The Uncanny Valley: Involvement of Fast and Slow Evaluation Systems

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Abstract

Synthetic characters that are very human-like are often perceived as creepy. This effect goes by the name "uncanny valley" phenomenon (Mori, 1970). There is a broad range of theories that try to explain its origin but it is not certain which of these theories are right. On the one hand, there are fast system theories that claim that fast and automatic evaluation processes are an explanation for the uncanny valley. On the other hand, there are slow system theories that suggest that slow and conscious evaluation processes play a role. The present study tries to uncover whether the fast, the slow or both systems are involved. Participants rated the eeriness of computer-generated faces that varied in human likeness. These ratings were done with presentation times of 100ms, 5s and unlimited. In essence, this part of the study was a replication of a study by Moll and Schmettow (2015). Furthermore, participants had to fill in questionnaires to measure a negative attitude towards robots, human-robot-uniqueness, animal reminder sensitivity and religious fundamentalism. The questionnaires were chosen because earlier research indicated their ability to predict sensitivity to the uncanny valley (MacDorman & Entezari, 2015). The results suggest that the fast system makes a substantial contribution to the overall evaluation that lies at the core of the uncanny valley phenomenon. This conclusion rises from the observation that presenting the stimuli for a very short presentation time of 100ms is enough to form a reliable judgment of eeriness. In contrast, the involvement of the slow system could not be investigated properly because none of the questionnaire scores could predict the eeriness ratings in any of the conditions.

Keywords: uncanny valley, androids, CG characters, fear and disgust system

The Uncanny Valley: Involvement of Fast and Slow Evaluation Systems

The Japanese roboticist Masahiro Mori coined the term "uncanny valley" in 1970 (Mori, MacDorman, & Kageki, 2012). He discovered that people experience robots as creepy when they start to look too real. However, if a robot still looks like a robot while being a little human-like, people tend to like him. But once the robot's appearance is very human-like, imperfections in the robot create discomfort in many persons. According to Mori, this discomfort is caused by a mismatch between the expected human qualities and the actual imperfect nonhuman qualities of the robot. At another point, when human-likeness rises again and the robot comes close enough to the looks of a real human being, the effect decreases and feelings of affinity rise again. Mori visualizes this effect by drawing a graph with affinity on one axis and human-likeness on the other (see Figure 1). The area in question where affinity drops rapidly looks like a valley, giving rise to the name "the uncanny valley" (UV).

The UV cannot only be observed with robots but also with computer generated (CG) characters. In 2005, the uncanny valley took its toll in Zemeckis' movie "*Polar Express"* where many CG characters were perceived as creepy and thereby ruined the experience for many viewers (Kaba, 2013; Zemeckis, 2005). He pursued to create characters that look as realistic as possible. Eventually, the characters were very well animated but viewers did not need much effort to tell that they were not real but computer-generated. Thus, the CG characters fell straight into the eerie depth of the UV and were perceived as horrifying, creepy or cold. Tinwell, (2014) calls the UV a threat to movie and game productions. The producers of the movie 'The Incredibles', did not pursue this sort of hyperrealism but chose to abstract their characters to the point where they resembled cartoon figures. These less human-like CG characters prevented discomfort in the viewers and allowed them to form bonds with the characters (Butler & Joschko, 2007; Kaba, 2013; Tinwell, 2009). However, such an approach is rather a workaround than a real solution to the problem. What if someday producers desire to have hyper realistic characters in their movie and game productions? One solution is the design CG characters that are absolutely indistinguishable from real humans. Unfortunately, as of today, technology is still too limited to render CG characters that are indistinguishable from real actors. Hence, the first option is not feasible. The second option is to understand the underlying mechanisms it is driven by. The UV is known since 1970 but it is far from being fully understood. Yet, the more it is understood, the easier it gets to counteract its effects.

"Any fool can know. The point is to understand."

— Albert Einstein

In the last decades, researchers came up with many different theories about evaluation processes that might be involved. These evaluation processes are suspected to be either evolved, fast and automatic processes (fast system theories) or slower conscious processes involving higher cognition (slow system theories). Unfortunately, as of today, it is still unclear which of these theories is correct and which systems really are involved. A recent study by Moll and Schmettow (2015) provided evidence for the involvement of the fast system. They presented stimuli with differing presentation times and observed that the UV also has an effect if a stimulus is presented for a very short amount of time. In another study, MacDorman and Entezari (2015) collected empirical data indicating the engagement of the slow system. They found that there are attitudes and traits that can predict UV sensitivity for robots. Based on their results, MacDorman and Entezari proposed that not only one system is involved, but that the slow system and the fast system work in unison to create feelings of uncanniness. Apparently, there is a lack of empirical data to support this claim. The present study will try to bridge this gap by conducting an experiment that might enable some insights into the interplay of the fast and the slow system.

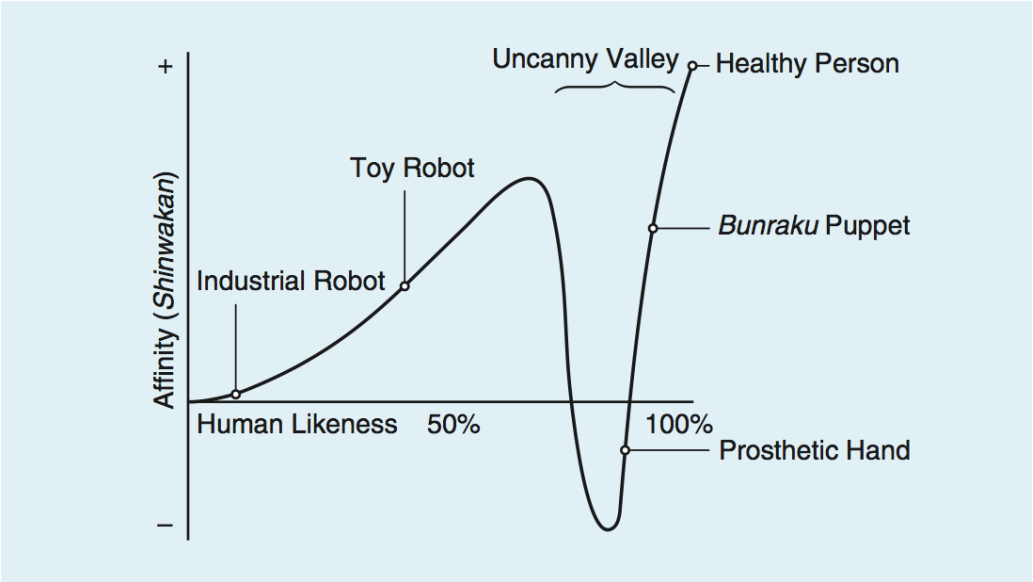

Figure 1. Mori's graph depicts the uncanny valley (Mori et al., 2012).

1.1 Two Blocks of Theories about the Origin of the Uncanny Valley

In the last decades, researchers came up with many different theories trying to explain why people experience discomfort when looking at synthetic characters that come too close to the looks of a real human. The theories they came up with can be broadly divided into two blocks: fast system theories and slow system theories. It is important to pinpoint the

differences between the fast and the slow system to prevent confusion. The two systems describe different evaluation mechanisms that come into play when someone is confronted with a synthetic character. The fast system theories describe evaluative processes that function fast and automatically might be biological adaptations that aided in natural selection (Moll & Schmettow, 2015; Steckenfinger & Ghazanfar, 2009). Evaluations that are part of this system are likely to happen so rapidly that someone is barely aware of the evaluative processes at work. In contrast, the slow system theories refer to evaluative processes that require higher cognitive processing. These evaluation processes are assumed to have a higher processing time than the mechanisms of the fast system. For instance, a conscious reflection that involves someone's attitudes is regarded as an evaluative process of the slow system.

1.2 Related Research

The recent studies conducted by Moll and Schmettow (2015) and MacDorman and Entezari (2015) are considered to be the foundation on which the present study is built. Parts of their studies are replicated with the aim to better understand which evaluation systems are involved. Moll and Schmettow presented images of human-like CG faces with differing degrees of abnormalities and asked the participants to rate the eeriness of these faces. In one condition, the participants could choose how long they wanted to look at a stimulus. These ratings were highly correlated with the ratings that were done in another condition in which the stimuli were presented for a mere 50ms. According to their results, a presentation time of 50ms is long enough to form a reliable judgment of eeriness. They conclude that this rapid evaluation must be rooted in a mechanism of the fear and disgust systems, because evaluations relying on higher cognition would most likely be more time consuming. After all, the accuracy of these rapid evaluations implies that the fast system plays a major role in the UV.

Secondly, the recent study by MacDorman and Entezari (2015) tried to shed more light on the origins of the uncanny valley by collecting empirical data to examine the relationship between individual differences and sensitivity to the uncanny valley. Participants were asked to rate the eeriness of videos showing robots with varying degrees of human-likeness. Correlations were found between ratings of eeriness and the Animal Reminder Sensitivity (ARS), Anxiety, Religious Fundamentalism (RF) as well as with a negative attitude towards robots (NARS) and human-robot uniqueness (HRU). All of these five traits have predicted UV sensitivity for videos of androids. Just like androids, humanlike CG characters resemble humans and are synthetic characters. This leads to the expectation that

this set of questionnaires measures constructs that are applicable not only to androids but also to human-like CG characters. Besides anxiety, all of the questionnaires measure traits that are related to the slow system. Therefore, four of the five questionnaires will be used in the present study to better understand the influence of the slow system on the eeriness ratings. The questionnaire that measures anxiety will be used anyway to see if the findings regarding this questionnaire can be replicated. Ultimately, replicating these two studies enables to measure how much of an influence the slow system and the fast system actually have on eeriness ratings for human-like CG characters. The resulting knowledge would be a valuable addition to the pool of what is already known about the UV so far. In the following, the fast and the slow system theories will be introduced.

1.2 The Fast System: Evolved Psychological Mechanisms

Over the course of millions of years a set of psychological mechanisms has evolved by natural selection. These mechanisms made it more likely that a human individual survived and reproduced (Nesse, 2005). One of these evolved mechanism are face processing mechanisms. Lewkowicz and Ghazanfar (2012) claim that people build a prototypical representation of an average face to differentiate between healthy and potentially sick individuals. If someone is confronted with a face that does not match this prototype, a feeling of discomfort is induced. It is hypothesized that this psychological mechanism is a product of evolution and provided an advantage in natural selection. Another study found that a face that does not meet the developed standards is perceived as unfit and unhealthy (Jones, Little, Burt, & Perrett, 2004; Rhodes & Tremewan, 1996). A group of 6-month old and 12-month old infants were compared and it was found that the 6-month old infants did not yet experience the uncanny valley effect. They hypothesized that this was the case because the 6-month old infants had not yet formed the prototype of a human face in their heads. This is in support of the idea that face prototypes play a role in the uncanny valley. Steckenfinger and Ghazanfar (2009) conducted a study with five monkeys and found that facial prototypes likely play a role in the UV. It seems that monkeys learn how a monkey face usually looks by regularly looking at other monkeys' faces. Thus, monkeys build certain expectations about how a monkey's face looks. When presented with an imperfect CG monkey's face, the expectations were violated and the monkeys experienced the UV. Nakane, Young and Bruce (2014) explain that some sort of expectancy violation might trigger a person's attention on a subconscious level when a CG face violates the expectations that a person or a primate has about a face.

