Does render style affect perception of personality in virtual humans?

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Abstract

Delivering appealing virtual characters conveying personality is becoming extremely important in the entertainment industry and beyond. A theory called the 'Uncanny Valley' has been used to describe the phenomenon that the appearance of a virtual character can contribute to negative/positive audience reactions to that character [Mori 1970]. Since the style used to render a character strongly changes the appearance, we investigate whether a difference in render style can indirectly influence audience reaction, which we measure based on perception of personality. Based on psychology research, we first scripted original character dialogues in order to convey a range of ten typical personality types. Then, a professional actor was recruited to act out these dialogues, while his face and body motion and audio were recorded. The performances were mapped onto a virtual character rendered in two styles that differ greatly in appearance: an appealing cartoon style and unappealing ill style (Figure 1). In our experiment, participants were asked questions about the character's personality in order for us to test if the difference in render style causes differences in personality perception. Our results found an indirect effect of render style where the cartoon style was rated as having a more agreeable personality than the ill style. This result has implications for developers interested in creating appealing virtual humans, avoiding the 'Uncanny Valley' phenomenon.

CR Categories: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—[Rendering]

Keywords: animation, personality, motion capture, perception

1 Introduction

Creating appealing virtual characters is an important task for developers of computer graphics applications since these characters can induce positive emotions, increase immersion, and enhance enjoyment of the spectator. The level of character appeal varies with physical appearance, render style, body motion, etc. Personality traits are also connected with appeal and the Uncanny Valley, with a recent study showing that negative personality traits are attributed to characters with an uncanny appearance [Tinwell et al. 2013]. Our study explores the personality/appeal interaction further by examining if the perception of personality can be altered with an 'uncanny' or unappealing appearance.

Although psychology literature is rich with research on personality, there is a lack of resources providing situation descriptors or dialogue to convey a range of complex personalities. Our first task was to use the literature in order to build such a resource that could be used for future studies on personality perception. Using these

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Figure 1: *Animation screenshots from the ToonCG character displaying a conscientious personality (left) and the HumaIll character displaying a low conscientious personality (right).*

dialogues, we then investigated if personality perception would be affected by the style used to render the character that portrayed it.

We aim to address a number of questions: Can we build reliable dialogue resource to convey a range of complex personalities grounded in psychology research? Are certain personalities considered more appealing than others? Could changing the render style alone alter the perception of personality?

2 Background

Some studies have linked visual information with particular subjective responses associated with the perception of personality in virtual humans. Carter et al. [2013] used eye-tracking in addition to questionnaire measures for animation assessment and found that viewer attention to faces was affected by pleasantness ratings. They concluded that the style used to render the character had an effect on both viewing patterns and subjective opinions of the characters. In other work, Hyde et al. [2013] investigated the effect of render style on perception of character likeability, intelligence, and extraversion. They found that participants liked the realistic characters more than the cartoon characters, and that there was a correlation between extraversion and the speed of body motion. Some inadequacies in character's motion can also transfer to the observed personality of the character. For example, Tinwell [2013] found that virtual characters with inadequate upper facial animation exhibit personality traits associated with psychopathy.

In our previous work, we found no indirect effect of unpleasantness in body shape or render style on the perception of emotion [McDonnell et al. 2009] or trustworthiness [McDonnell et al. 2012]. However, in those studies we were interested in an immediate impression of the character, where participants were only exposed to the character for 3 seconds per trial. In this paper, we use longer sequences in order to portray a sufficient amount of personality characteristics and thus allow participants time to form a more complex impression of the character.

3 Personality Modeling

In this section, we explain our approach to building a resource providing situation descriptors to convey a range of personalities. Our approach draws from research on observable personality traits. The "Big Five" theory (see for example [Goldberg 1990; Costa and McCrae 1992; John et al. 2008]) and its continuous examination and re-evaluation make it a standard description of human personality in psychology research. The Big Five is a hierarchical model of personality traits with five broad factors (Extraversion, Agreeableness, Conscientiousness, Openness to Experience, and Emotional Stability). Each bipolar factor (e.g., Extraversion vs. Introversion) is further described by specific facets and traits (e.g. extraverts are talkative, sociable). Some studies showed that there are correlations between facets of the Big Five, and condensed the original model to the "Big Three", "Big Two" and the "General Factor of Personality (GFP)" [Musek 2007]. GFP is summarized as the difference between the personality that can be described as having high scores on all the facets of the Big Five and the personality that scores low on these facets. Musek [2007] described the Big One as an optimum blend of all socially valued dimensions.

