Universität des Saarlandes
Naturwissenschaftlich-Technische Fakultät 1
Fachrichtung 6.1 Informatik
Deutsches Forschungszentrum für Künstliche Intelligenz

Evaluating the Uncanny Valley

Proseminar: Human Computer Interaction
Supervisor: Dr. Alexis Heloir
Summer Semester 2009

Antonia Scheidel
Matr.-Nr. 2518049
ascheidel@coli.uni-sb.de

September 25, 2009

Abstract. Over the last decade, research has been conducted on the potential of androids to evoke uncanny sensations in humans (the so-called uncanny valley phenomenon): Experiments focussing on robot appearance have shown that static images of androids can avoid uncanniness if they are designed to be aesthetically pleasing. However, the appeal of such androids may only be achieved at the expense of physical realism.

Concerning robot movement and behaviour, experiments suggest that androids may not be accepted if their behaviour fails to live up to the level of human likeness purported by their appearance. Movements which are reminiscent of those of diseased human beings may elicit strong feelings of eeriness.

Exposure to eerie images of androids elicits unconscious defence mechanism usually connected to thoughts of death. However, androids are not genuine reminders of death or mortality.

The experiments we discussed seem to suggest that a closer examination of roots of the eerie sensation is imperative.

Introduction

In 1970, Japanese roboticist Masahiro Mori [9] postulated a metric to describe the amount of "familiarity"[1] elicited by robots. A high level of familiarity can be found in the interaction between human beings. A low amount of familiarity, on the other hand, is experienced when faced with something shocking, like zombies, or repulsive, like a corpse.

Mori states that the more human-like and realistic robots become, the more familiar they appear. At a certain level of human likeness, however, the familiarity decreases sharply and the robots are perceived as eerie. Mori calls this phenomenon the *uncanny valley*.

It is important to note, however, that the description of the uncanny valley phenomenon is based solely on Mori's intuition and that the graph reproduced in Fig. 1 is not accounted for by any empirical evidence. Because of this, in the past 5 years researchers have lead studies aimed at empirically validating the uncanny valley as seen by Mori.

In this paper, we will present the work of MacDorman and Ishiguro, David Hanson, and Goetz et. al. We will describe and discuss experiments they conducted in order to evaluate the uncanny potential of different aspects of robotic design which are appearance, movement and behaviour. Finally, we will present a study which examines the connection of the uncanny effect with our innate self preservation instinct.

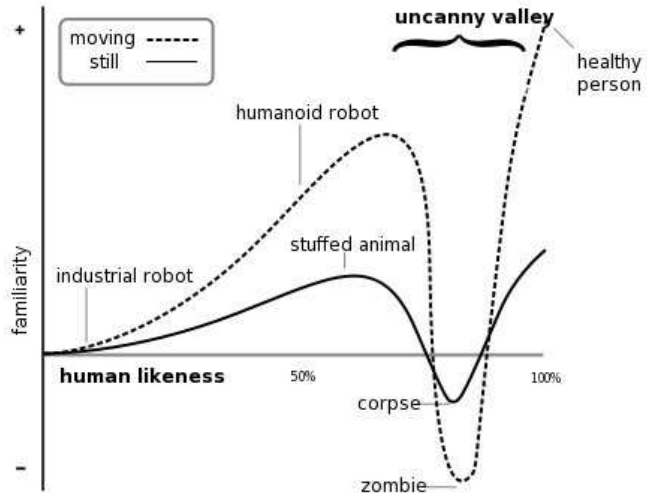

Fig. 1: The uncanny valley as seen by Mori [9] (simplified).

[1] *shitashimi* in the Japanese original – English equivalents are familiarity, intimacy and affection.

1 Evaluating Robot Appearance

As stated in the introduction, Mori himself has never attempted to validate the hypotheses he made about the uncanny valley experimentally. It was, in fact, not until very recently that this task has been attempted: In 2005, MacDorman and Ishiguro conducted a first basic experiment with the goal of validating the eerie effect of a robot's apperance.