Another theory that is related to the face processing mechanisms is based on the idea that people rely on other's facial expressions to learn more about possible threats in their surroundings (Blair, 2003). This allows them to protect themselves from transmittable diseases relying on other individuals' expressions. However, CG often lack facial expressions (Tinwell, Grimshaw, Nabi, & Williams, 2011; Tinwell, Nabi, & Charlton, 2013). Therefore, an effective communication of emotions like fear, sadness, disgust and surprise is inhibited. Consequently, the viewer cannot derive any information from the virtual character's face, which might in turn evoke feelings of discomfort.

Furthermore, there is a theory that involves disease-avoidance processes (Park, Faulkner, & Schaller, 2003). People experience a feeling of disgust when confronted with an individual that seems abnormal (Rozin & Fallon, 1987). In the past, abnormalities have indicated some form of disease that was potentially dangerous. Being sensitive to these imperfections in someone's appearance increased the chances to survive. This sort of mechanism is an example of pathogen avoidance. Consequently, the same mechanism might be triggered when someone looks at a human-like CG character. If a CG character shows signs of imperfection, the disease-avoidance process might elicit a disgust response to avoid a potentially contagious disease (Park et al., 2003). A lack of facial expressions or other bizarre attributes can trigger one of these mechanisms which leads to the perception of uncanniness (MacDorman & Entezari, 2015; Seyama & Nagayama, 2007; Tinwell, Grimshaw, Nabi, & Williams, 2011).

As outlined above in related research, Moll and Schmettow (2015) found that 50ms are enough to form a reliable judgment about the eeriness of a face. They suggest that the fear and disgust systems are involved in these rapid evaluations and provide strong evidence for the involvement of the fast system. They also assume that extremely specialized automatic face recognition processes are part of the explanation.

Anxiety is another trait that has been identified to predict uncanny valley sensitivity (MacDorman & Entezari, 2015). Research shows that emotions like anxiety and disgust are more quickly elicited in individuals who are emotionally less stable (Druschel & Sherman, 1999; Larsen & Ketelaar, 1991; Olatunji et al., 2007). Consequently, it is assumed that CG characters that fall into the uncanny valley will raise feelings of discomfort more quickly in individuals with high levels of anxiety.

1.3 The Slow System: Conscious Thoughts

The slow system theories include theories that explain the UV by evaluative processes that involve conscious reflections and higher cognitive processing. It is assumed that these mechanisms require more time to process a stimulus and form a judgment than the mechanisms that are part of the fast system theories. As introduced in the section about related research, MacDorman and Entezari (2015) found a number of traits that predict uncanny valley sensitivity. According to their findings, a person that scores high on these traits will experience the effects of the uncanny valley stronger than a person that does not inherit these traits. However, it is assumed that they can only influence the ratings if a person has enough time to consciously reflect on a given stimulus. The four traits are a negative attitude towards robots (NARS), animal reminder sensitivity (AREM), human-robot-uniqueness (HRU) and religious fundamentalism (RF). Several ways in which these traits could have an influence on UV sensitivity are outlined below.

Jentsch (2008) discovered that a feeling of discomfort is created in persons when they have problems to categorize a stimulus and coined the term 'category uncertainty' to describe this effect. Category uncertainty can arise when certain features of a face seem to belong to one category while some features appear to belong to another. Therefore, when presented with a face that is slightly modified to look like a computer-generated face, people might have problems categorizing the face as it might belong to a human or alternatively to a virtual character (MacDorman & Entezari, 2015). Recently, Moore (2012) identified this sort of category uncertainty as one of the causes of the uncanny valley. Other researchers described this effect as perceptual tension (Burleigh, Schoenherr, & Lacroix, 2013). The Human-Robot-Uniqueness questionnaire measures to what extent a person relates robots and humans to two distinct categories. People who see robots and humans as mutually exclusive are likely to experience discomfort when presented with an ambiguous face that might belong to either of the two categories. This might explain why people who scored high on HRU showed a higher sensitivity to the effects of the uncanny valley in MacDorman and Entezari's study.

A Negative Attitude Towards Robots (NARS) is another one of the traits that have been identified to predict uncanny valley sensitivity. In the original study a negative attitude towards robots had an impact on an individual's eeriness rating for videos of humanoid robots. Just like robots, computer-generated characters are humanlike and artificial. Hence, it is assumed that a negative attitude towards robots can also predict eeriness ratings for images of computer-generated characters.

Fundamentalism (RF). MacDorman and Entezari (2015) have shown that people who

have rather extreme religious fundamentalist views will have a higher sensitivity for the effects of the uncanny valley. They stated that this might be explained by the fact that their religious teachings taught them that God himself creates only humans to his own image. Hence, any entity trying to copy God's creation might be perceived as a threat to this belief. MacDorman and Entezari discovered that this effect could indeed be observed when looking at eeriness ratings for humanoid robots. Therefore, it might be that this holds true for computer-generated characters as well. Just as robots do, they possess humanlike characteristics and are not created by God but by human.

Animal Reminder Sensitivity (AREM) describes to what degree a person feels uncomfortable thinking of himself or herself as a creature that will eventually have to die. Animal Reminders have been found to activate cognitive and affective systems for threat avoidance and thereby cause emotions like fear and disgust (Cox, Goldenberg, Pyszczynski, & Weise, 2007; Olatunji et al., 2007). Furthermore, terror management research has found animal reminders to be responsible for an increased amount of death-related thoughts and a higher disgust sensitivity (Goldenberg et al., 2001; Goldenberg, Pyszczynski, Greenberg, & Solomon, 2000). In line with this theory, MacDorman and Entezari found evidence that people with high animal reminder, who are disturbed by the idea of their own mortality, show a higher sensitivity to the uncanny valley.

These four theories are only a few of an abundance of other theories that try to explain the uncanny valley phenomenon. There are other theories that have been proposed and are a part of the slow system theories. That is the cognitive dissonance theory (Hanson et al., 2005; MacDorman, Green, Ho, & Koch, 2009; MacDorman, Vasudevan, & Ho, 2008; Tondu & Bardou, 2011) and theories involving realism inconsistency (MacDorman & Chattopadhyay, 2015)). It is essential to understand that the two latter theories explain the uncanny valley phenomenon by slow processes that involve higher cognition.

1.5 The Present Study

The purpose of this study is to gain more insight into whether fast or slow or possibly both evaluation processes are responsible for the discomfort associated with the uncanny valley. The participants are asked to give a rating of eeriness for an abundance of images of computer-generated faces. Referring to the findings of Moll and Schmettow (2015), it is theorized that a presentation time of 100ms is enough to form a reliable judgment of perceived eeriness. This rating is compared to a rating that is done with an unlimited presentation time. This shows in how far the evaluation that is done based on this rather short

presentation time deviates from an evaluation that is done with an unlimited presentation time. In accordance with Moll and Schmettow (2015), it is expected that there is a high correlation between these two ratings.

> ***H1*** *The eeriness ratings in condition$_{100ms}$ are highly correlated with the eeriness ratings in condition$_{unlimited}$.*

The four traits that are taken from MacDorman and Entezari's (2015) study are expected to predict uncanny valley sensitivity for the images of CG characters. The questionnaires measure: Animal Reminder Sensitivity, Religious Fundamentalism, Human Robot Uniqueness and a Negative Attitude towards Robots. The results of the present study shall shed more light on the validity of these traits as a predictor for UV sensitivity for CG characters. It is expected that the scores on these questionnaire have an influence on the eeriness ratings when enough time is available to consciously reflect on a presented CG character.

> ***H2*** *The questionnaire scores have an effect on the eeriness ratings in the long conditions.*

It is assumed that a conscious or reflected evaluation of the slow system is not possible when a stimulus is presented for only 100ms. Therefore, the effect of the questionnaire scores on the eeriness ratings is most likely less pronounced in condition$_{100ms}$.

> ***H3*** *The questionnaire scores have more influence on the eeriness ratings in the long conditions than in condition$_{100ms}$.*

Ultimately, if participants with higher questionnaire scores have higher eeriness ratings in the long conditions, this suggests that the fast and the slow system complement each other. In other words, both, a conscious reflection and a fast and automatic evaluation would play a role. If the results indicate that this is the case, this would provide valuable information about the origin of the uncanny valley and the interplay of the fast and the slow system. Table 1 gives an overview of the expectations towards the involvement of the fast and the slow system.

Table 1

Involvement of the fast system and the slow system as expected across the conditions

Condition 100ms	Condition 5s & Condition unlimited
Fast system is engaged and has full impact on the eeriness ratings. 100ms are enough to process the stimulus appropriately with rapid evaluation mechanisms.	***Fast system*** is engaged and has full impact on the eeriness ratings as in condition 100ms.
Slow system is engaged but has only little to no impact on the eeriness ratings. More time would be required to process the stimulus appropriately as conscious evaluation mechanisms have a high processing time.	***Slow system*** is engaged and has full impact on the eeriness ratings. There is enough time to process the stimulus with conscious evaluation techniques.

Method

2.1 Participants

46 participants took part in this study (M_{age} = 21.13, SD*age* = 1.94, 37% male). All of them completed the questionnaires and the ratings of the images. 42 participants in this sample were undergraduate psychology students. These students used the university's online system to sign up for the study. They were awarded course extra-credits for participation. The remaining 4 participants were recruited via social networks and received no further benefits for participation. The participants could choose between Dutch and German for the language of the questionnaires and ratings. 8 participants chose Dutch as and 38 participants chose German as language for the experiment. There were two inclusion criteria. Participants had to be 18 years or older, fluent in German or Dutch and were required to have good vision (with or without correction).

2.2 Apparatus and Setting

Material. The images of the faces that are displayed have originally been used in a study conducted by Moll and Schmettow (2015). By mixing pictures of real faces with photos of dolls, robots or CG characters, a database of faces that have the potential to create feelings of discomfort in viewers has been created. In order to verify this database, Moll and Schmettow did a pilot-study to pick the 20 faces that were best able to elicit feelings of uncanniness. These 80 faces are used as stimuli in the present study. This sort of stimuli has successfully been used in another study where images of dolls and photos of humans were

mixed (Seyama & Nagayama, 2007).

