Length of Smile Apex as Indicator of Faked Expression

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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, often associated with a welcoming, positive attitude. In social interactions, people sometimes fake their smiles for this effect. Research has shown that one difference between faked and genuine smiles is that faked ones often have longer apexes. In this work, we explore creating fake and genuine smiles for virtual humans. We systematically varied the apex length and examined the effect of this manipulation on smiles of different lengths and on both male and female faces. Using mTurk, 40 subjects rated these smiles on their genuineness and fakeness. Contrary to previous findings, our results suggest that smiles of longer apex time are perceived as more genuine and less fake than smiles of shorter apex for virtual characters. This paper presents the design of the experiment followed by the results and discussion.

Keywords: emotions · facial expressions · perception of emotions · smile

1 Introduction

Virtual human characters have received increasing attention in recent years. People can interact with them, either conversationally or physically, to get information, practice social interaction skills, receive training, or be entertained [5], [7], [9, 10]. Often, we want our virtual human characters to appear genuine, sincere, and welcoming to the user.

Smiling is one of the most common facial expressions and is often associated with a welcoming and positive attitude. Factors related to how people smile have become an increasingly important research topic because of its observed use in both positive and aversive environments [1, 2]. Because smiles are easily discernible from other expressions, one may present a smile when lying or when being insincere [2]. This leads to the distinction between at least two types of smiles: genuine and fake. According to Ekman and Friesen, fake expressions arise when people learn to interrupt their natural emotional response and instead present a voluntary, masked expression [2].

Further, Ekman and Friesen pointed out that genuine and fake smiles differ in onset, apex, and offset timing [2]. In a faked smile, the apex is usually too

long, making the person appear to intentionally hold the expression. Thus, the onset time falls short, and the smile appears on the face abruptly. The offset time of a fake smile is also in some way irregular, indicating the person has stopped intentionally holding the expression [2].

In this work, we examine the effect of varying the duration of smile apex with respect to its onset duration for virtual humans. We created the smiles using the VHuman Toolkit from the Institute for Creative Technologies (ICT) at the University of Southern California [4]. We tested using two smiling virtual human characters (male and female) and for three different lengths of the smile: 3, 5, and 7 seconds. We chose to study longer smiles because people often exhibit longer smiles and other conversational agents, such as robots, may have slower-moving faces. Contradicting to our initial hypothesis based on Ekman and Friesen's findings, the results indicate that smiles with longer apex time are perceived as more genuine and less fake than smiles of shorter apex.

In the next sections, we first summarize related works on genuine and fake smiles, then present our empirical study examining the effects of different smiling factors on participants' perception of genuineness and fakeness of the virtual human. We discuss the implication of the results followed by a plan of future work.

2 Related Work

Ekman and Friesen examined the facial muscles used in smiling and identified two major muscles are being used: zygomatic major, extending the lip corners, and orbicularis oculi, raising the cheek and tightening the lower eyelid [2]. Along with Ancoli, they found a significant correlation between happiness and the frequency, duration, and intensity of the zygomatic major facial muscle's movements [3].

In this work, we concentrate on studying the impact of the duration of the smiles for expressing genuineness in virtual humans because it is one of the most studied factors. The duration of a smile, like other expressions and behaviors, can be separated into onset, apex, and offset timing [2], [6]. 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.

Through analyzing data collected from observing how human subjects smile, Ekman and Friesen found that genuine and fake smiles differ in onset, apex, and offset timing [2]. Fake smiles usually have longer apexes and shorter onset and offset times that make the expression appear suddenly and remain for a prolonged time. The faked smiles then disappear from the face in a similar, quick manner [2].

