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Unmasking the Uncanny:

The Effect of the Uncanny Valley in 21st Century Character Design

Submitted to the Faculty of Film, Art and Creative Technologies
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Declaration of Originality

This dissertation is submitted by the undersigned to the Institute of Art Design & Technology, Dun Laoghaire in partial fulfilment of the examination for the BA (Honours) in Design for Stage and Screen (Character Makeup Design). It is entirely the author's own work except where noted and has not been submitted for an award from this or any other educational institution.

Signed: 

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Abstract

In the 20th century, certain roboticists and filmmakers pursued a joint goal: To replicate a human with the use of technology. One roboticist, Masahiro Mori, noticed an issue as they began to reach this goal of human likeness as the robots started to become eerie and he developed a theory, the Uncanny Valley theory, as an explanation for this phenomenon. In 2004, *The Polar Express* celebrated a huge feat in filmmaking possibilities, by using motion capture technology to produce a feature film that showcases a full cast of animated digital humans, but there was something off about them. This thesis considers the theory of the Uncanny Valley as a cause for digital human's inherent eeriness. The following two decades saw filmmakers who used this technology face challenges in preventing their digital humanlike characters from falling victim to this Uncanny Valley phenomenon. An analysis of the characters in the film *Avatar* proves that it is possible to bypass this valley through certain character design principles and filmmaking techniques, achieving successful digital humanlike characters. Yet a discussion on the film *Cats* proves that despite 15 years of developments in this technology since *The Polar Express*, the Uncanny Valley still poses a threat to filmmakers and is something they must consider when working with digital humans. Lastly, a consideration of the success of the horror film *M3GAN* offers alternative methods of replicating a human and proves the Uncanny Valley effects can be beneficial in certain cases. Overall, this thesis is an exploration of films that feature digitally animated humanlike characters and how these characters are often negatively received and perceived as creepy. This thesis considers how the theory of the Uncanny Valley illuminates our understanding of character design and animation techniques and how filmmakers can utilise certain principles to avoid it or take advantage of this eerie phenomenon.

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Introduction

In 1970, roboticist Masahiro Mori published his theory of the Uncanny Valley in which he proposed that an observer's likability for an object, a robot in his case, steadily increases with the object's resemblance to a human being. As an object's human likeness nears that of an actual human being there is a sudden drop in our likability towards the object, we experience jarring, negative emotions, as we are faced with a human that is unfamiliar to us. He points towards unnatural movement and flaws in the object's design as possible causes that elicit this eerie phenomenon. Although originally published in the field of robotics, this theory can be observed in areas such as digital character design where the goal is to replicate a human being.
In this thesis, I will focus my discussion on how the theory of the Uncanny Valley illuminates our understanding of character design in 21st-century filmmaking. By examining four films that have ignited discussions on Mori's theory of the Uncanny Valley in popular media and academic discourse -, primarily *The Polar Express* (2004), *Avatar* (2009), *Cats* (2019) and *M3GAN* (2022) -, I showcase specific characteristics that induce this Uncanny Valley effect in digital character design. Throughout this thesis, I will prove that the Uncanny Valley plays a crucial role in filmmaking today, whether deliberately employed or not, specifically in films that feature animated humans or digitally enhanced humans.

The first chapter of this thesis will focus on the film *The Polar Express* which brought the term 'Uncanny Valley' into the dialect of conversations about filmmaking in the early 2000s. *The Polar Express*, follows the journey of a young boy on Christmas Eve as he boards a train that takes him to the North Pole. The film was the first of its kind to only feature digital realistic human characters achieved through motion capture technology - A process which tracks the movements and facial expressions of a human actor and allows animators to use this data to animate a digital character. This technology enabled actor Tom Hanks to star in 6 different roles in this film: ranging from a young boy to the old character of Santa Clause. Since its release in 2004, *The Polar Express* has become synonymous with the theory of the Uncanny Valley as a result of the severe critical backlash the film received due to its "terrifying" (rosilylips, 2020) characters. Through critical analysis of this animated film, I will provide reasoning as to why the characters of this film fell victim to Mori's theory of the Uncanny Valley.

Following an example of a film that fell victim to the Uncanny Valley, in the second chapter I will compare *The Polar Express* to *Avatar*. This film takes place on an alien planet called Pandora, home to a tribe of 10-foot-tall blue beings called the Na'vi. Scientists link human minds to Na'vi bodies to allow humans to explore Pandora. Through the use of developed motion capture techniques and a 'facial action coding system'- providing animators with realistic facial expressions and the ability for keyframe animation, saw the success of humanlike digital characters that did not elicit negative emotions, aiding the filmmakers in their storytelling. Despite both films using similar motion capture technology, I will highlight the aspects and design choices the filmmakers of *Avatar* made that prevented the characters of this animated film from falling into the Uncanny Valley and facing the same fate as *The Polar Express*.

In the third chapter of this thesis, I will introduce a more recent film that fell victim to the Uncanny Valley: *Cats.* This film adaptation of the theatre classic follows a tribe of digital cat-humans, the "Jellicles", as they compete in the "Jellicle Ball". This film features humans in digital fur suits achieved through a developed version of motion capture that combines both human actor and digital fur technology – realistic animated fur applied in post-production. Although the characters had a high level of realism, they were criticised for their "freaky" (Cantrell & Hawkes, 2011) and "jarring" appearance, situating them in the dip of Mori's Uncanny Valley. Through examining the pitfalls of the character design and its links to the Uncanny Valley I aim to prove that Mori's theory still poses a threat to current filmmakers, despite advances in technology and developments in realistic animation techniques.

Finally, the fourth chapter will provide a discussion of the horror film *M3GAN* and consider how the designs of the characters deliberately used the pitfalls of the Uncanny Valley as tools to create a character that instilled terror in audiences. *M3GAN* is the story of a realistic human-like robot that develops a mind of her own, a horror movie that capitalises on the fear of artificial intelligence's potential. The character of M3gan is a realised version of the examples Mori used in his original theory, an uncanny humanlike robot that appears unnerving. This film achieved commercial success and the filmmakers were praised for the unsettling design of their character. Through critical analysis of the character design featured in this film, I will highlight aspects that allow the Uncanny Valley to benefit certain filmmakers.

Chapter One: The Polar Express (2004)

1.1 The Uncanny Valley

To discuss the theory of the Uncanny Valley, it is first important to understand and define what is considered "uncanny" within the fields of visual studies, film and animation. The term "uncanny" was first defined by Sigmund Freud in his essay '*Das Unheimliche*'. He describes the "uncanny" as the class of terrifying which brings us back to something long-known to us (Freud, 1976, 2), or, as Monahan describes in Dolls, Doppelgängers, and Diabolical Others: The Demonisation of Children's Culture in Horror Cinema: "Once extremely familiar to us, but which may not be anymore." (Monahan, 2024, 5). The term 'Uncanny Valley', on which I will focus throughout this thesis, was coined by Masahiro Mori, a Japanese roboticist. His theory, which was first developed concerning his research and development in robotics, is defined: "a person's response to a humanlike robot would abruptly shift from empathy to revulsion as it approached, but failed to attain, a lifelike appearance" (Mori, MacDorman, 2012). Mori also visualises the Uncanny Valley using the graph below:

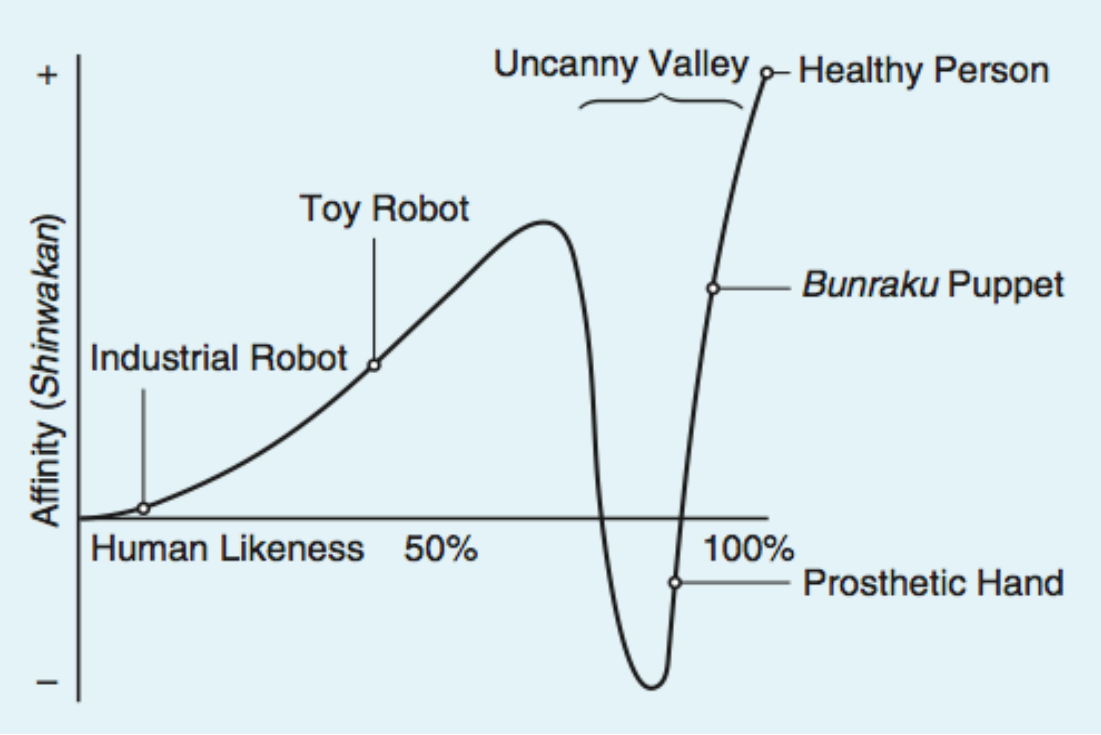

Fig. 1. Graph of the Uncanny Valley. Mori, Masahiro. "The Uncanny Valley (From The Field)". *IEEE Robotics & Automation Magazine*.

The graph (*Fig. 1*), charts the relationship between a viewer's "Affinity" to the "Human Likeness" of an object, character, film, or other visual media. Affinity, in the context of Mori's and my research, is defined by Kätsyri et al as the positive emotions or likability an observer associates with a character that they perceive to have similar qualities as another character that is familiar to them, possibly the observer themselves (Kätsyri et al, 2015). Mori proposes in his article that "in climbing towards the goal of making robots appear human, our affinity for them increases until we come to a valley, which I call the *uncanny valley*" (Mori, 2012, 2), where the affinity of the viewer toward the object, (or robot in the context of Mori's research), decreases significantly reaching a potential point of "terror" as suggested by Freud. He illustrates the Uncanny Valley phenomenon using the example of a prosthetic hand. He states that a robotic hand can appear humanlike with the use of prosthetic skin to cover the bolts. An observer, perceiving this robotic hand to be a human hand, instantly experiences affinity towards the hand due to its human likeness. If the observer interacts with the hand by touching it, they may experience an eerie sensation and a sense of dread as their expectation of a warm human hand contradicts the boneless, cold robotic hand. The hand instantly becomes uncanny as it was familiar to the observer at first, but upon realising it is not real, the hand is no longer familiar and a sense of affinity towards it is lost (Mori, 2012, 3).

The dip in Mori's graph, which he identifies as the Uncanny Valley, represents the eerie sensation we feel when we encounter certain living-dead things, or human-like characters that feature unfamiliar characteristics. Examples found in the depths of this valley are corpses, zombies, realistic humanoid robots and, as I will argue in this thesis, realistic animation in films. But why are we equipped with this reaction? Mori asks if it's essential for our survival as human beings (Mori, 2012, 5). Tom Geller poses an answer to this question in 'Overcoming the Uncanny Valley', saying "they're [uncanny humanlike characters] like animated corpses lacking volition and desire and are reminders of how easily we could lose the warmth that defines our humanity" (Geller, 2008, 11).

Mori uses the example of a Bunraku puppet to demonstrate how some objects avoid falling victim to the Uncanny Valley effect. Mori states that once on stage "the puppets absolute size is ignored, and its total appearance, including hand and eye movements, is close to that of a human being. So, given our tendency as an audience to become absorbed in this form of art, we might feel a high level of affinity for the

puppet" (Mori, 2012, 3). In comparison to the prosthetic hand, a Bunraku puppet achieves human likeness due to its subtle movements, rather than its aesthetic likeness to a human. In his essay, Mori highlights how subtleties in movement greatly affect our affinity towards objects such as robots. He says that we may feel affinity towards a mechanical robot's hand that has been programmed to move like a human hand, versus the eerie sensation we may experience once a prosthetic hand starts to move (Mori, 2012, 3), highlighting how it is only when an object visually looks human that movement affects its uncanniness. To this end, Mori reveals that movement may be an important aspect in designing robots or characters alongside their human likeness which I will explore further in my thesis.

1.2 *The Polar Express* and the Uncanny Valley

The theory of the Uncanny Valley came to my attention after the release of The *Polar Express (2004)*. This film has become synonymous with the term due to the look of its characters and their unnatural movements. The film features completely digital replicas of the actors using Vicon motion capture technology. Motion capture is chosen by filmmakers who want to achieve realistic, lifelike animations. In the context of *The Polar Express*, the performers' movements were captured on set using tracking points on their bodies and this data was transferred to the animators who could then digitally replicate the actor's movements. Achieving convincing human movement and complex human expression is not possible with keyframe animation alone. One benefit when using performance or motion capture technology is a reduced production time which may be attractive to some filmmakers. While *The Polar Express* was the first film to entirely use the performance capture technique, proposing a revolutionary technology for filmmaking, it was met with mixed criticism from audiences when it was released in 2004. At the time, Tom Hanks was very optimistic about the creative freedom this technology could bring, stating "you will no longer be limited by your size, shape, skin colour, age or gender. If you have the interpretation that the director wants for the role, then you can play any role" (Aldred, 2011, 6). Ultimately, the motion capture technology employed in The Polar Express enabled Hanks to play six different roles simultaneously, ranging from a young boy to Santa Clause. The animators relied on his acting performance, captured and transmitted by various trackers, to fit each different character and recreate Hanks' movements digitally.

Unfortunately, Tom Hanks' enthusiasm to play multiple roles as a result of *The Polar Express'* motion capture technology capabilities led to criticism towards the film due to the character's movements, labelling them as "puppet-like" (Jenkins, 2004). Despite the commercial success of this film, it failed to avoid the pitfalls of Mori's theory. Criticism of this film is now dominated by the term "uncanny". Mark Langer speculates in his paper 'The Rotoscope, the Double and the Uncanny', that a motion-captured character is, fundamentally, uncanny due to the merging of something organic, a living body, with something inorganic, digital animation, "forcing the viewer's uncomfortable struggle to distinguish whether the body in question is actually alive" (Aldred, 2011, 4). She writes that at the start of the 21st century, there was a

fear amongst actors and critics that these digital actors might replace real Hollywood actors (Aldred, 2011, 1). This fear surrounding human replacement has reemerged more recently in 2023 due to the SAG-AFTRA strikes, with many actors voicing their fears over the developments in AI's capabilities to replicate their likeness without their permission (Gaskins, 2023). "There's a concern that we can create something that will destroy us" (Geller, 2008, 17). Yoseph Bar-Cohen theorises that humanity is preparing itself for this eventuality. "For the first time we're doing pre-preparation on technology that doesn't even exist. We are starting to have dis-cussions of robo-ethics on all levels" (Geller, 2008). This societal concern surrounding technology has appeared on screen in films such as *The Terminator (1984)* which in turn strengthened that fear. Even digital art, in some cases, is not considered "real art" and with the emergence of AI systems like DALL.E that can create digital art in seconds, people are still apprehensive towards technology in creative fields. As advancements in technology blur the line between real and digital humans and strengthen the fear of being replaced, the Uncanny Valley emerges as a result of our heightened anxiety around the fear of the other. Therefore, it is prevalent in areas such as films that feature digitally animated humans.