Experiment. The experimental apparatus used for the rating was a computer with a 22 inch display with a mouse and a keyboard as input devices. The computer was used to run the application that has first been used in Moll and Schmettow (2015). Fig. 2 shows two screenshots of the application running. The application can be run in Dutch or German and provides a framework for a successive presentation and rating of image files. It is fed with the image files of the 80 faces that were created and validated as outlined above. The image files are displayed and the application awaits user input. The subjects use the mouse in order to choose a value on a horizontal floating point scale ranging from 0 to 5. In each condition, all of these 80 stimuli are presented. The presentation of a stimulus follows the same pattern in $condition_{100ms}$ and $condition_{5s}$. First, a white fixation cross is shown on a black background on which the subject is asked to focus. Then, the stimulus is presented for 100ms or 5s. Finally, an opaque layer covers the stimulus. Once the layer disappears, a rating scale is shown (Fig. 2 and Fig. 3). The procedure differs a bit in $condition_{unlimited}$. Just as in the other conditions, a white fixation cross is shown on a black background. However, the stimulus and the rating scale are displayed simultaneously, which allow the subject to look at the stimulus for as long as desired. Input is given by moving the mouse along the scale to the desired value and submitting the rating with a mouse-click. The rating scale that appears on the rating screen is designed to rate the perceived eeriness of the faces that are displayed and is described in more detail in the measures section below. Throughout the three conditions, each subject has to rate a total of 240 stimuli. To prevent fatigue and in order to ensure that the subject remains concentrated, the application initiates a break whenever a subject rated a block of 16 stimuli. This break is optional and can be canceled by pressing any button. Once the subject is done with the ratings in a condition, the application transitions automatically to the next condition. Between condition5s and $condition_{unlimited}$, the application asks the subject to fill in the questionnaires that are placed on the table in front of the subject. At the end of the questionnaire and to continue using the application once the questionnaires are filled in. Then, the application launches the ratings in $condition_{unlimited}$. Throughout the whole experiment, the application displays instruction screens to guide the actions of the subject. This makes instructions by the researcher redundant.

Measures. The rating scale that is used in the application displays one of the eight items of Ho and MacDorman's (2010) eeriness subscale for each stimulus. The same subscale has been used in Moll and Schmettow's (2015) study and has been translated to Dutch and German. In order to increase translation accuracy this translation has been refined and

validated using the backwards translation technique. See Appendix G and H for the complete translations. Each of the 80 stimuli is paired with one of the eight items and these stimulus-item pairs remain the same across the conditions. Each item of the scale is worded in the same way, beginning with 'The face is…' and allowing the subject to choose between two adjectives to end the sentence with. Subjects give a rating by choosing a decimal between 1.0 and 5.0 to express which of the two opposing adjectives that are presented they agree more with as a description for the stimulus (e.g. a value between 1.0: 'reassuring' and 5.0: 'eerie').

The questionnaire that is used includes five subscales. Firstly, the 'Negative Attitude towards Robot Scale' (NARS) by Nomura, Kanda, Suzuki, & Kato (2004) consists of 11 five-point Likert items. Secondly, the 'Human-Robot-Uniqueness scale' by MacDorman and Entezari (2015) consists of 11 seven-point Likert items. Thirdly, the 'Animal Reminder Sensitivity scale' by Olatunji et al. (2007) consists of 7 items. Fourthly, the 'Anxiety-scale' by Goldberg (1999) consists of 10 five-point Likert items. Fifthly, the 'Religious Fundamentalism-scale' by Altemeyer & Hunsberger (2009) consists of 12 nine-point Likert items. In their original versions, these scales were published in English. Hence, they had to be translated to Dutch and German. To ensure the linguistic accuracy of these translations, the back-translation technique has been used. This technique has shown that the Dutch and the German questionnaire could be considered as being equivalent enough. This allowed comparisons between the results from the Dutch and the German questionnaire. On average, filling in the questionnaires took twenty-five minutes.

The setting. The experiment was carried out in two of the rooms in the GWLab of the University of Twente. Each of these rooms was approximately 3 by 3 metres and had a door that could be closed during the experiment. Prior to the conduction of the experiments, the procedures have been reviewed by the ethical committee of the University of Twente and have been found to be ethical.

2.3 Design

This study was designed in a way that allowed to make both, within-subject observations and between-subject observations. The independent variables were the morphing level of the stimulus, the condition and the scores on the different traits that were measured by the five subscales of the questionnaire. The dependent variable was the eeriness rating of the faces. Looking for correlations between trait scores and the eeriness ratings of the faces allowed to make between-subject observations. The fact that the stimulus-item pairs remained the same across $\text{condition}_{\text{unlimited}}$ and $\text{condition}_{\text{trial}}$ allowed within-subject observations as the

scores for each stimulus-item pair could be compared across the condition$_{unlimited}$ and round$_{100ms}$ condition for each participant.

Figure 2. Two screenshots of the application. On the left, a stimulus is presented. On the right, the rating scale is displayed The red circle can be moved with the cursor.

2.4 Procedure

First off, the researcher guides the participant to the seat in front of the computer. He then explains the procedure of the experiment and asks for open questions. Once the participant has given informed consent, the researcher launches the application. He then invites the participant to read the instructions on the screen thoroughly and remains seated in the room. Before the beginning of the real experiment, a trial rating round is started. In this trial round the participant can get used to the rating procedure and the controls by rating the faces of ten celebrities. The researcher makes sure that there are no more questions about the rating procedure and informs the subject that the application will use instruction screens to guide the subject through the course of the experiment. Subsequently, the researcher leaves the room and the participant starts with condition$_{100ms}$. The researcher is seated outside of the room to answer any questions that may arise. Once the participant completed all of the three conditions and is done with filling in the questionnaire, the application tells the participant to leave the room and speak to the researcher. Then, the researcher thanks the participant for taking part in the study and asks for any open questions about the study. He also offers a debriefing and asks for feedback on the experiment to find potential flaws in the experiment.

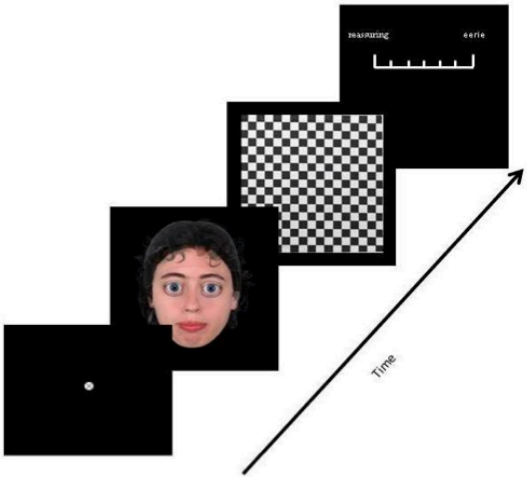

Figure 3. Flowchart depicting the face rating procedure as seen in Moll (2015).

2.5 Data Analysis

The mean and standard deviation of the questionnaire scores are calculated and the scores on the questionnaires are correlated to identify possible overlap between the questionnaires. Two Linear Mixed Models (LMM) are built to predict the eeriness ratings (Table 3 and Table 4). The fixed effects of Model 1 are condition and morphing level. The random effects of Model 1 are Item, Face and Participant. The interaction effects are participant:morphing level, face:morphing level, and participant:condition. Model 2 introduces the questionnaire scores. Furthermore, the $condition_{unlimited}$ and $condition_{5s}$ are merged into "long condition". The fixed effects of Model 2 are condition, morphing level, ANX score, HRU score, NARS score, RF score and the AREM score. The random effects of Model 2 are Item, Face and Participant. The interaction effects are long condition:morphing level, long condition:ANX score, long condition:HRU score, long condition:NARS score, long condition:RF score and finally long condition:AREM score.

Results

This section starts by looking at the questionnaire scores and the eeriness ratings separately. Then, the relationship between the questionnaire scores and the eeriness ratings are investigated.

3.1 Individual Differences as Measured by the Questionnaires

The mean scores of the questionnaires measuring anxiety, animal reminder sensitivity and a negative attitude towards robots were situated somewhere around zero (M=-.05, .08 and .08) with standard deviations SD = .35, SD = .25 and SD = .28 (see Table 2). On the Human-Robot Uniqueness questionnaire, the mean score was M = .35 with a standard deviation of SD = .30. The mean score on the Religious Fundamentalism questionnaire was M = -.63 (SD = .22). Personality scores were obtained by averaging over all answered items.

Table 2
Mean scores and standard deviations on the questionnaires that measure individual differences

	N	M	SD	Minimum	Maximum
Anxiety	46	-.05	.35	-.75	.70
Animal Reminder Sensitivity	46	.08	.25	-.43	.57
Human-Robot Uniqueness	46	.35	.30	-.18	.90
Negative Attitude Towards Robots	46	.08	.28	-.50	.64
Religious Fundamentalism	46	-.63	.22	-1.00	-.15

3.2 Correlations between the Questionnaires and Internal Consistency

Figure 2 shows in how far the five questionnaires are inter-correlated. Dancey and Reidy's (2007) definition is used to categorize the correlations as either weak, moderate, strong or perfect. According to their definition, r values < .20 show weak correlations, r values >= .20 and < .50 signal moderate correlations, r values >= .50 and < .80 are categorized as strong correlations and lastly, a 1.0 correlation is considered a perfect correlation. The scores on the Human-Robot Uniqueness (HRU) scale were strongly correlated with the scores on the Negative Attitude towards Robots Scale (NARS) (r = .51). The second strongest correlation is a moderate correlation between the Religious Fundamentalism (RF) scale and the NARS (r = .39). Another similar moderate correlation can be found between the NARS and the RF scale (r = .38). Anxiety is moderately correlated with NARS (r = .35) and also moderately correlated with Animal Reminder Sensitivity (r = .31). All other correlations have an r value < .30 and are depicted in Fig. 4.

The internal consistency of the questionnaires has been calculated from the answers that were given. The NARS ($\alpha = 0.80$), the HRU scale ($\alpha = 0.82$) and the Anxiety-scale ($\alpha = 0.86$) have a good internal consistency, whereas the internal consistency of the RF scale ($\alpha = 0.71$) is acceptable. Lastly, the Cronbach's alpha of the AREM scale ($\alpha = 0.25$) is unacceptably low.