Since the Big Five factors are found to contribute most to the variation of human behavior, they can also to some extent predict it [Paunonen and Ashton 2001]. People with certain combinations of traits would therefore react differently to people with other sets of traits. This predictive behavior can be deduced from observable behavior, self-ratings or ratings of others. Studies show that people can assess personality of others even at zero-acquaintance [Borkenau and Liebler 1992; Back et al. 2011; Mehl et al. 2006], based on physical appearance from photos [Naumann et al. 2009], type of motion [Neff et al. 2010; Argyle 1988; North 1975] and even use of language [Gill and Oberlander 2003; Dewaele and Furnham 2000]. Behavior can also be observed through emotional responses to certain situations.

When constructing an observable set of traits in virtual characters, we have to take into account that the observations of personality are known to be biased. Studies show that a person's perception of another person's personality is influenced by their own personality [Serfass and Sherman 2013; Paunonen and Hong 2013], especially when the information about the person observed are sparse [Ready et al. 2000] or when the observed person exhibits traits which the observer is sensitive about (e.g. neurotic observers will be more sensitive to perceptions of criticism [Serfass and Sherman 2013]). There is also an effect of gender - women are known to be better decoders of both posed and spontaneous nonverbal behavior and are better in encoding it as well [Hall 1979; Ambady et al. 1995]. For this reason, we asked our participants to give information about their personality before starting the experiment and also aimed to balance the number of male and female participants, where possible.

All of this information alongside the descriptions of the Big Five traits were used in our creation of diverse and observable personalities. We first created personality descriptions, taken from the Big Five facets [Goldberg 1990; Costa and McCrae 1992; John et al. 2008], zero-acquaintance observations [Mehl et al. 2006] and language analysis [Gill and Oberlander 2003; Dewaele and Furnham 2000]. Then, we described situations in which to place the personalities in order to bring out the Big Five traits and their polar opposites (10 different scenarios in total). This information provided guidelines for the actor who adapted the descriptions to his own expressive performance for each of the 10 situations.

4 Stimuli Creation

For the purposes of this experiment, we conducted a performance-capture session using one professional male actor. A 21-camera Vicon optical system was used, where 52 markers were placed on the body and 36 markers on the face. We did not capture finger or eye motion in this study. Audio was captured simultaneously using a Behringer C-2 studio condenser microphone placed in front of the actor. The actor was instructed to perform responses to the 10 situations by taking into account personality and situation descriptions, as outlined in the previous section. For example, the actor was told that he would portray an extraverted personality in a situation where he received a new television as a birthday present from his friends. He was instructed to express gratitude, be humorous, show positive emotions and mention how important his friends are. He was also given information on the type of body language (e.g., expressive, physically animated) and language (e.g., informal, use plural "we") he should use. The length of each performance depended on the actor's free interpretation of the character and the capture was stopped when all the main characteristics of the personality were expressed.

In order to display the animation, we chose a male virtual character from our previous work [McDonnell et al. 2012] as we had collected perceptual ratings for this character on a range of scales (appeal, familiarity, friendly, eerie, etc.). We choose to render the character using two render styles that were rated as significantly different in appearance on the majority of scales: a cartoon style, referred to as 'ToonCG', and an ill looking style 'HumanIll'. ToonCG was similar to the style used in computer graphics cartoons in the industry and was rated as highly appealing, friendly, and familiar. In contrast, the HumanIll character had the appearance of disease and was rated by participants as both unappealing and eerie, particularly when moving [McDonnell et al. 2012]. In order to determine if the render style alone affected ratings, all other factors remained the same - motion, audio, viewpoint, and geometry, etc.

Similar to the approach used in our previous work [McDonnell et al. 2012], the captured body motion was mapped onto a skeleton where joint angles were computed and used to drive the virtual character in Autodesk 3ds Max 2014. The facial motion was directly applied to the bones of the character's face. In total, 20 animation clips were created for the experiment (10 situations x 2 render styles). The average length of a clip was 37 seconds (min: 30 sec, max: 47 sec).