The presence of the Uncanny Valley can completely skew audiences' perception of a film. In the case of *The Polar Express*, the story follows the journey of a young boy who doubts the existence of Santa Clause and regains his belief in the magic of Christmas. It is a heartwarming story of friendship and wonder. The warm message of this film contrasts with descriptions of Mori's Uncanny Valley characters "animated corpses lacking volition and desire" (Geller, 2008, 1), despite both being critically linked. Jessica Aldred uses the term "synthespian" in her critique of *The Polar Express*. "Photo-real but not real, lifelike but not living" (Aldred, 2011, 1). If the audience loses affinity towards a character on screen due to their appearance, it can be dire in the success of the film as a whole. The actual story being told in a film can become lost and overshadowed by the unsettling feelings conjured by Uncanny Valley characters. In the case of *The Polar Express*, another critic wrote "cold eyes, warm heart" (Geller, 2008, 15), proving the impact Mori's Uncanny Valley theory has on storytelling and filmmaking. The film is now synonymous with the Uncanny Valley, rather than the story being told.

1.3 Examples from *The Polar Express* demonstrating this theory

Jessica Aldred argues that these synthespian characters appear uncanny to the audience "due to their liminal position between live action and animation, and their differing codes for visual appearance and physical movement" (Aldred, 2011). These differing codes for visual appearance can be so minute, yet so clear to the audience. "The audience is conscious of the fact that they are looking at virtual characters set in a virtual world and are therefore more critical in the way these are presented to them" (Aldred, 2011, 3). From an animation perspective, the use of performance capture technology to create these realistic human characters leaves very little room for error as the audience becomes hyper-critical of the characters due to the looming presence of Mori's Uncanny Valley theory.

Fig. 2. Still image of Hero Boy's blank expression. *The Polar Express* (2004), Warner Bros. Pictures

The above image, *Fig. 2*, is a still image taken from a scene in *The Polar Express* where 'hero boy' discovers a magical golden ticket that appeared in his pocket. This character's motion capture was a mix of Josh Hutcherson and Tom Hanks acting, and the animation was supervised by David Schaub. While Aldred highlights the uncanniness of characters that are not quite live-action and not quite animation, in the case of Hero Boy, the technology used allowed the animators to merge the performances of these two actors to create a single character. Hero Boy is not quite Hutcherson and not quite Hanks, which is uncanny in and of itself. This is one of the first scenes in the film to showcase magic, so the boy is meant to appear bewildered by what he just found. Upon its release, the film was well received but one criticism

that kept emerging was about the characters' lifeless and emotionless expressions. Film critic Paul Clinton used the cliche" the eyes are the windows to the soul -- so these characters look soul dead." One CNN headline wrote" "The Polar Express," should be subtitled "The Night of the Living Dead." The characters are that frightening.'' (Clinton, 2004).

The facial expression on the character in this image exemplifies the lack of emotion the characters displayed throughout the film. The absence of strong emotional reactions from the characters causes our affinity towards them to dwindle and we view them more like robots, rather than human-like characters with whom we can empathise.

Fig. 3 & 4. Still image reworked to look less uncanny. Jenkins, Ward. 'The Polar Express: A Virtual Train Wreck (conclusion)'

One such criticism the film received came from Ward Jenkins in his article 'The Polar Express: A Virtual Train Wreck'. He concludes that the "terrible" and "stiff" character designs could have been avoided if "they hired somebody with an inkling of

aesthetic value to determine what needed to be fixed" (Jenkins, 2004). Ward took it upon himself to prove this statement. He reworked the still image from The *Polar Express*, of the boy looking at his ticket with a vacant expression (*Fig. 3*) and digitally tweaked the character to look less uncanny. With the slight use of shadows around the eyes of the character, softening of the pupil's glare and tweaks to the eyebrows and mouth, Ward was able to breathe life back into this character (*Fig. 4)*. It is these subtle changes in the animation which lifted this character out of the Uncanny Vally, demonstrating that there is a fine line between creating realistic and /or vapid-looking characters that animators and character designers must balance. These details prove to be a consistent problem for animators and filmmakers. Hal Hickel, one of the animation supervisors for the *Pirates of the Caribbean (2003-2007)* movies, spoke about how important these minute details are. Speaking of a scene where a human actor transforms into a digital animation he said "we preserved his eyes for a split second before he fully transformed. That's always where the audience is looking, and people are really sensitive if you get the eye line off even just a little bit. People have a lifetime of looking at others' eyes" (Geller, 2008, 15).

In 2008, a study called the 'Digital Emily Project' was performed by Alexander et al (Bouwer & Human, 2017, 5). They aimed to digitally create a person whose animation did not fall victim to the Uncanny Valley effect. This study produced five guidelines for animators to follow to create a realistic digital actor:

1. facial scanning resolution to show skin texture,
2. visual aspect data for a range of facial expressions,
3. naturalistic facial animation especially eye movement,
4. true to-life skin reflectivity,
5. exact lighting consolidation with the actors' surroundings.

Regarding *The Polar Express,* the animators failed to achieve two of these guidelines: an insufficient range of facial expressions, rendering the characters "emotionally vacant" (Aldred, 2011, 9), and limited naturalistic facial animation turning "Tom Hanks into an Uncanny Valley monster" (Botes, 2022). It is the lack of these two guidelines which allowed the characters and animation of the film to fall victim to the Uncanny Valley. As outlined, Alexander et al's five guidelines highlight the difficult challenge animators face in employing motion capture technology to digitally animate their films, and the fine line between their realistic human characters succeeding or falling into Mori's Uncanny Valley.

While the Uncanny Valley phenomenon is a niche occurrence in the wider film industry, it is often films that use motion capture technology that fall victim to this effect. Although there are cases where animators and filmmakers have used this technology and managed to jump over the Uncanny Valley, I will discuss some examples throughout the rest of my thesis, particularly *Avatar* (2009), *Cats* (2019) and *M3GAN* (2022) as a way to contrast and compare how animation processes illuminate our understanding of the Uncanny Valley theory in 21st-century filmmaking.

Chapter Two: *Avatar (2009)*

2.1. *Avatar* and Motion Capture

The Polar Express' release which, as demonstrated above, was received with critical feedback due to its failure to avoid the Uncanny Valley in character and world design, placed the use of motion capture technology at odds with the overarching filmmaking industry in the 21st century. On the one hand, filmmakers sought to innovate and use technology to their advantage in digitising 'real' characters and actors, while on the other hand, the technology seemed unable to avoid the effects of the Uncanny Valley it created. In 2009, however, "*Avatar*", created and directed by James Cameron, was released to critical and box-office success. In fact, as Jenna Ng states, the film had been branded as "revolutionary and groundbreaking" (Ng, 2012). Its success is in part due to its fantastical visuals and its use of motion capture technology. Despite using the same performance capture techniques that Robert Zemeckis first used in The *Polar Express*, *Avatar* is not shrouded by the term 'Uncanny Valley'. So, how has James Cameron been able to circumnavigate the pitfalls of the Uncanny Valley and learn from the mistakes of *The Polar Express*? In this section of my thesis, I aim to explore the techniques that Cameron and his team employed in their character design, filmmaking and animation process that allowed the film to avoid the Uncanny Valley and gain critiques saying the film "contains such visual detailing that it would reward repeating viewings" (Ebert, 2009). Fluekieger remarked that this film is a revolutionary milestone for visual effects, which created hype around the film. (Schwind, 2018). *Avatar* features 10-foot tall, blue, slender indigenous humanoids called the Na'vi, (Földesi, 2015), living amongst floating islands, fluorescent animals and giant trees on the planet of Pandora. The plot follows Jake Sulley, a former Marine, as he partakes in the colonising of Pandora through understanding how the Na'vi live. His mind is connected to a Na'vi avatar to allow him to explore the poisonous planet, where he falls in love with this tribe of beings and vows to protect them against the military which sent him there. It is celebrated as a visual masterpiece, with a Guardian review labelling it an "astonishing feast for the eyes" (Hewitt, 2022).