In order to be able to retrace the curve of the uncanny valley empirically, a selection of robots covering a range from very low to very high human likeness would be imperative. Such a thing not being available, MacDorman and Ishiguro decided to substitute this kind of scale with collections of static, morphed images ranging from photographs of mechanical-looking humanoid robots to very human-like robots[2] to actual human beings. The results of their experiment were then discussed in the form of a counter-experiment by Hanson [3, 4]. Both experiments are portrayed and discussed in the following.

1.1 Experiment by MacDorman and Ishiguro

Description. MacDorman and Ishiguro used two sets of 11 images (Fig. 3 and Fig. 2). Both sets contain, respectively, one photograph of a humanoid robot, one of an android and one of a human being (male in one set, female in the other) [3]. To create a scale of varying human likeness, the three photographs were treated as follows: The photograph of the humanoid robot was morphed into the photograph of the android, which was in turn morphed into the photograph of the android's human model. As evident from Fig. 3 and Fig. 2, there are, respectively, four morphed image between every two real photographs.

Fig. 2: One of the sets of morphed images used in the experiment. Annotations added to the original version from [8].

The human participants were shown the images and asked to rate them on three scales: Human likeness (i.e. mechanical vs. human-looking), familiarity (strange vs. familiar) and eeriness (extremely eerie vs. not eerie).

[2] called *androids* hereafter

[3] Incidentally, in both cases, the human being had served as a model for the android.

Results. As evident[4] from Fig. 3, the perceived human likeness increases monotonously, just as expected and intended by the experiment's design. A second observation to be made would be that familiarity and eeriness are in roughly inverse proportion to each other. This seems to validate Mori's notion that the uncanny valley is a region with very low familiarity. Therefore, the most important outcome of the experiment is the fact that the result graph (Fig. 3) indeed displays a region where images were rated with low familiarity and high eeriness. This "uncanny region" seems to correspond to and thus act as proof toward the uncanny valley as plotted by Mori.