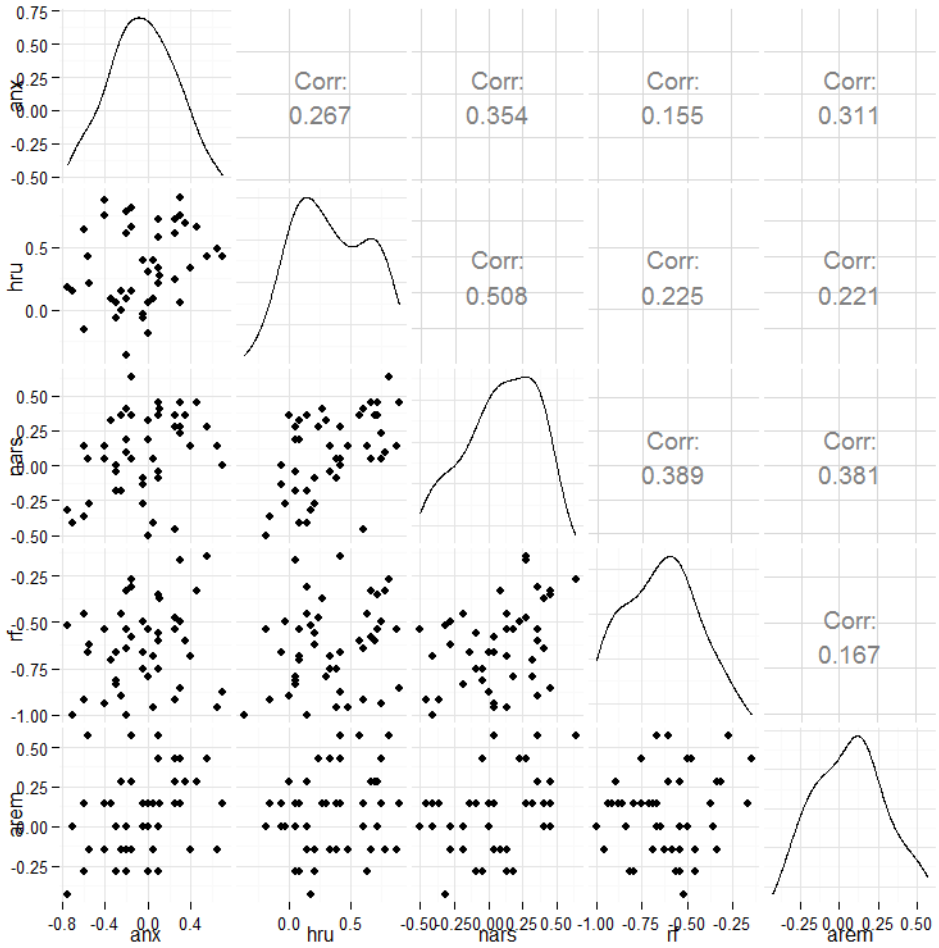

Figure 4. Correlations between the five questionnaires.

3.3 Correlations between the Eeriness Ratings across the Conditions

The eeriness ratings in condition$_{5s}$ are highly correlated with the ratings in condition$_{unlimited}$ (Fig. 5). In contrast, the eeriness ratings from the brief condition$_{100ms}$ are not as highly correlated with the ratings in condition$_{unlimited}$, but still visibly correlated.

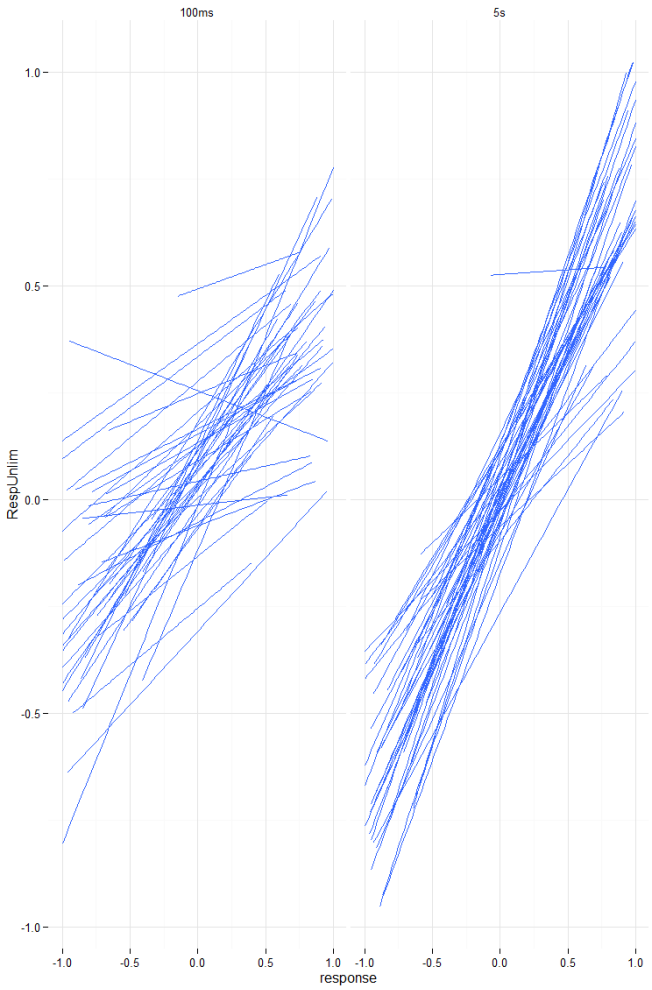

Figure 5. Visualization of the correlation between eeriness ratings in the two conditions with limited presentation time and the unlimited condition.

3.4 Influence of the Presentation Times on the Eeriness Ratings

The intercept of the first General Linear Mixed Model is -.24 and represents the eeriness rating in condition$_{100ms}$ for morphing level 1. With a certainty of 95% it can be assumed that this value lies somewhere between -.35 and -.14. According to the model, the eeriness ratings in condition$_{5s}$ will be .04 higher than in condition$_{100ms}$, 95% CI [-.01, .10]. However, it is not certain that this is the case, as the CI indicates that the value could also be negative. Apparently, for condition$_{unlimited}$, something very similar can be observed. Here, the difference in means is β = .05, 95% CI [-.01, .10]. Again, the CI does not allow to draw conclusions about how the ratings differ in regard to condition$_{100ms}$ due to a high uncertainty.

Table 2

The first General Linear Mixed Model

Parameter	Location	Lower 95% CI	Upper 95% CI
(Intercept)	-.24	-.35	-.14
Fixed Effects			
Condition 5s	.04	-.01	.10
Condition unlimited	.05	-.01	.10
Morphing Level	.09	.08	.10
Condition 5s: Morphing Level	.02	.00	.03
Condition unlimited: Morphing Level	.02	.00	.03
Random Effects			
Item	.04	.03	.10
Face	.18	.13	.26
Participant	.11	.09	.15
Interaction Effects			
Participant: Morphing Level	.04	.02	.05
Face: Morphing Level	.04	.02	.05
Participant: Condition	.08	.07	.11

3.5 Influence of the Morphing Levels on the Eeriness Ratings

In condition$_{100ms}$, eeriness ratings increased by .09 with each level of morphing that was added (Table 3). The 95% CI is very narrow ranging from .08 to .10. Hence, it is very likely that eeriness ratings really increased proportionally with the morphing level.

The effect sizes of both interaction effects between the two conditions and the morphing level were close to zero (β = .02, 95% CI [.00, .03]). Consequently, the effect of the morphing level seems to be no different in the two conditions with longer presentation times. Fig. 6 and Fig. 7 visualize the relationship between morphing levels and eeriness ratings.

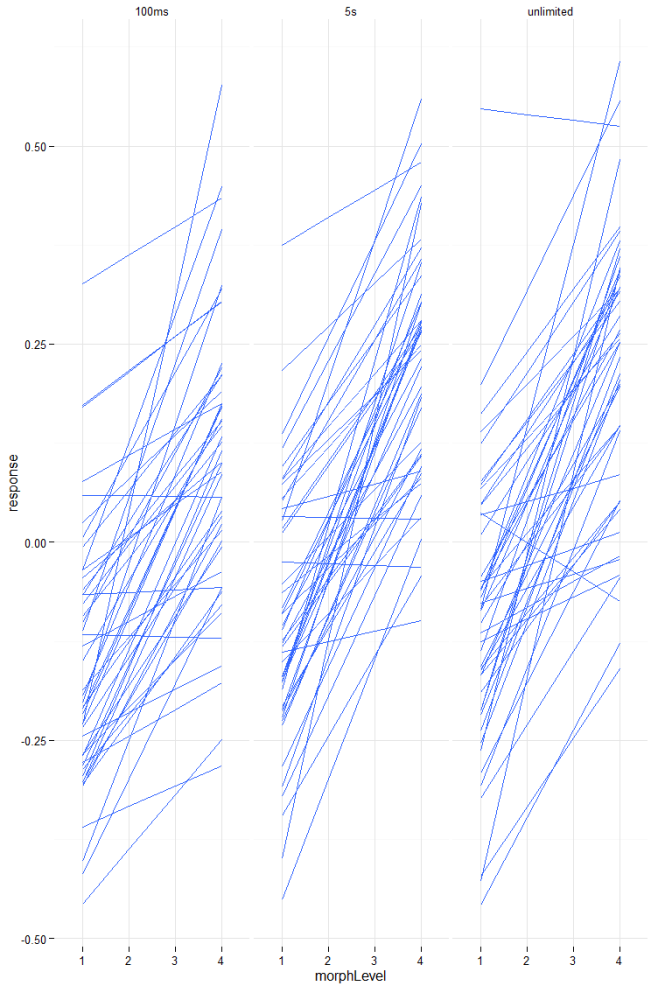

Figure 6. Association between eeriness ratings and morphing level, conditional on presentation time.

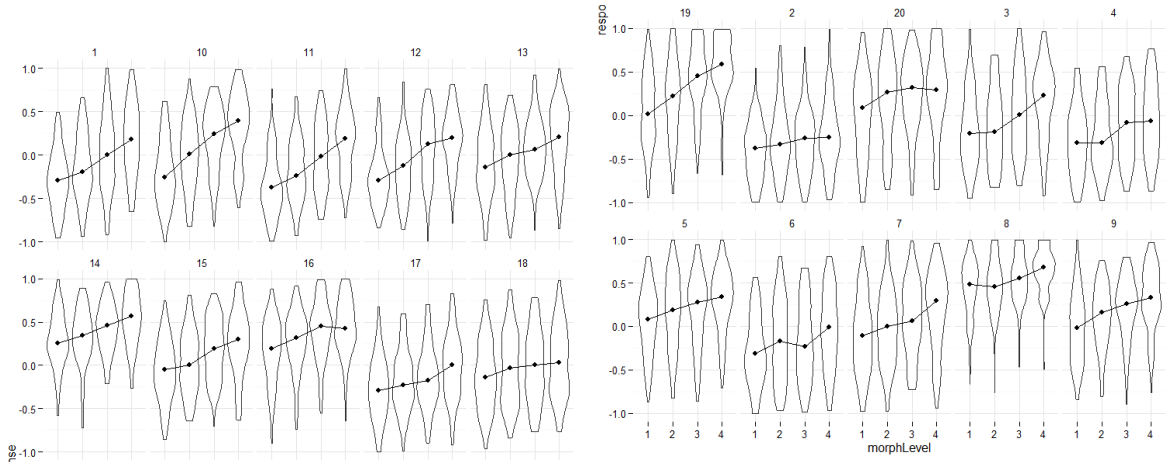

Figure 7. The four morphing levels of the 20 faces and the accompanying eeriness ratings.

In the second General Linear Mixed Model, the questionnaire scores are introduced (Table 4). Furthermore, for the sake of model parsimony, $condition_{5s}$ and $condition_{unlimited}$ have been summarized as long condition.

3.6 Influence of the Questionnaire Scores on the Eeriness Ratings

The intercept of this second model is β = -.20, 95% CI [-.42, .01.] (Table 4). The HRU questionnaire and the RF questionnaire have virtually no impact with β = -.02 and β = .06 respectively. The 95% CI intervals range from -.23 to .19 and from -.20 to .33. The Anxiety and NARS scale have a negative impact on the eeriness ratings with β = -.10 and β = -.15 respectively. The Animal Reminder Sensitivity (AREM) scale has the biggest effect size with (β = .17). However, all of the 95% credibility intervals are very broad and therefore, these effects turn out to be highly uncertain. In general, all of the scales have very broad 95% credibility intervals and predict eeriness ratings poorly. Furthermore, it should not be forgotten that the AREM scale has an extremely low internal consistency ($\alpha = 0.25$).

