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Survival Horror Games – An Uncanny Modality

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Abstract

This study investigates the relationship between the perceived eeriness of a virtual character with the perception of human-likeness for some attributes of motion and sound. 100 participants were asked to rate 13 video clips of 12 different virtual characters and one human. The results indicate that attributes of motion and sound do exaggerate the uncanny phenomenon and how frightening that character is perceived to be. Strong correlations were identified for the perceived eeriness for a character with how human-like a character's voice sounded, how human-like facial expression appeared and the synchronization of the character's sound with lip movement; characters rated as the least synchronized were perceived to be the most frightening. Based on the results of this study, this paper seeks to define an initial set of hypotheses for the fear-evoking aspects of character facial rendering and vocalization in survival horror games that can be used by game designers seeking to increase the fear factor in the genre and that will form the basis of further experiments which, it is hoped, will lead to a conceptual framework for the uncanny.

Introduction

The survival horror game genre deliberately gratifies the pleasure humans seek in frightening themselves and, in this, it is no different to horror cinema. Where such games differ, though, is in their digital origin and their interactive and typically immersive environments. All video games are digitally created and all video games rely on player input to trigger the majority of events, images and sounds, with this interactivity contributing to player engagement and immersion (see McMahan, 2003; Calleja, 2007 and Grimshaw, Nacke & Lindley, 2008, for example).

Some cinematic theorists argue that the success of certain films created within the classic horror cycle of Hollywood film was due to an uncanny modality that evolved as viewers experienced the transition between silent to sound cinema (Spadoni, 2000, p.2). Spadoni states that the success of the films *Dracula* (Browning, 1931) and *Frankenstein* (Whale, 1931) was partly due to the timing of the films' releases in relation to the sound transition timeline (p.2). At a time when Hollywood was moving from silent to sound cinema, horror film directors were able to exploit the technical limitations of the new medium to increase the perceived eeriness for their films. Sounds that may have been perceived as unnatural or odd due to the technical restrictions at the time, were used to the advantage of *Dracula* and *Frankenstein*, to create a greater conceptual peculiarity for the viewer, thus setting them apart from other horror films. *Frankenstein* was proclaimed by critics as "timeless", with a visual icon for a character that continues to endure (p. 94) and attributes such as a lack of facial expression and nonhuman-like grunts and snarls exaggerated the uncanny. Image and sound were used to elicit sensations of fear and dread for the character Dracula. Critics were impressed with the haunting textures and qualities of Dracula's speech, whilst inaccuracies in the synchronization of sound with image also evoked a sense of the uncanny for the viewer. With respect to video games, assertions have been made as to how the mechanisms and processes by which cinematic characters create an ambience of fear might also be mapped to virtual characters in horror games (Brenton, Gillies, Ballin & Chatting, 2005 and Perron, 2004).

The term eerie has been attributed to robots that elicit an uncanny sensation for the viewer (Ho, MacDorman & Pramono, 2008 and MacDorman, 2006). The emotion term *fear* has also been identified as a strong indicator of both the uncanny and the eerie sensation attributed to an uncanny robot (Ho et al., 2008). Therefore, for our experiment, the term eerie is used to identify the level of fear a viewer may experience based on how strange (uncanny) or familiar they perceive a virtual character to be; the stranger a character is perceived to be then the greater the sense of eeriness and fear attributed to that character. Our study investigates the relationships between how eerie a virtual character is perceived to be and perceived human-likeness of motion and sound. Initial results indicate that certain attributes, such as facial expression, synchronization of lip movement with voice and the particular qualities of a character's speech, do exaggerate both the uncanny phenomenon and, therefore, how frightening a character is perceived to be. Our study builds upon previous work by having an experimental methodology that concentrates on not only the image (a moving image in this case) but also the sound. This is part of an ongoing body of work that, we hope, will lead to precise cross-modal definitions of the uncanny.

Context

The Image Modality

In working towards an understanding of what causes certain things to lie within a field of what is frightening or *uncanny*, Freud (1955) made reference to an essay *On the Psychology of the Uncanny* by Jentsch (1906) that first initiated the subject of the uncanny in contemporary thought. Jentsch characterized the uncanny as a mental state instilled when one cannot distinguish between the living and the dead or differentiate between what appears to be animate or inanimate; the feeling caused by "waxwork figures, ingeniously constructed dolls and automata" (p. 226).

Building on this theory, the roboticist Masahiro Mori (1970, as translated by MacDorman and Minato, 2005), 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 caused them to appear eerie, evoking a negative effect for the viewer. The positive relationship Mori identified between the perceived familiarity for a robot with human likeness is inverted at 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 included 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 moving characters.

MacDorman (2006) states that the principles of Mori's theory of the uncanny can work to the advantage of engineers when designing robots with the purpose of being unnerving within an appropriate setting and context. Based on the success of the horror game genre, MacDorman notes that the perception of eeriness does not always serve as a negative impact for the viewer. Hoeger and Huber (2007) recognize that, for the horror genre of games, elements of the uncanny can enhance the game experience by evoking feelings of tension and dread and identify this as the *gamerly uncanny*; a human-like game character represents an imperfect simulacrum of a living body and an anxiety of resemblance is triggered as the avatar appears incomplete and not wholly human (p.153).

Brenton et al. (2005) state that despite extensive experimental research on characters in collaborative environments, there were, in 2005, a limited number of studies relevant to the Uncanny Valley (the situation has improved somewhat as of date of writing). As is usually the case in studies of the uncanny for avatars within the survival horror game genre, writings on the uncanny focus on the psychoanalytical model or appearance for the character with little or no contextualization of the relationship between aspects of motion and sound and the uncanny.

Working towards identifying factors that contribute to the uncanny for robots, Ho et al. (2008) observed that aspects of a robot's "appearance and motion quality strongly influence how people feel about robots, especially in headshots" (p.175). The authors suggest that the uncanny for robots can be exaggerated if there is a mismatch in the degree of human-likeness for a robot's appearance and motion, for example "humanlike eyes and teeth… combined with its absence of skin or hair" (p.176). Other authors suggest that, for androids, if human-like appearance causes

us to evaluate an android's behaviour according to a human paradigm, we are more likely to be aware of disparities from human norms; a robot is eeriest when a human-like appearance creates an expectation of a human form (Matsui, Minato, MacDorman & Ishiguro, 2005).

Brenton et al. (2005) also suggest that, for virtual characters, a high level of graphical realism raises similarly high expectations for attributes of motion and behaviour and that the uncanny sensation may be generated when such attributes do not match the realistic appearance of that character. (Laurel (1993) makes a similar point in suggesting that there is an expectation that different modalities have the same resolution (pp.164-165) – in this case, she is talking about the sensory modalities of vision and sound but we suggest that the same principle holds for visual appearance and motion and behaviour.) Brenton et al. propose that experiments should be conducted to test this theory using realistic virtual characters from film and animation as opposed to interactive characters (where a high graphical realism may be less achievable). Walker, of the facial animation company Image Metrics, states that the claimed photo-real facial animation that they have so far achieved for film and television, can also be achieved for animation in video games, it is just not *yet* possible for a real-time gaming environment: "We can produce Emily-quality animation for games as well, but it just can't work in a real-time gaming environment" (quoted in Ashcraft, 2008). Walker also suggests that video games would benefit from these more realistically rendered faces; game developers look to realism for characters to increase player engagement and immersion. (Authors such as McMahan (2003) and Grimshaw (2008b) suggest that what is required to enhance immersion and engagement is less a mechanical and physical realism and more a perceptual realism.) To analyze user responses to the uncanny, our study uses virtual characters from film and animation, autonomous social agents and characters from video games (in addition to a filmed human). The findings from this study suggest that whilst the current restrictions for interactive characters can exaggerate the uncanny, this works to the advantage of zombie-type characters in the survival horror game genre that are intended to evoke an eerie sensation. However, for realistic human-like characters where the game designer has not intended such a reaction, the current limitations in technology raises a viewer's awareness that the character does not behave in a way that they would expect based on their realistic appearance.

