The Uncanny Wall

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Abstract: This paper proposes that increasing technological sophistication in the creation of realism for human-like, virtual characters is matched by increasing technological discernment on the part of the viewer. One of the goals for achieving a realism that is believable for virtual characters is to overcome the Uncanny Valley where perceived strangeness or familiarity is rated against perceived human-likeness. Empirical evidence shows that the Uncanny can be applied to virtual characters, yet implies a more complex picture than the shape of a deep valley with a sharp gradient as depicted in Mori's original plot of the Uncanny Valley. Our results imply that: (1) perceived familiarity is dependent upon a wider range of variables other than appearance and behaviour and (2) for realistic, human-like characters, the Uncanny Valley is an impossible traverse, is not supported fully by empirical evidence and the concept is better replaced with the notion of an Uncanny Wall.

Keywords: Uncanny Wall; Uncanny Valley; overcoming; impossible traverse; realism; human-like; virtual characters; video games; strangeness; familiarity; arts and technology.

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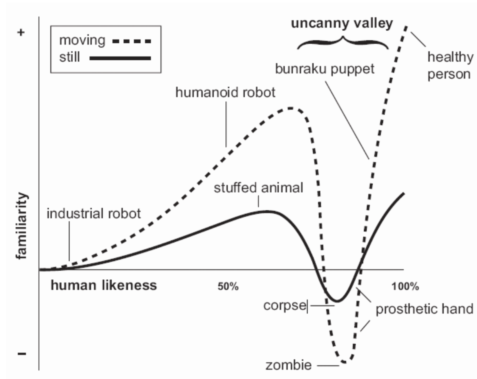
Andrew Williams is a Principal Lecturer in the School of Business and Creative Technologies at the University of Bolton. He has published on engagement and motivation in game development processes and on the use of competitive strategy games as a way of motivating students. Currently, he is leading a project relating to the use of gesture-driven interfaces for games. He leads a team of seven in delivering three games-related undergraduate programmes and teaches on the advanced games technology, games design team project and games evaluation modules. He has sat on a number of review panels for the provision of games undergraduate degrees and he is currently an external examiner for the University of Hull's MSc in games programming.

1 Introduction

The roboticist Masahiro Mori observed that as a robot's appearance becomes more human-like it is perceived as familiar to a viewer, until finer nuances from human norms cause them to appear strange, evoking a negative effect for the viewer (Mori, 1970, as translated by MacDorman and Minato (2005)). The positive relationship, Mori identifies between the perceived familiarity for a robot with human-likeness is inverted at a certain point where the robot is perceived as more strange than familiar. This sudden negative relationship occurs at the point where the robot appears close to being human and is referred to as the Uncanny Valley. Mori includes corpses, zombies and lifelike prosthetic hands as examples of things that lie in the Uncanny Valley and predicts that this phenomenon will be even more exaggerated with motion. Mori recommended that to avoid the risk of robots falling into the valley, designers should aspire to the first peak prior to the valley achieving merely a humanoid appearance, as opposed to the second peak of total human-likeness (Figure 1).

Despite being recognised as a phenomenon that is not only restricted to human-like robots (Ramey, 2005) the majority of explanations for the uncanny, with regards to virtual characters, remain untested (Brenton et al., 2005; MacDorman and Ishiguro, 2006; Steckenfinger and Ghazanfar, 2009). Studies that have been carried out since for virtual characters have included the use of still images as stimuli and state that the findings from their studies may not apply to animated faces or bodies thus providing the opportunity to further investigate how motion and sound may exaggerate the Uncanny (Green et al., 2008; MacDorman et al., 2009; Rozin and Fallon, 1987; Schneider et al., 2007). By implementing unused data from a previous empirical study using videos of virtual characters, we attempt to plot the Uncanny for such characters (Tinwell and Grimshaw, 2009a). Based on the findings from our study, this paper proposes the theory that instead of an Uncanny Valley, designers of realistic, human-like characters are faced with an Uncanny Wall, created by the viewers' continually improving discernment of the technical trickery used in the character's creation; this discernment prevents complete believability in the human-likeness of that character.