The predictive power of the questionnaire scores seems way higher in the conditions with long presentation times. High scores on Anxiety, HRU and NARS have effect sizes of β = -10 + .11, β =-.02 -.16 and β = -.15 + .19. Thus, in the conditions with longer presentation times, a high score on anxiety seems to be associated with higher eeriness ratings, a high score on HRU with lower eeriness ratings and a high score on NARS with higher eeriness ratings. RF and Animal Reminder Sensitivity (AREM) have effect sizes of β = -.08 and β = -.01. Accordingly, a high score on the RF scale is associated with lower eeriness ratings, whereas a high score on the AREM scale seems to be unrelated to the ratings. However, a closer look at the confidence intervals reveals a strikingly big lack of precision. The margins of error range from ME = .17 (Anxiety) to ME = .27 (RF) in the confidence intervals of all questionnaires. Due to the fact that for all questionnaires the margin of error is bigger than the effect size, it cannot be assumed that the questionnaire scores can predict someone's eeriness ratings. Figure 6 shows the error bars for the effect sizes of the interaction effects between the long presentation times and the questionnaire scores.

Table 4

The second General Linear Mixed Model. The questionnaire scores are introduced. The prediction of the eeriness ratings is now based on condition, morphing level and questionnaire scores

Parameter	Location	Lower 95% CI	Upper 95% CI
(Intercept)	-.20	-.42	.01
Long Condition	.05	-.15	.24
Morphing Level	.05	.01	.10
Anxiety Score	-.10	-.26	.08
Human-Robot Uniqueness Score	-.02	-.23	.19
Negative Attitude Towards Robots Score	-.15	-.40	.10
Religious Fundamentalism Score	.06	-.20	.33
Animal Reminder Sensitivity Score	.17	-.07	.40
Long condition: Morphing Level	.03	-.02	.08
Long condition: Anxiety Score	.11	-.07	.28
Long condition: Human-Robot Uniqueness Score	-.16	-.37	.05
Long condition: Negative Attitude Towards Robots Score	.19	-.07	.45
Long condition: Religious Fundamentalism Score	-.08	-.35	.20
Long condition: Animal Reminder Sensitivity Score	-.01	-.25	.23

Discussion

As of today, it is not certain which of the theories about the origin of the uncanny valley are right. On the one hand, there are slow system theories that explain the phenomenon in reference to conscious evaluations that involve higher cognitive processes. On the other hand, there are fast system theories that explain the phenomenon in reference to rapid and automatic processes that are inherited in every individual. However, a lack of empirical evidence makes it unclear which of these theories are correct. The present study combines the experimental setup of the study by Moll and Schmettow (2015) and parts of a study by MacDorman and Entezari (2015) to shed more light on this issue. First, participants were asked to rate the eeriness of images depicting human-like CG characters with presentation times of 100ms, 5s or unlimited presentation time. Secondly, the participants had to fill in a number of questionnaires that measure four traits. The traits that are measured by these questionnaires

have successfully predicted UV sensitivity and are related to the slow system (MacDorman & Entezari, 2015). The four traits are religious fundamentalism, a negative attitude towards robots, human-robot uniqueness and animal reminder sensitivity. In addition, one questionnaire measured the trait anxiety, which is related to the fast system. An analysis was performed in order to understand the influence of the varying presentation times on the eeriness ratings. Furthermore, it was examined whether or not the questionnaire scores can predict the eeriness ratings in the different conditions.

The results suggest that the fast system plays a major role in the phenomenon. The ratings that are done with a very short presentation time of only 100ms are highly correlated with the ratings that are given with an unlimited presentation time. Hence, people can evaluate the eeriness of a stimulus reliably even if it is only presented for a brief period of 100ms. This indicates that the evaluation that results in the effects of the UV is most likely done by a system that is able to perform a rapid processing and judging of a stimulus. This finding is in line with the conclusion that Moll and Schmettow have drawn in their 2015 study in which they observed a similar pattern. Subsequently, the first hypothesis is confirmed and it can be assumed that the fast system theories embody a vital part of the explanation for the UV phenomenon. In contrast, the results do not indicate that the slow system theories are part of the explanation. While the four traits had predictive power for eeriness ratings in a study by MacDorman and Entezari (2015) they are unable predict the ratings in the present study. The second hypothesis cannot be confirmed as the traits cannot predict the eeriness ratings in the long conditions. Likewise, it cannot be shown that the questionnaire scores have more predictive power in the longer conditions than in $condition_{100ms}$, as the traits fail to predict the eeriness ratings in any of the conditions. Thus, the third hypothesis cannot be confirmed. The fact that neither the second nor the third hypothesis can be confirmed, means that the results of this study did not bring any new insights into the working of the slow system in the UV. However, the results clearly indicate that the fast system plays a substantial role in the evaluation processes involved in the uncanny valley phenomenon, which is an important finding and a successful replication of Moll and Schmettow (2015). Interestingly, there remains an amount of unexplained variance between the ratings in the long conditions and $condition_{100ms}$ and the correlation between these ratings is far from perfect (see Fig. 5). This variance remains to be explained.

4.1 A Critical Look at the Present Study

A number of participants reported that they felt limited by the eeriness scale that has been used to rate the faces. They reported that the two adjectives did not always meet their actual impression of the faces or that they felt that the adjectives were not really opposed to each other – even though they were supposed to be. This in turn, made it hard for some participants to choose for one alternative over the other. One might expect that this had a negative impact on the validity of the measurement. However, a closer look at the Linear Mixed Model reveals that higher morphing levels resulted in higher eeriness ratings (see section 3.5). Thus, the scale seems to be a measurement tool with high face validity as it measures what it purports to measure; the eeriness of a face. Contrary to the critique voiced by some participants, the high face validity suggests that the eeriness scale is a valid measurement tool.

Moreover, the use of translations might be a source of error. In order to eliminate language barriers as much as possible, the questionnaires have been translated from English to German and Dutch. This way the participants could answer the questionnaires and do the ratings in their native language. It was expected that participation in one's native language would eliminate language barriers and thereby yield the most accurate ratings. However, the downside of this approach is that the questionnaires and the eeriness scale had to be translated. Peña (2007) describes translations as a source of error which might alter the original meaning of all kinds of material. In an attempt to reduce this threat, the backward translation technique has been used to achieve a semantically identical Dutch and German translations of the questionnaire and the eeriness scale.

After all, there are so many different slow system theories which could impossibly be included and operationalized within the reach of one single study. The four questionnaires that were used in this study can be regarded as a small extract of a thick book of slow system theories. In no way do they represent all of the theories. Working with a different set of questionnaires might have allowed to investigate the 3rd hypothesis more appropriately. It could not be shown that the traits as measured by the questionnaires had any influence on the eeriness ratings in the long conditions (2nd hypothesis). Yet, the assumption that the questionnaire scores will have more influence on the eeriness ratings in the longer conditions than in condition$_{100ms}$ (3rd hypothesis) builds upon the second hypothesis. Subsequently, there was no point in comparing the influence of the questionnaires across the conditions as the influence equaled zero in all of the conditions. As a matter of fact, the non-confirmation of the 2nd made a proper investigation of the 3rd hypothesis impossible. There is a number of

different reasons that could explain why the 2nd hypothesis could not be confirmed. The two questionnaires Negative attitude towards Robots (NARS) and Human Robot Uniqueness (HRU) were measuring traits that were explicitly related to robots. However, the stimuli that were used in the present study were not directly related to robots but depictions of CG characters' faces. A study by Destephe et al. (2015) identified the attitude that someone holds about robots as the main predictor for eeriness ratings and attractiveness ratings for robots. Destephe et al. used the same eeriness scale to measure eeriness as the present study and robots as stimuli. This indicates that the choice of the robot-related questionnaire might have been inappropriate for the CG character stimuli. Hence, another questionnaire that is more specifically related to CG characters might have more predictive power for the eeriness ratings. This might explain why the NARS and the HRU questionnaire failed to predict the eeriness ratings. The reason for using the questionnaires anyway, is that it has been assumed that this questionnaire measures some underlying construct that is applicable to both; robots and CG characters. Consequently, the questionnaires were used in order to find out if they could not only predict UV sensitivity for humanoid robots but also for CG characters. However, as the questionnaires turned out to have no predictive power for the eeriness ratings, it cannot be assumed that the HRU and the NARS questionnaire measure more general underlying constructs.

The eeriness ratings might have been influenced by another factor that has not been controlled. Hanson et al. (2005) claim that aesthetics and social responsiveness can make a robot with any degree of human-likeness appealing - with no regard to how human-like that robot is. Likewise, they discovered that anthropomorphic characters can be disturbing and appealing at any level of realism and not only at levels that fall into the valley. For instance, in another study Hanson (2006) demonstrated that even robots situated at the very left of the graph (very low human-likeness) can be perceived as uncanny if they lack aesthetics. This contradicts the idea of the uncanny valley according to which there is a certain degree of human-likeness that makes an artificial character uncanny. Thus, aesthetics might be another factor that influences the perception of uncanniness. Research suggests that people differ in regard to their aesthetic preferences (Wiersema, 2011; Wiersema, van der Schalk, & van Kleef, 2012). In addition, the results of a study by Destephe (2015) suggest that attractiveness is a factor that has an influence on how well a human-like robot is accepted. With this in mind, the eeriness ratings that were given in this study might have been influenced by a subject's aesthetic preferences. Pretend that a person looks at an artificial character, reflects on it and concludes that the presented character does not suit his or her aesthetic preferences.

This would be an example of another influence that is related to the slow system as it is a conscious reflection. However, as the questionnaires did not include a scale to identify differences in aesthetic preferences, it cannot be said in how far they influenced the ratings.

