Creating Genuine Smiles for Digital and Robotic Characters: An Empirical Study

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***Abstract*—Facial expressions are important cues of people's emotions, attitudes, and intentions. Smiling is one of the most common facial expressions and is often associated with a welcoming, positive attitude. In social interactions, people sometimes fake their smiles for this effect, and phony fake smiles can often be detected by others. In this work, we explore creating smiles for digital and robotic s characters that seem genuine. In our study, we used male and female digital characters and a Zeno boy robot that is a humanoid robot with facial muscles. We systematically varied the overall length and the apex length of the smiles and examined people's perceptions of them. Our results indicate that smiles with longer apex lengths appear more genuine and less fake to people for both digital characters and social robots, and 5s seems to be the optimal length of a genuine smile.**

I. Introduction

Smiling is one of the most common and recognizable facial expressions [1]. It is often associated with a welcoming and positive attitude. In social interactions, people sometimes put up a smile to be polite, hide their true feelings, or be sarcastic. However, fake and felt smiles have many differences, which can often be detected by others [1].

In this work, we investigate how to create smiles for digital and robotic characters. Digital and robotic characters have received increasing attention in recent years. People can interact with them to obtain information, develop social interaction skills, receive training, or simply be entertained [2], [3], [4], [5], [6]. In such applications, most of the time we want the synthetic characters to appear genuine, sincere, and welcoming when they are interacting with the user, and in particular when they smile.

Factors related to how people smile have been studied extensively. Ekman and Friesen examined the facial muscles used in smiling and identified two major muscles being used: the zygomatic major, extending the lip corners, and the orbicularis oculi, raising the cheek and tightening the lower eyelid [1]. Upturning one's lip corners by the zygomatic major facial muscle's movements has been identified as a universal facial expression of joy across cultures [7], [8]. The most common difference between fake and felt smiles is whether the orbicularis oculi muscles are involved. When faking smiles, people often just curve their lips. In contrast, when the smile is felt the orbicularis oculi muscle is usually activated, which raises the cheeks and forms crow's feet around the eyes [1]. Genuine and fake smiles are also different in their onset, apex, and offset timings [1]. A smile's onset time is the duration from the start of the smile to its apex. The apex duration is when the smile is at its most intense, and the offset of the smile is the span of time from apex until all evidence of the smile is absent from the face. Ekman et al. pointed out that fake expressions arise when people interrupt their natural emotional response and instead present a voluntary, masked expression [1]. Often the time, the apex of the smile is too long in fake smiles, making the person appear to hold the expression intentionally. Thus, the onset time falls short, and the smile abruptly appears on the face. A fake smile's offset time is also in some way irregular, indicating the person has stopped intentionally holding the expression [1]. Frank, Ekman and Friesen also surveyed the lengths of people's smiles. Their study shows that the duration of smiles varies a lot. Genuine smiles have an average length of 4s, and fake smiles have an average length of 6s, and sometimes people may smile for more than 10s [9].

Ekman and Friesen's finding regarding apex length has been confirmed in several research studies using digital characters. Ochs, Niewiadomski, and Pelachaud [10] let participants create smiles for a virtual character, and the majority used shorter onset and offset times for fake smiles and longer onset and offset times for genuine smiles. Krumhuber and Kappas [11] asked participants to watch animations of digital characters' smiles. They found that smiles with longer onset and offset times were judged as significantly more genuine than their shorter counterparts, and smiles lost authenticity when their apexes were held too long – the smiles with apexes closer to 1s were judged as significantly more genuine than the smiles with apexes closer to 5s. In neither study did the characters speak to the participants.

In our previous work, we observed an opposite trend. In our study the participants watched videos of digital characters smiling and greeting them, we found that the characters that smile with longer apexes were perceived as more genuine and less fake than those who smile with shorter apexes [12]. Many factors may affect how a smile is perceived. We suspect that the context of the smile may matter, i.e. in addition to smiling our characters also talked to the participants, and there may be a difference between how people perceive other people's smiles and digital characters' smiles. Finally, different from other experiments that are all laboratory-based, the subjects in this study were recruited from Amazon mTurk. Though we think the different result we obtained is unlikely caused by the subject population, in this study, we will replicate the experiment in a laboratory to see whether the same phenomenon will be observed.