2.2 How *Avatar* avoided the effects of the Uncanny Valley

The designs for the *Avatar* characters were imagined by the Stan Winston studio and were sent to Weta Digital, a New Zealand-based visual effects company having previously won Academy Awards for The Lord of the Rings, to bring them into their digital form. As outlined in Chapter 1 of this thesis, realistic humanlike characters are at risk of falling into the Uncanny Valley. In his original essay, Mori predicts it is possible to create a safe level of affinity by pursuing a different design. "A good way to avoid the uncanny valley is to move a character's proportions and structure outside the range of 'human'." (Geller, 2008). Tom Geller suggests that characters that clearly are not human but are anthropomorphic do not conjure that creepy Uncanny Valley feeling. A possible explanation that supports his theory is that anthropomorphic characters, having humanlike characteristics, do not feature in Mori's graph of the Uncanny Valley because these are not humanlike. Yet they may achieve affinity, or likability, due to their closeness to humans portrayed in their characteristics. Cameron originally came up with elegant, tall designs with feline characteristics for the Na'vi that "retained humanoid forms with human-facial characteristics" (Földesi, 2015). In this early stage of creation, before detailed designs or any motion capture filming, Cameron's choice of an anthropomorphic design may have aided in avoiding the effect of the Uncanny Valley.

As noted in Chapter 1, Achieving a character design that does not elicit the eeriness of the Uncanny Valley is not enough to avoid its effects, movement is a factor that filmmakers must consider in their process when creating digital characters. During the filming of motion capture, James Cameron used a 'swing camera' which allowed him to "adjust and direct scenes just as if shooting live action" (Ng, 2012). This technology was able to provide Cameron with a screen with a low-resolution version of the CG avatars in the Pandora environment. By using reflective marker points to track movement data on both the actors, alongside the swing camera, this technology allowed Cameron to visualise the blue Na'vi aliens within a Pandora environment in real-time, while simultaneously directing the actors in real-time whose motions (body and face) and facial expressions were being digitalised (Ng, 2012). It allowed him to have real-time control over how the characters interact with their digital bodies. Cameron managed to avoid Uncanny Valley effects produced by discrepancies in movement using this technology. As Mori discussed in his original theory of the

Uncanny Valley, if someone or something with human likeness moves in a way that is unfamiliar to us, we experience negative emotions and lose affinity for it (Mori, 2012, 4). The use of the swing camera allowed Cameron to ensure the movements of the digital avatar were familiar to us.

However, despite the successful efforts of designers in creating computer-generated characters, the effects of the Uncanny Valley are not guaranteed to be avoided. Similarly, to Mori's example of a prosthetic hand, mentioned in the previous chapter, an object or a character that has a human likeness can create affinity when it is still, but once it starts to move can easily tumble into the Uncanny Valley. This is true for facial movement and expressions proved by Tinwell et al: they observed that animated, humanlike characters are perceived as significantly more uncanny when there are discrepancies in movement and limited movement in the upper face, leading to a lack of emotional expressivity (Tinwell et al, 2011, 28). In the case of *Avatar*, the animators had to ensure that every subtle movement on screen did not conjure the valley's eerie effect, which would overshadow the characters and render the efforts of the designers useless. By drawing from the learnings and mistakes of facanimators, where they used low-resolution helmet cameras to track facial expressions which produced frontal perspective recordings that distorted the data due to the fish-eye lens, the *Avatar* animators opted for a different method in their approach to creating motion of facial expressions in order to promote affinity between audience and character and avoid the Uncanny Valley. According to Schwind, the animators instead used a system called 'facial performance replacement' (Schwind, 2018), where the facial expressions of an actor for a scene are re-recorded and motion is tracked using multiple cameras and perspectives, allowing animators to impose this more accurate motion data to these scenes in post-production. Furthermore, Ekman and Friesen's 'facial action coding system' was used by animators to rig each digital character with a facial muscle system and was linked to basic emotions. This system featured action units such as brow lowerer, cheek raiser and upper lip raiser. It allowed animators to produce realistic human emotion, but only in a neutral pose so this was not applicable when the character had to speak. It can be observed in the film on a character's face when they react to their environment. "But the fine nuance of the actor's performance had to be done by keyframe. The facial rig just freed the animators to concentrate on those all-important details" (Schwind, 2018). This level of control allowed the animators to

retain as much of the original performance as possible and avoid uncanny, expressionless characters. Although, achieving convincing facial expressions was not easy for the animators due to the Na'vi's lack of eyebrows. Basilli notes that facial animation was made more difficult as eyebrows are an essential part of expression (Acharya, 2022). According to Ekman, a true smile triggers a "particular expression around the eyes that occurs with the contraction of a muscle that orbits the eye" (Acharya, 2022). Yet, he claims that this expression is not triggered by a fake smile. Therefore, as the Na'vi lacked eyebrows, this expression was so subtle that it risked going unnoticed and resulting in a "false smile" (Acharya, 2022). Animators were challenged here as if their characters were perceived to have false emotions, the Na'vi risked resulting in a similar fate to *The Polar Express* characters. Their extreme efforts resulted in the film gaining reviews such as "James Cameron and his crew really nailed the expressions and the nuances of human emotion" (Yi Chie, 2009). This suggests that motion capture technology alone is not enough to create digital human-like characters with adequate facial expressions that avoid the Uncanny Valley effect.

2.3 Designing Characters that avoid the Uncanny Valley

As motion capture technology became more commonly used by filmmakers in the early 2000s, it was important that designers and animators were aware of the Uncanny Valley effect and ways to avoid it. A study was conducted by Bouwer and Human to examine the impact of the Uncanny Valley theory on the perception of animated human characters. A short scene was filmed using performance capture technology. This data was used to produce the same scene in four different animation styles: real human actor, photorealistic computer-generated (CG) character, Pixar character and toon character. Participants in this study found the photorealistic CG character more eerie than the other three characters (Bouwer & Human, 2017). In the findings, it is noted that "Audiences are more sensitive to any imperfections in the applied animation to realistic CG characters than in the stylised characters" (Bouwer & Human, 2017). These imperfections come about during the creation process of the character as there is inconsistency in the rendering and sculpting of features. This results in "unequal levels of realism, which makes it difficult to assign a category to the entity, increasing feelings of uncertainty in the observer" (Schwind, 2018).

Fig. 5 & 6. Comparison of Photorealistic CG Character and Pixar Character. Bouwer, W. & Human, F. (2017). 'The Impact of the Uncanny Valley Effect on the Perception of Animated Three-Dimensional Humanlike Characters'

Schwind suggests that to avoid uncanny effects, designers can increase the physical attractiveness of a character (Schwind, 2018, 3). He notes that symmetry and smooth skin are important factors in physical attractiveness. The designers of the Na'vi used this approach, with one stating "in designing Neytiri, one of the challenges was making her look sufficiently alien but with enough familiar and appealing aspects to make Jake's attraction to her seem natural and convincing." (Földesi, 2015). They achieved this goal, as one such review remarked "Cameron and his artists succeeded at the difficult challenge of making Neytiri a blue-skinned giantess with golden eyes… I'll be damned. Sexy" (Ebert, 2009). One point Schwind observes in his article is that audiences didn't seek perfection with CG characters. "Light imperfections are still more appealing than perfectly smooth skin or facial symmetries". Although smooth

skin and symmetry are important factors in physical attractiveness (Schwind, 2018), affinity increases when light imperfections and textures are visible. This supports Stix's concern that the work of cosmetic surgeons can yield an uncanny result (Stix, 2008). Bouwer observed that eeriness increased with a photo-realistic skin texture (Bouwer & Human, 2017). To create a more attractive character the texture should be turned down but not completely. This is the balance character designers must strike in order to increase affinity. The Na'vi characters have skin texture but not deep wrinkles, striking this balance.

Similarly, when discussing The *Polar Express*, the eyes of a digital character are a huge factor in avoiding or falling into the Uncanny Valley. Schwind claims that people "fixate on the eyes before they consider other features in assessing if a character is real or not real" (Schwind, 2018). The Na'vi characters had large, golden, cat-like eyes with the area around the eyes keeping the shape and proportion of the actors who played them (Földesi, 2015). They point out that "for the avatars the similarity to the humans portraying them had to be evident, at least for the face" (Földesi, 2015). This kept designers in a realm that would ensure affinity towards characters, as audiences recognise the human actor in the digital avatar. Bouwer & Human proved in their article that affinity for a CG character increased when the eyes were enlarged by 10%, as illustrated in the comparison of the charcter in *Fig. 5 & 6*. But they also proved that CG character's eyes enlarged by over 50% results in Uncanny Valley feelings of eeriness (Bouwer & Human, 2017). In order to avoid negative effects, designers should ensure that if enlarging a character's eyes, it should only be increased by 10-49% to gain the most amount of affinity before the character appears uncanny.