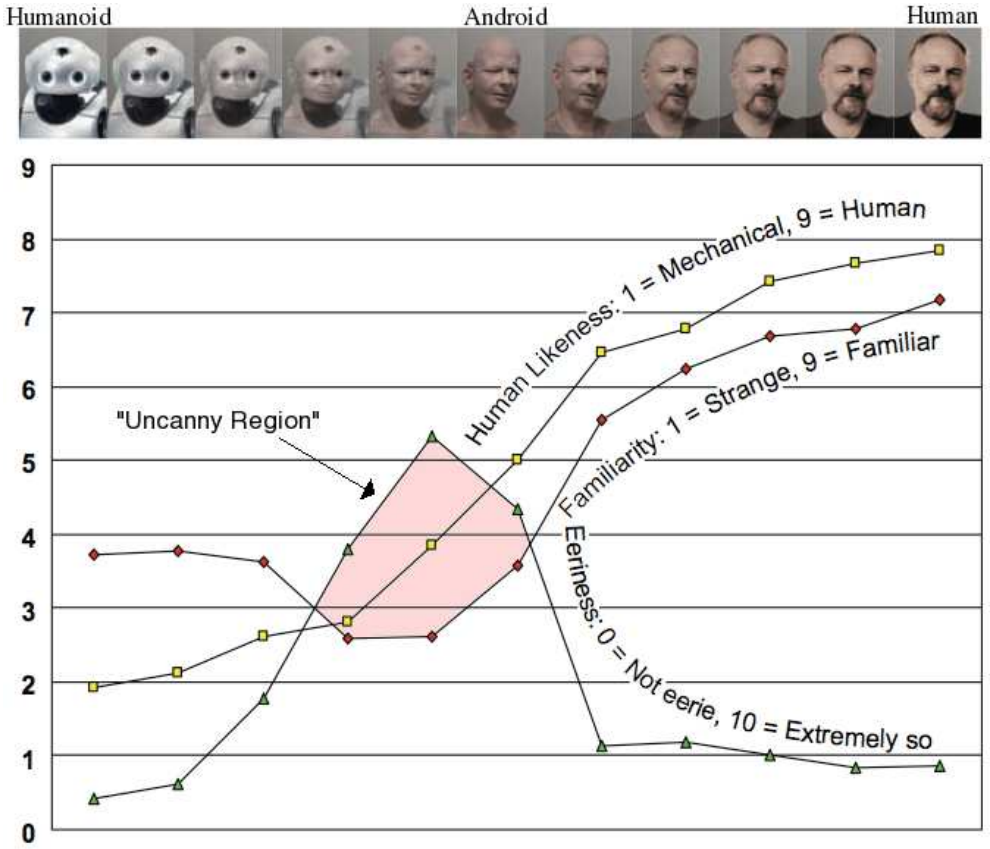

Fig. 3: The second set of morphed images: The android has been modelled after science fiction author Philip K. Dick (left). To "bring out the contrast in eeriness between a prepared and unprepared android.", the Philip K. Dick android was left unclothed and with hair and portions of the scalp removed.
Below the images is the result graph (annotated version, original from [8]). It displays an "uncanny region" corresponding to Mori's uncanny valley.

[4]The result graph for the images reproduced in Fig. 2 displays, in slightly less pronounced form, the same particularities as Fig. 3 and is therefore omitted for brevity's sake.

Discussion. Despite their success in reproducing the uncanny valley effect using morphed images, it cannot be said that MacDorman and Ishiguro have proven the existence of the uncanny valley even for the static domain: As the causes for the uncanny sensation are complex and largely unknown, it is very hard to determine which aspects of the images were perceived as eerie. There is reason to suspect, however, that a part of the eeriness may have originated, as MacDorman and Ishiguro themselves admit, from the fact that "the figures are not the product of human design or natural selection".

And indeed, a closer look at the images rated as particularly eerie reveals particularities resulting from the morph process: The humanoid robot's head-mounted camera, for example, becomes an ominous black spot on the forehead of the uncanny "morphed androids" and the "shoulder" part of the humanoid robot's chassis looks disquieting when combined with an almost human-looking face (cf. the fifth image in Fig. 3. It is highly unlikely that such features would be included in an actual android's design.

1.2 Counter-Experiment by Hanson

MacDorman and Ishiguro, intending to reproduce the uncanny valley effect predicted by Mori, chose images with distinctly eerie qualities for their experiment. Robot designer David Hanson raises the question of how results may vary if an experiment is designed to prove that androids can, in fact, be appealing.

Description. Hanson's experiment is largely modelled after that by MacDorman and Ishiguro and uses two sets of images, as well. He created one set of images using the same technique as MacDorman and Ishiguro, morphing a photograph of a humanoid robot (the same as in [8]) into a photograph of the Philip K. Dick android into a photograph of Philip K. Dick. This time, the android was shown in prepared state and a different picture of the writer was used. (cf. Fig. 4)

Another set of images was creating by manually designing transition images between the photographs rather than automatically generating them. (Fig. 5) The instructions and rating scales (human likeness, familiarity, eeriness) given to the participants were the same as in MacDorman's and Ishiguro's experiment.

Results. The results for the control morph set closely resemble those obtained in the MacDorman/Ishiguro experiment inasmuch as they, too, reproduce the uncanny valley effect. However, there is no uncanny region visible in the result graph of the experimental morph (cf. Fig. 5): None of the designed images was rated as particularly eerie.

Fig. 4: The "control morph" from Hanson's experiment [3]. The results for this set of images reproduced an uncanny region very similar to the one in [8] (see our annotation).

Discussion. The morphed images rated as uncanny in Hanson's experiment (cf. Fig.4) display some similarities to those in MacDorman's and Ishiguro's: It can be suspected that in their case, too, the eeriness may have been caused, at least partially, by the abnormalities in appearance resulting from the morphing. An example for this could be, analogous to section 1.1, the black spot on the forehead or the uncanny mixture of distinctly human features like wrinkles and a moustache in an obviously artificial face (e.g. the third image in Fig. 4). This supports the hypothesis that the technique of morphing images brings about too many uncanny side-effects and should therefore not be the preferred way of creating a "human likeness scale".