In addition, we want to investigate how to create genuine or fake smiles using not only digital characters but also social robots. Social robots and digital characters share many similarities but also create quite different experiences when people interact with them. For example, Power et al. found that people are less likely to reveal sensitive information to a co-located robot than its equivalent digital character. On the other hand, people spend more time with the robot and their attitude towards the robot is more positive [13]. In our previous work, we found using a social robot makes the expression of certain emotions easier, e.g. anger, while others harder, e.g. shyness [14]. This is mainly because of two factors. One is that social robots can move physically in the shared space between them and the user. The other is that there is usually noise associated with the robots' movements. Therefore, in this work, it is worthy to examine whether digital characters and social robots should follow the same principles when smiling.

Because in most applications the synthetic characters will both smile and talk to the user, we will continue to investigate in this context. Similar to our previous work, we want to study the effects of two parameters on human perception of smile genuineness and fakeness in synthetic characters (including digital and robotic characters). One is the relative length of the apex compared to the onset and the offset of the smile. The other is the overall duration of the smile. In our previous study, we observed a similar phenomenon as Ekman et al. described regarding the overall duration of the smiles, i.e. longer smiles (7s vs. 3s or 5s) are more likely to be perceived as fake. We did not observe any difference between the smiles that are 3s long and 5s long. In this work, we want to investigate whether using a robotic face makes any difference.

II. Experimental Studies

We conducted two experiments to evaluate smile genuineness and fakeness on synthetic characters. In these experiments, we systematically varied the length of the smiles and the duration of smile apex with respect to its onset and offset durations for two digital characters and one robotic character.

The first experiment is a replication of our previous study [12] on the effects of apex length and overall duration on the genuineness and fakeness of smiles. This time, we used participants recruited on campus instead of from mTurk. In the second experiment, we tested the same conditions using a robotic character. Robokind Zeno produced by Hanson Robotics was used in this study [15]. Figure 4 shows a picture of it. We chose this robot because it has a lifelike moveable face for expressing emotions, instead of a rigid, plastic or virtual face as in many other humanoid robots.

A. Experiment 1 – Genuine/Fake Smiles for Digital Characters

1) Participants: The participants were recruited from undergraduate students at Rensselaer Polytechnic Institute (RPI). They participated in the experiment for fulfilling the experiment participation requirement of their psychology courses. This experiment recruited 25 subjects in total. 16 of them are male, and 9 are female.

2) Experimental Material and Procedure: In this study, the digital characters were created by using the Virtual Human Toolkit [16]. The two characters used in the study are the default male character Brad and the default female character Rachel, as shown in Figure 1. Each character has two types of smiles: one with a shorter apex and one with a longer apex. Each type of smile may last 3s, 5s or 7s long. For each smile, its onset and offset times are the same. When the apex duration is short, it is shorter than the smile's onset and offset time and is not exceeding 1s, the length found by Krumhuber and Kappas for producing the most genuine smiles [11]. When the apex duration is long, it is longer than the smile's onset and the offset time and is also longer than 1s. The onset, apex, and offset times for each smile are listed in Table I. A total of 12 videos were created as the experimental material.

TABLE I. Smile Phase Times (seconds)

Total	Onset	Apex	Offset
3	1.2	0.6	1.2
3	0.5	2.0	0.5
5	2.1	0.8	2.1
5	1.0	3.0	1.0
7	3.0	1.0	3.0
7	1.5	4.0	1.5

Fig. 1. Digital Characters

In each video, the character's smile was created using AU6, AU7 and AU12 from the Facial Action Coding System (FACS) [1]. Ekman and Friesen mapped most muscle movement involved in smiling to AU12, the lip corner puller. They noted that when used extremely, AU12 could cause change similar to AU6, the cheek raiser. In addition, Ekman and Friesen showed that AU6 and AU7, the cheek raiser and the lower eyelid tightener, are typically both employed in genuine smiles [1]. In our study, these action units were manipulated together to create the smiles. When the character begins to smile, the intensities of all action units gradually rises to reach the predefined apex intensities by the end of the onset time. After holding the smile at its apex, the action units' intensities decreases until the characters' faces return to a neutral state. The intensity values during onset and offset are linearly interpolated. Figure 2 shows an example of these dynamics using a 3s smile with a short apex.