Figure 1 Mori's plot of perceived familiarity against human-likeness as the Uncanny Valley taken from a translation by Karl MacDorman and Takashi Minato of Mori's *The Uncanny Valley*



For the purposes of this paper, the term 'realism' is used to describe attributes of a character where the designer has intended that it be perceived as realistically human-like and this covers aspects of, and relationships between, appearance, motion, behaviour, sound and, in some cases, context. As some video game developers pursue realism in an attempt to bridge the Uncanny Valley for human-like characters in video games, it can sometimes seem that the more human-like characters become, the more vociferously potential users will object (Gouskos, 2006). As users become acclimatised to the current level of technological achievements in approximating realism, it seems they have developed a heightened level of awareness for the attributes that make a character appear lifeless as opposed to lifelike. The more a virtual character is intended to be realistic, the less forgiving the viewer is when identifying a difference or strangeness for that character. This is symptomatic of the Uncanny sensation within the context that Freud (1919) described for distinguishing between human and non-human-like forms.

The empirical data collected for our study provided evidence to suggest that realistic, human-like characters, proclaimed as overcoming the Uncanny Valley (Plantec, 2008), were actually rated as less familiar than a human; implying that they have not yet accomplished this feat. We put forward the idea that increased habituation with the technology used in the attempt to create realistic, human-like characters only serves to draw a viewer's attention to differences from the human norm. Accordingly, we propose conjecture of the Uncanny Wall may never be climbed as the viewer becomes ever more discerning of the use of this technology. We also introduce future work for developing a high fidelity facial animation tool to facilitate further enquiry into realism and the Uncanny for virtual characters (see Section 4.3).

1.1 The Uncanny sensation

A number of authors have discussed the Uncanny as it relates to perceptions of a range of artificial character types. As Minato et al. (2004) suggest the Uncanny sensation may not be in response to a single phenomenon, but instead various factors influence how human-likeness is perceived for both appearance and behaviour. They found that on interaction with an android, the Uncanny was particularly strong for pre-school children aged between three and five years old, that the Uncanny would be stronger for children, as opposed to adults, and that habituation would also lead to a change both in interaction with and perception of the android. Bartneck et al. (2007) relate the Uncanny as a consequence of a framing effect where, on encountering an android, the expectations raised from selecting our 'human-frame' fall short of the data structure that we have stored for this particular frame. The authors suggested that whilst results showed that the framing effect had little impact on the perception of still pictures of robots, the results may differ for the perception of moving robots (for our study, videos were used for all stimuli). Ramey (2005) suggests that the Uncanny is caused by an overlap of two otherwise separate categories ('human' and 'robot') and it challenges the intuition of one's individual identity or one's humanity, creating a paradox for the features that justify one's existence as human. This idea of conflict or paradox as the root of the Uncanny bears similarities to Plantec's (2007) use of the theory of cognitive dissonance to explain the Uncanny. When confronted with a realistic, human-like character, a viewer is prevented from believing that it is real as contradictory beliefs occur to identify flaws and to stop the viewer from being tricked.

The overall context for which the character is presented to the viewer is also important with regards to initiating an Uncanny sensation. Characters placed out of context may be deemed Uncanny if a situation seems unexpected for a viewer. For example, the 'Kuleshov effect', demonstrates that the same footage may be interpreted differently by the viewer when placed in different contexts (Mobbs et al., 2006). For this experiment, the virtual characters were placed in their usual environments, as would be expected within a typical video game setting. The human stimulus was also presented within a room setting with no abstraction or manipulation of the background environment. Keeping the virtual characters and human within their natural or expected environments reduced the overall risk of exaggerating the Uncanny with characters judged as being out-of-context.

1.2 Traversing the valley

Attempts to increase realism within the areas of robotics and virtual characters raise the question*: is it possible to overcome the Uncanny Valley?* Brenton et al. (2005) suggest that for virtual characters, a viewer's response is likely to change over time; characters will appear less Uncanny as viewers grow accustomed to them. Using the example of Duane Hanson's *The Jogger*, Brenton et al. (2005) state that the sculpture appears, "less Uncanny the second time that it is viewed because you are expecting it and have pre-classified it as a dead object". They also suggest that those involved in the development of realistic, human-like characters or those with a high level of exposure to realistic, human-like characters (e.g. an advanced experience of playing video games or using 3D modelling software), would be even more accustomed to, and less likely to detect uncanniness from interacting with this type of character. Hanson (2006) claims that, whilst very abstract robots or cosmetically peculiar people can be Uncanny, it is possible to design against the Uncanny for androids. The findings from Hanson's study show that making adjustments to still images of androids across a spectrum of human-likeness, to make androids' features more 'friendly and attractive', can result in the Uncanny being removed from results where it was previously evident. Whilst Hanson notes that the Uncanny Valley is not preordained, the changes Hanson applied to the morphs involved cartoonish, stylised features, as opposed to realistic human-like features. As we explain below, we believe that a traversal of the Uncanny Valley is impossible because of increasing sophistication on the part of the viewer and that the concept of uncanniness for virtual characters is better viewed as the proposition of an Uncanny Wall.

