My dear robot – anthropomorphism and loneliness

Bachelor thesis

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Abstract

In the past few years the concept of anthropomorphism became a relevant topic in the human-robotic interaction due to improvements in humanlike robots and increased use in social health care facilities. The Three-Factor Theory of Epley tries to explain when humans tend to anthropomorphize robots and when not on three psychological determinants (Epley, Waytz, & Cacioppo, 2007). Our research investigates the association of the psychological determinant sociality motivation and anthropomorphism.

We examined the association by testing the influence of induced loneliness and chronicle loneliness on anthropomorphizing robots. The induced loneliness was tested in an experiment in which participants were separated in two conditions (experimental and control) and rated robots on the 'Perceived Humanness' Index. The chronicle loneliness was measured by the UCLA Loneliness Scale. The results were tested by a linear mixed effects model and a correlational analysis and a significant result was found. Participants in the experimental condition rated robots higher on the 'Perceived Humanness' Scale than participants in the control group. The 'Three Factor Theory' of Epley could only partially be confirmed and needs further research on the dispositional factor chronicle loneliness.

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1. Introduction

Older people living in nursing homes often report feelings of loneliness, isolation and lack of control. Many older people have difficulties forming new social relationships and outline that their quality of life has suffered. This leads to psychological problems such as depression (Robinson, MacDonald, Kerse, & Broadbent, 2013). The research of Heinrich and Gullone (2006) undermines the need for social connection. They found out that people would consider living on an isolated island as a "nightmare" and mild levels of isolation would lead to increased depression and suicidal thoughts.

To counteract the loneliness and strengthen social interaction, the Japanese Intelligent Systems Research Institute (ISRI) invented the white seal Paro. Paro is an interactive robot and is made of artificial fur. Research showed that companion robots, such as Paro, decrease loneliness and improve the social interaction (Robinson et al., 2013).

The example of Paro shows that the involvement of robots in health care increases and the improvement in the field of human-robotic interaction (HRI) play a crucial role in the future. As the development of robots improves and the affinity to humans becomes stronger, we need to take a look on how we can support a positive social interaction between robots and humans and increase the effectiveness of the interaction. To get a deeper understanding on how humans perceive nonhuman agents we investigated the 'Three Factor Theory of Anthropomorphism' of Epley (2007), which contains the three psychological key determinants elicited agent knowledge, effectance motivation and sociality motivation.

Our research examines the psychology determinant sociality motivation of the 'Three Factor Theory of Anthropomorphism' of Epley (2007). We have chosen to investigate the situational and dispositional variable of the determinant sociality motivation: chronic loneliness and social disconnection. In the experiment of Epley et al (2008) the situational variable was tested by dividing the participants into three conditions: loneliness, fear and control. They have been given videos for each condition which should induce loneliness, fear and neither of both. Afterwards the participants rated their pets. The results have shown that participants in the loneliness condition gave their pets more anthropomorphistic traits than in the other two groups. Further Epley examined the correlation between chronicle lonely people and their tendency to anthropomorphize

their pets. He found a slightly negative correlation (α=.02). In other words, how lonely a person was and how highly he rated his pet on anthropomorphistic traits. In our experiment we replicate Epley's research, but leaving out the fear condition, because it had no significant effect. Our experiment tests if the findings can also be confirmed as we use robots and not pets.

1.1 Anthropomorphism

The first person using the term anthropomorphism was the Greek philosopher Xenophanes (Waytz, Cacioppo, & Epley, 2014). With this term he described the likeness of religious people and their gods. He noticed that white people have white gods and black people have black gods. Anthropomorphism defines the attribution of different aspects of humans, like characteristics or mental state, to nonhuman agents. These either real or imagined nonhuman agents include animals, religious entities, technological gadgets, natural forces or mechanical devices. Further anthropomorphism also contains physical features such as seeing supernatural entities in humanlike forms and mental capacities, such as consciousness which people think is unique for humans. This leads to two distinct ways. The first is anthropomorphizing nonhuman agents like technology gadgets or animals and the other way is by strengthening their belief in an anthropomorphized supernatural entity like God (Guthrie, 1993). In fact, religious followers believe that their supernatural entity owns humanlike characteristics.

Another important point which needs to be mentioned is what anthropomorphism is not! Anthropomorphism does not involve animism. Animated live in a non-human agent is not a unique human characteristic. Secondly, anthropomorphism is not always consistent in its strength. There are different forms and levels of anthropomorphism (Złotowski et al., 2014). An example is that user of computers or other technological gadgets curse their gadgets, but they are aware that their computer or ipad do not have humanlike characteristics. Thirdly anthropomorphism goes further than just attributing observable actions like fast or aggressive to nonhuman agents. A dog barking and snarling at someone and stating that the dog is aggressive is a description of observable actions but anthropomorphism requires going beyond these observable actions and making assumptions about unobservable humanlike characteristics (Waytz et al., 2014).

