Computers in Human Behavior 36 (2014) 286–296

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Children's perception of uncanny human-like virtual characters

Angela Tinwell [a,*], Robin J.S. Sloan [b]

[a] University of Bolton, Faculty of Games, Computing, and IT, England, United Kingdom
[b] Abertay University, Institute of Arts, Media, and Computer Games, Scotland, United Kingdom

ARTICLE INFO

Article history:
Available online 4 May 2014

Keywords:
Uncanny Valley
Children
Facial expression
Human-like charactersl
Video games
Animation

ABSTRACT

The Uncanny Valley phenomenon predicts that humans will be less accepting, to the point of rejection, of synthetic agents with a human-like appearance. This is due to a perception of a strangeness or difference in how those characters look and behave from the human norm. Virtual characters with a human-like appearance are increasingly being used in children's animation and video games. While studies have been conducted in adult perception of the Uncanny Valley in human-like virtual characters, little work exists that explores children's perception of "uncanniness" in human-like virtual characters. Sixty-seven children between 9 and 11 years of age rated humans and human-like virtual characters showing different facial expressions for perceived strangeness, friendliness, and human-likeness. The results showed that children do experience uncanniness in human-like virtual characters, perceived as stranger, less friendly, and less human-like than humans. This perception of the uncanny was exaggerated further in human-like characters with aberrant facial expression. That is, when showing a startled expression and/or happiness with a lack of movement in the upper face including the eyes, eyebrows, and forehead. The possible implications of including human-like virtual characters in animation and video games for this age group are discussed.

1. Introduction

Previous studies into adults' perception of the Uncanny Valley in human-like virtual characters have elucidated factors which exaggerate the uncanny in characters. While many presentational factors may contribute to uncanniness such as: incongruence in gesture and timing of movements (Ho, MacDorman, & Pramono, 2008; MacDorman & Ishiguro, 2006; Minato, Shimda, Ishiguro, & Itakura, 2004), jerky motion (MacDorman, Coram, Ho, & Patel, 2010), disproportionate facial features (Green, MacDorman, Ho, & Vasudevan, 2008; Seyama & Nagayama, 2007), and an asynchrony of speech (Tinwell, Grimshaw, & Abdel Nabi, in press), much of this criticism is focused on aberrant facial expression in a character (Hodgins, Jörg, O'Sullivan, Park, & Mahler, 2010; Tinwell, Abdel Nabi, & Charlton, 2013; Tinwell, Grimshaw, Williams, & Abdel Nabi, 2011a). Specifically, adults rated headshots of virtual characters with a human-like appearance presenting different facial expressions as less human-like and familiar (Tinwell, Grimshaw, Williams, et al., 2011a) and more hostile (Tinwell et al., 2013) than videos of humans. Furthermore, the magnitude of perception of the uncanny in human-like virtual characters was increased when movement (and therefore emotional expressivity) had been eliminated in a character's upper facial region including the eyes, eyebrows, and forehead (Tinwell, Grimshaw, Williams, et al., 2011a, 2013). Based on these previous studies into facial expression and the uncanny in human-like virtual characters by Tinwell et al. (2011a and 2013), for the purpose of this present study, the word aberrant refers to a lack of movement in a character's upper face including the eyes, eyebrows, and forehead. Adult perception of the uncanny was stronger for some emotions than others, especially so when characters presented a startled expression in response to a fearful and/or surprising event (Tinwell, Grimshaw, Williams, et al., 2011a; Tinwell et al., 2013). However, characters presenting happiness were less prone to uncanniness, despite a lack of movement in the upper face (Tinwell, Grimshaw, Williams, et al., 2011a). Tinwell, Grimshaw, Williams, et al. (2011a) suggested that a reduced saliency in emotion increased how unpredictable, and therefore how uncanny, that character was perceived to be particularly when presenting more negative emotions. Furthermore, the viewer may also perceive a lack of empathy in an uncanny character with aberrant facial expression (i.e. a lack of movement in the upper facial region) to the extent that they are unfriendly, hostile, have anti-social tendencies, and are perceived as a threat (Tinwell et al., 2013).

* Corresponding author. Address: University of Bolton, Faculty of Games, Computing, and IT, Deane Road, Bolton BL3 5AB, United Kingdom. Tel.: +44 (0)1204 903589; fax: +44 (0)1204 903500.
E-mail address: A.Tinwell@bolton.ac.uk (A. Tinwell).

http://dx.doi.org/10.1016/j.chb.2014.03.073
0747-5632/

Despite the increase in realism in children's animation and video games, there have been no studies to investigate if children perceive the uncanny in animated, human-like virtual characters. The majority of studies on the Uncanny Valley have been conducted with adults and further work is required to investigate if children experience uncanniness in human-like virtual characters (Dautenhahn et al., 2005; Hall & Woods, 2005; Woods, K., & J., 2004). This present study represented a systematic investigation to test if primary school children perceived the uncanny in animated, human-like virtual characters when the characters presented a startled expression and when they presented a happy expression. Then, if uncanniness was detected, if this effect was exaggerated when movement had been disabled in a character's upper face, including the eyes, eyebrows, and forehead, when presenting a startled and/or happy expression.