The Sound Modality

There is a relatively large body of work which investigates the semantics of sound in a variety of contexts and some of this includes the potential of sound to arouse the more negative emotions associated with the uncanny. A very brief survey would list the work of Edworthy, Loxley, and Dennis (1991) on sonic parameters affecting perceived urgency, work on defining a functional semantic framework for sound by Ballas (1994) in which, among other points, he discusses the exclamatory (that is, alarm-like) function of sound and relates this to various sonic parameters, and the soundscape studies of Schafer (1994).

Thus far, there has been little work into the uncanny nature of sound in the context of virtual characters' sounds other than references to lip synchronization with speech. Quantic Dream's tech demo, *The Casting* for the video game *Heavy Rain* (2006), was first revealed at the third Electronic Entertainment Expo in 2006 and the main character, Mary Smith, received criticism for being uncanny. MacDorman (quoted in Gouskos 2006), states that a lack of

synchronization with speech and lip movements was one of the factors that people found disturbing about this character: "In addition, there is sometimes a lack of synchronization with her speech and lip movements, which is very disturbing to people. People 'hear' with their eyes as well as their ears. By this, I mean that if you play an identical sound while looking at a person's lips, the lip movements can cause you to hear the sound differently". Much of the work on the uncanny has been almost exclusively visually based. There has, however, been some work, in the field of computer games, on the fear potential of sounds. Grimshaw (2008a) proposes a conceptual framework of sound in First-Person Shooters and includes a discussion of the semantics of alarms in such a context while Ekman and Kajastila (2009) conducted a small-scale study the results of which suggest that making the localization of sound difficult increases the fear factor. Kromand (2008) identifies a horror game soundscape that "operates within a framework of uncertainty that constantly holds the player between knowledge and ignorance" (p.18). Diegetic sound in survival horror games borrows many of the conventions and clichés of diegetic sound in horror film. Sound for which there is no identifiable on-screen visual source "intensifies causal listening in taking away the sense of sight" (Chion, 1994, p.32) and this, for Chion, enhances the mysteriousness of such *acousmatic* sounds. In the horror genre (film or game), this is the sound that goes bump in the night.

Here though, the intrinsically interactive nature of computer games and the fact that game levels are typically re-played many more times than films are re-watched marks the difference in sound reception between the two mediums. Game players have kinaesthetic control over the majority of heard sounds; they can choose to move towards (or away from) an acousmatic sound and, if the sound's source thus appears on screen, they have exercised their power to de-acousmatize or visualize that sound. The sound therefore becomes *known* or, in its original sense, a canny sound that is no longer mysterious. This potential loss of suspense and fear (the reasons for the sound designer including the sound in the first place) is increased by the essentially repetitive level- and challenge-based nature of many games in the survival horror genre. Levels are repeatedly played (all the more so in multi-player games) until the challenges presented by that level have been overcome and the next level may be attempted. Sounds and their significance become familiar. The pathetic, little-girl crying of the Witch in *Left 4 Dead,* (2008), is, when first heard, an acousmatic and uncanny sound cunningly designed to appeal to the protective, pastoral instinct of the player. However, as anyone who has played the game will testify, the Witch is to be avoided at all costs. Where her wailing may have first been attended to in the causal listening mode – *what is the source of that sound?* – and the source investigated (typically leading to the sudden death of the novice player's character), subsequently it is attended to in what Grimshaw has identified as the *navigational* listening mode (2008a, p.54) – *where is the source of that sound?* – and, where possible, the player is best advised to exercise kinaesthetic judgement in navigating away from the Witch.

Thus, the routine nature of gameplay militates against the uncanny intent of the sound. Once familiar and known and its cause and semantics fully comprehended, sound loses its power to inspire mystery, suspense and fear – it is no longer an uncanny sound. This suggestion is supported by the claims above that it is uncertainty in the soundscape that creates fear. Game soundscapes that are built upon shifting sand and which act against normality or perceived reality promote uncanniness. Familiarity equates to certainty and thus the uncanny is lost. The challenge to sound designers is to find techniques to maintain the uncanny nature of the sound over repeat

gameplays.

Although the experiment reported in our paper presented virtual characters in an un-gamelike environment, such characters are more usually encountered in the context of the game world and gameplay. Whilst this paper attempts to identify affective elements of the characters' self-produced sounds, the design of future experiments should take the wider game context into account. This might include the musical soundtrack (*Left 4 Dead*, for example, has a musical soundtrack that, in some cases, bears a strong relation to the game's diegesis) and it should certainly include the effects of sounds other than that produced by the character.

Cross-modality

Our paper only makes a start in investigating the implications for uncanniness of the relationship between the image and sound modalities. There exists a relatively large body of work on this cross-modal relationship and, indeed, some authorities argue that in some contexts the senses operate together in the perception of a single event (Warren, Welch & McCarthy, 1982, for instance). Anderson (1996) states that, "Perception is an information-gathering activity. And when it occurs in two or more sensory modes simultaneously, it is a process of information comparison, an active search for cross-modal confirmation" (p.82) and Gröhn, Lokki, Savioja, and Takala (2001) discuss the concept of cross-modal confirmation in the context of virtual environments. Gaver (1993), working from an ecological conception of perception as Anderson does, notes there is often a connection between an object or organism's physical properties and its typical, defining sound. For example, material and size (parameters easily represented in virtual worlds); metal objects tend to have brighter timbres than wooden objects and larger objects tend to produce louder and deeper sounds than smaller objects (think of an elephant and a mouse). Perhaps subverting such relationships in survival horror games will increase the level of uncanniness and fear.

Spadoni (2000), discussing the horror genre in early sound cinema, equates much of the uncanny with a lack of perceived synchronization between image and sound (pp.58-60). Human laughter is perceived as ghostly, incorporeal laughter because it appears not to emanate from the mouth of the character on screen. This is, in fact, precisely the case and remains so to this day. Cinema speakers, home entertainment system and computer speakers (and headphones) are physically disjunct from the screen displaying the image. It took some time for Chion's *audio-visual contract* to be established for sound cinema and several different methods of film sound recording and reproduction to be tried and tested before audiences were willing to accept the source of a sound to be the character on screen. This convention of acceptance of synchronization between on-screen image and (physically) off-screen sound goes under several labels such as *synchresis* (Chion, 1994) or *synchrony* (Anderson, 1996) and, in the field of psychoacoustics, the *ventriloquism effect* (for example, Warren et al., 1982). (Presumably, there will be no need for such perceptual deceit once flat-panel speakers with accurate point-source technology provide simultaneously a visual display.)

Along with previously-mentioned differences between cinema and computer games (such as the possibilities of the navigational mode of listening and kinaesthetic interaction), there are other ways in which the two mediums differ. These have an effect upon the conjunction between

image and sound and, as a result, have an effect on the sense of the uncanny. While the quality of individual audio samples (a footstep or a scream, for example) may be viewed as realistic (and are often recorded directly from their real-life correlates should such exist), the quality of the resultant soundscape (the combination of simultaneously sounding audio samples), while often impressive, is much less realistic particularly in its representation of acoustic space. This is directly due to the lack of computer processing power and this same technical deficiency accounts for the low levels of image realism in the game (especially for animated characters). Real-time graphics cannot compete with the potential realism of film graphics. Another important difference between the survival horror game genre and the horror film genre is that there are rarely any close-ups of characters' faces during gameplay. Should such a thing occur for a significant span of time, and should the character be speaking, then it may well be that the technical limitations of real-time processing would contribute to a sense of the uncanny by destroying the perception of synchresis. This uncanny effect would accord with the results noted in our experiment where there was a high correlation ($r = 0.89$) between a sense of uncanniness and a lack of lip/sound synchronization. Two things should be borne in mind though: the experiment was not run in a game-like context, and statistical association (as indicated by the high correlate) is not necessarily statistical causality. Future experiments can be designed to test the degree of causality between lack of synchronization and uncanniness.

<center>Method</center>

Our methodology comprises an empirical study using virtual characters and the collection of qualitative data to investigate if aspects of a virtual character's motion, behaviour, and sound exaggerate the uncanny and the eerie sensation felt by a viewer. For virtual characters it has been suggested that to reduce the risk of eeriness for a character the safest option is a clearly non-human appearance with the ability to emote like a human (Schneider, Wang & Yang, 2007). In response to Mori's interest in how motion would impact perception (the valley would be even more exaggerated with moving characters, 1970), Schneider et al. state that a further study using video clips instead of still images would help better support their theory. Our study develops this suggestion by using video clips of virtual characters as the experimental stimuli.