As I discussed in Chapter One, attempting to replicate a human using motion capture technology and computer graphics can often result in the conjuring of unwanted Uncanny Valley effects. In Mori's original theory, he highlights the importance of affinity saying: "given their lack of resemblance to human beings, in general, people hardly feel any affinity for them" (Mori, 2012, 2). The character designers who worked on *Avatar* succeeded in creating affinity for the Na'vi. Audiences can experience empathy towards the characters due to their resemblance to their human actors, which makes them seem familiar and human. Sam Worthington who played the main character Jake said he saw his personality reflected on screen (Schwind, 2018). Whereas in *The Polar Express* when Tom Hanks played six completely different roles it was hard for audiences to feel any affinity towards a

character that had no reflection of a human actor behind it. Apart from the character of the conductor, it is difficult to recognise Hanks in any of the characters he portrayed. It could be argued that Hanks got lost amongst his numerous different roles and was only supplying movement for his "puppet-like" (Jenkins, 2004) digital avatars, while Sam Worthington was acting through his digital avatar. Duncan notes that "We went back to a much more traditional foundation. We came to realize that if we wanted the audience to relate emotionally to these characters, there needed to be familiar touchstones" (Schwind, 2018). Cameron's team recognised the importance of making these characters relatable to humans to increase the audience's affinity towards these digital beings and keep them out of the Uncanny Valley. They achieved this by making sure that each actor behind their avatar was recognisable in their digital form. *Fig. 7.* shows how Joel David Jones's own facial features are reflected in the design of the Na'vi character that he is portraying. In this image, it is clear to see that the designers retained Joel's mouth and jaw shape. The artists enlarged but kept his original eye shape and the surrounding area, along with a golden render on the eyes they ensured he is distinctly Na'vi, while still being familiar as Joel's eyes. The designers succeeded in striking a balance in their characters that was human enough to ensure affinity but stylized enough that they didn't have to concern animators with exact human replication.

Fig. 7. Creating Norm's (Joel David Moore) avatar. Actor photographed, conceived as a Z-Brush sculpture, finished in Photoshop, and finally sculpted as a life-size bust for lighting reference. Földesi, B. (2015). *Creating the Na'vi – Go behind the scenes at Stan Winston studio – Part Two*

Chapter Three: *Cats (2019)*

3.1. *Cats*

The technical advances in motion capture technology in recent years, particularly in the development from *The Polar Express* to *Avatar* which I previously discussed, brings forth a new question: is the Uncanny Valley a thing of the past for contemporary filmmakers? The critical reception of *Cats* (2019), another film which uses motion capture technology, directed by Tom Hooper, however, suggests that the Uncanny Valley remains a prevalent issue in contemporary filmmaking.

Based on the previous achievements of the filmmakers, the film adaptation of *Cats* had the potential to be a box office hit. Renowned filmmaker Tom Hooper, who had huge success with a theatre-to-film adaptation of *Les Misérables* (2012), directed an A-list cast with household names such as Dame Judi Dench, Taylor Swift and James Cordon, and a budget of almost 100 million USD. Hooper's adaptation of the 1981 musical follows a tribe of cats called the "Jellicles" as they compete in the annual "Jellicle Ball" where one cat is chosen to be reborn. The film is set in neon-lit streets of 1930s London and features human-cat "uncanny hybrids who trigger feelings of creepiness and disgust" (Cantrell & Hawkes, 2021). Unfortunately, after the release of the first trailer the film faced extreme backlash online. A scathing review read "Andrew Lloyd Webber's beloved musical (based on Old Possum's Book of Practical Cats by T.S. Eliot) has long been thought to be unfilmable- a thought some are wishing was adhered to after viewing the trailer" (Nolan, 2019). The criticism of the trailer echoed the same Uncanny Valley sentiment as *The Polar Express* did 15 years prior. Despite the technological advances in motion capture and VFX [visual effects] techniques, the film *Cats* proved the Uncanny Valley is just as much of a threat and challenge for filmmakers today. As a result of the prevalence of the Uncanny Valley, *Cats* was awarded the Worst Picture from the Razzie Awards. Further criticism was drawn to the screenplay, and direction, with the film receiving nominations for Worst Screenplay, Worst Director, Worst Screen Combo, Worst Supporting Actress and Worst Supporting Actor (2020, The Golden Raspberry (Razzie) Awards LLC).

3.2 *Cats* and the Uncanny Valley

As with previous films that suffered from the Uncanny Valley effect, the film *Cats* used a form of motion capture technique to create its CGI-enhanced characters. The film featured a new 'digital fur technology' which is "an animation technique that combines live-action performance with hyper-realistic CGI to create, in this case, human-cat hybrids" (Cantrell & Hawkes, 2021). The performers were dressed in motion capture suits to allow the VFX team to apply their digital fur in post-production (Zemler, 2019). The characters in *Cats* being CGI-enhanced versus the *Avatar* characters being fully CGI is a key difference between the use of motion capture technology. As the *Cats* characters retained a sense of humanness and reality through this blend of motion capture and live action, this choice fundamentally led them to be perceived as humanlike, possibly a reason for their uncanniness. Or was Hooper's use of motion capture the reason for the characters in the film to be labelled as "creepy" (Cantrell & Hawkes, 2021)? As discussed in my previous chapters, *The Polar Express* suffered Uncanny Valley effects due to its use of early motion capture technology. The film *Cats*, however, was made nearly a decade after the successful development of motion capture technology and the VFX artistry and design of James Camerons *Avatar*. Cameron proved 10 years prior that it is possible to create digital characters that avoid the Uncanny Valley. Hooper failed to employ some of Cameron's methods while filming *Cats*, such as the use of a 'swing camera' to visualize in real-time how the characters will look on screen. The performers had no idea what they were going to look like in the finished film. Jennifer Hudson, one of the lead actors remarked "I have an amazing imagination to embody this without fully seeing what I am supposed to be" (Zemler, 2019). In a behind-the-scenes look at the creation of the film, James Cordon commented that the only knowledge they have of how they will look in the final film is that they will be covered in digital fur (Universal Pictures, 2019). A key difference to be noticed between the methods of Cameron and Hooper is that, for *Avatar*, Cameron prioritised character designs. Before filming *Avatar*, Cameron, Weta Digital and the Stan Winston Studio produced hundreds of concept drawings of the characters. As Földesi documents in their blog, the character design process was lengthy, with Stan Winston Studio creating life-size versions of the characters and sculpted and painted multiple busts (Földesi, 2015). It is difficult to find evidence to the same level of *Avatar* of any character designs for *Cats* prior to the

animation process, only the mention of the 'digital fur technology'. Therefore, it could be argued that Hooper prioritised the realistic fur technology over the design of the characters in *Cats*. With adequate development and trialling as part of character creation, similar to the process of designing the Na'vi in *Avatar*, it would be clearer to see what technical methods could be used to achieve the desired character. In the case of *Cats*, it is possible that motion capture technology was not the appropriate method of special effects to create the characters. Filmmakers should prioritise their character design over technical effects to ensure they create likeable characters that reduce the risk of the Uncanny Valley.

Fig. 8. Francesca Hayward and Robbie Hayward playing their digitised fursonas, *Cats* (2019), Universal Pictures.

In James Cameron's *Avatar* and Tom Hooper's *Cats*, both directors and their teams had a similar goal: to ensure the actor behind the digital character was recognizable. Why did the final characters in these films receive such different receptions from audiences and why do Hooper's characters appear uncanny and not Cameron's? A main difference in design choice between the two films is that the characters in *Avatar* are clearly not meant to be human. With enlarged eyes and warped head shapes, it is clear to audiences that the Na'vi are alien beings living on a planet adjacent to ours. Whereas the characters in *Cats* are categorically ambiguous, they retain a human body shape, hands and face but veer towards cat characteristics with a tail, ears and fur. With both directors aiming to retain some level of human likeness in their character designs, they had very different approaches. Cameron chose

to bring about this likeness through the facial expressions of the Na'vi characters in *Avatar*, by retaining the area around the character's eyes, while Hooper chose to retain human likeness for his characters in *Cats* by retaining the actor's face. This resulted in the *Cats* characters appearing too similar to humans, and falling into the Uncanny Valley, proving Mori's original theory. They conjure feelings of disgust for audiences as their uncanniness reminds us of something "once extremely familiar to us, but which may not be any more" (Monahan, 2024). An audience's instant impression of the characters is that they are human. The characters in *Avatar* can avoid this because, as an audience, we instantly recognize that they are not supposed to be human, therefore we don't judge them as such. Cameron and his team produced designs that gained affinity from the audience because they are familiar to us through their human likeness portrayed in their human expressions. Hooper's character designs have benefitted from stylistic choices that focused the goal of human likeness on the facial expressions instead of the actual face of the actor. This proves that when creating realistic digital characters using motion capture technology, anthropomorphic design choices should only apply to human characteristics, such as human facial expressions, and not human features, such as exact replication of the human face.