5 Experiment

A between-groups design was used for this experiment, where participants in the first group viewed the 10 animation clips rendered using the ToonCG style and participants in the second group viewed the 10 animation clips rendered using the HumanIll style. This paradigm was used as it allowed us to indirectly measure the effect of render style, without participants having explicit knowledge of what was being tested (i.e., if a within-groups design was used, a contrast effect may have occurred where participants would be aware of the different styles being tested and might alter their personality ratings accordingly). 36 participants (18 per group, 15 females and 21 males), aged 19 - 44 (average age: 28), took part in the experiment. Participants were students from different disciplinary backgrounds as well as employed individuals from various fields, recruited mainly via university mailing list. They were naïve to the purpose of the experiment, and were given book vouchers as a reward for participation.

Participants were first asked to rate their own personality on the Ten-Item Personality Inventory (TIPI) [Gosling et al. 2003]. TIPI is an questionnaire which measures the Big Five factors as dimen-
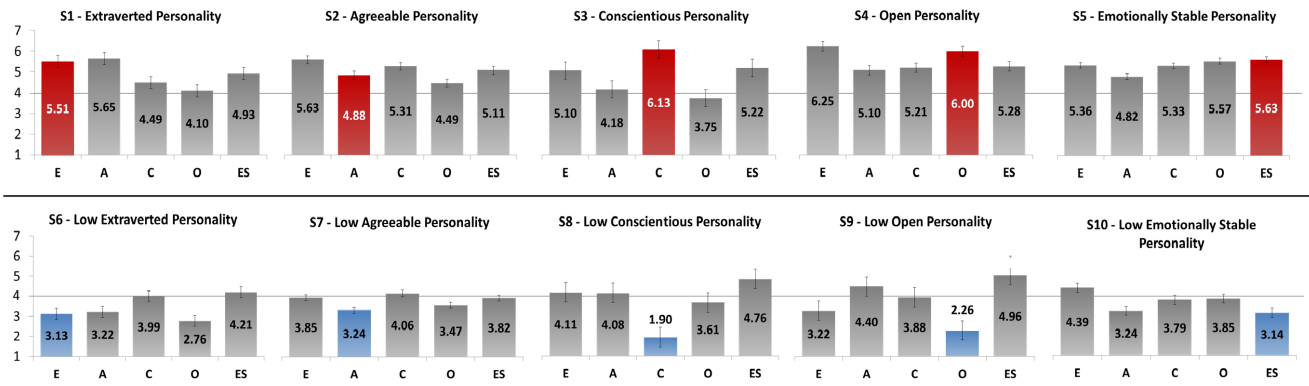
Figure 2: *TIPI ratings on scales: E - Extraversion, A - Agreeableness, C - Conscientiousness, O - Openness, ES - Emotional Stability, averaged over render style and participant sex, for the 10 situations which portray high (upper graphs) and low (lower graphs) expressions of the Big Five traits. Colored bars represent the average ratings of the intended trait, for each situation (e.g., red bar shows an average rating of 5.42 for the extraverted trait in the situation intended to display an Extraverted Character). Each bar is labeled with the average mean value and standard error bars.*

sions. Each scale describes one pole of the dimension with two markers taken from existing Big Five instruments [Goldberg 1990]. For example, *extraverted, enthusiastic* are markers of the positive pole of the Extraversion dimension (*reserved, quiet* are markers of the negative pole).

After the self-ratings, the 10 animation clips were shown per participant in random order, and they were informed that the character possessed different personality traits in each clip. After each trial, they were asked: "How appealing do you find this virtual human? Use all cues: appearance, motion and audio", on a scale from 1 (Not Appealing At All) to 7 (Extremely Appealing) by pressing the number keys on the keyboard. A high appeal rating was explained as meaning that the character is one that the participant would like to watch more of, and would be captivated by a movie with that character as the lead actor. Following this, participants rated the character's personality on the TIPI scales. They did this by reporting their level of agreement that the character's personality matched that of each trait marker pair, from 1 (Strongly disagree) to 7 (Strongly agree) and then continued to the next animation. The TIPI traits can been seen on the horizontal axis of Figure 2.

6 Results

We first recorded ratings of the 10 scales of the TIPI questionnaire, for all participants. As is common practice for analyzing TIPI ratings [Gosling et al. 2003], we then collapsed the 10 scales down to 5 by averaging the scores for the positive poles (e.g., Extraversion) with the reverse scores for the opposite pole (e.g., Low Extraversion). This gave us 5 scales in total (Extraversion, Agreeableness, Conscientiousness, Openness, and Emotional Stability). For each of the scales, a three-way repeated measures ANalysis Of VAriance (ANOVA) was conducted with within-groups factor *situation* (10) and between-groups factors *participant sex* (2) and *render style* (2). For all scales, there was no main effect of participant sex, implying that ratings of personality were consistent across male and female participants. Furthermore, we tested for a correlation between participant's own personality ratings and their ratings of character on the same scales and found no correlation, implying that in our study *the sex and the personality of the participant did not affect their ratings of character personality*.