100 participants were used with 92 males and 8 females. The participants were mainly university students from the School of Games Computing and Creative Technologies (GCCT) at Bolton University in addition to professionals working within the academic sector and video games industry. Students were selected from the Computer Games Design, Computer Games Software Development and Computer Games Art courses. It was expected that these participants would have a higher experience level in playing video games and of using three-dimensional modelling software as opposed to others students within the university.

Participants were presented with 12 video clips of a selection of virtual characters and 1 video clip of a real human placed in different settings and engaged in different activities (see Figure 1). The video clips included six realistic, human-like characters; (1) the *Emily Project* (2008), (2) and the Warrior (2008) by Image Metrics; (3) Mary Smith from Quantic Dream's tech demo *The Casting* (2006); (4) Alex Shepherd from *Silent Hill Homecoming* (2008) and two avatars (5) Louis and(6) Francis from *Left 4 Dead* (2008); four zombie characters, (7) a Smoker, (8) The Infected, (9) The Tank and (10) The Witch from *Left 4 Dead*; (11) a stylised human-like

Chatbot character *"Lillien"*, (2006); (12) a realistic, human-like zombie (*Zombie 1)* from the video game *Alone in the Dark* (2009) and (13) a real human.
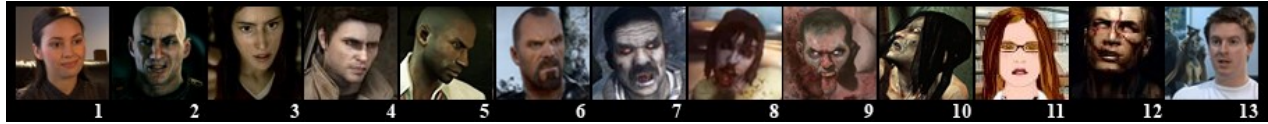

Figure 1. The 13 characters used in the experiment.

The participants were asked through a web-based questionnaire to rate on a 9-point scale how human-like they perceived the character to be from 1 (*nonhuman-like*) to 9 (*very human-like*). To measure the perceived eeriness for a character, participants were asked to rate how strange (eerie) or familiar they perceived the character to be from 1 (*very strange*) to 9 (*very familiar*). Participants rated how human-like the character's voice sounded and how human-like the facial expression appeared using a scale from 1 (*nonhuman-like*) to 9 (*very human-like*). Participants were asked to select from five statements that best described qualities for the character's speech (a) the voice is slow, (b) the voice is monotone, (c) the voice is of the wrong pitch/intonation, (d) the voice sounds like it belongs to the character, or, (e) none of the above. For facial expression, participants selected parts of the character's face that appeared either exaggerated or showed a lack of facial expression including: (a) cheeks, (b) forehead, (d) eyes, and (e) mouth. Participants could select option (f) no observed exaggeration, or no observed lack, if, in their opinion, this was not applicable for a character. Participants were also asked to rate how synchronized the character's voice appeared to be with lip movement from 1(*not synchronized*) to 9 (*perfectly synchronized*). The video clips were played in random order to each participant.

Results

The majority of participants had an advanced experience of playing video games (83) with 14 participants having a basic level and only 3 participants with no previous experience of playing video games. Sixty-three participants had a basic level of experience of using 3D modelling software, 23 an advanced level and 13 with no experience of using this type of software. Eighty-four of the participants were within the age range between 18-24, 10 between 25-30 and 6 above the age of 31.

An assessment of internal consistency reliability revealed satisfactory values for this experiment; Cronbach's alpha was 0.94 or higher for scales used to measure perceived human-likeness and familiarity (see Figure 2), synchronization of speech with lip movement (see Figure 3) and perceived human-likeness for voice and facial expression (see Figure 4) for virtual characters.

Table 1
Mean scores for perceived strangeness, human-likeness, and human-likeness for voice and facial expression.

Character & Number	Mean Score			
	Strengeness[a]	Human-like[b]	Voice[c]	Expression[d]
The Tank (9)	2.33	2.39	2.25	2.72
The Witch (10)	2.4	3.28	2.76	3.04
Chatbot (11)	2.99	3.23	2.68	2.39
Zombie 1 (12)	3	5.24	4.23	4.88
The Infected (8)	3.1	4.43	2.88	3.42
The Smoker (7)	3.21	4.19	2.29	3.32
Mary Smith (3)	4.53	6.63	7.54	5.37
The Warrior (2)	5.23	7.68	6.37	7.22
Alex Shepherd (4)	6.38	6.84	7.78	6.18
Francis (5)	6.8	7.34	7.75	6.85
Louis (6)	7.02	7.27	8.04	6.92
Emily (1)	7.25	8.67	8.8	8.4
Human (13)	8.26	8.8	8.79	8.6

Note. Judgments were made on 9-point scales; strangeness (1 = *very strange*, 9 = *very familiar*); and from (1 = *nonhuman-like*, 9 = *very human-like*), for human-likeness, voice, and facial expression.

[a]$M = 4.81$, $SD = 2.11$
[b]$M = 5.85$, $SD = 2.17$
[c]$M = 5.55$, $SD = 2.71$
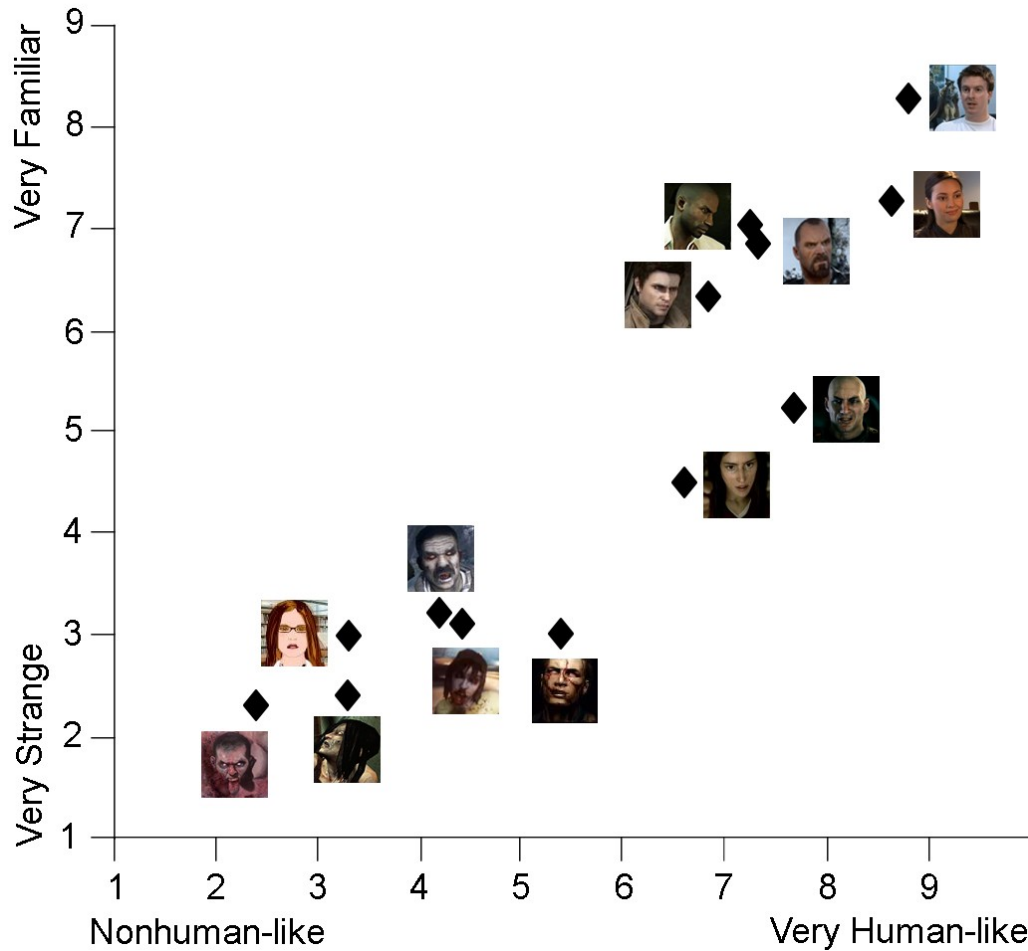[d]$M = 5.3$, $SD = 2.20$

Figure 2. Mean ratings for how human-like a character is perceived to be against mean ratings for perceived familiarity.

