactions with less realistic-looking avatars were viewed more positively when the avatar exhibited random eye gaze (Ekman & Friesen, 1982). Taken together, these studies on the effect of embodied agent or avatar appearance and behavior suggest that there needs to be a

### Table 2

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<tr>
<th>Dependent variable</th>
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<th>Dependent variable</th>
<th>β</th>
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<td><strong>Interaction satisfaction</strong></td>
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<td>Step 1: General positivity</td>
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<td>.38**</td>
<td>.16**</td>
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<tr>
<td>Step 2: General positivity</td>
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<td>.27***</td>
<td>Step 2: General positivity</td>
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<td>.09**</td>
<td>.16**</td>
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<td><strong>Liking</strong></td>
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<td><strong>Interaction enjoyment</strong></td>
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<td>Step 1: General positivity</td>
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<td>Step 1: General positivity</td>
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<td><strong>Comfort</strong></td>
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| Step 1: General positivity | .56*** | .56*** | .26*** | Step 1: General positivity | .31** | .31** | .10*
| Step 2: General positivity | .57*** | .57*** | .26*** | Step 2: General positivity | .30** | .30** | .20** |
| Counselor empathy | .76*** | .76*** |     | Counselor empathy | .68** | .68** |     |
| **Copresence** |     |      |     | **Satisfaction w/Medium** |   |      |     |
| Step 1: General positivity | .29*** | .29*** |     | Step 1: General positivity | .49*** | .49*** | .24** |
| Step 2: General positivity | .62*** | .62*** | .33*** | Step 2: General positivity | .48*** | .48*** | .24** |
| Counselor empathy | .86*** | .86*** |     | Counselor empathy | .75** | .75** |     |

*p < .05.

**p < .01.

***p < .001.

Fig. 4. Model showing the relationship between smiling, empathy, and other variables.
match between the level of both appearance and behavior. When a mismatch occurs, interactions are inhibited and social influence is reduced. According to Slater and Steed (2001), this is because people tend to hold higher expectations for more human-like representations than they do for less realistic-looking ones. Thus, the more realistic-looking an embodied agent or avatar appears, the more realistic its communicative behaviors such as facial expressions need to be in order for the digital representation to elicit social responses. In contrast, less communicative realism is needed in interactions with less realistic-looking embodied agents or avatars.

In this study, we attempted to increase the communicative realism of our peer counselor by adding a digitally-rendered smile. Because the same digital peer counselor representation and same smiling animation were used for all interactions, one might expect that a smile would affect the positivity of social evaluations equally regardless of whether participants thought they were interacting with another person or a computer. However, this was not the case. Instead, a digitally-rendered smile enhanced social evaluations of embodied agents while it decreased them for avatars.

Unfortunately, one limitation here is that the design did not allow us to determine the reason for people's negative reaction to a smiling avatar. Recall that the animations attempted to mimic the movement of the zygomaticus major and orbicularis oculi muscles as occurs with Duchenne smiling. Our animations, however, were no doubt imperfect. Thus, something about the animation itself may have affected people differently depending on whether they thought their partner was a human or a computer. Alternatively, participants in the avatar condition may have been more sensitive to the timing of the onset of the smile or its duration. Future research is needed to address these important issues.

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