2 Methodology

Our methodology comprises an empirical study using virtual characters and the collection of qualitative data to investigate if the Uncanny can be applied to virtual characters, and if so, which factors contribute to the Uncanny. In response to Mori's (1970) interest in how motion would impact perception (the valley would be even more exaggerated with moving characters), it has been suggested that for recent empirical studies where still images of robots or virtual characters have been used as stimuli, the results might have produced a different outcome had moving images been used as stimuli instead (Bartneck et al., 2007; Hanson, 2006; MacDorman et al., 2009; Schneider et al., 2007). Our study develops this suggestion by using video clips of virtual characters as the experimental stimuli.

Participants (*n* = 100) of which 92 were male and 8 female, were mainly university students from the School of Games Computing and Creative Technologies at the University of Bolton in addition to professionals working within the academic sector and video games industry. Students were selected from the games design, computer games software development and games art courses.[1]

Participants were presented with 14 video clips of a selection of virtual characters and one video clip of a real human placed in different settings and engaged in different activities. As shown in Figure 2, the video clips included: six photo-realistic characters (numbered 1–6); five zombie characters (numbered 7–11); three stylised, human-like characters (numbered 12–14) and a human (number 15).

1 The Emily Project (Image Metrics, 2008a)
2 Warrior Demo (Image Metrics, 2008b)
3 Mary Smith from Quantic Dream's tech demo *The Casting* (2006)
4 Alex Shepherd from *Silent Hill Homecoming* (Konami, 2008)
5 Louis from *Left 4 Dead* (L4D) (Valve, 2008)
6 Francis from (L4D)
7 a Smoker from (L4D)
8 The Infected from (L4D)
9 The Tank from (L4D)
10 The Witch from (L4D)
11 a photo-realistic human-like zombie (Zombie 1) from the video game *Alone in the Dark* (Atari Inc, 2009)
12 a Chatbot character 'Lillien' (Daden Ltd, 2006)
13 Lara Croft from *Lara Croft Tomb Raider: The Action Adventure* (Eidos, 2006)
14 Mario from *Mario and Sonic at the Olympic Games* (Sega, 2007)
15 a human.

The participants were asked through a web-based questionnaire to rate on a nine-point scale how human-like they perceived the character to be from 1 (*non-human-like*) to 9 (*very human-like*). (The same nine-point scales of familiarity and human-likeness were applied in this experiment as used by MacDorman (2006) so that results could be compared.)

To measure the perceived familiarity for a character, participants were asked to rate how strange or familiar they perceived the character to be from 1 (*very strange*) to 9 (*very familiar*). Participants were also asked to rate their level of experience both by playing video games and of using 3D modelling software from the options, *None*, *Basic* or *Advanced*. The video clips were played in random order to each participant.

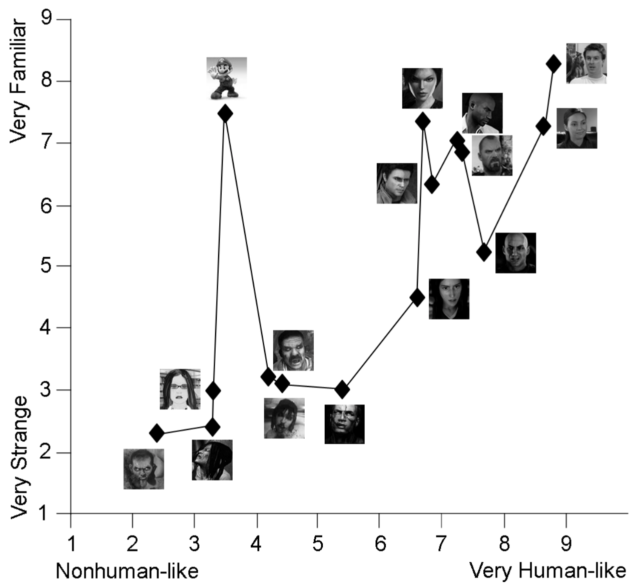
Figure 2 The 15 characters used in the experiment