Ekman and Friesen's finding has been confirmed in a few research studies using virtual characters. Ochs, Niewiadomski, and Pelachaud [8] let participants create smiles on a virtual agent, and the majority used shorter onset and offset times for fake smiles and longer times for genuine smiles. Krumhuber and Kappas [6] manipulated the durations of onset, apex, and offset times and found that

smiles with longer onset and offset (closer to half of a second) were judged as significantly more genuine than their shorter counterparts (closer to one-tenth of a second). Similarly, they found that a smile lost authenticity the longer its apex was held, with apexes closer to 1 second being judged as significantly more genuine than smiles with apexes closer to 5 seconds.

In Krumhuber and Kappa's work, the smiles were brief and presented to the subjects without a dialogue context [6]. In this work, we want to further examine the effect of apex length on the genuineness of a virtual character's smile when the smiles are longer and when the virtual characters are initializing a dialogue with the user.

We encoded the virtual characters' smiles using the Facial Action Coding System (FACS), which was invented by Ekman and Friesen [2] and has been widely used for labeling facial expressions. Ekman and Friesen mapped the zygomatic major muscle to action unit AU12, the lip corner puller. They noted that when used extremely, AU12 could cause change similar to AU6, the cheek raiser. Orbicularis oculi was mapped partially to AU6 and partially to AU7, the lower eyelid tightener [2]. In our study, these action units were manipulated together to create different smiles.

3 Experimental Design

3.1 Participants

The participant sample was taken from registered workers on Amazon Mechanical Turk (MTurk) who have completed 100 or more tasks through the crowdsourcing system prior to this study and who have an approval rating of 90% or greater. The sample size is 40 adults (19 men, 21 women; mean age = 31.95 years, range = 20 to 66 years).

3.2 Materials and Procedure

We created a series of smiles on virtual human characters by the use of the Virtual Human Toolkit developed at the Institute for Creative Technologies (ICT) at the University of Southern California [4]. Two characters were employed for the study, the default male character Brad and the default female character Rachel, both pictured in Figure 1. Each character was programmed to give smiles with a shorter apex time than onset, intended to be genuine, and smiles with a longer apex time than onset, intended to be fake. Each type of smile lasted either 3, 5, or 7 seconds long. We chose longer smile durations than previous studies because we plan on replicating the work on a social robot, which will need to present longer smiles in order to sync with other bodily movement. The onset, apex, and offset times for each smile are listed in Table 1. We created smiles with identical durations for both the male and female characters. In total, 12 videos of smiles were created.

The action units employed for both genuine and fake smiles were units 6, 7, and 12, as suggested by Ekman and Friesen [2]: the cheek raiser, the lower eyelid

Table 1. Smile onset, apex, and offset times, in 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. The male and female virtual human characters from the VHuman Toolkit

tightener, and lip corner puller, respectively. When the character begins to smile, all action units are gradually updated in intensity to reach the predefined apex intensity by the end of the specified onset time. We linearly interpolated the intensity during onset. After the character holds the smile at apex, the action units begin to gradually decrease to return to a neutral state. Similarly, we linearly interpolated the intensity during offset. Figure 2 shows an example of how the intensities of these action units are updated over time using a 3 second smile intended to be genuine—that is, with a shorter apex time than onset time.

To put the smiles into context, in each video the male or female character showed their smiles along with simple verbal statements. They first say, "My name is," followed by the character's name and a smile, then, "Have a good day," followed by a smile. The two smiles are identical, i.e. they have the same duration and are both genuine or both fake. Videos of the smiles were administered to human participants who rated the smiles on how genuine, welcoming, and felt the smiles appeared, as well as how false, fake, and forced they appeared. The rating questions for each video were randomly ordered to prevent any ordering effect.

For participating in this study, participants completed a survey in which they watched 12 videos of virtual characters smiling in random order and rated the smiles on 5-point Likert scales for the following metrics: genuine, welcoming, felt, fake, false, and forced.