The mean rating for familiarity was 4.81 with a standard deviation of 2.81 (see Table 1). The correlation between perceived human-likeness and perceived familiarity was $r = 0.93$. This strong correlation indicates that viewers tend to find nonhuman-like characters more uncanny but this is a broad assessment and the results below provide a more detailed analysis as to which characteristics exaggerate the uncanny.
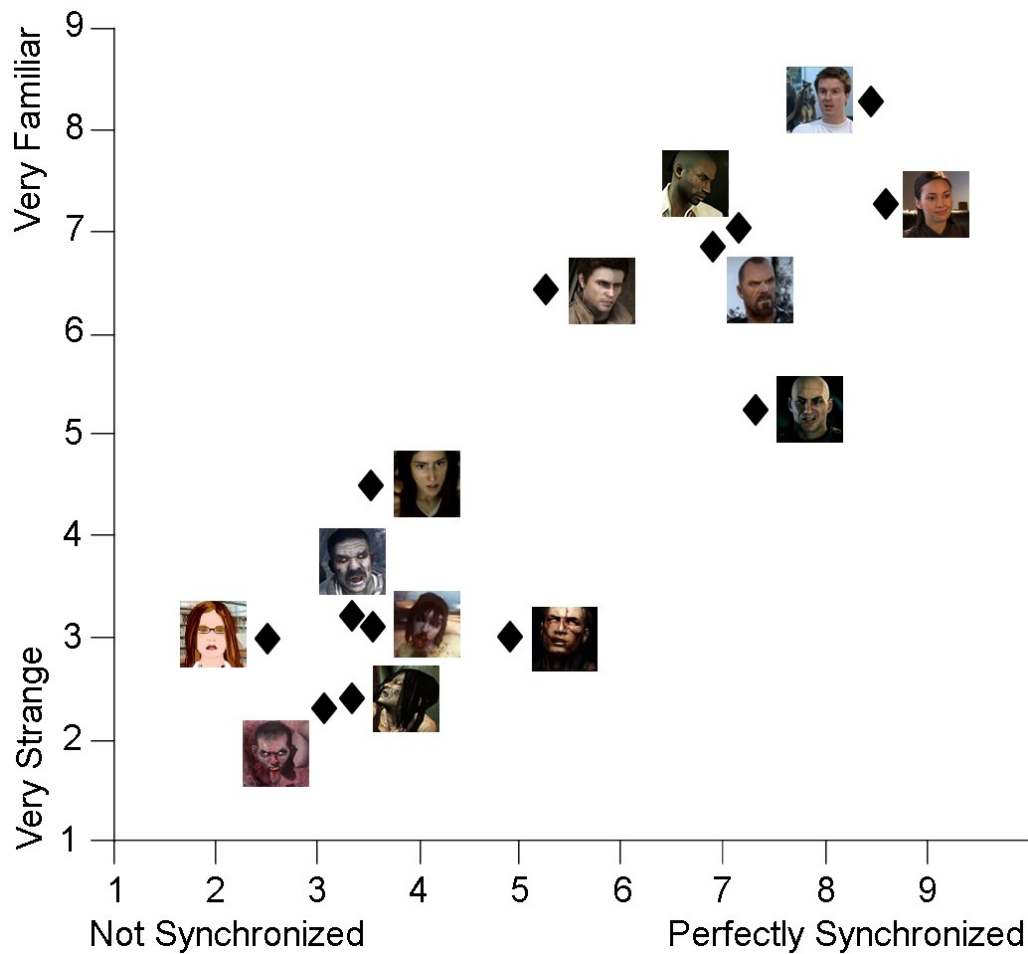
Figure 3. Mean ratings for the perceived eeriness of a character and the mean ratings for synchronization of sound with lip movement.

The results revealed a high correlation of $r = 0.89$ between how eerie a character is perceived to be and the lack of synchronization of sound and lip movement. Characters rated as close to perfect for lip-vocalization synchronization were perceived as less strange than those with disparities in synchronization. Characters rated as the least synchronized were perceived to be the most eerie and were therefore likely to be the most frightening.
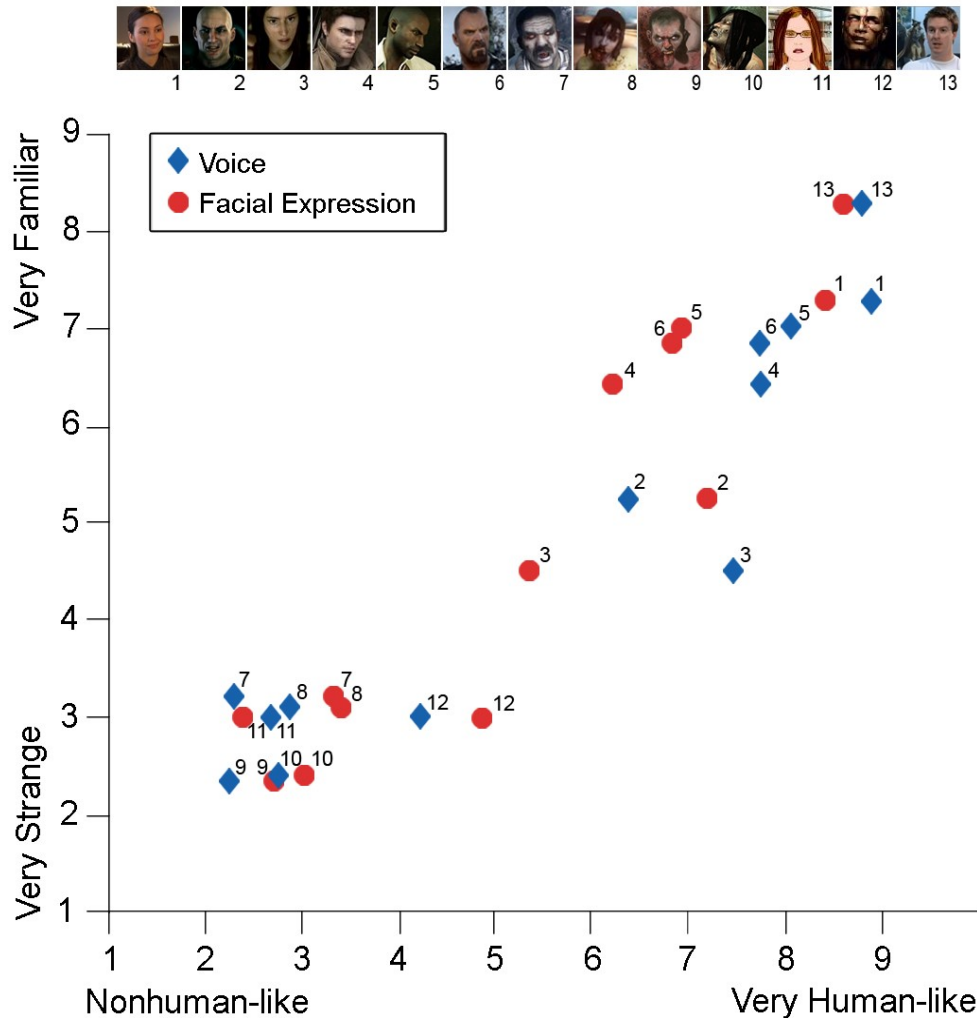
Figure 4. Mean ratings for how strange or familiar a character is perceived to be against perceived human-likeness for a character's voice and facial expression.

The results revealed a correlation of $r = 0.94$ between how familiar a character is perceived to be and how human-like the character's voice is perceived to be. A correlation of $r = 0.94$ was also measured between how familiar a character is perceived to be and how human-like facial expression is perceived to be. The high correlations imply that the less human-like a voice sounds, the more strange a character is perceived to be and that the less human-like the facial expression for a character appears, the greater the perceived eeriness and fear for that character.

Qualities of Speech

To assess which speech qualities contribute to the voice of a virtual character being regarded as less human-like, median values were calculated as an indicator of central tendency for a character's strangeness rating along with median ratings for speech quality; whether the speech seemed (a) slow, (b) monotone, (c) of the wrong intonation, (d) if the speech did not appear to belong to a character, or (e) none of the above.