To put the smiles into a social context, the characters showed their smiles along with simple sentences. First, they say "My name is," followed by the character's name (Brad or Rachel) and a smile, then, "Have a good day," followed by a smile again. The two smiles in the same video are identical, i.e. they have the same total duration and the same onset and apex times. The verbal statements come from pre-recorded speech within the toolkit.

Each participant watched all 12 videos and rated each smile

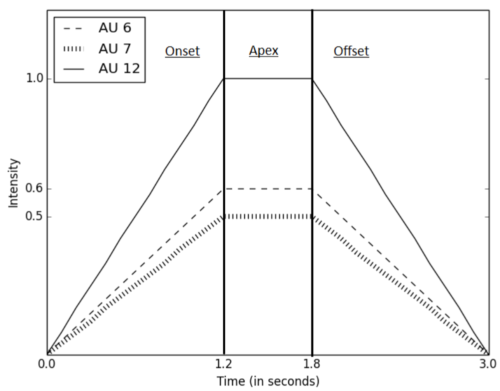

Fig. 2. Intensity of Action Units over Time

on a 5-point Likert scale for its genuineness and fakeness respectively, with 1 = least (genuine or fake) and 5 = most (genuine or fake). We chose to rate genuineness and fakeness separately for studying whether they are exactly the opposite concepts from each other. The order of the videos was randomly determined for each participant to prevent any ordering effect.

3) Results: For both virtual characters, two-way repeated measures ANOVAs were performed using SPSS. The independent variables are smile apex length with two levels (shorter apex than onset and longer apex than onset) and the overall duration of the smile with three levels (3s, 5s, and 7s). Four ANOVA tests were conducted on the male's smiles rated as genuine, the male's smiles rated as fake, the female's smiles rated as genuine, and the female's smiles rated as fake. The *F* ratios for the main effects and the interactions are reported in Table II. The same statistical results from Experiment 2 which uses the Zeno robot are also reported in this table for easy comparison. The *F* value is labeled with "*" if it is significant at .05 level and "**" if it is significant at .01 level.

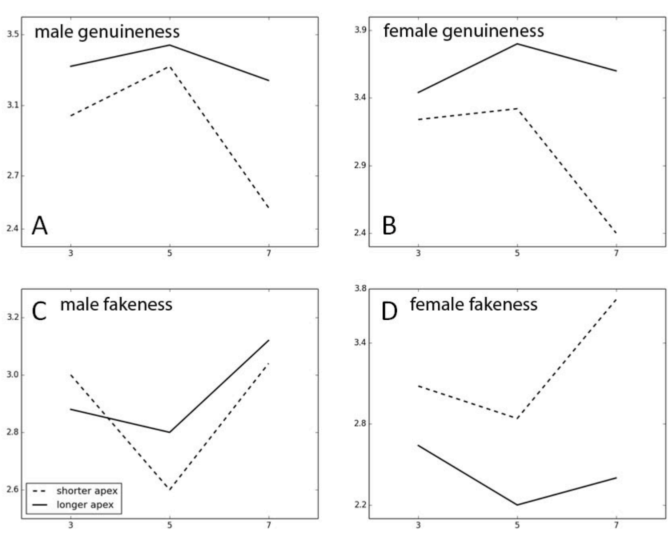

Fig. 3. Interaction Effect between Apex Length and Duration for Digital Characters

As shown in Table II, regarding smile genuineness both apex length and overall duration are significant factors for both the male and the female characters. Regarding smile fakeness, both apex length and overall duration are significant factors for only the female character. The interaction effect was significant only for the ratings of genuineness and fakeness on the female character's face. We plotted the mean ratings from different conditions in Figure 3 for showing the interaction effects. The x-axis shows the lengths of the smiles and the y-axis shows the main ratings from the subjects. As shown in this figure, even though the interaction effect is not significant for the male character, the same pattern of results can be observed for the female character.