In comparison, the manually designed androids display cartoon-like features. While they may not look perfectly human, they retain qualities which make human faces look appealing or at least non-threatening. Examples are the baby-face features in the more humanoid-looking figures in Fig. 5 or the full, slightly smiling lips in the faces closer to the Philip K. Dick android.

1.3 Conclusions for Mori's uncanny valley

Having succeeded in both reproducing and eliminating the uncanny valley effect, what conclusions does Hanson draw from his experiments? On the one hand, he is ready to at least partly reject it, stating that "it seems strongly that the uncanny valley may not be true". On the other hand, he admits that the notion that there is an uncanny valley is not inconsistent with his results. He further acknowledges that the form of presentation used may not be optimal, as he restricts his refusal of the uncanny valley to the static domain [4] and suggests that "Future experiments should be animated, interactive, and with participants in the presence of actual robots."

This notion is seconded by MacDorman and Ishiguro: Although willing to count their results as proof towards the existence of the uncanny valley, they take into account the fact that static images can be manipulated like in Hanson's experiment – and admit that "only limited conclusions can be drawn from ratings of still images". Like Hanson, they suggest that it is imperative to explore "the effects of movement and [...] interaction".

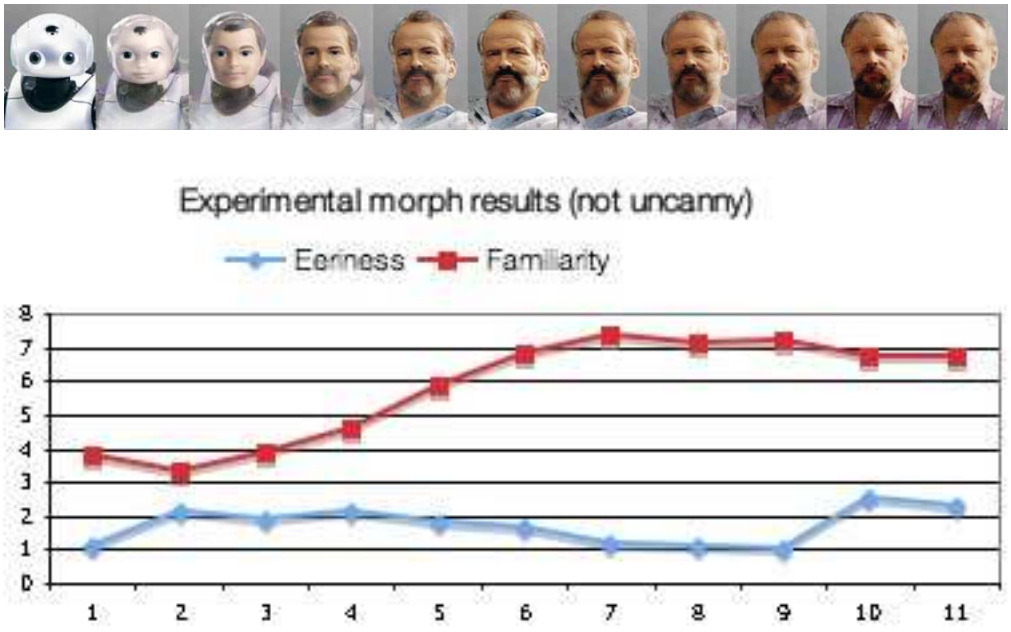

Fig. 5: The "experimental morph" from [3]. If images are designed "with the intention of making them appealing and not eerie", this completely changes the results (result graph simplified).

2 The Effect of Movement and Behaviour

According to Mori, movement greatly intensifies the uncanny valley effect. In order to evaluate this hypothesis, examples would have to be found for situations where a robot's movement creates or amplifies an eerie sensation. As the valley, by definition has an ascending slope as well, there should also be examples where a robot's movements help increase its familiarity.