Table 2 shows the median strangeness values for the 13 characters. With 13 characters it was difficult to establish a clear overall picture of the vital relationships over multiples of speech, so characters with the same median value for strangeness were grouped together in order that vital relationships were made evident for the grouped data. The median values for the different attributes of speech quality were then calculated for these grouped characters. For example, the characters, The Infected, The Smoker, Zombie 1, and the Chatbot all had a median strangeness value of 3 and were therefore grouped together. The median values for qualities of speech for this character group were then calculated out of 400 responses (100 participant responses for each of the four characters in the group), with the median values of *Slow* (24), *Monotone* (21.5), *Wrong intonation* (40), *Belongs(to the character)* (42) and *None* (8.5), also shown in Table 2. If there was just one character with a particular median value for strangeness, then the median values were calculated as a possible rating out of 100 responses. For example, the character Emily was the only character with a median strangeness value of 8, so the results show the median speech ratings for this one character of *Slow* (2), *Monotone* (0), *Wrong intonation* (2), *Belongs (to the character)* (87) and *None* (6). Although grouping the characters has hidden much of the original detail for the results, this method provides a clear overall picture as to the fundamental relationships that are associated with the perceived eeriness for a virtual character.

Table 2
Median ratings for speech qualities for those characters or groups with the same median strangeness value.

Median Strangeness for Character or Group	Slow	Monotone	Wrong intonation	Belongs	None
The Tank, The Witch, (*Mdn* = 2)	10	9.5	23.5	56.5	16.5
The Infected, The Smoker, Zombie 1, Chatbot, (*Mdn* = 3)	24	21.5	40	42	8.5
Mary Smith, (*Mdn* = 4)	8	3	20	20	8
The Warrior, Alex Shepherd, (*Mdn* = 6)	14	17	17	62.5	7.5
Louis, Francis, (*Mdn* = 7)	2.5	3.5	6.5	79.5	4.5
Emily, (*Mdn* = 8)	2	0	2	87	6
Human, (*Mdn* = 9)	1	15	4	72	6

Note. Judgments for strangeness were made on 9-point scales (1 = *very strange*, 9 = *very familiar*). For speech qualities, median values were calculated out of a total of 100 participants for each character or as a total of 100 x *n* for each data group.
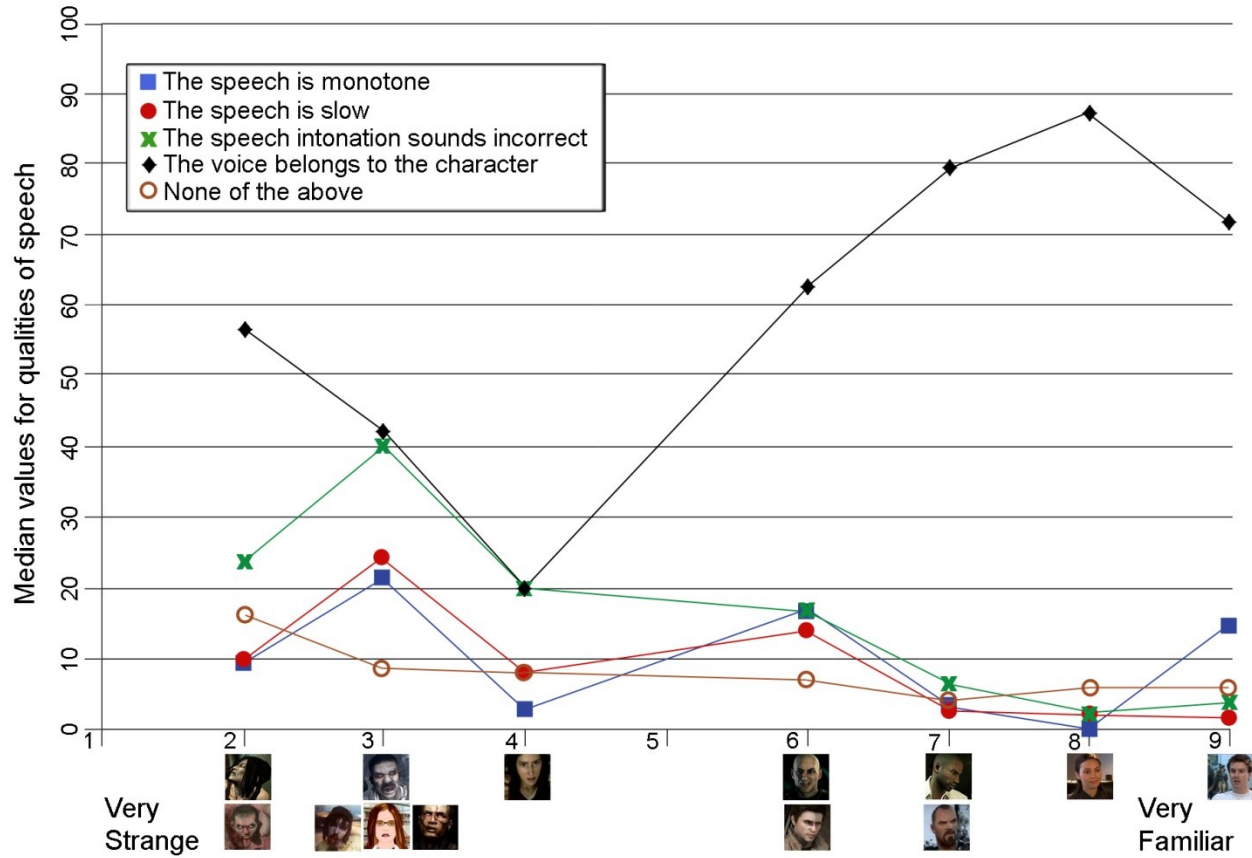
Figure 5. Median strangeness ratings for characters (or groups with the same median strangeness) against median ratings for qualities of speech.

Figure 5 shows the median strangeness ratings for the 13 characters in Table 2. Median values for speech qualities were then calculated for those characters or groups with the same median value for strangeness. The plot for "the speech intonation sounds incorrect" and "the voice belongs to the character" are almost mirror images indicating that achieving the correct intonation for a voice, in keeping with what the viewer may have expected for that character, might be a contributing factor towards the believability of a character. Characters with the same median value for strangeness can show quite different median values for different speech qualities.

For those characters who were rated as most strange with a median strangeness value of 2 (see Figure 5), the inhuman-like screeches for the Witch and hisses and snarls from the Tank were regarded as sounds that these types of characters were likely to make; they were perceived as sounds that belonged to the characters. Such sounds enhanced the believability of these characters as they were in keeping with their nonhuman-like appearance. However, for the realistic, human-like character Mary Smith, 20% of participants identified a lack of correct pitch and intonation for speech. A close study of the video indicates other potential contributory factors such as a mismatch between the acoustics and volume and materials of the room, a mismatch between the gestures and posture of the character and the conveyed emotion of the

voice, and errors of sound recording (excessive plosives where the microphone clearly is with the distant camera). With a score of $M = 3.53$ for perceived synchronization of voice with lip movement (see Figure 3), it seems these factors may have contributed to viewers being less convinced that the voice actually belonged to Mary Smith and this may have increased the sense of perceived eeriness for this character.

Facial Expression

The results from this experiment show a strong correlation ($r = 0.94$) for the perceived familiarity of a character with how human-like the character's facial expression is perceived to be (see Figure 4). To investigate which factors of facial exaggeration contributed to the uncanny for virtual characters, median values were calculated for a character's strangeness rating and those characters with the same median value for strangeness were grouped together. The same method of median grouping used for speech qualities was applied to these results in order to determine a clear overall picture as to the relationships between facial expression and the perception of eeriness. The median ratings for a perceived *lack* of facial expression and a perceived *over-exaggeration* of facial expression were then calculated for characters or groups with the same median strangeness value including the forehead, eyes, cheeks, and mouth (see Table 3).

Table 3
Median ratings for a perceived lack of and over-exaggeration of facial expression for characters or groups with the same median strangeness value.