At last, there exists the inverse process of anthropomorphism, called Dehumanization. Dehumanization means that people aren't seen as humans and are treated as animals (Epley, Akalis, et al., 2008; Złotowski et al., 2014). This process mostly occurs in people who have strong social connections to others. It is reported that people with strong social bounds tend to dehumanize outgroup members easier than people suffering from social isolation (Waytz, Epley & Cacioppo, 2007).

1.2 Three Factor Theory

What leads people to anthropomorphize nonhuman agents? To get a deeper understanding on anthropomorphism and what influences people to anthropomorphize nonhuman agents we refer to the "Three-Factor Analysis of Anthropomorphism" (Epley et al., 2007). The three primary factors are elicited agent knowledge, effectance motivation and sociality motivation. The first factor elicited agent knowledge is the cognitive determinant. In this process of inductive reasoning people apply their own mental states and characteristics onto the non-human agent. Elicited agent knowledge contains the knowledge humans have about themselves and this is the basis for inductive processing. The knowledge about oneself is more accessible than the knowledge about nonhuman agents, because the knowledge about humans is earlier achieved, more specific and better experienced. But as knowledge about nonhuman agents is accessible, this knowledge is used and the knowledge about the self gets reduced.

The second factor effectance motivation involves the understanding, predicting and decreasing ambiguity in the environment of oneself and the non-human agent. Effectance motivation describes the desire of humans to interact in their own environment effectively. In terms of anthropomorphism, effectance motivation includes interacting effectively with nonhuman agents and improving the ability to understand complex mechanism and predicting the behavior of nonhuman agents in the future.

The last determinant sociality motivation is the need for social bounds and described in 1.4, because we examine this factor in our experiment. In a study of Epley and colleagues (2007) a connection between loneliness and anthropomorphism was found. In the study pet owners were asked to fill in a scale with descriptions for their pet and a

loneliness scale. In this study 14 traits were presented from anthropomorphist traits (thoughtful, sympathetic, etc.) to behavioral traits not related to anthropomorphism such as aggressive, agile and active. The results were that people lacking from social connections were more likely to anthropomorphize their pets than people feeling well social connected. Another research underlined the connection between loneliness and anthropomorphism as participants were manipulated in their social connections and in the study tended to anthropomorphize their pets with traits correlated to social connection (Epley et al., 2008).

1.3 Perceived Loneliness

Recent research suggests that social pain is a signal that shows us that our social connections are weakening and need to be repaired (Cacioppo & Hawkley, 2009). Hawkley en al. (2009) suggests that the wellbeing and health of the individual and the survival of our genes could motivate the need for social connections. This means that there is a basic need to form social bonds with others and our environment. People actively seek for social connections (Twenge, Catanese, & Baumeister, 2003). As people fail to form stable social relationships with other humans, they tend to replace them by non-human agents (Złotowski, Strasser, & Bartneck, 2014). Furthermore, loneliness supports social connection through the anthropomorphizing of pets, technological gadgets and supernatural entities. So, socially isolated people have a basic motivation to fill in the social gap with their cognitive capacities. Even Aristotle found out that people need other people and this need is so powerful that people anthropomorphize nonhuman agents to satisfy this need (Epley, Waytz, Akalis, & Cacioppo, 2008; Epley, Waytz, & Cacioppo, 2007).

1.4 Sociality Motivation

The focus lies on sociality motivation as this is linked to loneliness and anthropomorphizing nonhuman agents. The tendency to anthropomorphize nonhuman agents is much higher when the individual feels lonely and then actively starts seeking for a social connection with non-human agents (Epley et al., 2007).

There are three variables that influence social motivation: situational, developmental and cultural. The situational influence needs to be taken into consideration because the amount of loneliness people experience differs from the context they are in. In experiments, people were manipulated and were confronted with loneliness. Further evidence that loneliness increases anthropomorphism was found by Eyssel and Reich (2013). In the research participants were told that the first task was to examine emotional influence on memory processes and the second task was to evaluate the robot Flobi. Then the participants were divided into two groups: experimental and control. Participants in the experimental group were manipulated and asked to think of an event where they felt lonely and had to write a short letter about it. In the control group, participants had to review the day before in detail. Afterwards participants were shown the robot Flobi and had to attribute traits to the robot. A seven-point Likert scale was used to measure the answer of the respondents. The anthropomorphic attributes were measured by *mind perception* (e.g. feeling pain, making plans) and *human essence* (friendly, organized, sociable). It was found that participants in the experimental group attributed more anthropomorphist traits to the robot and had more commonalities with the robot than the control group. This research suggests that internal mental states motivate individuals to seek for social connections with non – human agents. Another research undermines the findings of Eyssel. People who lost a good friend or relative create stronger beliefs in god and are likely to use coping as a strategy to compensate their loss (Epley et al., 2007).