The latter requirement is met to some extent by an experiment described in [6] and [8]: An android was presented to participants in a two-second Turing test, once static, another time moving. The still android was believed to be human by only 23% of participants while the moving android convinced 70% of its humanness. This is easily explained by the fact that total stillness is a distinctly non-human quality. A living human being, at least, is characterised by a multitude of incessant subtle movements such as blinking, breathing, unconsciously adjusting our position when standing or sitting, etc. At a two-second glance, this may be all we need to make the distinction between living and un-animated. Of course, the same moving android may fall into the very trough of the uncanny valley upon closer inspection.

The effect of robot or android movement in regard to the uncanny valley has

not been researched extensively, although the vast majority of contributions to the field emphasise the importance of examining moving androids[5].

However, a general prediction may be made based on what is expressed by MacDorman and Ishiguro as "Androids violate human expectations about how a person should proceed during interaction." As androids grow more and more life-like (cf. the high human likeness ratings for Hanson's Philip K. Dick android in Fig. 5) in appearance, the gap between the human-likeness purported by the appearance and what the android can afford behaviour-wise widens. However, Goetz et al. showed that the acceptance of a robot depends on the perceived balance of appearance and behaviour. [2] As a general rule, one could conclude that the more human-like a robot looks and the more social skills its appointed task requires, the more human-like behaviour is expected. The acceptance of a perfectly dressed, largely human-looking android acting as a drawing instructor (example from [2]) will presumably be low if the android fails to behave and move as expected.

Conclusions for Mori's uncanny valley. The Turing test example may be interpreted to support Mori's prediction that a robot might escape the uncanny valley and reach the second peak of the graph by convincingly imitating human movement. The fact that number of participants accepting the android as human tripled when it displayed movement seems to mirror the increasingly sharp difference in familiarity between moving and still robots toward the second peak.

The research conducted by Goetz et al. and MacDorman's and Ishiguro's reflections on how androids violate our expectations, however, do not necessarily suggest a valley. They rather predict a monotonous increase in the risk of low acceptance/familiarity as the human likeness grows. It must be noted here that, as MacDorman and Ishiguro mention, "it seems that not all forms of expectation violation can result in eeriness". Indeed, Goetz et al. had their participants rate the obnoxiousness of robots' demeanours. This may suggest that robots may not always evoke an eerie sensation but could in some cases appear even presumptuous because they seemingly claim to be more proficient than they are in reality.

Yet, a special case of imperfect robot movement may very well be considered eerie: Jerky movements may sometimes bear a distinctly uncanny resemblance to, for example, epileptic spasms. In a sense, these movements are very human-like but are instinctively and strongly rejected by healthy human beings. We assume that a robot displaying such movements could elicit feelings of disgust or the unconscious need for self-protection similar to those that make human beings shy away from an epileptic person. Following this, the depth of the

[5] [5] discusses more limitations of static images and [1] summarises the problem thus: "After all, the goal of robotics is to bring real robots into our society and not movies and pictures of them."

trough of the uncanny valley for moving robots may be considered as justified.

3 Do Androids Serve as Reminders of Death?

3.1 Introduction to Terror Management Theory

Terror management theory[6] examines human beings' reactions to reminders of their mortality, both conscious and subliminal. Confrontation with death or mortality is met with two kinds of defences, proximal and distal. Proximal defences are conscious reactions like denial, rationalisation of, or self-distraction from thoughts of death. Distal defences are subconscious changes in a person's attitude toward and judgement of their surroundings: The *mortality salience hypothesis* posits that, if reminded of death, people will adopt an attitude which helps them defend their worldview.

"Worldview" in this context encompasses religious, spiritual or other social theories. According to TMT, one characteristic of a worldview is the promise of overcoming death, either symbolically or literally: In the case of most religions, adhering to the laws and rules particular to the respective religion is said to be rewarded by rebirth, resurrection, or other forms of "afterlife". On a less spiritual level, an example for a worldview would be the belief that following the laws and unwritten rules of one's surroundings (family, society) will make one live on in the memories of the people one leaves behind.

Worldview-threats are opinions which criticise our lifestyle or country. Moral transgressors can also act as worldview-threats and if they do, our distal defences make us judge them more harshly. Another aspect of the mortality salience hypothesis is that death-awareness can cause us to sympathise with nationalist opinions or, in general, people who support our worldview. These kinds of distal defences are activated by both conscious and subliminal reminders of death. However, TMT research has shown that subliminal stimuli immediately activate distal defences, while distal defences triggered by conscious stimuli do not appear until after a period of delay.