Mdn Strangeness for Character or Group	Forehead		Eyes		Cheeks		Mouth		None	
	Lack	Over	Lack	Over	Lack	Over	Lack	Over	Lack	Over
The Tank, The Witch (*Mdn* = 2)	57.5	4	52.5	26	54.5	4.5	38.5	37.5	26.5	51
The Infected, The Smoker, Zombie 1, Chatbot *(Mdn* = 3)	59	3	51.5	16.5	55	2.5	30	35	21.5	56.5
Mary Smith (*Mdn* = 4)	46	4	19	24	47	8	18	62	31	27
The Warrior, Alex Shepherd (*Mdn* = 6)	32	11	13	21	26.5	15	9	35.5	52	48
Louis, Francis (*Mdn* = 7)	31.5	10	15.5	23	20	6	10	18.5	53	59
Emily *(Mdn* = 8)	14	2	3	6	12	10	1	17	79	78
Human *(Mdn* = 9)	6	9	8	7	5	0	3	7	86	83

Note. Judgments for strangeness were made on 9-point scales (1 = *very strange*, 9 = *very familiar*). For lack of facial expression and an exaggeration of facial expression, median values were calculated out of a total of 100 participants for each character or as a total of 100 x *n* for each data group.
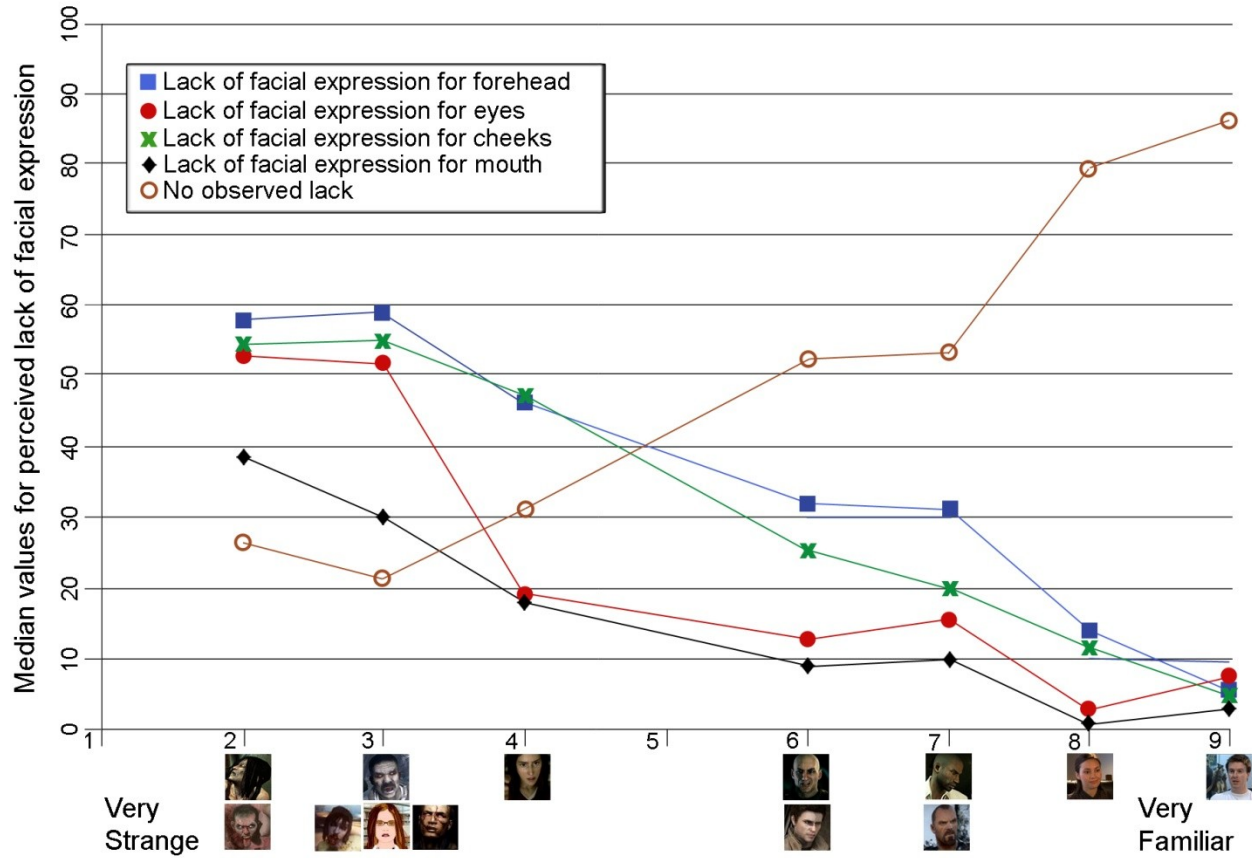
Figure 6. Median ratings for strangeness against median values for a perceived lack of facial expression for those characters or group with the same median strangeness value.

Figure 6 shows an overall pattern where participants observed a heightened awareness for a lack of facial expression for characters rated as more strange than familiar. The results imply that the perceived eeriness for a character increases when there is a lack of expressivity for parts of the face, particularly in the mid and upper region of the face including the forehead, eyes, and cheeks.

The character groups perceived as more strange than familiar with median strangeness values (2) and (3) had significant increases in a participant's perception of a lack of emotional expressivity for the forehead, cheeks, and eyes (see Figure 6). Over half the participants rated the Witch zombie as having a lack of facial expression for the forehead (58%), the eyes (53%), and the cheeks (54%); similarly for characters with a median strangeness rating of 3, The Smoker zombie received high scores for a perceived lack of facial expression for these parts of the face; forehead (60%), eyes (54%), and cheeks (54%).

The results shown in Figure 6 suggest that a lack of facial expression for the mouth is less significant for the perceived eeriness of a character than lack of expression in the mid and upper parts of the face. An indirect correlation of $r = -0.98$ was calculated for individual responses between "no observed lack" and "a lack of facial expression in the forehead". This very strong

indirect correlation implies that a character is regarded as more strange if there is a perceived lack of facial expression in the forehead and that a character is perceived as more familiar if there is no observed lack of facial expression for the forehead and upper parts of the face. The implications for this potentially significant finding are developed further in the Discussion section of this paper.
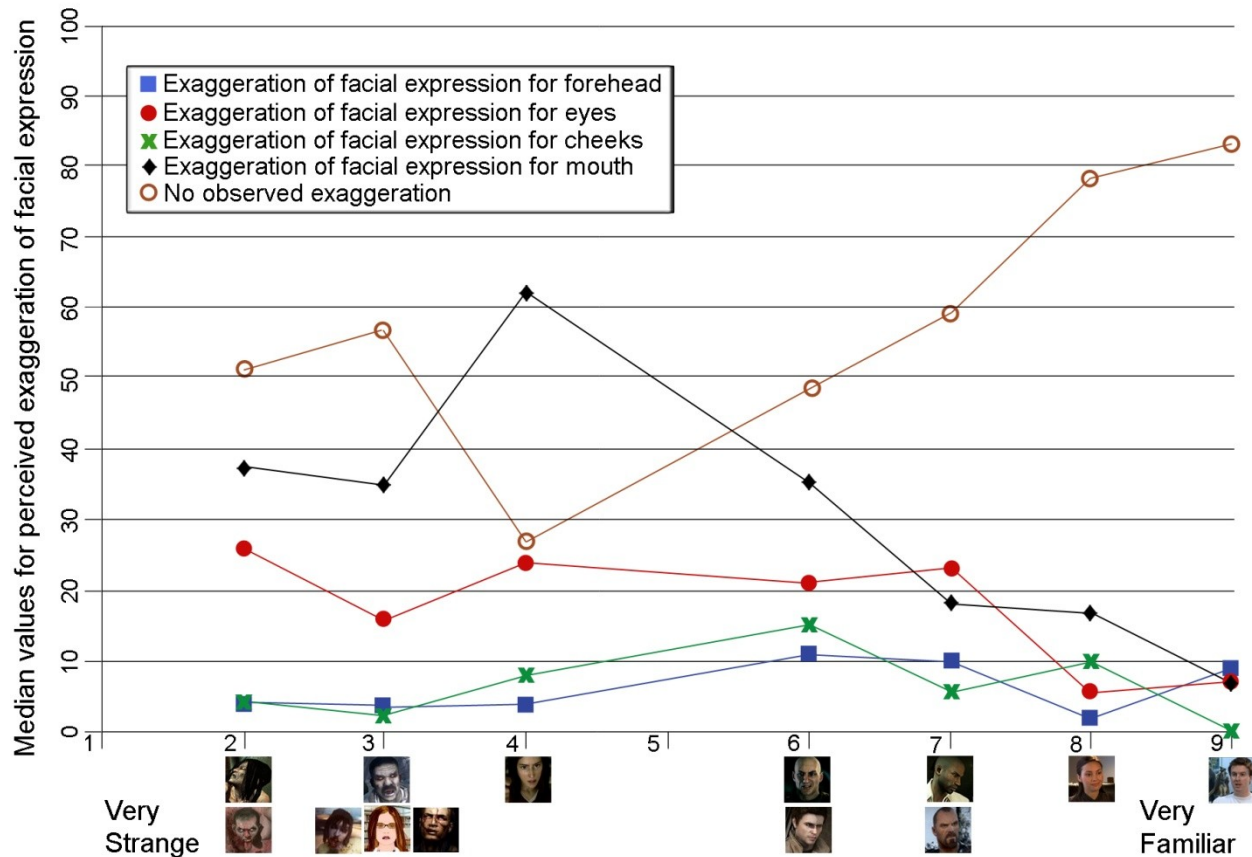