From Figure 3, we can also see that similar to the results from our previous study [12], a longer apex time, in general, is associated with the smile being rated as more genuine and less fake. Post-hoc comparison using Fisher's test show that the mean ratings of smile genuineness were significantly higher in the smiles with a longer apex time for both the male and the female characters than the smiles with a shorter apex time (3.33 vs. 2.56 for the male character; 3.61 vs. 2.99 for the female character). Consistently, the mean ratings of smile fakeness were significantly higher in the smiles with shorter apex time than the smiles with longer apex time for the female character (3.21 vs. 2.41).

As mentioned before, the total duration of the smile is also a significant factor for all ANOVA tests on digital characters, except for ratings of fakeness on the male character. In general, the smiles lasting 7s were rated as most fake, and the smiles lasting 5s were rated as most genuine. Post-hoc comparison using Fisher's test shows that for both the male and female characters, ratings of smile genuineness were significantly higher in smiles lasting 5s than smiles lasting 7s (3.38 vs. 2.88 for the male character; 3.56 vs. 3.00 for the female character). For both characters, a comparison between the smiles of 3s and 5s and between 3s and 7s on the ratings of smile genuineness yielded non-significant differences. The ratings of smile fakeness for the female character were significantly higher in smiles lasting 7s than 5s (3.06 vs. 2.52). We found no significant difference between smiles of 3s and 5s and between 3s and 7s regarding how fake they are for the female character, and no significant difference between any conditions for the male character.

B. Experiment 2 – Genuine/Fake Smiles for a Robotic Character

The second experiment intends to investigate the effects of the same factors on the genuineness and fakeness of smiles using a robotic character – Zeno. Like the digital characters in Experiment 1, Zeno gives smiles with either long or short apex lengths and with the total duration of the smile being 3s, 5s or 7s. There are 6 conditions in total. The onset, apex, and offset times for Zeno's smiles are the same for the digital characters, which are shown in Table I.

1) Participants: Similar to Experiment 1, the participants were recruited from undergraduate students at Rensselaer Polytechnic Institute (RPI). They participated in the experiment for fulfilling the experiment participation requirement of their psychology courses. This study recruited 28 subjects in total. 21 of them are male, and 7 are female.

TABLE II. Main Effects and Interaction Effect across All ANOVAs for Digital and Robotic Characters

	Male Digital Genuineness	Female Digital Genuineness	Robot Genuineness	Male Digital Fakeness	Female Digital Fakeness	Robot Fakeness
Apex Length	$F(1,24) = 4.21$*	$F(1,24) = 18.50$**	$F(1,27) = 2.03$	$F(1,24) = 0.08$	$F(1,24) = 26.59$**	$F(1,27) = 0.35$
Overall Duration	$F(2,48) = 3.38$*	$F(2,48) = 3.67$*	$F(2,54) = 0.37$	$F(2,48) = 1.51$	$F(2,48) = 3.69$*	$F(2,54) = 0.28$
Interaction (Apex Length * Overall Duration)	$F(2,48) = 1.12$	$F(2,48) = 4.43$*	$F(2,54) = 1.89$	$F(2,48) = 0.25$	$F(2,48) = 3.19$*	$F(2,54) = 5.54$**

Fig. 4. Zeno from Hanson Robokind

2) *Experimental Material and Procedure:* Zeno's face is embedded with eight motors for controlling the movements of its facial muscles. The functions of the motors are not exactly equivalent to facial action units. However, they do give us control to the robot's eyebrows, eyelids, and left and right smile muscles. We found that the left and right smile muscles together correspond to AU12. Because the robot has no equivalent muscles for AU6 and AU7, we manipulated the eyebrows and eyelids muscles to allow the robot to have equivalent amounts of facial movements in its smile as the digital characters. The intensities of these various facial muscles were adjusted to follow the same onset, apex, and offset lengths as for the digital characters' smile.

Similarly as using the digital characters, Zeno said "My name is Zeno," followed by the smile, then "Have a good day," followed by another smile. The two smiles have identical timing and apex length. This time, the verbal statements were generated by text-to-speech.

Each participant watched Zeno going through all 6 conditions and rated each smile on a 5-point Likert scale for its genuineness and fakeness respectively, with 1 = least (genuine or fake) and 5 = most (genuine or fake). The order of the videos was randomly determined for each participant to prevent any ordering effect.