The characters in *Cats* have been nicknamed "freaky" and "disgusting" (Cantrell & Hawkes, 2021). The audience's repulsion towards these characters was one of the main reasons for this film's commercial failure. Responses stating "That's the thing that makes these characters so . . . creepy. They're just people with CGI fur" (Kachel, 2020), highlight the importance of good character design for avoiding the Uncanny Valley effect on digitally enhanced characters. As previously suggested in my thesis, character designers should lean towards anthropomorphism when designing virtual human characters to avoid Uncanny Valley effects. But in the case of *Cats*, it was "reinterpreted as "human with animal characteristics," rather than vice-versa" (Di Placido, 2019). Carolyn Anderson proposes that expression and interpretation were sacrificed for technical replication (Anderson, 2020). Hooper's adaptation from stage to screen did not attempt to involve any creative expression for its final character designs. The final character designs for *Cats* fell deep into the Uncanny Valley because they failed to create affinity for audiences to empathize with the character due to their categorical ambiguity (Cantrell & Hawkes, 2021). The actors retained their human proportions and the majority of their face to allow for expressive characters while combined with digital fur, cat ears and a tail. The hybridisation of cat and human

conjured feelings of unease in viewers, proving these characters come from the Uncanny Valley. As these characters were perceived as almost human, affinity for them dropped due to their subtle strangeness; human likeness while presenting as cats. “Being able to empathize with a character does not depend on said character fitting perfectly into their human environment” (Di Placido, 2019). The final characters were perceived by audiences as uncanny due to their inherent ambiguity between cats and humans. The feelings of disgust and unease conjured by the Uncanny Valley prevented audiences from identifying and empathizing with the characters. With responses to the character designs labelling them as “irredeemably flawed” (Delingpole, 2019), it is not surprising that “the $100 million production scratched out just $6.5 million in ticket sales on opening weekend, drawing in an 18% fresh score on Rotten Tomatoes and a C-plus CinemaScore from audiences” (Yasharoff, 2019).

As movement played a large role in Mori’s Uncanny Valley theory, it can be observed as a reason that gave Hooper's characters a level of uncanniness. As highlighted by Tinwell earlier in this thesis, movement in a character's facial expression must be considered, along with physical movement, as causes that lead to a character's uncanniness (Tinwell et al, 2011). If we consider previous points in my thesis, The *Polar Express* was criticized for its lack of facial expression in its human characters, *Avatar* succeeded in gaining affinity through its human facial expressions in its alien characters and *Cats* was criticised for its non-human characters having a human face. We can deduce that a digital character's facial expressions are a huge factor in deciding whether a character suffers from Uncanny Valley effects or not. As referenced in chapter one, the ‘Digital Emily Project’ highlights a range of facial expressions as one of its five guidelines for animators to follow to create a realistic digital actor that does not fall victim to the Uncanny Valley (Bouwer & Human, 2017). While the *Cats* characters achieved a range of facial expressions, the merging of humanlike movement in the character's expressions and human-catlike movement in the characters' bodies produced discrepancies in the character's overall movement which led to confusion for audiences. Moris example of the startling and eerie sensation experienced when a prosthetic hand begins to move, is seen when the cat-human hybrids begin to move. “While the characters purport to be cats, they walk and talk like humans, which creates a perceptual mismatch between the human likeness of the characters and their feline features” (Cantrell & Hawkes, 2021). This mismatch prevents audiences ability to placing the characters in a category that is familiar to

them. Therefore, the characters cannot be trusted, affinity towards them is lost, and they fall deeper into the Uncanny Valley. The character's ambiguous human-cat movements were labelled as “embarrassing” by film critic Shiela O’Malley who said, “grown humans crawling around in furry suits pretending to be cats” (O’Malley, 2019).

3.3 The Persistence of the Uncanny Valley in Film

The backlash the film *Cats* received as a result of its uncanny characters proves Mori's original Uncanny Valley theory is still relevant to filmmakers today. Will this theory always pose a challenge when creating digital characters for film? Neill Blomkamp, director of District 9 (2009), believes "It's inevitable that the uncanny valley just goes away" (Dring, 2017). He theorises that with the population being more exposed to uncanny characters and real-time graphics from video games, this visual aesthetic will become familiar and accepted.

Other researchers in the field of robotics have attempted to measure the variables that allow the Uncanny Valley to exist. In 2015 Złotowski, J.A. Et al released their findings after they undertook a study to examine the influence repeated interactions had on an audience's perception of two robots, one almost indistinguishable from a human with high human likeness (Geminoid HI-2), and the other machine-like robot with only very low human likeness (Robovie R2)(Złotowski, J.A. Et al, 2015). Although this study focuses on the uncanny regarding its effects on robots, similar to Mori's original theory of the Uncanny Valley, we can relate their findings to animated computer characters.

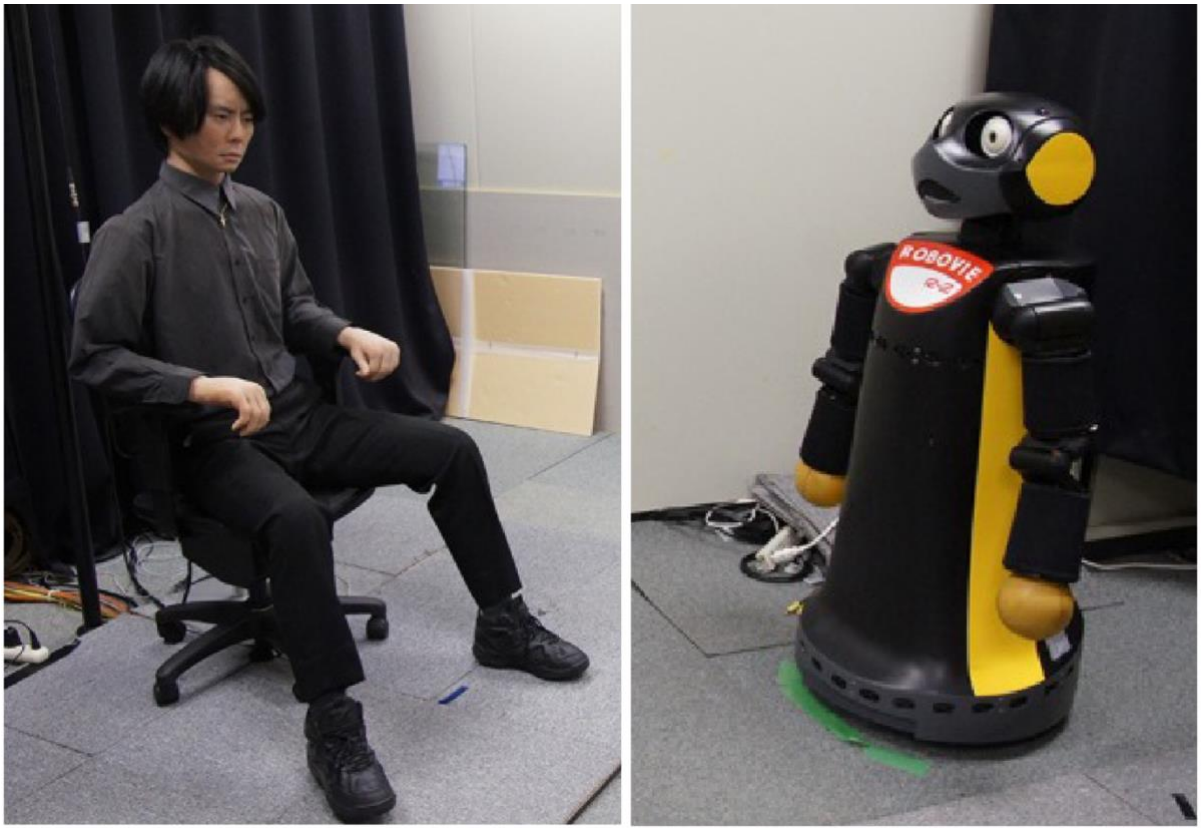

Fig. 9 & 10. Experiment Setup of Geminoid HI-2 and Robovie R2. Złotowski, J.A. Et al (2015). 'Persistence of the uncanny valley: the influence of repeated interactions and a robot's attitude on its perception'. *Frontiers in Psychology*