Figure 7. Median strangeness values against median values for a perceived over exaggeration of facial expression for those characters with the same median strangeness value.

Figure 7 demonstrates that for characters rated as more strange than familiar, a perceived over-exaggeration for the mouth is of greater significance than other parts of the face, such as the forehead, eyes and cheeks in the mid and upper region of the face. An indirect correlation of $r = -0.90$ was calculated for individual responses for each character and the human, between "no observed exaggeration" and "an over exaggeration of facial expression for the mouth". This strong indirect correlation implies that a character is regarded as more strange if there is a perceived exaggeration of facial expression for the mouth whilst a character is perceived as more familiar if there is no observed exaggeration of facial expression, including the mouth.

An over-exaggeration is observed for the forehead, eyes, and cheeks for some characters within groups perceived as more strange than familiar; the Witch scored an individual rating of 30% for a perceived over-exaggeration of the eyes. Such observations are also relevant to characters deemed as more familiar than strange; 34% of participants noticed an exaggeration of

the eyes for the realistic, human-like character Louis. While this particular attribute may have exaggerated the uncanny for the Witch as a zombie-type character, this may have had a detrimental effect for the protagonist Louis, who may be perceived as more human-like and less eerie without this particular characteristic.

Discussion

When Mori's theory of the Uncanny Valley was applied to the 13 characters, the results reveal that five zombie characters intended to contest a sense of the real do fall below the mean rating for familiarity ($M = 4.81$, $SD = 2.81$), being perceived as more strange than familiar, evoking an unsettling sensation for the viewer as Mori predicted (see Figure 2). Mori's theory (as translated by MacDorman and Minato, 2005) predicts that zombie characters would fall within the valley, being perceived as more strange than familiar (pp. 33-35). The results of this study imply that virtual zombie characters, with the purpose of being unsettling for the viewer, do conform to the theory of the Uncanny Valley.

The realistic, human-like character Mary Smith also fell below the mean rating for perceived familiarity with a rating of $M = 4.53$ (see Figure 2). The facial expression was found to be one of the most unsettling characteristics for this character; 46% of participants observed a lack in facial expression for the fore head (see Figure 6) whilst 62% of participants observed that the mouth movements were over-exaggerated (see Figure 7). This behaviour increased the perceived strangeness for this character resulting in a lack of believability. For the Chatbot character, which received a mean familiarity rating of $M = 3.00$ (See Figure 2), attributes such as a lack of human-likeness for the voice (see Figure 4) and lack of synchronization of lip movement with speech (see Figure 3) were found to be the most annoying and irritating characteristics.

With regards to the Uncanny Valley, the roboticist David Hanson who has created several realistic human-like robot heads, expresses the opinion that it is unlikely that perception of human-likeness can be plotted on one axis; "it depends on shape, timing, movement and behavior" (quoted in Ferber, 2003). He states that the idea of the uncanny is "really pseudoscientific, but people treat it like it's science". The strong correlation coefficient of $r = 0.93$ that we have discovered between perceived human-likeness and perceived familiarity provides evidence to the contrary. Our results suggest that Mori's theory of the Uncanny Valley can be used to measure over all perceived human-likeness, however as Hanson states, other factors such as shape, timing, movement, and behaviour can be investigated individually as possible contributing factors for perceived human-likeness.

This study indicates that particular attributes for motion and sound, identified as factors that exaggerate the uncanny for human figures within the classic horror cycle of Hollywood film, also apply to virtual characters intended for animation and video games. Synchronization problems with the recorded voice during the early sound period heightened a viewer's awareness of films as manufactured artifacts (Spadoni, 2000, p. 34). Instead of a whole entity, figures onscreen were regarded as objects created within a production studio that could easily come apart within a movie theatre, "a reassembly of a figure" (Spadoni, 2000, p. 19). The results from our study suggest that uncanny perceptions of mismatches in lip movement and sound for

onscreen figures within the early sound period of cinema mirror a similar reaction for virtual characters within video games and animation. The Witch zombie received a mean rating of just $M = 3.34$ for perceived synchronization of voice with lip movement (see Figure 3). The high-pitched cries and shrieks from the Witch combined with the jerky, haphazard movement for the character's lips and face augmented the perceived eeriness for this character. Participants seemed somewhat confused by the chaotic movement and irregular sounds, making the viewer feel uncomfortable. The results imply that these attributes added to the perceived creepiness for this zombie.

Despite being mostly stationary within the video (presumably, discrepancies between sound and image would be easier to spot), the Chatbot character received a lower score ($M = 2.51$) than the Witch ($M = 3.34$) for perceived synchronization of voice with lip movement (see Figure 3). Despite the intended human-like appearance for the former character, the simplicity of animation for parts of the Chatbot's face, including the lips, enhanced the perceived degree of separation of movement from sound for this character. The simplistic qualities of sound and motion serve to heighten the viewer's awareness of this character as a manufactured object hence increasing the perceived eeriness for this character. For characters intended to evoke fear within the context of a survival horror game, it may be suggested that a lack of synchronization of voice with lip movement exaggerates the uncanny sensation for a viewer. The results of this study suggest that deliberately causing a mismatch in lip and voice synchronization for zombie characters may help achieve an anticipated effect of fear and eeriness for the viewer, however further experiments using models for which parameters of lip-vocalization synchronization can be varied would provide more backing for this theory.

For speech qualities associated with the uncanny, the results from our study indicate that the perceived slowness, how monotone speech is, and whether speech is of the wrong intonation are qualities that exaggerate the uncanniness of a virtual character thereby increasing the perceived eeriness for a viewer (see Figure 5). This type of speech delivery is evident for the Chatbot character whose voice was rated individually as being both slow (75%), monotone (59%), and of an incorrect intonation (76%). The unnatural and unreal qualities for this character's speech serve to increase the perceived strangeness, exaggerating the uncanny for this character. The 'speech' for Zombie 1, placed with the Chatbot and two other zombie characters with a median strangeness of 3 (see Figure 5), was also rated individually as both monotone (29%), slow (42%), and of an incorrect intonation (34%). This may have been a conscious design decision by the game designers to deliberately cripple the speech qualities for this character which, it seems, has increased the perceived eeriness for this zombie.

Similar observations have been made by Spadoni (2000) in relation to early horror talkies. In particular, he discusses the "weird textures" of Bela Lugosi's voice in the title role of *Dracula* claiming that the actor's performance set the standard for what the 'voice of horror' should be (pp. 63-70). For early sound film words were pronounced slowly, emphasizing every "syl-la-ble", (p. 15). Whilst this recording process allowed for the most intelligible dialogue for a film, this impeded delivery style made the speech sound unnatural and unreal. Critics acknowledged that one of the most shocking characteristics of the eponymous character in *Dracula* was the distinctive quality of vocal tone and pronunciation; "slow painstaking voices pronouncing each syllable at a time like those of radio announcers filled the theatre" (p. 64). The unique textures of

Dracula's speech increased the creepiness for this character and the unsettling feeling for the viewer. Dracula's voice, the ethereal voice of the undead, is compared to the voice of reason and materiality that is Van Helsing's. In the former, the uncanny is marked by uneven and slow pronunciation, staggered rhythm and a foreign (that is, not English) accent and all this produces a disconnect between body and speech. Van Helsing's speech, by contrast, is the embodiment of corporiality; authoritative, clearly enunciated and rational in its delivery and meaning.