3.2 Motivation for the Experiment

In the experiment discussed hereafter, MacDorman and Ishiguro attempted to find proof for the hypothesis that androids are perceived as uncanny because they act as reminders of our mortality. They did so by examining whether androids produce distal defences – which is of importance not only as a part of the quest for explanations for the uncanny valley effect, but for philosophical and design reasons as well: As MacDorman and Ishiguro say, creating androids with the known side-effect of potentially evoking a certain political bias in people, "raises ethical concerns". Furthermore, should the distal defences be

[6] proposed by Pyszczynski, Greenberg and Solomon, abbreviated TMT hereafter

activated by conscious stimuli, i.e. should androids provoke conscious thoughts about death and mortality, their design would probably have to be reconsidered: Although habituation may extenuate this, the human tendency to avoid and reject reminders of death will make it difficult to employ androids built for interaction with human beings.

3.3 Description

Two groups of participants were exposed to a set visual stimuli. (Fig. 6) The experimental set contained an uncanny image of an android, while the control group was shown a not-eerie image instead.

Fig. 6: The experimental and control images used in the experiment. [8] The experimental image shows an android whose face has been (partially) powered off, which is apparent in the upturned, slightly opened eyes. The control image shows a young Asian female.

After a period of delay, participants were given a questionnaire which will now be described briefly:

Worldview-related questions. Participants were asked to read two political campaign speeches, one by a candidate described as charismatic, while the other one was characterised as relationship-oriented[7]. After that, participants read two statements from foreign students visiting their country. One of them criticised the participants' country, while the other praised it.

In both cases, participants were asked to rate the insightfulness of both candidates, how well they liked them, and to state which one they would vote for (in the students' case, in student government elections). Previous research suggested that if distal defences had indeed been activated in the participants, they should prefer charismatic over relationship-oriented leaders and worldview support over worldview criticism. [8]

[7] this leadership style, Solomon explains in [12], is characterised by appeals like "I encourage all citizens to take an active role in improving their state. I know that each individual can make a difference..."

Word completion puzzles. As a next step, participants were asked to solve word puzzles. Incomplete words were presented in the following form: "COFF- -", with a question mark underneath, in this case, the first hyphen. Participants were instructed to select from several given choices the letter they thought was missing at the indicated position. In this case, the alternatives were *i* and *e*, thus allowing for *coffin* and *coffee*. 14 of the 35 word puzzles given had such choices between a "normal" word and one considered as related to either death or the uncanny. According to previous research, choosing the latter would indicate a subconscious activation of death or uncanny-related concepts.

3.4 Results

Worldview-related questions. The results showed a statistically significant preference for both the charismatic political candidate and the praising foreign student in the experimental group. The experiment thus largely reproduces results from previous TMT experiments which had used a genuinely death-related stimulus (as opposed to MacDorman's and Ishiguro's image of an android).

Word completion puzzles. The experimental group chose uncanny-related words significantly more often than the control group. This was also observed for the combination of death and uncanny-related words. However, no statistical significance could be found in the case of death-related words only. This aspect runs counter to expectations based on previous TMT research: When a death-related stimulus was used, participants showed a statistically significant preference for death-related words.

3.5 Discussion

Experimenters' conclusions. MacDorman and Ishiguro admit that their description of the responses to the given stimulus are not necessarily complete[8], nor universally applicable to all human beings.

Their major concern, however, is with the nature of the uncanny sensation. As the eeriness is consciously experienced, it can be regarded as a form of affect[9]. The image of the android may therefore have to be treated as a conscious reminder of death, comparable to stimuli such as witnessing a car accident. (And indeed, the close resemblance the android bears to a human corpse supports this theory.) The fact that the stimulus elicited distal defences may be interpreted in two ways: Either the android image really is a conscious

[8] Proximal defences were not taken into account due to the design of the experiment; some distal defences may have been too weak or have occurred too late to be detected.