3 Results

Figure 3 plots the mean ratings for how human-like a character was perceived to be against perceived familiarity. Mean scores were achieved for the following variables; familiarity ($M = 5.16$, $SD = 2.16$) and human-likeness ($M = 5.75$, $SD = 2.11$). A strong correlation (by Pearson's definition) was identified between familiarity and human-likeness, $r(15) = 0.74$, $p < 0.01$.

When participants were grouped together under different levels of experience for using 3D modelling software (*None* ($n = 13$), *Basic* ($n = 64$) and *Advanced* ($n = 23$)) and playing video games (*None* ($n = 3$), *Basic* ($n = 14$) and *Advanced* ($n = 83$)) the results revealed no significant difference for perceived familiarity and human-likeness for each group. Full details of the data collected from this experiment can be found in the conference version of this paper (Tinwell and Grimshaw, 2009b).

Figure 3 Mean ratings for how human-like a character is perceived to be against mean ratings for perceived familiarity



4 Discussion

4.1 Limitations of Mori's theory

Recent empirical studies go against Mori's theory of the Uncanny Valley. Results imply the simplistic valley shape Mori originally plotted may be misleading in that it does not fully represent the complexities of the Uncanny phenomenon. The two-dimensional construct that Mori originally envisaged is in disaccord with recent attempts to plot the Uncanny Valley (Bartneck et al., 2009; Ho et al., 2006; Minato et al., 2004; Tinwell and Grimshaw, 2009b). It seems unlikely that the Uncanny can be reduced to just the two factors, perceived familiarity and human-likeness. Various factors of motion and sound can influence how Uncanny an object is perceived to be and the Uncanny is instead a multi-dimensional model.

Our experiment confirms the weaknesses of the Uncanny Valley theory when subjected to empirical evidence. When ratings for perceived familiarity were plotted against human-likeness, the results depict more than one valley shape (see Figure 3). The plot is of greater complexity than Mori's smooth valley shape, with a less steep gradient than Mori's steep slope. The most significant valley occurs between the humanoid character Mario on the left and the stylised human-like Lara Croft on the right. The nadir for this valley shape is positioned at about 50–55% human-likeness that is lower than Mori's original prediction of 80–85% human-likeness.

For experiments conducted with robots using motion and sound, the results are also inconsistent with Mori's Uncanny Valley. MacDorman (2006) conducted an experiment using videos of robots from mechanical to human-like, including some stimuli with speech, depicted no significant valley shape when ratings for perceived familiarity were plotted against ratings for human-likeness. Valley shapes that did emerge were shallower and less steep than Mori's original valley. It was also observed that robots may be rated differently for familiarity even when judged as having the same degree of human-likeness. An experiment using a robotic copy of a human by Bartneck et al. (2009) found no significant difference between the two conditions *movement* (with motion and speech) and *still*, when the robot was compared to the human. No significant difference was found between the human and the android for perceived likeability despite a significant difference in perceived human-likeness. The inconclusiveness of results where movement is included as a factor both for virtual characters and robots support MacDorman's (2006) suggestion, in that factors beyond human-likeness (when judging how a character looks) may influence the Uncanny. Further investigation is required to define how other factors such as speech, facial expression and context may apply to a multi-dimensional model of the Uncanny.

