Attractiveness and Confidence in Walking Style of Male and Female Virtual Characters

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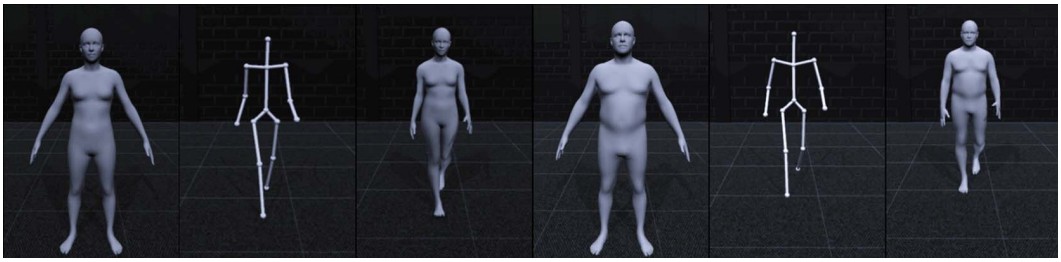

Figure 1: Screenshots of the virtual scene showing the static and walking virtual characters generated using the MoSh algorithm, and the walking stick-figures for one woman and one man from the bmlRUB database.

ABSTRACT

Animated virtual characters are essential to many applications. Little is known so far about biological and personality inferences made from a virtual character's body shape and motion. Here, we investigated how sex-specific differences in walking style relate to the perceived attractiveness and confidence of male and female virtual characters. The characters were generated by reconstructing body shape and walking motion from optical motion capture data. The results suggest that sexual dimorphism in walking style plays a different role in attributing biological and personality traits to male and female virtual characters. This finding has important implications for virtual character animation.

Keywords: Animated virtual characters, attractiveness, confidence, sex differences

Index Terms: Computing methodologies—Computer graphics—Animation—Motion capture; Computing methodologies—Computer graphics—Shape modeling—Mesh models;

1 INTRODUCTION AND RELATED WORK

Animated virtual characters are used in a range of applications, including interactive virtual reality games, tutoring games, training, and general interfaces. To date, many of these applications use highly stylized characters to avoid negative responses from the viewers that arise from inconsistencies between different aspects of the rendering. Recent advances in computer graphics methods and statistical models of human bodies have allowed for significant improvements of the visual fidelity of virtual characters. However, little is known about biological and personality inferences made from body shape and motion of virtual characters with high levels of realism. In this study, we investigated how perceived attractiveness and confidence relate to body shape and walking motion of male and female characters, and how these two attributes relate to sex-specific differences in walking style. To generate realistic virtual characters, we used the MoSh algorithm that allows reconstruction of a person's shape and motion from motion capture (mocap) data [4, 6].

In the last two decades, there has been significant work on learning statistical models of 3D human faces, e.g. [1], and body shapes, e.g. [5]. The ability to create a broad range of stimuli with biometrically plausible shape variations has been used by several researchers to examine the relationship between shape features and semantic attributes [2, 7]. Streuber et al. [7] showed that when learning the mapping of linguistic descriptor terms to 3D body parameters, attribute ratings of body-shape features provide sufficient information to reconstruct a person's body shape that is perceptually indistinguishable from a high-resolution body scan. Body-shape features were also found to be related to descriptions of personality traits [2]. These studies suggest that people have a shared understanding of body shape that is reflected in language and this extends to more abstract language-based descriptions of personality traits. Whether and how bodies in motion are similarly related to descriptions of biological and personality traits is still unknown.

Human motion is rich in socially relevant information, such as a person's identity, health, and biological sex. Humans are extremely sensitive to animate motion patterns and highly efficient in extracting information encoded in these patterns [10]. Numerous studies have investigated how information is encoded in normal walking behaviour using point-light displays, e.g. [8]. Those studies found that the dynamic part of the presentation is much more important for determining a person's sex than the structural part. The exaggerated male walking pattern is determined by a wide step width, a significant sway of the shoulders, and the elbows being held away from the body. The exaggerated female walking pattern is determined by a significant rotation in the hips, little lateral motion in the upper body, and the elbows being held close to the body [9]. Little is known about how this sexual dimorphism in walking style relates

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978-1-7281-6532-5/20/$31.00 ©2020 IEEE
DOI 10.1109/VRW50115.2020.00188

to attributes of psychological or social relevance, such as biological and personality traits. This topic is of interest for research on person perception and research on the perception of animated characters.