Złotowski, J.A. Et al found that "a robot that is perceived as uncanny is not able to affect its likeability by a positive or negative interaction. In that sense its lower likeability is persistent" (Złotowski, J.A. Et al, 2015). When applied to realistic human animation, the film *The* Polar Express exemplifies their finding. Despite the protagonist being a young boy in a heartwarming Christmas story, audiences perceived the character as unlikeable due to his uncanniness. This is in contrast to their finding that the machine-like robot, which was perceived as less uncanny, affected its likeability due to its behaviour during human interactions (Złotowski, J.A. Et al, 2015). This can be observed in regard to the reception of the animated characters in *Avatar*. Due to the Na'vi characters avoiding the effects of the Uncanny Valley, their behaviour on screen determined their likability, much like a human actor, allowing the story and characterisation to develop. Złotowski, J.A. Et al observed that "after the last interaction both robots were perceived as less eerie than after interacting with them for the first time" irrespective of the robot's embodiment (Złotowski, J.A. Et al, 2015). Their findings support Blomkamp's theory that increased exposure to uncanny beings decreases their perceived eeriness.

Chapter 4: *M3GAN (2022)*

4.1. *M3GAN*

Throughout my thesis so far, I have looked at examples of films where directors and designers, knowingly or unknowingly, attempted to avoid Uncanny Valley effects on their characters. Until this point, I have discussed how the Uncanny Valley phenomenon is often perceived as having a negative effect on character design and outlining its unwanted effects in filmmaking. Ultimately, avoiding the Uncanny Valley poses a challenge for character design, however, what if filmmakers embraced its eerie effects? In this chapter, I aim to relate how the theory of the Uncanny Valley can be used as a tool for horror, as a genre of filmmaking. By looking back through my thesis and outlining the causes of the Uncanny Valley, I aim to examine which aspects of character design can be used to create a character that might illicit uncanny horror in audiences. By exemplifying the film *M3GAN* (2022), I will prove how the Uncanny Valley can have a positive effect that filmmakers can take advantage of.

The story of *M3GAN* follows a roboticist, Gemma, and her orphaned niece, Cady, who adjust to living together with an Artificial intelligence powered doll that develops self-awareness. Gemma designed the doll to be a companion and protector to Cady, but the robot doll proceeds to get more hostile with each person who upsets Cady. This horror film is associated with Moris's theory of the Uncanny Valley due to its main theme of robotics. As Moris's theory observed the negative emotions elicited by a humanlike robot, Megan acts as an example of one of the beings found in the valley of his graph when the design of a robot veers too humanlike.

4.2. *M3GAN* and the Uncanny Valley

The character design for the Artificial intelligence robot doll, M3gan, deliberately played on the eeriness of Uncanny Valley that films such as *The* Polar Express suffered from. *M3GAN*s executive producer confirmed the film's link saying she is “the real-life version of a Polar Express character “ (Pierce-Bohen, 2023). *M3GAN* director Gerard Johnstone spoke about his vision of the character design for M3gan in an interview saying” ultimately the choice we made is she is going to look uncanny and that’s going to be enough” (HeyUGuys, 2023). This design approach lends to the perception of M3gan on screen, she appears like a normal girl, yet it is hard to distinguish what is unsettling about her appearance. The character designer for the film, Adrien Morot, confirmed Mori’s Uncanny Valley as a major influence in his design saying, “There should be that fine line of ‘uncanny valley’ where the finish, the eyes, the hair, everything should be looking almost real” (Stephan, 2023). Morot FX Studios, having previously gained success with an Oscar nomination for Prosthetics makeup in *The Whale* (2022), with contributions from Weta Workshop realised the final puppet of M3gan. During filming, Johnstone utilised various methods to portray her on screen: Phil Sloggett recounts “There was the ‘main’ M3gan, an animatronic, which had full internal facial rigging with actuators at the corners of the mouth, under the eyelids and the eyebrows,” (Voyager, 2023). He goes on to explain that for full movement scenes, actor Amie Donald played M3gan, she wore a silicone mask which was later replaced with a digital version of the puppet's face. Sloggett adds that various other pole-rigged puppets were used to film M3gan’s body parts (Voyager, 2023). Johnstone's choice to practically realise M3gan on set through the use of puppeteering aided his filmmaking process, similar to Cameron's approach with the use of a ‘swing camera’ to visualise the motion capture actors in their CG environment in real-time for *Avatar*. This method enabled Johnstone to direct the puppeteers in real time to enhance the uncanny effect produced by discrepancies in movement and gave him control over how uncanny M3gan was perceived on screen. One of the puppeteering crew on M3gan commented that the filmmaking process was “Made so much easier when they have either a reference or a puppet that they tweak a little bit to enhance the performance” (Voyager, 2023). This is in contrast to the methods used by Zemeckis with *The Polar Express* and Hooper with *Cats*, as both filmmakers relied on post-production to visualise how their characters would be perceived on screen. Ultimately,

from my case studies, real-time visualisation of humanlike characters during the filming process proves to benefit filmmakers, whether their goal is to avoid or enhance effects caused by the Uncanny Valley.

Fig. 11. Comparison of Cady (left) and M3gan (right), *M3GAN* (2022), Directed by Gerard Johnstone [Film], Universal Pictures

But what exactly makes the design of M3gan so uncanny? Pierce-Bohen notes that the character design of M3gan relies on her being perceived as "synthetic enough for everyone around her to drop their guard, while her appearance is life-like enough to make her a terrifying villain" (Pierce-Bowen, 2023). At first glance, her character is similar to that of a child's doll with very little skin texture, enlarged blue eyes and an expressionless face. As stated earlier in my thesis, visible skin texture, realistic eyes and a range of facial expressions are key factors in a character appearing as a real human that avoids the Uncanny Valley. The character designers working on this film utilised these factors to enhance M3gan's uncanniness, striking that balance of humanlike yet not human, situating the character at the bottom of the dip in Mori's graph of the Uncanny Valley. From a distance, the character of M3gan is perceived as a real girl. This incident occurs in a scene halfway through the film as shown in *Fig. 11.* This scene features Cady and M3gan sitting in the back of a car. Initially, in this scene, we see Megan from a side profile and both characters from the point of view of a teacher who has just come over to greet them. The teacher perceives both characters as human and inquires as to whether they are "sisters". Once M3gan turns her head to look towards the camera, the teacher physically revolts shouting "Jesus Christ!", experiencing the negative effects of the Uncanny Valley as her comfort level with the

artificial character diminishes drastically (Stix, 2008). This scene exemplifies the human likeness of the design of M3gan and how subtle her uncanny features are.

Observing M3gan in comparison to Cady in *Fig. 11*. Highlights a key aspect that makes her appear uncanny: her eyes. As mentioned in Chapter 1 of this thesis, audiences focus on a character's eyes and are sensitive to any discrepancies which may make the eyes look unfamiliar to a human's eyes (Geller, 2008). In *Fig. 11*, the design of M3gan features slight darkness around her eyes which, in comparison to Cady, is unnatural for a human girl's eyes. Macdorman, Green and Ho suggest when creating a CG character that avoids the Uncanny Valley effect to ensure the proportions of the CG face are within human norms (Macdorman, 2009). In the case of M3gan's design, her eyes have been enlarged to a point that is unnatural for a human being. This slight difference is a constant reminder throughout the film that she is not human and allows the character of M3gan to repeatedly fall into the Uncanny Valley, creating an eerie sensation for audiences.