From our results, it may be suggested that characters serving the role of protagonist within a video game, such as Mary Smith or Alex Shepherd (see Figure1), or those characters which may not intentionally contest a sense of the real, such as the Chatbot character, are perceived to be more strange than familiar due to the particular attributes for their speech which make the character appear less human-like to the viewer. The character, Alex Shepherd, was placed along with the Warrior character with a median strangeness of 6 (see Figure 5). This group received the second highest median value for perceived slowness of speech (14) and the second highest median value for how monotone the speech sounded (17). Whilst these attributes appear to add to the perceived eeriness for monsters by exaggerating the uncanny, these attributes conversely detract from the perceived believability of characters intended to serve as protagonists within a video game.

Different attributes of facial expression served to increase the uncanny for figures within the classic horror film genre. Viewers were aware of both a lack of facial expression and an over-exaggeration of movement for parts of the face such as the forehead, eyes, cheeks, and mouth. For the monster Frankenstein, a boney flat ridge was placed across his forehead to induce a lack of facial expression for this part of the face. This provided a signal of the monster's "otherness" for the viewer while the rest of his features were left to express the character's emotions naturally (Spadoni, 2000, pp. 102-103). Our results imply that a viewer's awareness of a lack in facial expression for the forehead, eyes and cheeks (the mid and upper part of the face) increases for those characters rated as more strange than familiar (see Figure 6). A very strong indirect correlation coefficient of $r = -0.98$ was calculated for individual responses, between no observed lack of facial expression and a lack of facial expression in the forehead thus implying that a character is regarded as more familiar if there is no perceived lack of facial expression in the forehead. Busso and Narayanan (2006) find that, with regards to how humans communicate and interact, the upper face region has more degrees of freedom to convey non-verbal information (such as emotional content) than the lower-face region which is highly constrained by the articulatory processes (p. 555). They recommend that "for human-like facial animations, this facial area should be properly modelled and rendered to convey more realistic emotional representations" (p. 555). The results from our study provide backing for this observation by implying that, for those characters perceived as more strange than familiar, there is a heightened awareness of a lack of facial expression for the cheeks, eyes and forehead in the mid and upper part of the face. As viewers find it harder to interpret human emotion for the virtual character, they may be less trusting thereby increasing the perceived eeriness of that character. Whilst this attribute may add to the fear factor for zombie characters (with viewers being more suspicious of them), if a game designer has not accurately depicted the facial expression of a photo-realistic human-like character correctly, viewers may find it strange and uncanny.

This study also suggests that an over-exaggeration of the mouth can exaggerate the uncanniness of a virtual character. For characters rated as more strange than familiar, a perceived over-exaggeration of the mouth is of greater significance than other parts of the face, such as the forehead, eyes and cheeks (see Figure 7). A strong indirect correlation of $r = -0.90$ was calculated for individual responses between no observed exaggeration of facial expression and an over-exaggeration of facial expression for the mouth implying that a character is regarded as more familiar if there is no perceived exaggeration of facial expression for the mouth. As actors adjusted to the transition from silent to sound film, viewers were acutely aware of the exaggerated lip movements of human figures onscreen; the over-acting and expressivity of the characters needed to be toned down (Spadoni, 2000, p. 23). Viewers regarded actors with these unnatural gesticulations as more comical and subsequently less believable. Whilst this characteristic has served to increase the perceived eeriness for zombie-type characters within this study, it appears to have also had a negative effect for realistic, human-like characters otherwise not intended to evoke the uncanny. For example, the character Mary Smith received a possible 62 responses out of a possible 100, as having a perceived over-exaggeration of facial expression of the mouth; the hero, Alex Shepherd, received an individual score of 24 responses out of a possible 100 for a perceived over-expressivity of the mouth. Mary Smith and Alex Shepherd might have been perceived as more human-like and familiar had the intensity of articulation been toned down for these characters. Based on these findings it can be suggested that game designers should ensure that the lower part of the face and mouth is modelled with less exaggeration of articulation and that a greater level of attention be paid to details of facial expression for the mid and upper regions of the face; if the desire is to avoid the uncanny, the modelling paradigm should be more Marlon Brando than Bela Lugosi.

Brenton et al. (2005) proposed that a high level of graphical realism for a character's appearance raises high expectations for a character's motion and behaviour. If the quality of motion and behaviour do not match up with the character's realistic, human-like appearance, it can increase the perception that the character is not real, thus evoking a sense of the uncanny. Vinayagamoorthy, Steed, and Slater (2005) suggest that a virtual character will be regarded more positively when its behaviour conforms to human behaviour in keeping with the degree of human photo-realism. The results of this study support these theories for the photo-realistic, human-like characters used here. If the attributes of a character's facial expression and voice did not match with the perceived human-like realism for that character, they were regarded as more uncanny. The virtual character Emily received the highest scores for *familiar* ($M = 7.25$) and *human-like* ($M = 8.67$) (see Table 1). Out of all of the virtual characters, Emily also received the highest scores for *No observed exaggeration* (78) and *No observed lack* (79) of facial expression (see Figure 7). Emily also received the highest score for *The voice belongs to the character (87)*, beating the score for the human (72). It seems that the expected motion and behaviour for Emily was more in keeping with Emily's realistic, human-like appearance than other realistic, human-like characters within this study. Characters with lower scores than Emily for *No observed lack* or *over-exaggeration* of facial expression and whether *The voice belongs to the character* included Mary Smith, Alex Shepherd, Louis, and Francis (See Figures 5, 6, and 7) and these were also rated as stranger and less human-like (see Figure 2). For example, Mary Smith may have expected to receive higher scores for *familiar* ($M = 4.53$) and *human-like* ($M = 6.63$), if the perceived motion and behaviour expected for this character were more in keeping with her realistic, human-like appearance (see Table 1).

Conclusion

For increasing realism of visual appearance of virtual characters, our study leads to the following hypotheses:

1. Uncanniness increases with increasing perceptions of lack of human-likeness of the facial expression.
2. Uncanniness increases with increasing perceptions of lack of human-likeness of the character's voice.
3. Uncanniness increases strongly with increasing exaggeration of articulation of the mouth during speech and this relationship is of more significance than that between uncanniness and mid and upper facial expression.
4. Uncanniness increases with increasing perceptions of lack of synchronization between the character's lips and the character's sound.

The results also provide support for Brenton et al.'s suggestion that Mori's theory of the Uncanny Valley can be applied to virtual characters although we recognize that stronger evidence would be supplied by presenting the characters in context.

In order to work further towards the construction of a conceptual framework of the uncanny for video game characters, we plan further experiments to test the validity of the hypotheses above. A realistic three-dimensional model of a human-like head will be constructed in such a way that changes in a variety of parameters can be programmed and the results played back to viewers in a more game-like context. Parameters that can be changed one at a time might include aspects of the articulating processes of speech, mid, or upper facial expression, or the synchronization of sound with lips.

We would like to suggest one further hypothesis that will be tested at a later date as technological developments progress. Mindful of the contemporary claims for realism that the character Mary Smith provoked (and her current assessment as quite uncanny and unsettling by our participants) and mindful of recent claims that the Emily character has finally overcome the Uncanny Valley (Plantec, 2008), we propose the following:

5. Increasing technological sophistication is matched by increasing discernment on the part of the viewer and thus the Uncanny Valley is, in reality, an impossible traverse.

Attempts to create realistic virtual characters are doomed to Sisyphean failure if the purpose is to overcome the Uncanny Valley. Indeed, we would suggest that the Uncanny Valley phenomenon can, in fact, be harnessed in certain genres of video game precisely for the purposes of increasing player fear and anxiety. When the next technological miracle is announced in the Uncanny Valley stakes, we will include that virtual character in the same experiment we have conducted here. If our hypothesis is correct, the Emily character will be firmly back in the depths of the Uncanny Valley.

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