2 Experiment

We used the walking motions of 50 men and 50 women from the bmlRUB mocap database [8]. Each actor's body shape and walking motion was reconstructed from the mocap data using the MoSh algorithm [4].[1] MoSh produces an animated 3D mesh using the data-driven SMPL model that parameterizes the inter-individual variance in body shape and pose-dependent shape deformations. The 100 walkers were presented in three different ways (Figure 1): (1) as a 3D virtual character with each actor's shape and walking motion, (2) as a 3D virtual character in a static A-pose, and (3) as a walking stick-figure with lines connecting 15 skeletal landmarks [8]. The stimulus set consisted of 300 stimuli (100 walkers x 3 presentations) and was presented in virtual reality using the Oculus Rift DK2. The animated stimuli were presented such that they walked directly towards the participant over a distance of 4 m. The static virtual characters were placed 3.5 m in front of the participant and were displayed for the same duration as the walking motion of each actor (M = 6 s). After the stimulus was shown, participants were prompted to rate how they perceived the stimulus on a 6-point Likert scale. In Experiment 1, 40 observers (20 female, 20 male) rated the attractiveness of the 100 walkers (1 – not attractive, 6 – very attractive) and in Experiment 2, another 36 observers (18 female, 18 male) rated the walkers' confidence (1 – not confident, 6 – very confident). The experiment was programmed in the Unity game engine.

3 Data Analysis and Results

The motion patterns of the 100 walkers were analyzed using the algorithm described in [8, 10]. Based on linearization of the motion data, a motion space was defined that is spanned by the first 9 principle components. Using participants' attractiveness and confidence ratings, linear discriminant functions were computed separately for the three presentation types, walker sex, and participant sex. The discriminant function for sex-specific differences in walking style was computed in the same way. These functions define 9D vectors in the motion space that generalize the respective trait and allow morphing between walking styles with high and low rated attractiveness and confidence, and between an exaggerated female and male walk. To analyze how sexual dimorphism in walking relates to attractiveness and confidence ratings, correlations were calculated between the coefficients of the respective linear discriminate functions. The results are reported as Pearson's correlation coefficients (r).

The analysis revealed strong correlations between the ratings of the animated characters and the stick-figures (attractiveness: mean r = .62; confidence: mean r = .75), and between the ratings of the animated and the static characters (attractiveness: mean r = .74; confidence: mean r = .33). Because the stick-figures contain little shape information and the static characters only share shape information with the animated characters, this finding suggests that both motion and shape contribute to how attractive and confident animated characters are perceived. The ratings for the stick-figures and the static characters were only weakly correlated (attractiveness: mean r = .17; confidence: mean r = .17).

Correlations of the ratings with sexual dimorphism in walking style revealed that it plays a different role in males and females for perceived attractiveness and confidence. Sexual dimorphism in walking style dominates female attractiveness assigned to animated characters (r = .46) and stick-figures (r = .5). The more feminine a woman walks, the more attractive she is rated. Sexual dimorphism in walking style dominates male confidence assigned to animated characters (r = -.25) and stick-figures (r = -.42). The more masculine a man walks, the more confident he is rated. Perceived male attractiveness, on the other hand, is determined by increased vertical body movements which make the walk appear bouncy and energetic, both for animated characters (r = .47) and stick-figures (r = .54). Increased vertical movements were also found important for perceived female confidence, both for animated characters (r = .56) and stick-figures (r = .53). High ratings of the static virtual characters were characterised by tall and slim body shapes for male and female attractiveness, and female confidence, and tall and strong body shapes for male confidence (as compared to small and heavy body shapes). Male and female participants agreed on their ratings.

[1] The bmlRUB dataset is part of AMASS [6] (`https://amass.is.tue.mpg.de/`) which unifies different optical marker-based mocap datasets by representing them as realistic 3D human meshes using the MoSh++ method.

4 Conclusions and Future Work

We investigated how perceived attractiveness and confidence relate to body shape and walking motion of virtual characters, and sex-specific differences in walking style. Our results indicate that these two attributes relate both to the shape and walking motion of animated characters. Further, we found that sexual dimorphism in walking style seems to play a different role in attributing biological and personality traits to male and female virtual characters. In line with previous research [9], sexual dimorphism in walking was more important for female attractiveness, whereas increased vertical motion was important for male attractiveness. Interestingly, the opposite seems to be true for perceived confidence. These results are important to consider in applications using animated virtual characters because inferences made from the character's appearance and motion could influence the user's behaviour.

We generated virtual characters based on the body shape and walking motion of 100 actors using the MoSh algorithm [4, 6]. This method avoids problems with reduced perceived realism of animations introduced by re-targeting a person's motion onto a character with a different body shape [3]. While our representation of walking motion allows the synthesis of new walking styles with different levels of perceived attractiveness and confidence, more research is needed on how to diminish the human visual system's sensitivity to inconsistencies between shape and motion in animations.

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