1.1. The Uncanny Valley

Unsatisfied with robots of just a mechanical appearance that served a functional role in industry, some engineers wished to explore how a robot's appearance and behavior may be designed to interact with humans on a more social level. As such, android robots were designed with a human-like appearance with the purpose to mimic and interact with humans. However, Mori (2012) observed that increased efforts to simulate a human's appearance and behavior reduced how accepting humans were of the androids. This was due to perceived anomalies between the android's human-like appearance and its behavior, so the android was regarded as strange. The android's human-like appearance raised expectations that it would behave as a human, and failure to do so evoked a negative empathetic response from the viewer to the extent of repulsion. To help explain this negative reaction, Mori (2012) used a word synonymous with the eerie, unsettlingly feeling evoked by horror stories, the "uncanny". Mori (2012) plotted a hypothetical graph to show how the positive relationship between one's affinity towards a robot and an increased human-likeness was interrupted as the robot appeared close to, but not fully human (see Fig. 1). This caused a valley shaped dip that Mori (2012) coined "The Uncanny Valley". Objects that may provoke the uncanny such as zombies, corpses, and life-like prosthetic hands were placed in the valley and Mori predicted that uncanniness would be exaggerated with object movement.

Mori (2012) originally used the Japanese neologism *Shinwakan* to describe the uncanny effect. In English, *Shinwakan* is translated as "perceived familiarity"; however, the reliability of using

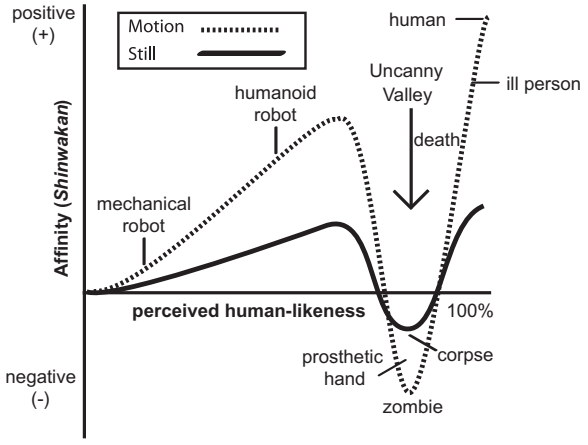

Fig. 1. The Uncanny Valley that plots a viewer's affinity towards an object against how human-like the object is (Mori, 2012).

familiarity as a description to measure uncanniness has been questioned by previous authors (see, e.g., Bartneck, Kanda, Ishiguro, & Hagita, 2009; Ho & MacDorman, 2010; MacDorman, 2006; Tinwell, Grimshaw, & Williams, 2011b). Participants (especially children) may misunderstand how perceived familiarity should be interpreted in the context of measuring the uncanny. Instead, it may be construed as how well-known or popular a character is to an individual or in mainstream culture, or how often a person has encountered a character of that type. To avoid such confusion, other variables have been suggested to measure the uncanny in synthetic agents including "unstrange or strange" (Tinwell, Grimshaw, Williams, 2011b, p.334) and "unfriendly or friendly" (Bartneck et al., 2009, p.271).

1.2. Children's interaction with human-like virtual characters

Motion-capture technologies that capture an actor's performance, have facilitated increased realism in animation and video games designed for adults and children (Freedman, 2012). High definition digital cameras capture an actor's movement and this data is then transferred to a computerized three-dimensional (3D) character model to animate that character. As such, in addition to characters with an anthropomorphic appearance such as "Shrek" or "Sonic the Hedgehog", characters with a human-like appearance are being featured in children's animation and video games. Some 3D modelers regard an increase in aesthetic realism as highly desirable, as a way to increase a viewer's engagement with an animation or game (Aylett, Paiva, Woods, Hall, & Zoll, 2008; Hodgins, Jörg, O'Sullivan, Park, & Mahler, 2010; Ravaja, Turpeinen, Saari, Puttonen, & Keltikangas-Järvinen, 2008). However, the audience has been critical of these human-like characters with many reported as evoking the uncanny (Freedman, 2012; Geller, 2008; Hodgins, Jörg, O'Sullivan, Park, & Mahler, 2010; Kaba, 2013; Pollick, 2010).

Protagonist characters in children's animations, such as "The Conductor" in *The Polar Express* (Zemekis, 2004), "Tintin" (Spielburg, 2011), and "Milo's Mom" in Disney's *Mars Needs Moms*, (Wells, 2011) were intended to be perceived as empathetic, with a warm personality who would appeal to a younger audience. However, rather than being perceived as likeable and friendly, some viewers became frustrated at a perceived lack of emotional expressivity from these characters due to their unnatural and limited facial expression (Buchanan, 2011; Eberle, 2009; Jenkins, 2004; Kaba, 2013; Pavlus, 2011; Rose, 2011). Their abnormal facial expression disturbed and annoyed some of the audience so that these characters were regarded as strange and uncanny (Beck, Stevens, Bard, & Cañamero, 2012; Buchanan, 2011; Eberle, 2009; Jenkins, 2004; Kaba, 2013; Levi, 2004; Oddey & White, 2009; Pavlus, 2011; Pollick, 2010; Rose, 2011; Schager, 2011). Limitations in rendering capacity for video game footage that is played in real-time can challenge game designers further when attempting to overcome the Uncanny Valley. Automated and/or procedural generation techniques are used in video game engine software to generate a character's movement and facial expression, and this real-time footage may lack the detail of pre-recorded animation. With a suggested age rating of "ten years plus" by the Entertainment Software Rating Board (ESRB), the video game *Harry Potter and the Half-Blood Prince* (Electronic Arts, 2009) was designed to attract children as well as adult players. However, some players were distracted and put off by Harry Potter's eerie facial expression and he was criticized for a lack of emotional response to emotive situations (Klepek, 2009).

1.3. Previous investigation into the Uncanny Valley

Other authors have theorized that uncanniness may be caused by perception of a threat to one's own well-being and triggers