There remains a certain amount of ambiguity as to the actual meaning of Mori's original concept for the Uncanny Valley. Bartneck et al. (2009) ask whether the notion of the Uncanny Valley has been 'lost in translation' (p.270). When translated in Japanese the word that Mori used in the title for the Uncanny Valley is *bukimi*, which stands for 'weird, ominous or eerie'. Words synonymous of the Uncanny in English include: 'unfamiliar, eerie, strange, bizarre, abnormal, alien, creepy, spine tingling, inducing goose bumps, freakish, ghastly and horrible' (MacDorman and Ishiguro, 2006, p.312). Whilst there appears to be a generic understanding of the word that Mori used in the title for the Uncanny Valley; the appropriateness of the term *shinwa-kan* that Mori used to describe the variable to measure the Uncanny has been questioned. There is no direct translation for the word *shinwa-kan* in English and it is an uncommon word in Japanese culture. As the opposite to unfamiliarity (one of the synonyms for *bukimi*), the word familiarly is used as an equivalent for the word *shinwa-kan* that Mori used in his original paper. The word strange is a typical word used to describe what is unfamiliar, however the word familiarity may be open to misinterpretation. The word familiarity might be construed as how well-known an object appears, e.g. a well-known character in popular culture or an android replica of a famous person.

For our study, it was explained to participants that familiarity should be interpreted to describe objects that did not appear strange or odd, as opposed to whether an object was well-known. However, a misinterpretation for the word familiarity may still have served as a limitation for our study. Despite being instructed to rate perceived familiarity in regards to how human-like a character is perceived to be, participants may have rated the characters Mario and Lara Croft as familiar because of how well-known they are. To improve the experimental validity for future studies it may be beneficial to include human-like, stylised characters that are not as easily recognisable as icons within the gaming industry.

With doubt as to the authenticity of the word familiarity, Bartneck et al. (2009) used the term likeability instead for their experiment. Having identified a strong correlation between the words familiarity and likeability, Bartneck et al. (2009, p.275) claimed that this translation was actually closer to what Mori had originally intended

> "We also conclude that our translation of *Shinwa-kan* is different from the more popular translation of 'familiarity'. We dare to claim that our translation is closer to Mori's original intention and the results show that the correlation of likeability to familiarity is high enough to allow for comparison with other

> studies. We also feel the need to point out that just because a certain translations or interpretations are used often, does not automatically make them true."

With no direct translation for the word *shinwa-kan* and with doubt as to the certainty of the popular translation familiarity, Bartneck et al. (2009, p.271) proposed that *shinwa-kan* could be introduced to experiments as a 'technical term' in its own right. This may however cause problems when comparing results for dependent variables from one experiment to another where the more generic translation 'familiarity' has been used. Other words such as 'rapport' (Kang, 2009, p.55) or, as we suggest, 'unstrange' (the opposite of strange) may be closer to Mori's original intention. Investigation into the Uncanny may be more robust if a standard word was to be used for the dependent variable to describe and measure perceived uncanniness. Until a word can be settled upon, various translations of the word *shinwa-kan* may raise contention.

With a lack of empirical evidence to support the notion of an Uncanny Valley, our notion of the Uncanny Wall adheres to the two meanings of the Uncanny. Freud (1919) presented in his essay 'The Uncanny'. Freud (1919) used the word *unheimlich* to define the Uncanny of which its derivative, *heimlich*, has two meanings: that which is familiar and agreeable or that which is concealed and should remain out of sight. We put forward it may never be possible to overcome the Uncanny Valley as a viewer's discernment for detecting subtle nuances from the human norm keeps pace with developments in technology for creating realism. Characters such as Mary Smith (The Casting, 2006) or those in animation, such as *Final Fantasy* (Sakaguchi, 2001) or *Beowulf* (Zemeckis, 2007), may have at first 'wowed' viewers by their apparent realism. Nevertheless, viewers soon developed the skills to detect abnormalities in how such characters looked and behaved with observations of such flaws publicised in mass media (Plantec, 2007).

Not only is the Uncanny Wall conjecture an exposition of the first Freudian sense of *heimlich/unheimlich* as that which is familiar or agreeable, but also the Uncanny Wall represents the second meaning of *heimlich* described as that which should be kept out of sight. The unwelcome exposure of the technological processes used to create a character and the perception of those processes as flaws in the presentation of that character, allow us to use both meanings and not exclusively, but in unison. The Uncanny Valley holds out some hope for a traversal to the other side in achieving believable realism, comparable to that of a human. However, the Uncanny Wall concept works against such aspiration. Similar to the outcomes of myths, fables and legends of ancient times and modern day stories, characters created by man (such as Frankenstein or Pinocchio) will always be regarded as lesser than those created by gods. Kang (2009) suggests that we can react in a variety of responses to the Uncanny in relation to how much control we perceive to have over the given situation, or how much of a threat the character is perceived to be. If there is little or no threat, characters (such as Pinocchio) may be regarded as cute and comical. Frankenstein's monster, judged as more powerful threat, was considered strange and freakish evoking little sympathy from his comrades. When confronted with being created by man that contradicts our 'worldview' (Kang, 2009, p.50), we may choose to either, ignore, be amused by or condemn such beings, in defence of our very own existence.