3) *Results:* Two-way repeated measures ANOVA tests were conducted in SPSS to evaluate the participants' ratings of smile genuineness and fakeness in regards to apex length (shorter than onset and longer than onset) and overall duration (3s, 5s, and 7s).

The F ratios for main effects are reported in Table II, together with the results from using the digital characters. We found that for the robot character, neither apex length nor overall duration was a significant factor for the ratings of genuineness or fakeness of the smiles. Though not being statistically significant, we found that the ratings of genuineness were still higher in longer apex conditions than in shorter apex conditions (3.44 vs. 3.16), and shorter apex conditions had higher ratings of fakeness (2.49 vs. 2.37). This is consistent with the results from using the digital characters.

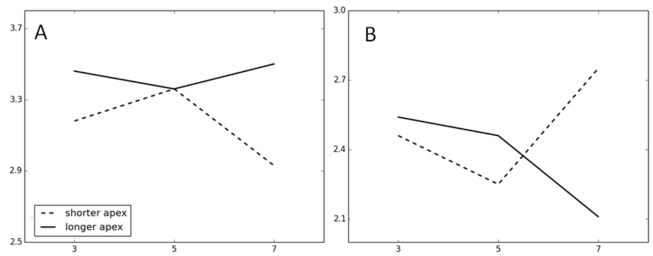

Fig. 5. Interaction Effect between Apex Length and Duration for Ratings on Robotic character: a) Genuineness, b) Fakeness

The interaction effect was only significant for ratings of fakeness on the robot's smiles. We plotted the mean ratings from different conditions in Figure 5 for showing the interaction effects. The x-axis shows the lengths of the smiles, and the y-axis shows the main ratings from the subjects. In this figure, we can see a large difference in the ratings of genuineness and fakeness between shorter and longer apex lengths for the 7s conditions. We performed additional one-way ANOVA tests for each total duration level using apex length as the only independent variable. For the 3s and 5s conditions, apex length does not affect the ratings of genuineness or fakeness significantly. However, we found that apex length did have a significant impact at the 7s condition on both smile genuineness and fakeness for the robotic character. And consistent with the previous trend, smiles with longer apex in general were rated significantly more genuine and less fake than those with shorter apex (3.50 vs. 2.93 for genuineness; 2.11 vs. 2.75 for fakeness).

C. Comparison between Digital and Robotic Characters

Part of our goal in this work is to investigate whether there is any difference in expressing smiles for real humans, digital characters, and robotic characters. We performed additional repeated-measures ANOVA tests to examine whether there was a difference between the ratings given for the digital characters and for the robotic character. In these tests, we used apex length (2 levels) and total smile duration (3 levels) as the within-subjects independent variables, and character type as the between-subjects independent variable. These ANOVA tests were conducted to compare the ratings of the genuineness and fakeness of the smiles for both the male and female digital characters to those for the robotic character. For better understanding the difference between using digital characters and a robotic character, we also combined the ratings for the male and female digital characters to create a new group. The ratings from this group were also compared to the ratings for the robotic character. In total, 6 ANOVA tests were performed.

TABLE III. COMPARISON BETWEEN DIGITAL AND ROBOTIC CHARACTERS

	Male vs. Robot Genuineness	**Female vs. Robot Genuineness**	**Both vs. Robot Genuineness**	**Male vs. Robot Fakeness**	**Female vs. Robot Fakeness**	**Both vs. Robot Fakeness**
Apex Length	$F(1,51)=5.83^*$	$F(1,51)=13.00^{**}$	$F(1,76)=13.21^{**}$	$F(1,51)=0.06$	$F(1,51)=12.66^{**}$	$F(1,76)=4.38^*$
Overall Duration	$F(2,102)=3.14^*$	$F(2,102)=3.49^*$	$F(2,152)=4.43^{**}$	$F(2,102)=1.41$	$F(2,102)=2.71$	$F(2,152)=2.69$
Actor Type	$F(1,51)=0.95$	$F(1,51)=0.00$	$F(1,76)=0.27$	$F(1,51)=9.71^{**}$	$F(1,51)=4.88^*$	$F(1,76)=8.04^{**}$