4.2 A Question of Generalizability

Some findings of laboratory studies cannot be reproduced in the real world but only under the very specific circumstances under which a study was conducted. This is known as a lack of generalizability or external validity; a construct which is addressed by the question 'whether a causal relationship holds over variations in persons, settings, treatments, and outcomes' (Shadish, Cook, & Campbell, 2002). Apparently, MacDorman and Entezari (2015) showed that the NARS, HRU, RF and AREM scale could predict eeriness ratings. However, this effect could not be reproduced in the present study. Still, that does not necessarily mean that the findings of one of the studies are incorrect. Rather, the difference between the findings might be explained by a lack of generalizability. Or, in other words - the findings might only be applicable under the specific circumstances under which the experiment by MacDorman and Entezari was conducted. In order to pinpoint whether this is the case, it is vital to to first identify in which regard the two studies differed. Firstly, the stimuli that were used in the two studies differed. Whereas the present study relied on still images of CG characters' faces, the replicated study chose videos of humanoid robots as a stimulus. Thus, the stimuli differed in regard to whether locomotion - or movement - was involved. One might argue that the questionnaires only have predictive power for eeriness ratings of stimuli that involve locomotion. Mori (1970) suggested locomotion as an important factor in the uncanny valley. This idea gained further support by Destephe (2015) who claimed that jerky motion aggravates feelings of uncanniness. Hence, locomotion might indeed be a factor of influence on the ratings. Moreover, it is possible that the showcase of a robot that is performing an action might have stimulated the participants to think about the topic more thoroughly than images do. A study by June (2014) uncovered that the use of videos in lectures could successfully stimulate critical thinking among students. This increase in critical thinking was attributed to a heightened degree of visualization. Pretend that a person watches a video of a robot performing an action as in the study by MacDorman and Entezari (2015). Watching this video might stimulate visualization of robots in our future lives and might ultimately lead to the frightening idea of robots taking our jobs. This thought would surely have a negative impact on the ratings that are made on the scales "Negative Attitude towards Robots" and "Human Robot Uniqueness" as the videos confronted the participants with a

possible outlook on what they might expect in a future with robots all around. In contrast, it is unlikely that images that merely showed images of morphed faces (robot faces merged with human faces) triggered an alike response and conscious reflection. Consequently, locomotion has the potential to stimulate critical thinking and might directly increase feelings of eeriness. Thus, the lack of locomotion in the stimuli that were used, is one of the differences between the two studies that could account for the fact that the questionnaires failed to predict eeriness ratings for CG characters. However, the stimuli differed not only in regard to locomotion but also in regard to what exactly they portrayed. The stimuli that were used in this study displayed faces of CG characters, whereas MacDorman and Entezari depicted robots with varying degrees of human-likeness. As outlined in section 4.1, it might be that the questionnaires measure constructs that are not relevant for the perception of CG characters but exclusively related to robots. Hence, the seemingly conflicting findings of the two studies might both be correct as the deviation might simply indicate that the questionnaires only have predictive power for UV sensitivity in robots but not for CG characters.

In conclusion, the fact that the results of MacDorman and Entezari (2015) could not be replicated might be explained by two ways in which the stimuli significantly differed. Firstly, the stimuli of the original study were full of locomotion, whereas this study used still images. Secondly, this study's stimuli were depictions of faces that belong to CG characters, whereas the original study used stimuli that showed robots with varying degrees of human-likeness and a real human.

4.3 Conclusion and Implications for Future Research

It could be shown that rapid and automatic processes make a substantial contribution to the overall evaluation that lies at the core of the uncanny valley phenomenon. This is based on the observation that a presentation time of 100ms is enough to form a reliable judgment of eeriness. Thus, the findings of Moll and Schmettow (2015) were successfully replicated. However, the questionnaire scores on anxiety, animal reminder sensitivity, religious fundamentalism, human robot uniqueness and a negative attitude towards robots could not predict UV sensitivity in CG characters. Therefore, it cannot be inferred that the slow system theories provide an explanation for the UV phenomenon. Limitations regarding the questionnaires complicated a proper investigation of the slow system theories.

In the light of what happened to Polar Express, it is vital that producers will one day be able to counteract the uncanny valley's negative effects. This is stressed by the growing demand for CG characters. The knowledge that can be obtained from this study can be

regarded as one further step on the long way to a full understanding of the phenomenon. Understanding which sort of evaluation processes are involved is important to develop a core understanding of the effect and might provide an excellent starting point for further research. Therefore, in the long run, the results of this study and future research could turn out to be beneficial for future movie and video game productions as they might stimulate further research, which unveils even more information about the underlying mechanisms. This knowledge in turn will one day allow producers to better predict people's reactions to the characters they create and thereby help them to avoid the pitfalls of the uncanny valley. But it is not only the movie and video game industry that is likely to benefit from these insights. The high number of articles written about the uncanny valley in the past few years indicates that there are many researchers who have a high interest in this topic. Hence, research in this field follows a twofold aim of, firstly, aiding movie and video game producers and, secondly, pushing research about the uncanny valley phenomenon by contributing to the existing pool of knowledge. Due to the fact that the present study's results could not uncover how much the slow systems really are involved, the task for future research is clear. One task of future research might be to identify traits that can predict UV sensitivity for CG characters and not only for videos of androids. There might be a different set of traits for the prediction of uncanny valley sensitivity in CG characters. Yet, this set of traits still remains to be unveiled. Identifying these traits would pave the way for further research on the involvement and interplay of the fast and the slow system. The first step might be to compile a list of traits that is potentially related to UV sensitivity with CG characters. This list could be based on literature research. The second step would be to collect empirical data to explore if these traits can actually predict eeriness ratings. If that is the case, the third step would be to conduct a study with a similar approach as the present study to discover if these traits only have an influence with long presentation times or if this influence is similar with shorter presentation times. That study would then have a solid base to build up on and would allow for a better investigation of the slow system theories to find out more about the interplay of the fast and the slow system. Ultimately, advancements in this field will have an impact on the media of tomorrow. Despite all the uncertainty surrounding the uncanny valley, one thing is certain: Synthetic characters will take up more and more prominent roles in our daily lives. Therefore, we should do our best to make this contact as "uncanni-*less*" as possible.

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Appendix A: Human–Robot Uniqueness (vs. Equivalence) Index

The items load on a single factor and are ordered by their factor loadings, listed in parentheses. Removing the last one or two items slightly improves the reliability of the index with the Cronbach's á rising from .89 to .90.

A high score indicates that a person sees humans and robots as two mutually exclusive categories.

Therefore, when presented with a face that is slightly modified to look like a computer generated face, people might have problems to categorize a face. In other words, people might have problems to say whether it is a real face or a face that belongs to a virtual character. Jentsch (1906) discovered in that this sort of category uncertainty can cause discomfort (MacDorman, 2015). This kind of uncertainty can arise when certain featurers of a face seem to belong to one category while some features appear to belong to another. Recently, Moore (2012) assumed that this category uncertainty might be one of the causes of the uncanny valley. The Human Robot Uniqueness (HRU) questionnaire measures to what degree a person tells a robot to another category than a human. When used in 2015 by MacDorman and Entezari, people who scored high on HRU showed a higher sensitivity to the effects of the uncanny valley.

Eleven 7-point Likert items

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1. Someday robots will be able to feel pain and heartache just like human beings do.[R] (.79)
2. It is absurd to consider a human being and a robot to be the same kind of thing. (.78)
3. Human beings have a soul, which a robot could never have. (.77)
4. Even if a robot might one day seem human, it would never be anything like a real human being. (.77)
5. Reproduce human brain processes in a robot, and the robot would be conscious.[R] (.74)
6. In a sense, human beings are nothing more than highly sophisticated, self-replicating robots.[R] (.73)
7. It would be alright if someday we could not tell robots from human beings.[R] (.72)
8. Human beings are fundamentally different from robots. (.72)
9. Since only human beings are created in God's image, no robot could ever be. (.70)
10. The internal workings of human beings and robots are governed by the same physical processes.[R] (.56)
11. When taking on human occupations, robots also take on moral responsibility for their actions.[R] (.35)

[R] Reverse scaled

Appendix B: NARS Items with Subscales

Eleven 5-point Likert items

(1: I strongly disagree, 2: I disagree, 3: Undecided, 4: I agree, 5: I strongly agree)

Item No.	Questionnaire	Item Sub-Scale
1	I would feel uneasy if robots really had emotions.	S2
2	Something bad might happen if robots developed into living beings.	S2
3	I would feel relaxed talking with robots*	S3
4	I would feel uneasy if I was given a job where I had to use robots.	S1
5	If robots had emotions I would be able to make friends with them.*	S3
6	I feel comforted being with robots that have emotions.*	S3
7	I would hate the idea that robots or artificial intelligences were making judgements about things.	S1
8	I would feel very nervous just standing in front of a robot.	S1
9	I feel that if I depend on robots too much, something bad might happen.	S2
10	I would feel paranoid talking with a robot.	S1
11	I am concerned that robots would be a bad influence on children.	S2

*= reverse-scaled

Appendix C: Animal Reminder Sensitivity Scale

Three True / False items and Four 3-point Likert items.

1 It would bother me to see a rat run across my path in a park.

2 I think homosexual activities are immoral.

3 I think it is immoral for someone to seek sexual activities from animals.

O Not disgusting *O slightly disgusting* *O very disgusting*

4 You see a bowel movement unflushed in a public bathroom.

5 You hear about an adult woman who had sex with her father.

6 You hear about a 30-year old man who seeks sexual relationships with 80-year old women.

7 You see someone accidentally sticking a fish hook through his finger.

Appendix D: Revised 12-Item Religious Fundamentalism Scale

Twelve 9-point Likert items

This survey is part of an investigation of general public opinion concerning a variety of social issues. You will probably find that you *agree* with some of the statements, and *disagree* with others, to varying extents. Please indicate your reaction to each statement by blackening a bubble in SECTION 1 of the bubble sheet, according to the following scale:

Blacken the bubble labeled –4 if you *very strongly disagree* with the statement.
–3 if you *strongly disagree* with the statement.
–2 if you *moderately disagree* with the statement
–1 if you *slightly disagree* with the statement.

Blacken the bubble labeled +1 if you *slightly agree* with the statement.
+2 if you *moderately agree* with the statement.
+3 if you *strongly agree* with the statement.
+4 if you *very strongly agree* with the statement.

If you feel exactly and precisely *neutral* about an item, blacken the "0" bubble.

You may find that you sometimes have different reactions to different parts of a statement. For example, you might very strongly disagree ("–4") with one idea in a statement, but slightly agree ("+1") with another idea in the same item. When this happens, please combine your reactions, and write down how you feel on balance (a "–3" in this case).

1. God has given humanity a complete, unfailing guide to happiness and salvation, which must be totally followed.

2. No single book of religious teachings contains all the intrinsic, fundamental truths about life.[a]

3. The basic cause of evil in this world is Satan, who is still constantly and ferociously fighting against God.

4. It is more important to be a good person than to believe in God and the right religion.[a]

5. There is a particular set of religious teachings in this world that are so true, you can't go any "deeper" because they are the basic, bedrock message that God has given humanity.

6. When you get right down to it, there are basically only two kinds of people in the world: the Righteous, who will be rewarded by God; and the rest, who will not.

7. Scriptures may contain general truths, but they should NOT be considered completely, literally true from beginning to end.[a]

8. To lead the best, most meaningful life, one must belong to the one, fundamentally true religion.

9. "Satan" is just the name people give to their own bad impulses. There really is *no such thing* as a diabolical "Prince of Darkness" who tempts us.[a]

10. Whenever science and sacred scripture conflict, *science* is probably right.[a]

11. The fundamentals of God's religion should never be tampered with, or compromised with others' beliefs.

12. *All* of the religions in the world have flaws and wrong teachings. There is *no* perfectly true, right religion.[a]

[a] indicates item is worded in the con-trait direction, for which the scoring key is reversed.