"After the eyes, facial movement is a close second in importance to maintaining (or failing to maintain) believability", (Geller, 2008). Puppeteer Paul Lewis provides information on his approach when animating M3gan stating "Too much movement did not work. The more still she was the … stronger she was on screen and the more effective and the more unsettling" (Voyager, 2023). He specifically chose a "less is more" (Voyager, 2023) approach. On-screen, M3gan's body movements and her facial expressions are very minimal with most of her movements restricted to a slow head turn and limited movement in her mouth area. This gave M3gan an expressionless face, contrasting to one of the guidelines Alexander et al highlighted to avoid Uncanny Valley effects in a humanlike character: to create naturalistic facial animation with "elaborated movement of the eyes and mouth" (Bouwer & Human, 2017). M3gans facial expressions, or lack thereof, compare to the facial expressions featured on *The Polar Express* characters, with both receiving reviews saying, "blank expression" (O'Connor, 2023) and "expressionless mannequins" (Smithey, 2018). M3gan's design and movements operate similarly to Moris' example of a prosthetic hand which I described in Chapter 1 of this thesis. Both subjects garner affinity from observers due to their humanlike appearance, and both unnerve the observer, plunging into the Uncanny Valley once they start to move unnaturally. This highlights how discrepancies in movement heighten negative

uncanny effects on a human-like character and is something filmmakers should consider if their goal is to elicit uncanny effects.

4.3. Designing Characters using the Uncanny Valley

Previously in my thesis, I have highlighted certain guidelines that researchers and filmmakers recommend in order to avoid unwanted Uncanny Valley effects on a digital or humanlike character, specifically from the findings of 'The Digital Emily Project', research from MacDorman, Green and Ho, and studies conducted by Bower and Human (2017). In this chapter, I aim to illuminate certain design principles that filmmakers, notably in the horror genre, can utilise in their characters to exploit the effects of the Uncanny Valley.

One comparison which was repeatedly linked to the characters of The Polar Express was to zombies. In their article Philips and Mendoza conclude that "Zombies are subliminal reminders – of our atavistic survival instinct, of our fear of the other, our fear that we might be the other, of the death of the planet" (Philips & Mendoza, 2016). Out of all monsters in media, zombies pose as the uncanniest as they lie in "a boundary space between human and non-human (originally human and animal) - the imaginary region between being and non-being, presence and absence" (Boon - Philips & Mendoza, 2016) This duality is echoed in many other themes surrounding discussion of the Uncanny Valley: life and death, familiar and unfamiliar, animalistic and humane, empathy and threat (Kiintonen, 2022). Previous victims of the Uncanny Valley straddled this duality with *The Polar Express* characters being both realistic yet not real and the *Cats* characters being both human and feline. Filmmakers can utilise this to elicit a categorical ambiguity in their character designs and trigger our instinctual "fear of the other" (Philips & Mendoza, 2016). Kiintonen demonstrates this in their paper on utilising the Uncanny Valley in favour of character design where they produced a game character based on their research. Their designs were influenced by the "surrounding theme of the uncanny – conflict". Kiintonen states that they employed this conflict through attraction and aversion, where their goal with this character was to break expectations for the observer (Kiintonen, 2022). Regarding the films I have discussed, this idea of broken expectations can be observed in *Cats* with the characters purporting to be cats yet moving and talking as humans. *M3GAN* uses this idea, as explained in 4.1, where the teacher realises M3gan is not a real human. With this in mind, character designers can incorporate opposing themes in their designs to break the expectations of audiences and in turn, elicit eerie uncanny effects in fear of the other.

The theme of repetition has surrounded the idea of the uncanny since Sigmund Freud's paper outlining the uncanny. He wrote that a cause is an involuntary repetition where “the uncanny arises as the recurrence of something long forgotten and repressed” (Gray, 2019). If we consider the films I have referenced in this thesis, repetition can be observed in the films that suffer from the Uncanny Valley. Johnstone utilised repetition of movement as a tool to enhance his character's uncanniness. The movement of a slow head tilt was repeated in scenes throughout the film which became familiar, despite the differing mood of each scene creating conflict when she was in an unfamiliar environment. It became unsettling not knowing what her head turn signalled. As for *The Polar Express*, repetition was noted in the character's limited range of facial expressions, with the repetition of basic emotions leading to them being perceived as expressionless. This is in contrast to *Avatar*, where the character's expressions do not appear as repetitive due to the ‘facial action coding system’ that was used to tweak the basic expressions.

Fig. 12. M3gan’s eeriness enhanced through filming techniques, *M3GAN* (2022), Directed by Gerard Johnstone [Film], Universal Pictures

Regarding filming techniques of an uncanny humanlike character, Ferric et al highlight certain framing and lighting aspects in a study conducted on the digital puppet Ondel Ondel, an Indonesian Betawi performance art featuring giant puppets, that enhance the Uncanny Valley's eerie effects (Ferric et al, 2022). Ferric et al claim that the use of a medium shot from the chest up on an uncanny character aids in conveying the character's emotions to the audience (Canini et al 2013). In cases where an uncanny character’s emotions are unclear, Anne Laks argues that “faces are portrayed in close-ups (a device traditionally used to align audiences with characters’

perspectives), and viewers are thus invited to read or project psychological states" (Anne Laks, 2015). This technique can be used to further disorientate audiences, causing them to question the humanity of the uncanny human-like character. Ferric et al conclude that the use of low lighting can be used to enhance contrast to create a mysterious atmosphere (Nurcahyo - Ferric et al, 2022), positioning a character, as exemplified in *Fig. 12* by M3gan, in a space between human and non-human (Boon - Philips & Mendoza, 2016) that enhances their eerieness.

Conclusion

As I have discussed in this thesis, due to the uncanny valley's prevalence in areas such as films that feature digitally animated humans filmmakers must be aware of its effects.

The use of motion capture technology alone to replicate a human digitally on-screen results in Uncanny Valley effects due to the technology's inability to capture nuances in movement from the actors. The characters in *The Polar Express* suffered from this process, resulting in a limited range of facial expressions and facial animation that appeared unnatural. The discussion of this film highlights how failure to avoid the uncanny valley when aiming to replicate a human digitally results in the film's story being overshadowed by the eeriness of the uncanny valley.

Cameron's *Avatar* proved that it is possible to create digital human-like characters that do not fall victim to the uncanny Valley. By choosing an anthropomorphic design for the characters that retained the actor's facial expressions and characteristics while still appearing unhuman, the filmmakers achieved a level of affinity due to the character's human likeness. The combination of the swing camera, the 'facial action coding system', and keyframe animation aided the motion capture technology in achieving realistic human facial expressions and emotions. Avatar proved that placing the character in a realm that was not human allowed the animations to focus on realistic human expression rather than human replication.

A discussion on the characters featured in Hooper's *Cats* solidifies the uncanny as a threat to filmmakers despite developments in technologies such as motion capture. The reception of the characters highlights character design as an essential aspect of the success of a film. As observed, the categorical ambiguity of the character designs and character movements resulted in the uncanny Valley phenomenon. This chapter proves that the uncanny valley theory will remain a threat to filmmakers who work with human-like realistic designs, but Zlotowski et al. provided proof that repeated exposure to uncanny characters may reduce their perceived uncanniness.

With the discussion surrounding the uncanny Valley being largely negative, *M3GAN* provided an example to horror filmmakers that the uncanny Valley's effects can be used as tools to generate an eerie character. Drawing from the failures of past filmmakers, M3gan's deliberate near-human design gave way to the uncanny Valley due to her lack of facial expressions, unnaturally smooth skin, and still movements.

This film further proves Real-time visualization on set gives filmmakers control over their uncanniness. Finally, this thesis outlined specific design aspects to create a horror character influenced by the uncanny Valley. Filmmakers can incorporate opposing themes in their design and repetition to elicit eerie feelings.

Ultimately, this thesis explored how the theory of the uncanny Valley illuminates our understanding of character design and animation techniques of human-like characters. Its effects warp the audience's perception of films and is something that filmmakers should consider, particularly when creating digital human-like characters, as "the uncanny valley is an everyday phenomenon that occurs regardless of any explicit cognitive task" (Sasaki).

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