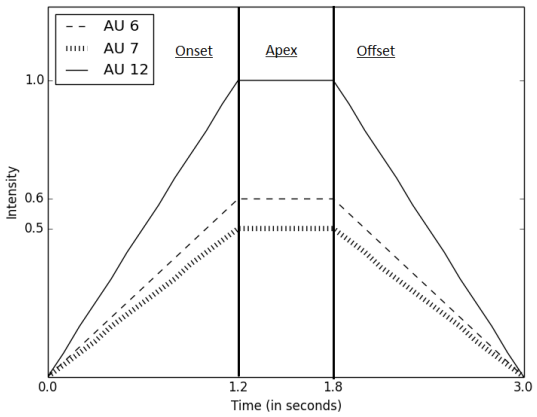

Fig. 2. The intensity of action units in generated smiles over time for a 3 second smile with shorter apex than onset Time

4 Results

For both virtual characters, scores on the 5-point Likert scales were summed into two overall scores: "genuineness" for genuine, welcoming, and felt ratings and "fakeness" for fake, false, and forced ratings. Two-way repeated-measures ANOVAs were performed using SPSS. The independent variables are smile apex length with two levels (shorter apex than onset, longer apex than onset) and the overall duration of the smile with three levels (3 seconds, 5 seconds, and 7 seconds). Four ANOVA tests were conducted: the male's smiles rated as genuine, his smiles rated as fake, and likewise for the female's smiles. We used an alpha level of .05 for all statistical tests. The interaction effect between the length of apex and the duration of the smile was significant in all of the ANOVA tests. We plotted the interaction effects in Figure 3.

The F ratios for main effects are reported in Table 2. We found that for both the male and female faces, apex length is a significant factor for the subject's ratings of how genuine and fake the smiles appear—the main effect of apex length is significant in all four ANOVA. However, contrary to our initial expectation, the longer the apex length is, the more genuine and less fake the subjects rated the videos to be.

Similar to smile apex, overall duration of the smile is a significant factor for all ANOVA tests, except for the ratings of fakeness with the male smile. In general, smiles lasting 7 seconds were rated as most fake, and smiles lasting 5 seconds were perceived as most genuine.

Post-hoc comparison using Fisher's test show that the mean ratings of smile genuineness were significantly higher in smiles of longer apex time for both the male and the female face than for the smiles with shorter apex time (3.18 vs. 2.93

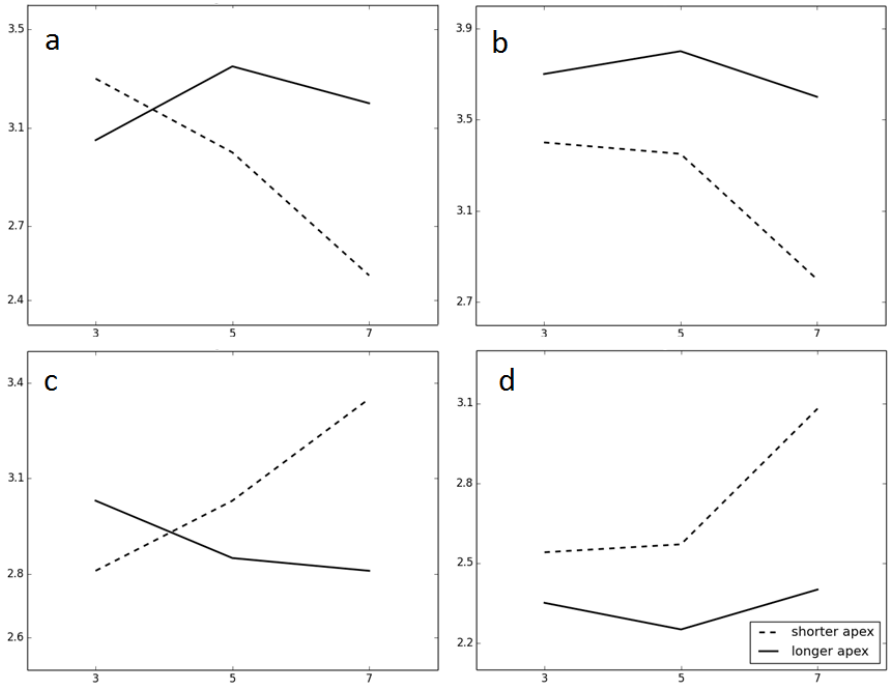

Fig. 3. Interaction effect between apex Length and duration for ratings: a) genuineness of the male face, b) genuineness of the female face, c) fakeness of the male face, d) fakeness of the female face