4.2 The effect of habituation

The results of this study imply that a viewer's level of experience in interacting with realistic, human-like characters does not have a significant impact for how Uncanny a character is perceived to be. Viewers with an advanced level of experience using 3D modelling software or with an advanced experience of playing video games, showed only a marginal difference in mean values for perceived familiarity and perceived human-likeness against the overall mean values for perceived familiarity ($M = 5.16$, $SD = 2.16$) and perceived human-likeness ($M = 5.75$, $SD = 2.11$) for the 15 stimuli within this study. This disputes Brenton et al.'s (2005) theory that those exposed to a greater level of interaction with realistic, human-like characters may be less aware of Uncanny traits. Instead, we propose that a generally increasing level of technological discernment on the part of viewers (perhaps at a societal-cultural level) maintains the Uncanny; successive developments in the pursuit of realism merely raise the bar of discernment. This discernment relates to the technology used rather than to habituation through use or exposure to any one character.

Minato et al. (2004) suggested that the habituation effect may alter a participant's interaction with an android, yet notes that further experiments would be required to test whether a participant would become more accepting of an android. We propose that the relationship between perceived acceptance and perceived familiarity would not be significant in reducing uncanniness over time. If the character was perceived as Uncanny on first contact, a character's believability is unlikely to increase beyond that of a human, no matter how accustomed to it one becomes. Familiarity may increase slightly as acceptance grows, but this increase would not reduce uncanniness significantly and may also only be for a temporary period. The flaws that a viewer may have grown to tolerate over time will be exaggerated yet again as soon as the next technological breakthrough for increasing realism is developed, hence reducing the overall perceived acceptance of a character. A viewer is reminded of the flaws in a character, thus decreasing perceived familiarity (Figure 4).

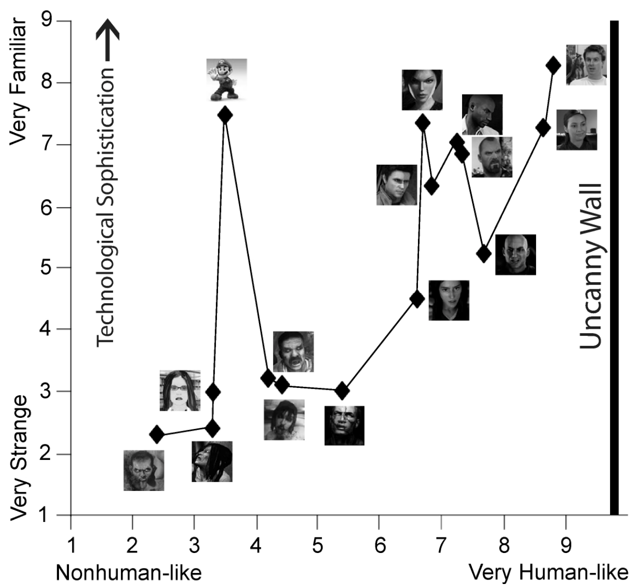
4.3 Future work

Higher levels of graphical realism can be achieved for virtual characters in animation and film as opposed to video games (Brenton et al., 2005; Sommerseth, 2007). Whilst the technology (such as hardware resources and processing power) is not yet available for achieving high polygon counts for characters in real-time, interactive 3D environments as is currently used for film; video game developers are continuing the pursuit of realism in the belief that video games will benefit from more realistic, human-like characters to increase player engagement and immersion (Ashcraft, 2008). As a result of the findings from this paper and as part of a wider body of research into building a conceptual framework of the Uncanny for virtual characters, we are creating an experimental facial animation tool specifically designed to create Uncanny and not Uncanny game characters according to the findings of our experimental results.