Appendix E: Anxiety scale (IPIP)

Ten 5-point Likert items (very inaccurate, moderately inaccurate, neither, moderately accurate, very accurate)

1. Worry about things
2. Fear for the worst
3. Am afraid of many things
4. Get stressed out easily
5. Get caught up in my problems
6. Am not easily bothered by things*
7. Am relaxed most of the time*
8. Am not easily disturbed by events*
9. Don't worry about things that have already happened*
10. Adapt easily to new situations*

- = reverse scaled

Appendix F: Eeriness scale in English, Dutch and German

Items used in our study including the Dutch and German translations

English items		**Dutch items**		**German items**	
Anchor low	**Anchor high**	**Anchor low**	**Anchor high**	**Anchor low**	**Anchor high**
Reassuring	Eerie	Geruststellend	Griezelig	Beruhigend	Unheimlich
Numbing	Freaky	Verdovend	Freaky	Gefühllos	Verrückt
Ordinary	Supernatural	Gewoonlijk	Bovennatuurlijk	Gewöhnlich	Übernatürlich
Uninspiring	Spinetingling	Niet inspirerend	Huiveringwekkend	Wenig anregend	Schaurig
Boring	Shocking	Saai	Schokkend	Langweilig	Schockierend
Predictable	Thrilling	Voorspelbaar	Spanend	Vorhersehbar	Aufregend
Bland	Uncanny	Uitdrukkingslos	Geheimzinnig	Ausdruckslos	Gruselig
Unemotional	Hairraising	Emotieloos	Schrikbarend	Emotionslos	Haarsträubend

Appendix G: Dutch translations of the questionnaires

Vragenlijsten

Dank u voor het evalueren van de afbeeldingen. Er volgen nu 6 korte vragenlijsten. Neemt u voor het invullen van zo veel tijd als u nodig hebt. Als u vragen heeft kunt u altijd terecht bij de onderzoeker.

Vragenlijst 1:

In hoeverre zijn de volgende uitspraken op u van toepassing?
Omcirkel een getal van -2 tot 2.

		Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
1.	Ik maak me snel zorgen.	-2	-1	0	1	2
2.	Ik ben bang dat het ergste geval zal intreden.	-2	-1	0	1	2
3.	Ik ben bang voor een groot aantal dingen.	-2	-1	0	1	2
4.	Ik raak snel gestrest.	-2	-1	0	1	2
5.	Ik blijf hangen in mijn problemen.	-2	-1	0	1	2
6.	Ik raak niet snel geïrriteerd door iets.	-2	-1	0	1	2
7.	Ik voel me meestal ontspannen.	-2	-1	0	1	2
8.	Ik raak niet snel verstoord door gebeurtenissen.	-2	-1	0	1	2
9.	Ik maak me snel zorgen over dingen die al gebeurd zijn.	-2	-1	0	1	2
10.	Ik pas me snel aan nieuwe situaties aan.	-2	-1	0	1	2

Vragenlijst 2:

In hoeverre zijn de volgende uitspraken op u van toepassing?
Omcirkel een getal van -2 tot 2.

		Helemaal mee oneens	Mee oneens	Neutraal	Mee eens	Helemaal mee eens
1.	Ik zou het ongemakkelijk vinden als robots gevoelens zouden hebben.	-2	-1	0	1	2
2.	Als robots zich ontwikkelen to levende wezens zou dit negatieve gevolgen kunnen hebben.	-2	-1	0	1	2
3.	Ik zou heel ontspannen zijn als ik met een roboter aan het spreken was	-2	-1	0	1	2
4.	Ik zou me ongemakkelijk voelen als ik op mijn baan gebruik van robots zou moeten maken.	-2	-1	0	1	2
5.	Als robots gevoelens zouden hebben, zou ik vrienden met hun kunnen worden.	-2	-1	0	1	2
6.	Ik heb een goed gevoel bij de voorstelling dat robots emoties hebben.	-2	-1	0	1	2
7.	Ik heb en hekel aan het idee da robots of kunstmatige intelligentie oordelen zouden vormen.	-2	-1	0	1	2
8.	Ik zou heel zenuwachtig zijn al ik voor een robot zou staan.	-2	-1	0	1	2
9.	Ik heb het gevoel dat er iets ergs zou kunnen gebeuren als wij te afhankelijk worden van robots.	-2	-1	0	1	2
10.	Ik zou me paranoïde voelen als ik met een robot zou spreken.	-2	-1	0	1	2
11.	Ik ben bang dat robots van slechte invloed op kinderen zouden kunnen zijn.	-2	-1	0	1	2

Vragenlijst 3:
In hoeverre zijn de volgende uitspraken op u van toepassing?
Omcirkel een getal van -3 tot 3.

		Helemaal mee oneens	Mee oneens	Beetje mee oneens	Neutraal	Beetje mee eens	Mee eens	Helemaal mee eens
1.	Op een keer, zullen robots in staat zijn om pijn en gevoelens net zo als mensen waar te nemen.	-3	-2	-1	0	1	2	3
2.	Het is absurd om mensen en robots bij dezelfde soort wezen te tellen.	-3	-2	-1	0	1	2	3
3.	Mensen hebben een soul. Een robot zal nooit een soul kunnen hebben.	-3	-2	-1	0	1	2	3
4.	Zelfs als een robot op een dag helemaal menselijk zou schijnen, zou deze robot nog steeds nooit echt menselijk kunnen zijn.	-3	-2	-1	0	1	2	3
5.	Als je de hersenprocessen van een mens helemaal in een robot zou reproduceren, zou de robot een bewustzijn hebben.	-3	-2	-1	0	1	2	3
6.	Op de een of andere manier zijn mensen niet meer dan hoog geavanceerde en zich zelf-voortplantende robots.	-3	-2	-1	0	1	2	3
7.	Ik zou het okay vinden als het op een keer onmogelijk zal zijn om mensen en robots van elkaar te tellen.	-3	-2	-1	0	1	2	3
8.	Mensen en robots verschillen op een fundamenteel niveau.	-3	-2	-1	0	1	2	3
9.	Door het feit dat mensen gecreëerd zijn naar het beeld van God zou een robot dit nooit kunnen zijn.	-3	-2	-1	0	1	2	3
10.	De interne processen van mensen en robots worden van dezelfde fysische processen gecontroleerd.	-3	-2	-1	0	1	2	3
11.	Als robots menselijke banen invullen, hebben zijn een morele verantwoordelijkheid voor hun handelingen.	-3	-2	-1	0	1	2	3

Vragenlijst 4:

Hoe u denkt over de volgende situaties?

Vink de optie aan die voor u van toepassing is.

		Niet afschuwelijk	Lichtjes afschuwelijk	Zeer afschuwelijk
1.	Je bent op een openbaar toilet en je ziet uitwerpselen die niet weggespoeld is.	o	o	o
2.	Je hoort van een volwassene vrouw die seks heeft gehad met haar vader.	o	o	o
3.	Je hoort van een 30 jaar oude man die op zoek is naar een seksuele relatie met een 80 jarige vrouw.	o	o	o
4.	Je ziet iemand die per ongeluk een vishaak door zijn vinger steekt.	o	o	o

Vragenlijst 5:

In hoeverre bent u het eens met de volgende drie uitspraken?

Kies voor "Niet waar" of "Waar".

		Niet waar	Waar
1.	Het zou me verstoren als er een rat langs mijn weg in de park zou lopen.	o	o
2.	Volgens mij zijn homoseksuele activiteiten immoreel.	o	o
3.	Volgens mij is het immoreel als iemand op zoek is naar seksuele activiteiten met dieren.	o	o

Vragenlijst 6:

In hoeverre bent u het eens met de volgende uitspraken?
Omcirkel een getal van -4 tot 4.

		Zeer sterk mee oneens	Sterk mee oneens	Gedeeltelijk mee oneens	Beetje mee oneens	Neutraal	Beetje mee eens	Gedeeltelijk mee eens	Sterk mee eens	Zeer sterk mee eens
1.	God heeft de mensen een complete een onfeilbare handleiding voor het bereiken van geluk en zaligmaking gegeven. Deze moet helemaal gevolgd worden.	-4	-3	-2	-1	0	1	2	3	4
2.	Er is geen boek met geestelijke leringen dat alle intrinsieke en fundamentele waarheden bevat.	-4	-3	-2	-1	0	1	2	3	4
3.	De oorsprong van kwaadaardigheid in deze wereld is satan. Hij vecht nog steeds wreed en voortdurend tegen God.	-4	-3	-2	-1	0	1	2	3	4
4.	Het is belangrijker een goede persoon te zijn dan aan God en de ene juiste religie te geloven.	-4	-3	-2	-1	0	1	2	3	4
5.	Er is een aantal religies in deze wereld die zo waar zijn dat het onmogelijk is om nog “dieper” te gaan. Zij zijn de fundamentele boodschappen welke God aan ons mensen heeft meegedeeld.	-4	-3	-2	-1	0	1	2	3	4
6.	Op zich zijn er maar twee soorten mensen op deze wereld: De rechtvaardigen die door God zullen worden beloond en de rest. De rest zal niet door God worden beloond.	-4	-3	-2	-1	0	1	2	3	4
7.	Wellicht bevatten de schriften algemeen geldige waarheden. Toch men zou deze NIET helemaal letterlijk en van begin tot aan het eind als waar beschouwen.	-4	-3	-2	-1	0	1	2	3	4

		Zeer sterk mee oneens	Sterk mee oneens	Gedeeltelijk mee oneens	Beetje mee oneens	Neutraal	Beetje mee eens	Gedeeltelijk mee eens	Sterk mee eens	Zeer sterk mee eens
8.	Om het beste en betekenisvolste leven te voeren, is het essentieel om deel te zijn van de ene fundamenteel juiste religie.	-4	-3	-2	-1	0	1	2	3	4
9.	"Satan" is slechts de naam, die mensen toekennen aan hun eigen slechte impulsen. Er is niet *zoiets* als een kwaad 'Prince of Darkness ", die ons in verzoeking leidt.	-4	-3	-2	-1	0	1	2	3	4
10.	Wanneer de wetenschap en de Bijbel met elkaar in tegenspraak staan, heeft waarschijnlijk de wetenschap gelijk.	-4	-3	-2	-1	0	1	2	3	4
11.	Het basisidee van de religie van God mag nooit worden afgebogen en mag nooit worden gemengd met de opvattingen van anderen.	-4	-3	-2	-1	0	1	2	3	4
12.	*Alle* religies van de wereld hebben hun eigenaardigheden en valse leringen. Er is *geen* perfecte, ware en juiste religie.	-4	-3	-2	-1	0	1	2	3	4

Dank u wel! Als u klaar bent met het invullen van de vragenlijst, kunt u weer terug gaan naar de computer. Er volgt een laatste ronde van beoordelingen. Deze ronde is zonder tijdslimit. Hierna bent u klaar met het onderzoek.

Appendix H: German translations of the questionnaires

Fragebögen

Vielen Dank für das Bewerten der Bilder. Es folgen jetzt 6 kurze Fragebögen.
Nehmen Sie sich für das Ausfüllen so viel Zeit wie Sie brauchen. Bei Fragen können Sie sich jederzeit an den Versuchsleiter wenden.