[9] [10] as referred to in http://www.spring.org.uk/2006/11/blurred-definitions-of-affect-and.php

stimulus and the distal defences have occurred due to the delay in the experiment – or the distal defences are activated by a non-conscious stimulus in the image, detached from the conscious part of the eerie sensation. MacDorman and Ishiguro tentatively suggest the first alternative.

Limitations. MacDorman and Ishiguro motivate further experiments, as the results only show the effects of one particular stimulus. As described above, the experimental image is static and displays a special case in android interaction, a robot (partially) switched off. Furthermore, the face in question displays obvious signs of death with its upturned, slightly open eyes and the slack jaw. It is therefore necessary, as MacDorman and Ishiguro state, to examine the effects of "uncanny movement in a robot that otherwise looks human and natural" – and, as the ultimate goal, study the responses of human beings engaged in interaction with an android. We expect that, furthermore, static images of "natural"-looking androids would have to be examined as another "uncanny stimulus". The images used in the experiments described in section 1 suggest that even without an actual resemblance to corpses, androids can be perceived as eerie.

Conclusions for Mori's uncanny valley. "Yes" seems to be the obvious answer to MacDorman's and Ishiguro's question "Does an uncanny appearance elicit distal defences?" However, it must be noted that not all distal defences are activated as expected: We will later discuss the fact that no statistically significant increase in death-related word completions (cf. section 3.4) could be detected in the experiment.

When considering the question MacDorman and Ishiguro used as the introduction to their TMT research, "Are humanlike robots uncanny because they remind us of death?", the answer is far less obvious. First, it is debatable whether androids do remind us of death: While the pr of the android as a conscious reminder of death is supported by the fact that distal defences could be detected at all, 3.4 suggests no strong subconscious activation of death-related concepts. However, the fact that the experimental group chose uncanny-related words significantly more often than the control group shows that the eerie sensation was accompanied by a subconscious activation of uncanny-related concepts. The experiment and its results may thus be summarised as follows: Dead-looking androids elicit an affective sensation of eeriness. After a period of delay, the uncanniness is still present subconsciously while death is not. At the same time, changes or particularities in attitude become apparent which bear a significant resemblance to the distal defences activated by reminders of death.

Although thoughts of death do not seem to be the perfect explanation for (even parts of) the uncanny sensation, it must be considered that we handle uncanny stimuli and thoughts of death a very similar way. This conception

has parallels in [8]. In their "Explanations of the uncanny valley", MacDorman and Ishiguro discuss a relation of the uncanny phenomenon to the emotion of disgust as a natural defence mechanism. They conclude that although eeriness is decidedly different from disgust (e.g. as described by Rozin [11]), it may serve the same function "by protecting us from potential exposure to transmittable diseases". Indeed, this very close to what Mori predicted when he considered that the uncanny valley "may be important to our self-preservation".

The above thoughts lead to one realisation: In spite of some apparent intersections with well-researched fields like disgust, the eerie sensation cannot be mapped to a more accessible, primary emotion. However, it seems to be desirable[10] and, in fact, imperative for a deeper understanding of the uncanny valley to investigate this direction.

Conclusion

In this paper, we have presented several approaches to evaluating the uncanny valley phenomenon suggested by Mori. The first section was dedicated to two experiments dealing with the appearance of androids. Using a scale of morphed images, MacDorman and Ishiguro were able to retrace the uncanny valley curve empirically. However, David Hanson eliminated the uncanny effect in his experiment by using carefully designed, appealing images of androids. We concluded from this that static images only allow for limited interpretations as they are prone to display unwanted side effects (caused by the morphing) and do not necessarily reflect the realities of robot design: For Hanson, whose design company aims at making "robots lovable and part of the human family", designing appealing and cartoon-like robots is a promising strategy. MacDorman and Ishiguro, on the other hand, are advancing the field of *android science* and posit that only androids which are *as human-like as possible* will help draw valuable conclusions on human nature. For them, creating non-threatening, but not perfectly human-looking androids is not an option.