Since Mori's original theory in 1970, increasing realism for human-like characters within film and video games has sparked a renewed interest in the Uncanny Valley phenomenon (Green et al., 2008; Steckenfinger and Ghazanfar, 2009). Academic research is currently being undertaken into human perception of facial expression and speech using facial animation tools within industry standard video game engines to generate realistic, human-like characters. Dyck et al. (2008) found that the expressions created for virtual characters using the facial animation tool *Faceposer*, within the video game engine (source Faceposer, 2008), were comparable to those created by humans with regards to recognition for a particular emotion. (Still images were used as stimuli; the results might have been different for the validity of emotions conveyed by a virtual character when compared to human emotions if motion was included as a factor.) Lankes et al. (2007) plan to use the Unreal (2009) video game engine to develop realistic, human-like characters and to observe and measure contextual perception of the viewer for facial expression in virtual characters. We plan to use the *Faceposer* phoneme extractor tool for an experiment to investigate how attributes of asynchrony of speech and human-likeness of voice may exaggerate the Uncanny. Future experiments are intended also by utilising the *Faceposer* expression tool to investigate how a perceived lack of or exaggeration of facial expression may exaggerate the Uncanny.

For studies that have been undertaken in academia investigating aspects of facial expression and speech for virtual characters, unless characters are used from existing video games, the simulation fidelity of characters could be said to fall short of the aesthetic levels of realism achieved in industry. Even then it has been observed that a higher fidelity of graphical realism is required for character facial models within existing video game engines including mouth movement (Tinwell and Grimshaw, 2009a) and improved modelling of the naso-labial area (Dyck et al., 2008). In relation to research already undertaken for the Uncanny, experiments have mostly been conducted using head-shots of characters in isolation, removed from an interactive 3D environment (MacDorman et al., 2009; Schneider et al., 2007; Seyama and Nagayama, 2007). For this facial animation tool, physical environments will be generated to a high level of graphical realism to allow future experiments into the Uncanny for aspects of a character's appearance and behaviour to take place within a game-like context.

Figure 4 The Uncanny Wall



Lankes et al. (2007) suggest that a multidisciplinary approach is required for developing an effective system for generating realistic, human-like characters; the design and development for this facial animation tool will encompass the expertise from the disciplines of psychology, informatics and professional 3D modellers. To achieve more believable expression based on scientific study, the *Faceposer* choreography tool implements flex animation techniques as defined by Ekman's (1978) facial action coding system (FACS) to control individual parameters for the facial muscles of video game characters. For example, a flex slider bar is available to control the magnitude of how a facial muscle in the forehead may create a frown in relation to the emotion that the character is trying to convey. It is intended that for aspects of facial expression, the FACS system will be implemented for creating facial expression for characters, but with a heightened level of realism for the graphical appearance of the character's face in keeping, or if not beyond, that of industry for both game cinematic animation and for in-game animation. This will be achieved by capturing high resolution images of a range of subjects using a dimensional imaging capture system to capture both facial images and vocal narration. The facial texture maps will be rigged to a 3D frame with corresponding action units applied to facial muscles using 3D animation software. 3D modellers will add further details to the aspects of the character's appearance including textures for skin and hair to obtain a higher graphical fidelity. Sound and image data will be stored in databases with corresponding slider bars to control the facial muscles and animation for both non-verbal and speaking characters.

As this paper suggests, despite increased realism for human-like characters, the Uncanny is a symptom that cannot be ignored. As yet there are no facial animation tools that allow the designer to measure and control levels of perceived uncanniness for motion and sound. The emphasis for this facial animation tool will be to aid a video games developer to design either for or against the Uncanny. For example, to eliminate the Uncanny for protagonist or hero-type characters when the Uncanny is not intended, or to exaggerate the Uncanny for zombie characters intended for horror games. In addition to slider bars used to control facial expression, we propose the development of a facial animation tool with an interactive set of slider bars to measure and control uncanniness for both facial expression and speech. The parameters for the 'Uncanny Sliders' will be defined based on the data collected from preliminary studies as part of building a contextual framework for the Uncanny and virtual characters. For example, changing the human-likeness of a character's voice from human-like to mechanical or exaggerating the mouth movements for articulation of speech to increase uncanniness for horror game characters (see Tinwell and Grimshaw, 2009a). For aspects of facial expression, the process of motion synthesis will be used to adapt data already stored from motion captures within the engine to achieve the desired outcome to increase the Uncanny for a character. A digital signal processor will be used to modify the characteristics of speech to increase how Uncanny the speech sounds for a character. The Uncanny slider bars will provide a tool to control the magnitude of perceived uncanniness for attributes of facial expression and speech, so that the designer is aware of the Uncanny for decisions made with character designs, preventing the Uncanny being an unintended symptom of their work based on an inappropriate usage of imagery and sound.