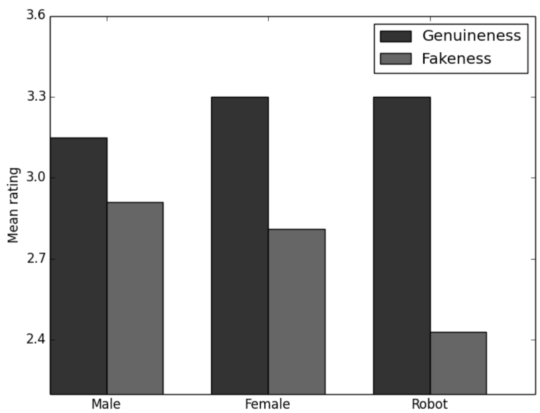

Fig. 6. Mean Ratings of Genuineness and Fakeness for Digital and Robotic Characters

We found no interaction effect in these ANOVA tests. The main effects are reported in Table III. The F value is labeled with "*" if it is significant at .05 level and "**" if it is significant at .01 level. Our results indicate that apex length had a significant main effect in all comparisons except for comparing the ratings of the male digital character to the robotic character. Total smile duration had a significant main effect only for the ratings of genuineness.

Character type had no main effect on the ratings of genuineness but did have a main effect on ratings of fakeness. A comparison of the mean ratings is provided in Figure 6. The mean ratings of smile genuineness for the digital characters (3.15 for the male only, 3.30 for the female only, and 3.22 for both digital characters combined) were not significantly different from the mean rating for the robotic character (3.30). However, the mean ratings of smile fakeness for the digital characters (2.91 for male, 2.81 for female, and 2.86 for both digital characters combined) are significantly higher than that of the robotic character (2.43).

III. DISCUSSION AND FUTURE WORK

In summary, for the ratings of smile genuineness on digital characters' faces, we were able to replicate the findings in our previous work [12]. We demonstrated again in this study that a longer apex time makes the smile seems more genuine and less fake to human subjects. Our results indicate that for a robotic character, apex length is only a significant factor for longer smiles (7s). For these longer smiles, longer apex length will make them seem more genuine and less fake than shorter apex length, which matches our results for digital characters. Even for shorter smiles, the ratings of genuineness were higher in the longer apex condition for the robotic character.

These results suggest that in general both digital and robotic characters should use a longer apex time in their smiles to appear more genuine. These trends contrast former studies using digital characters, as well as Ekman's original studies on how humans smile in real life. This may suggest a disconnect between how people naturally display their own smiles (consciously or not) and how they perceive the smiles of others, both real and virtual.

The length of the smile also plays an important role in deciding people's judgments of it. Overall, 5s smiles seem to be the best choice for being perceived as genuine and not fake, and 7s smiles are the worse choice.

While the results of this particular study cannot claim that digital and robotic characters should always display smiles in 5s and with longer apex lengths to appear more genuine and less fake to humans, at least it suggests a set of parameters to be used when the character wants to introduce him/herself with a sincere smile.

Interestingly, the results of our between-subjects analysis suggest that the robotic character is no more or less genuine than the digital characters overall but is considered less fake. This may be explained by the robotic character's physical presence in the observer's environment. Many researchers have argued that the physical embodiment of robotic characters increases their social presence to the user [17], [13], [14].

Future work will continue to examine the distinction between genuine and fake smiles. We plan to study other facial cues, such as symmetry in smiles and other action units that may present in smiles. For example, Ekman and Friesen discussed that when people fake their smiles, they may show an asymmetric smile and usually fail to conceal other involuntary facial cues [1]. Furthermore, from time to time, we may also want to create characters whose smiles seem fake or tricky. In this study, we did not differentiate between being unnatural and being tricky for the fakeness ratings. In the future, we will revise the questions for collecting more detailed feedbacks from the users.

IV. CONCLUSION

Having appropriate facial expressions is important for both digital and robotic characters. In this work, we investigated the difference between genuine and fake smiles, which has been extensively studied in human facial expressions. The results from this study indicate that in a simple, social interaction context with relatively long smile durations (longer than 3s), the smiles with a longer apex time than onset are in general perceived as more genuine and less fake for both digital and robotic characters. Overall, the robotic character was shown to be just as genuine as the digital characters and significantly less fake in its smiles.