The developmental influence is the second variable and states that children have different states of knowledge about the self and others. Children start with an egocentric reasoning and then learn to reason with another person's perspective. The underlying mechanism is that children develop an understanding for other agents. They assume that other than themselves can have a mental state. This gives them the opportunity to anthropomorphize nonhuman agents. Autistic people lack this understanding and therefore cannot attribute humanlike features to nonhuman agents(Epley et al., 2007).

Another component which develops during childhood and influences the social need of a person is his attachment style. The attachment styles influences a person's approach towards social connections (Epley, Akalis, Waytz, & Cacioppo, 2008). People with insecure attachment styles seek for social relationships and to fulfill their desire they tend to build up social connections with non-human agents to maintain strong social bounds and people with insecure – avoidant attachment styles are reported to have a stronger belief in god (Epley et al., 2007).

Although sociality motivation seems to be universal, the third variable culture also has an impact on how people react to loneliness. In collectivistic cultures loneliness or social isolation is much more severe, because the focus on social contacts is much higher than those in individualistic cultures, where autonomy and privacy play an important in role in addition to social needs (Epley et al., 2007). The cultural background influences people on how likely they would anthropomorphize nonhuman agents. People in modern industrialized cultures interact more with technical gadgets like cars and computers so therefore have a higher tendency to anthropomorphize with these gadgets rather than people in non-industrialized cultures, who refer more to the natural world.

1.5 Research questions

As we stated in our introduction there has been many approaches which suggested and also found out that lonely people replace humans with no-human agents to create social relationships and give them unique human characteristics. Further we need to distinguish between individuals who experience and feel loneliness in their everyday life and people we put in an emotional state of loneliness by our experimental condition. In both situations we expect that lonely people and people who were put in a lonely situation tend to anthropomorphize robots more than in the control group. In our research we seek for a positive effect between perceived loneliness and a tendency to anthropomorphize technical gadgets. To answer this question we sat up the research question: *"Sociality motivation has a positive influence on anthropomorphism"*. To test if the psychological determinant 'Sociality Motivation' has an influence two sub-hypotheses were established. The dispositional variable is tested by the sub-hypothesis *"chronicle lonely people have a stronger tendency to anthropomorphize robots"* and the situational variable is tested by the sub-hypotheses *"Socially disconnected people have a stronger tendency to anthropomorphize robots"*.

2. Method

2.1 Sample

We used convenience sampling to get n=29 participants. The recruitment of the participants was done via the Sona website of the University of Twente or via other social networks. Students intended to participate via Sona received a reward in form of Sona credits which they need for their study fulfillment. Other rewards were not offered. Convenience sampling was chosen to get a broad variance of individuals for the study. This means that we collected people from different studies and jobs and not only students from one faculty. The sample was composed of 11 women (40,7%) and 16 men (59,3%) where they were randomly distributed over the two conditions in the experiment. The average age was 23 (23.82) with a standard deviation of 2.2. The sample was split up into two evenly sub-samples: 13 participants joined the loneliness condition and 14 participants joined the social condition. The sub-samples had the same procedure, besides that the videos scenes. In the loneliness condition participants have been shown the "Cast Away" scene and in the social condition participants were shown the "Major League" scene.

*Table 1. Crosstab Condition*Gender*

		Gender		
		F	*m*	*Total*
Condition	Team	5	9	14
	Robinson	6	7	13
Total		11	16	27

2.2 Material

The materials were 20 short video clips of robotic movement. The video clips are five seconds long and contained one robot per video. The diversity goes from android robots that show human like movement to very mechanical robots with no humanlike movement and animalistic robots. The robots in the videos do different movements as the android robots which looked more humanlike were running or showed humanlike mimics, animalistic robots had typical movements from dogs or spiders. Each video was rated on the same Likert - scale conducting seven outcomes which then could be marked. The videos are only visual and do not have any sounds. Further the videos the participants see were randomly selected over the two trials. In addition, two manipulating stimuli are needed. The two manipulating stimuli are videos that put the participants in different moods. One video will be a short clip from the movie “Cast Away”. In this short clip the main actor realizes for the first time that he is completely alone on the island. The other video scene from “Major League” contains a short clip in which a team celebrates their victory with their fans. These two videos were chosen because they both imply the psychological states we wanted to arouse by the participants. The “Cast Away” video evokes a feeling of loneliness and social isolation and the other video is a control condition in which social isolation is not given and instead a feeling of social cohesion is created (Epley, 2008; Zemeckis & Broyles, 2000).