For future experiments (based on the given ambiguity of the term 'familiarity' as a dependent variable to measure the Uncanny), additional tests will be carried out to evaluate a more reliable description of the variable used to measure perceived uncanniness. Implementing a similar methodology used by Bartneck et al. (2009), we will ask participants to rate not only perceived familiarity, but also words that may strike a greater affinity to Mori's original term *shinwa-kan*. When broken down into separate components, the term *shinwa* is translated as 'mutually be friendly' or 'having similar mind' and *kan* stands for 'a sense of' (Bartneck et al., 2009, p.270). Participants will be asked to rate words used by previous authors to measure the Uncanny that may be less open to misinterpretation including perceived: 'rapport' (Kang, 2009, p.55); 'likeability' (Bartneck et al., 2009, p.270); 'attractiveness' (Schneider et al., 2007, p.546) and 'eeriness' (Hanson, 2006, p.18; MacDorman, 2006, p.27) in addition to new descriptions, e.g. 'unstrange' (the opposite to strange); 'acceptability' (if one may accept or reject such a character); 'harmony' (to establish perceived hostility); 'amicable' (to rate if one finds the character friendly); 'comfortable' (if the character makes the viewer feel uncomfortable or unsettled in any way) and 'union' (if one may relate to or associate with the character). The ratings for these variables will then be compared against the word 'familiarity' and each other to identify primarily if any words are significant in rating the Uncanny, and then if any words show greater significance than others. Based on the findings from these experiments, it may be possible to suggest alternative descriptions to measure the Uncanny in virtual characters that represent a greater resemblance to Mori's original term *shinwa-kan* and prevent potential confusion for participants.

5 Conclusion

The results from our study and previous work into the Uncanny and robots suggest that the Uncanny Valley, as Mori (1970) envisioned it, does not exist. Rather, it is more useful to think of it as a concept and a spur to developers; the impetus behind a form of Uncanny Turing test (similar testing techniques have already been used for androids, see Ishiguro (2005)), which brings us to the question: can the Uncanny Valley be traversed? We suggest the answer is no; rather than the Uncanny Valley, we make the proposition of an *Uncanny Wall* (Figure 4). Furthermore, this wall gets higher because of one other factor that other writers have included as an element of habituation. This factor is time. However, whereas Brenton et al. (2005) suggest that audiences, over time, become used to and accommodate factors that once led to the uncanny, we suggest that time leads to an increasing discernment on the part of viewers to technical trickery. This increasing sophistication of discernment is the reason why the wall rises as time passes and it may well be that this discernment is at a societal-cultural level rather than being an individual response. In 2007, Plantec suggested that it would only take another two years for an artificial human character to cross the Valley, 'the Holy Grail is a fully human looking, perhaps recognisable, virtual human, which we can all believe in without dissonance. I figure two more years with luck' (Plantec, 2007, p.4). In 2008, Plantec hailed the Emily character (which was used as one of the videos in our experiment) as having crossed the Uncanny Valley, 'I officially pronounce that Image Metrics has finally built a bridge across the Uncanny Valley and brought us to the other side' (Plantec, 2008, p.4). Yet, the experiment we describe here shows that the character judged consistently as less familiar than the video of a human being. While the difference was slight, we intend to rerun the experiment with the inclusion of the next-generation of virtual human as it is released. If our proposition of the Uncanny Wall is correct, we expect the familiarity difference between Emily and human to increase because the participants will have become more discerning in their assessment and therefore more able to recognise the technical trickery that attempts to persuade of the humanness of the character. Accordingly, we present the theory of the Uncanny Wall (represented in Figure 4) as:

> "technological discernment on the part of the audience generally keeps pace with technological developments used in the attempt to create realistic, human-like characters such that, ultimately, the perception of uncanniness for such characters is inevitable."

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Note

[1] For future studies, participants will be selected to represent a wider demographic of the population to investigate the significance of gender, age and experience for interacting with virtual characters and the Uncanny.