Table 2. F ratios for main effects and interaction effect across all ANOVA

	male genuineness	**female genuineness**	**male fakeness**	**female fakeness**
apex length	$F(1, 110) = 15.17$**	$F(1, 112) = 82.28$**	$F(1, 107) = 5.94$*	$F(1, 114) = 24.59$**
duration	$F(2, 220) = 7.38$**	$F(2, 224) = 12.05$**	$F(2, 214) = 1.74$	$F(2, 228) = 5.99$**
interaction	$F(2, 220) = 16.07$**	$F(2, 224) = 8.00$**	$F(2, 214) = 8.81$**	$F(2, 228) = 4.21$*

* Significant at the .05 level. ** Significant at the .01 level.

for the male face; 3.69 vs. 3.20 for the female face). Consistently, mean ratings of smile fakeness were significantly higher in the smiles with shorter apex time for both the male and the female faces than the smiles with a longer apex time (3.07 vs 2.91 for the male face; 2.72 vs 2.34 for the female face).

In terms of the overall durations of the smiles, for both the male and female characters, ratings of smile genuineness were significantly higher in smiles lasting 3 or 5 seconds than smiles lasting 7 seconds in smiles on both faces (3.15 and 3.17 vs. 2.84 for the male face; 3.56 and 3.59 vs. 3.20 for the female face). For both characters, a comparison between smiles of 3 and 5 seconds yielded a non-significant difference.

Ratings of fakeness for the female smile were significantly higher in smiles lasting 7 seconds than 3 seconds or 5 seconds (2.72 vs. 2.44 and 2.43). Smiles of 3 and 5 seconds are not different in terms of their ratings of fakeness. For the male face, smile duration does not affect the ratings of fakeness.

5 Discussion and Future Work

Contrary to Ekman's previous studies, smiles with a longer apex time than onset seems more genuine and less fake to our subjects. This trend is more significant for smiles that last 7 seconds than shorter smiles of 3 and 5 seconds, and it is also consistent across two different virtual human faces—one being male, and the other female.

On the other hand, this somewhat agrees with findings by Ekman and Friesen in which participants "who saw just the facial expressions judged people to be most truthful when they were, in fact, lying" [1]. Although in this study we put the character's smiles in the context of simple verbal statements, we suspect the statements were too simple to provide the participants a context for properly judging the smiles.

Practically, the results of this study suggests that when virtual human characters are used in a relatively simple social context and when their smiles last longer than 3 seconds, they should display smiles with a longer apex in order to appear more genuine to users.

Future work will examine more closely the distinction between genuine and fake smiles. We plan to study the phenomenon again when the smiles are embedded in a much richer social context, including a social robot capable of displaying facial expressions. In addition, we also plan to study manipulation of action unit classification and laterality. For example, Ekman and Friesen indicated that when people present fake smiles, they consciously raise their lip corners but usually fail to conceal other involuntary facial cues [2].

6 Conclusion

Having appropriate facial expressions is important for virtual humans. In this work, we investigated the difference between genuine and fake smiles, which has

been extensively studied in human facial expressions. Expression apex time was shown to have a significant effect on participants' observations and rating of smile genuineness and fakeness. The results from this study indicate that in a simple, social interaction context with relatively long smile durations (> 3 seconds), smiles with a longer apex time than onset are perceived as more genuine for virtual humans. Future work has been planned for further study of this phenomenon.

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