6.1 Situation

A main effect of situation occurred for each scale, implying that the situation affected ratings of personality. Figure 2 shows the ratings of the 5 scales on the 10 situations. The situations are labeled according to the personality they intended to portray e.g. Situation 1 - Extraverted Personality, Situation 6 - Low Extraverted Personality. On observation of this graph and using one-sample t-tests with a constant 4 (middle of the rating scale from 1-7), it can be seen that the intended traits were conveyed for each situation above chance (red bars for the situations that expected high ratings on the intended trait scale, and blue for the situations that expected low ratings, $p \approx 0.00$ in all cases). This implies that *our constructed situations conveyed the intended personality traits above chance*. We also observe that the intended trait was not the only trait that was strongly identified for each situation (e.g. Situation 1 received high ratings for the intended extraversion scale, but also for the agreeableness scale). This implies that the constructed situations not only elicited the intended traits, but also some other traits that were not specifically intended.

6.2 Render Style

A main effect of render style occurred for the **Agreeable** trait, where ToonCG was judged as significantly more agreeable than HumanIll ($F(1, 32) = 4.95, p < 0.04$). Means = 4.5 and 4.07 respectively. For this trait, a three way interaction also occurred between participant sex, situation, and render style ($F(9, 288) = 2.38, p < 0.02$) where female participants rated the HumanIll style as significantly less agreeable than the ToonCG style in Situation 3 ($p < 0.2$), while there was no significant difference between the styles for Situation 3 for male participants. No other main effect of render style or interaction with render style was found for the other four traits. These results are significant for developers of virtual characters as we have found evidence to suggest that the *style used to render a character can alter the interpretation of its personality*.

6.3 Appeal

Finally, we present the results of the ratings of appeal. No effect of render style or interaction with situation was found, however, a main effect of situation was found ($F(9, 306) = 15.48, p \approx 0.00$). Post-hoc analysis showed that each of the five positive situations

(1-5) were rated as significantly more appealing than each of the negative situations (1-6) ($p < 0.01$ in all cases). Furthermore, all of the positive situations were rated as equally appealing and all of the negative situations were rated as equally unappealing, except for Situation 10 which was rated as significantly more appealing than Situation 6 ($p < 0.05$). Our results imply that *the appeal of a scenario is highly dependent on the personality content* and the render style does not directly influence the overall appeal. However, we believe our task may have influenced this result on render style, since participants were asked to rate appeal after every situation and may have neglected the appearance of the character, since it was kept constant across all situations.

7 Discussion

Our most significant finding is that the perception of personality can be indirectly altered by changing the style used to render the character. In our experiment, the ill-looking render style evoked less desirable personality traits than the cartoon style. This was apparent in the agreeableness personality trait, where the ill style was judged overall as less agreeable than the cartoon style. This implies that the ill character was seen to be more critical and quarrelsome, as well as less sympathetic and warm than the cartoon. Our results have implications for character design since it is clear that the style used to render a character, with all other conditions the same, can affect how that character's personality is perceived. Our study is a first step at understanding this interaction and will require further experiments, e.g. larger range of render styles including an 'uncanny' photorealistic style, in order to quantify the effects seen here. We are also interested in the affect of geometry and animation stylization and whether these factors can effect personality perception and appeal.

One limitation of our current study is the fact that eye and finger motion were not included, which could have an effect on the perception of personality. Future work will explore which cues are most important for personality perception.

Our results have shown that the constructed situations were able to convey the intended personality traits of the Big Five. Some changes could be made to the construction of situations, as our results show that certain situations conveyed personality traits we did not specifically intend for the character to have. We also found that the appeal ratings of the Big Five traits could be generally described as more and less appealing, a result similar to GFP explanation of personality [2007]. Future studies wishing to effectively model personality, may find this result helpful. However, a limitation of our study is that only one actor was recruited to perform the situations in this experiment. Future studies will use professional actors and non-professionals with different ranges of personality traits, to further validate the appropriateness of the constructed situations.

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