REFERENCES

[1] P. Ekman and W. V. Friesen, "Felt, false, and miserable smiles," *Journal of Nonverbal Behavior*, vol. 6, no. 4, pp. 235–252, 1982.

[2] K. Dautenhahn, C. L. Nehaniv, M. L. Walters, B. Robins, H. Kose-Bagci, N. A. Mirza, and M. Blow, "Kaspar: A minimally expressive humanoid robot for human-robot interaction research," *Applied Bionics and Biomechanics*, vol. 6, no. 3-4, pp. 369–397, 2009.

[3] K. Johnsen, A. Raij, A. Stevens, D. S. Lind, and B. Lok, "The validity of a virtual human experience for interpersonal skills education," in *SIGCHI Conference on Human Factors in Computing Systems*, 2007, pp. 1049–1058.

[4] R. Niewiadomski and C. Pelachaud, "Model of facial expressions management for an embodied conversational agent," in *2nd International Conference on Affective Computing and Intelligent Interaction (ACII)*, 2007, pp. 12–23.

[5] M. Rehm and E. André, "Catch me if you can: Exploring lying agents in social settings," in *International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS)*, 2005, pp. 937–944.

[6] D. Traum, S. C. Marsella, J. Gratch, J. Lee, and A. Hartholt, "Multi-party, multi-issue, multi-strategy negotiation for multi-modal virtual agents," in *8th International Conference on Intelligent Virtual Agents*, 2008, pp. 117–130.

[7] P. Ekman, W. V. Friesen, and S. Ancoli, "Facial signs of emotional experience," *Journal of Personality and Social Psychology*, vol. 39, no. 6, pp. 1125–1134, 1980.

[8] P. Ekman and D. Keltner, "Universal facial expressions of emotion: An old controversy and new findings," in *Nonverbal communication: Where nature meets culture*, U. C. E. Segerstråle and P. Molnár, Eds. Mahwah, NJ: Lawrence Erlbaum Associates, 1997, pp. 27–46.

[9] M. G. Frank, P. Ekman, and W. V. Friesen, "Behavioral markers and recognizability of the smile of enjoyment." *Journal of personality and social psychology*, vol. 64, no. 1, p. 83, 1993.

[10] M. Ochs, R. Niewiadomski, and C. Pelachaud, "How should a virtual agent smile? morphological and dynamic characteristics of virtual agent's smiles," in *10th International Conference on Intelligent Virtual Agents (IVA)*, 2010, pp. 427–440.

[11] E. Krumhuber and A. Kappas, "Moving smiles: The role of dynamic components for the perception of the genuineness of smiles," *Journal of Nonverbal Behavior*, vol. 29, no. 1, pp. 3–24, 2005.

[12] J. D. McDaniel and M. Si, "Length of smile apex as indicator of faked expression," in *Workshop on Affective Agents co-located with 14th International Conference on Intelligent Virtual Agents*, 2014, pp. 25–32.

[13] A. Powers, S. Kiesler, S. Fussell, and C. Torrey, "Comparing a computer agent with a humanoid robot," in *2nd ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, 2007, pp. 145–152.

[14] M. Barron and M. Si, "Augment interactive storytelling with cognitive robot." in *Proceedings of the 6th Digital Games Research Association (DiGRA) Conference*, 2013.

[15] D. Hanson, S. Baurmann, T. Riccio, R. Margolin, T. Dockins, M. Tavares, and K. Carpenter, "Zeno: A cognitive character," in *AI Magazine, and special Proc. of AAAI National Conference*, 2009.

[16] A. Hartholt, D. Traum, S. Marsella, A. Shapiro, G. Stratou, A. Leuski, L.-P. Morency, and J. Gratch, "All together now: Introducing the virtual human toolkit," in *International Conference on Intelligent Virtual Humans*. Institute for Creative Technologies, 2013, pp. 368–381.

[17] Y. Jung and K. M. Lee, "Effects of physical embodiment on social presence of social robots," in *PRESENCE*, 2004, pp. 80–87.