Fragebogen 1:
Inwieweit treffen die folgenden Aussagen auf Sie zu?
Umkreisen Sie eine Zahl zwischen -2 und 2.

	Stimme gar nicht zu	Stimme eher nicht zu	Weder noch	Stimme eher zu	Stimme voll zu
11. Ich mache mir oft Sorgen.	-2	-1	0	1	2
12. Ich befürchte oft das Schlimmste.	-2	-1	0	1	2
13. Es gibt vieles vor dem ich mich fürchte.	-2	-1	0	1	2
14. Ich bin schnell gestresst.	-2	-1	0	1	2
15. Ich verheddere mich in meinen Problemen.	-2	-1	0	1	2
16. Ich lasse mich nicht leicht von etwas beunruhigen.	-2	-1	0	1	2
17. Ich bin die meiste Zeit entspannt.	-2	-1	0	1	2
18. Ein unerwartetes Ereignis bringt mich so schnell nicht aus der Fassung.	-2	-1	0	1	2
19. Ich mache mir keine Gedanken um Sachen, die bereits passiert sind.	-2	-1	0	1	2
20. Ich passe mich schnell an neue Situationen an.	-2	-1	0	1	2

Fragebogen 2:

Inwieweit treffen die folgenden Aussagen auf Sie zu?
Umkreisen Sie eine Zahl zwischen -2 und 2.

	Stimme gar nicht zu	Stimme eher nicht zu	Weder noch	Stimme eher zu	Stimme voll zu
12. Ich würde mich unwohl fühlen, wenn Roboter Emotionen hätten.	-2	-1	0	1	2
13. Wenn Roboter sich zu lebenden Wesen entwickeln würden, könnte etwas Schlimmes passieren.	-2	-1	0	1	2
14. Würde ich mit Robotern reden, wäre ich dabei entspannt.	-2	-1	0	1	2
15. In einem Job, in dem ich Roboter benutzen müsste, würde ich mich unwohl fühlen.	-2	-1	0	1	2
16. Hätten Roboter Emotionen, könnte ich mich mit ihnen anfreunden.	-2	-1	0	1	2
17. Ich fühle mich wohl dabei Zeit mit Robotern zu verbringen.	-2	-1	0	1	2
18. Ich kann den Gedanken nicht ausstehen, dass Roboter oder künstliche Intelligenz dazu in der Lage sein könnten eine eigene Meinung zu haben.	-2	-1	0	1	2
19. Vor einem Roboter zu stehen würde mich nervös machen.	-2	-1	0	1	2
20. Wenn wir zu stark von Robotern abhängen, könnte etwas Schlimmes passieren.	-2	-1	0	1	2
21. Ich würde mich paranoid fühlen, wenn ich mich dabei erwischen würde wie ich mit einem Roboter rede.	-2	-1	0	1	2
22. Ich denke, dass Roboter einen schlechten Einfluss auf Kinder haben könnten.	-2	-1	0	1	2

Fragebogen 3:

Wie sehr stimmen Sie den folgenden Aussagen zu?
Umkreisen Sie eine Zahl zwischen -3 und 3.

	Stimme ganz und gar nicht zu	Stimme größtenteils nicht zu	Stimme eher nicht zu	Unentschieden	Stimme teilweise zu	Stimme größtenteils zu	Stimme voll und ganz zu
12. Eines Tages werden Roboter dazu in der Lage sein Schmerz und Gefühle so wahrzunehmen wie wir Menschen.	-3	-2	-1	0	1	2	3
13. Es ist absurd einen Menschen und einen Roboter zur gleichen Kategorie von Wesen zu zählen.	-3	-2	-1	0	1	2	3
14. Menschen haben eine Seele, die ein Roboter niemals haben könnte.	-3	-2	-1	0	1	2	3
15. Selbst wenn ein Roboter eines Tages menschlich scheinen wird, wird er niemals wirklich so sein wie ein echter Mensch.	-3	-2	-1	0	1	2	3
16. Wenn man die Gehirnprozesse eines Menschen in einem Roboter reproduziert, hätte der Roboter ein Bewusstsein.	-3	-2	-1	0	1	2	3
17. Gewissermaßen sind Menschen lediglich hochentwickelte, sich selbst fortpflanzende Roboter.	-3	-2	-1	0	1	2	3
18. Es wäre okay für mich, wenn man eines Tages Roboter und Menschen nicht mehr auseinanderhalten könnte.	-3	-2	-1	0	1	2	3
19. Menschen unterscheiden sich grundlegend von Robotern.	-3	-2	-1	0	1	2	3
20. Nur Menschen sind nach dem Abbild Gottes geschaffen. Ein Roboter wird niemals nach dem Abbild Gottes geschaffen sein.	-3	-2	-1	0	1	2	3
21. Die internen Prozesse von Menschen und Robotern werden von den gleichen physischen Prozessen gesteuert.	-3	-2	-1	0	1	2	3
22. Wenn Roboter in Positionen eingesetzt werden, die sonst von Menschen gefüllt werden, haben Roboter eine moralische Verantwortung für ihr Handeln.	-3	-2	-1	0	1	2	3

Fragebogen 4:
Wie empfindest du die folgenden Situationen?
Kreuzen Sie die auf Sie zutreffende Option an.

		Nicht ekelerregend	Leicht ekelerregend	Sehr ekelerregend
5.	Du siehst nicht abgespülte Fäkalien auf einer öffentlichen Toilette.	o	o	o
6.	Du hörst von einer Frau, die Sex mit ihrem Vater hatte.	o	o	o
7.	Du hörst von einem 30 jährigen Mann, der auf der Suche nach Sexbeziehungen mit 80 jährigen Frauen ist.	o	o	o
8.	Du siehst wie jemand versehentlich einen Angelhaken durch seinen Finger steckt.	o	o	o

Fragebogen 5:
Inwieweit stimmst du den folgenden drei Aussagen zu?
Kreuzen Sie „Stimmt nicht" oder „Stimmt" an.

		Stimmt nicht	Stimmt
4.	Es würde mich stören, wenn eine Ratte meinen Weg im Park kreuzen würde.	o	o
5.	Ich finde homosexuelle Aktivitäten unmoralisch.	o	o
6.	Ich finde es unmoralisch wenn jemand sich nach sexuellen Aktivitäten mit Tieren sehnt.	o	o

Fragebogen 6:
Wie sehr stimmen Sie den folgenden Aussagen zu?
Umkreise eine Zahl zwischen -4 und 4.

	Ich widerspreche sehr stark	Ich widerspreche stark	Ich widerspreche teilweise	Ich widerspreche leicht	Neutral	Ich stimme leicht zu	Ich stimme teilweise zu	Ich stimme stark zu	Ich stimme sehr stark zu
13. Gott hat uns einen komplette und unfehlbaren Wegweiser auf dem Weg zur Glückseligkeit und Erlösung gegeben, den wir voll und ganz befolgen müssen.	-4	-3	-2	-1	0	1	2	3	4
14. Keines der Bücher über religiöse Lehren enthält alle wesentlichen und grundlegenden Wahrheiten über das Leben.	-4	-3	-2	-1	0	1	2	3	4
15. Der Ursprung alles Bösen in dieser Welt ist Satan, der noch immer durchgehend und grausam gegen Gott kämpft.	-4	-3	-2	-1	0	1	2	3	4
16. Es ist wichtiger eine gute Person zu sein als an Gott und die richtige Religion zu glauben.	-4	-3	-2	-1	0	1	2	3	4
17. Es gibt einige spezifische Religiöse Lehren in dieser Welt, die so wahr sind, dass es unmöglich ist noch „tiefer“ zu gehen, weil sie die grundlegenden Botschaften sind, die Gott der Menschheit mitgeteilt hat.	-4	-3	-2	-1	0	1	2	3	4
18. Im Grunde genommen gibt es nur zwei Sorten Mensch auf dieser Welt: Die Gerechten, die Gott belohnen wird; und den Rest, den Gott nicht belohnen wird.	-4	-3	-2	-1	0	1	2	3	4
19. Schriften enthalten möglicherweise allgemein gültige Wahrheiten, aber man sollte sie NICHT als vollkommen, wörtlich von Anfang bis Ende wahr ansehen.	-4	-3	-2	-1	0	1	2	3	4

		Ich widerspreche sehr stark	Ich widerspreche stark	Ich widerspreche teilweise	Ich widerspreche leicht	Neutral	Ich stimme leicht zu	Ich stimme teilweise zu	Ich stimme stark zu	Ich stimme sehr stark zu
20.	Um das Beste, bedeutungsvollste Leben zu führen, muss man zu der einen grundlegend wahren Religion gehören.	-4	-3	-2	-1	0	1	2	3	4
21.	„Satan“ ist bloß der Name, den Menschen ihren eigenen schlechten Impulsen geben. Es gibt *so etwas* wie einen teuflischen „Prinzen der Dunkelheit“, der uns in Versuchung führt, nicht.	-4	-3	-2	-1	0	1	2	3	4
22.	Immer wenn Wissenschaft und heilige Schrift sich widersprechen, hat vermutlich die *Wissenschaft* Recht.	-4	-3	-2	-1	0	1	2	3	4
23.	Der Grundgedanke der Religion Gottes sollte niemals abgefälscht werden und sollte niemals mit den Ansichten andere vermischt werden.	-4	-3	-2	-1	0	1	2	3	4
24.	*Alle* Religionen der Welt haben ihre Macken und unrichtige Lehren. Es gibt *keine* perfekte, wahre und richtige Religion.	-4	-3	-2	-1	0	1	2	3	4

Zutreffendes bitte umkreisen.

Männlich/Weiblich

Linkshänder/Rechtshänder

Wie alt sind Sie?

Alter: _____

Vielen Dank! Sie können sich nach dem Ausfüllen der Fragebögen nun wieder an den Computer setzen. Dort beginnt nun eine letzte Runde der Bilderbewertungen ohne Zeitbeschränkung. Danach ist die Untersuchung beendet.

Appendix I: Informed Consent

INFORMED CONSENT

To be filled in by the participant

I have been introduced to the procedures of this research by the researcher. Furthermore, I have been informed that any data that will be collected will be processed and saved anonymously. Therefore, the data published to third parties can in no way be associated with my performance.

Hereby, I assure to participate voluntarily in this research. I am aware of my right to stop participation at any time throughout the whole research process without giving any reason.
The researcher has answered all of my questions.

Name participant: ……

Date: …… Signature participant: …..…….

To be filled in by the researcher

I informed the participant about the procedures of this research. Furthermore, I will do my best to answer any questions that the participant will come up with. Lastly, I assure that the participant does not have to fear any negative consequences from prematurely quitting the experiment.

Name researcher: Adrian Benjamin Haeske

Date: …… Signature researcher: …..…….

Appendix J: Technical details on the computer used in this study

The computer that has been used in this study was able to run the program with a minimum of 60 frames per second. Furthermore, the display had a screen diagonal of 22 inches and was set to a resolution of 1650 x 1080 pixels.