In our second section, we focused on the aspect of robot movement and behaviour. It had to be noted that next to no research had been conducted in this area, so we could only make a prediction based on the studies of Goetz et al.: As the acceptance of androids depends on the perceived balance of appearance and behaviour, a human-like appearance will probably result in expectation violation when the android's behaviour fails to live up to the level of human likeness purported by its appearance. We noticed that this kind of expectation violation does not necessarily result in eeriness – however, it is to be

[10] MacDorman himself expresses this desire by suggesting a Master Thesis on the question "What emotions if any are related to the eeriness experienced in beholding near humanlike entities?" and points out that "the relationship between the uncanny valley, eeriness, and disgust has not been demonstrated". (cf. [7], also the attempt of Ho et al. at answering the question [5])

expected that androids whose movements are reminiscent of those of diseased human beings will elicit strong feelings of eeriness, disgust or repulsion.

In our final section, we presented and discussed an experiment where methods from terror management theory were applied to determine whether the uncanniness of androids may be based on the fact that they remind us of death. The experiment showed that the visual stimulus of a switched off android triggered distal defences usually connected to thoughts of death. Androids seem to be met with defence mechanisms similar to those we apply to cope with thoughts of death, but are not genuine reminders of death or mortality. We concluded that further research exploring the emotions which may cause the uncanny sensation is imperative.

For a general conclusion, we must join MacDorman and Ishiguro and most of their fellow researchers in expressing the opinion that the causes of the uncanny sensation seem manifold and complex. From our discussion of the experiments, we observe that it seems to be near impossible to eliminate side effects from one's results. We therefore expect that the results of further experiments will only be definite if research is conducted towards the roots of the eeriness.

References

[1] C. Bartneck, T. Kanda, H. Ishiguro, and N. Hagita. Is the uncanny valley an uncanny cliff? In *16th IEEE International Symposium on Robot and Human Interactive Communication, RO-MAN 2007*, pages 368–373, Jeju, Korea, 2007. IEEE.

[2] J. Goetz, S. Kiesler, and A. Powers. Matching robot appearance and behavior to tasks to improve human-robot cooperation. In *Proceedings of the 12th IEEE International Workshop on Robot and Human Interactive Communication*, pages 55–60, Lisbon, Portugal, 2003.

[3] D. Hanson. Expanding the aesthetic possibilities for humanoid robots. In *IEEE-RAS international conference on humanoid robots*, Tsukuba, Japan, 2005.

[4] D. Hanson. Exploring the aesthetic range for humanoid robots. In *ICCS/CogSci-2006 long symposium: Toward social mechanisms of android science*, pages 16–20, 2005.

[5] C.-C. Ho, K. F. Macdorman, and D. Z. A. D. Pramono. Human emotion and the uncanny valley: a glm, mds, and isomap analysis of robot video ratings. In *HRI '08: Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction*, pages 169–176, New York, NY, USA, 2008. ACM.

[6] H. Ishiguro. Android science: Toward a new cross-disciplinary framework. Cogsci-2005 workshop: Toward social mechanisms of android science, 2005.

[7] K. F. MacDorman. Selecting a master thesis theme. PDF retrieved from: `http://informatics.iupui.edu/academics/hci/thesis/Selecting_a_Master_Thesis_Theme.pdf`, 2007.

[8] K. F. MacDorman and H. Ishiguro. The uncanny advantage of using androids in social and cognitive science research. *Interaction Studies*, 7(3):297–337, 2006.

[9] M. Mori. The uncanny valley. *Energy*, 7(4):33–35, 1970.

[10] J. Panksepp. *Affective consciousness and the instinctual motor system: The neural sources of sadness and joy.* John Benjamins Pub. Co., 2000.

[11] P. Rozin and A. E. Fallon. A perspective on disgust. *Psychological Review*, 94(1):23 – 41, 1987.

[12] S. Solomon. Fear, death and politics: What your mortality has to do with the upcoming election. Online edition of *Scientific American*, retrieved from `http://www.scientificamerican.com/article.cfm?id=fear-death-and-politics`), 2008.