2.3 Measurement

The research focuses on loneliness and anthropomorphism. Thus different measurement tools are necessary. To examine loneliness as a dispositional factor we use the UCLA Loneliness Scale. The materials we need for the experiment are the UCLA Loneliness Scale to measure loneliness in the participants. This scale consists of 20 statements such as “I lack companionship” to “I am an outgoing person”. The UCLA Loneliness Scale has a high reliably with a Cronbach alpha of .91. (Hughes, 2004). The Scale contains 20 statements of loneliness and the participant can choose among four possibilities which fits best to the participant. The range is “Never”, “Rarely”, “Sometimes” and “Often” (Hughes, 2004). The second test we use is the “Perceived Humanness” test, developed by MacDorman. The “Perceived Humanness Scale” contains four different measurements: “humanness”, “attractiveness”, “eeriness” and “warmth”. For the current study we have chosen to take the “humanness” scale, because our research focuses on the subjective perception of humanness in nonhuman - agents and measures the tendency to anthropomorphize the different robots shown in the videos. The test includes different semantic items that are contrary to each other like “artificial – Natural” and the robots were rated on a 7 - point Likert scale. We do not take the Godspeed scale into account because the humanlike characteristics tested in the Godspeed scale were highly correlated to each other. The consequence is that these characteristics measure the same concept and are not distinct (Ho & MacDorman, 2010). Further the ‘Perceived Humanness’ scale has a high internal reliability (Cronbach’s $\alpha = .92$) and the test – retest reliability is constant (Ho & MacDorman, 2010). Another advantage of the MacDorman scale is that the scale is not specifically created for humanlike robots and can also contain other nonhuman - agents.

2.4 Procedure

The participant is placed in a quiet room with a desk, chair and computer to ensure no disturbing side effects. For this reason we used the research facilities of the University to maintain the silence and private atmosphere for the participant. After we gave the instructions and explained the procedure, the participant signs the informed consent. The informed consent advises the participant that their involvement is voluntary and that they may stop at each point of the study without naming any reasons. Further they participation will stay anonymous and will not be passed to other persons. After that the experiment starts with the first 10 video clips of robots which are randomized. The participant sees the clip for approximately five seconds and then can choose from the different semantic items if the robot in the video contained more humanlike or mechanical attributions. The items were chosen from the 'Humanness' Index of the 'Perceived Humanness' Scale by MacDorman. With the MacDorman scale we measure the within-subject to find difference before and after the treatment within one participant. The videos were shown repeatedly and by pressing the 'n' button participants were going on with the next video. After the first 10 video clips have been shown, the participant fills in the UCLA Loneliness Scale. The Loneliness questionnaire was placed here, because otherwise the participants were primed to loneliness before the experiment starts and the results were not reliable. The next step is to divide the participants into two equally groups. One group sees the "Cast Away" video clip, which creates a feeling of loneliness by the participants and the other group sees a video clip of a team celebrating their victory. This is the between - subject in the experiment to find difference between the groups. Now the two groups see another 10 short video clips which also are evenly distributed. The procedure is the same as by the first 10 video clips. So each participant has seen each of the 20 available videos.

2.5 Data Analysis

The collected data from the UCLA Loneliness Scale and the Perceived Humanness Scale were imported to the statistics program SPSS. The loneliness of participants was measured on two factors: situational and dispositional. The UCLA Loneliness Scale represented the dispositional factor and the pre/post condition represented the situational factor. The tendency to anthropomorphize nonhuman agents was measured by the 'humanness index' of the 'Perceived Humanness' Scale by MacDorman. The mixed linear effects regression model was taken in advantage of ANOVA because we have repeated measures from the same participant per stimulus and item. The Linear Mixed Model contains the 'random effects' and the 'fixed effects'. In this case the item, subject (participant) and stimuli were the random effects and the 'fixed effects' were The UCLA Loneliness Score and the pre/post condition (before treatment/after treatment). The dependent variable is the response from the "Perceived Humanness" Score. A correlational analysis was used to find significant results between the first three hypotheses. The main and interaction effects were tested by the Linear Mixed Model.

3. Results

3.1 Descriptive Statistics

For the statistical analysis a Cronbach's alpha of .05 was determined. The descriptive statistics of the demographics from the participants has been shown above in 2.1. The mean score of the UCLA test was *M*= 1.6 (*SD*= .34) and the mean score of the 'Perceived Humanness' responses was *M= 3.0 (SD= .57).*

3.2 Correlational analysis

The sub-hypothesis *"Chronically lonely people have a stronger tendency to anthropomorphize robots"* was tested by a correlational analysis. The correlation between the mean scores of the UCLA and the 'Perceived Humanness' Index express the sub-hypothesis and had a negative and not significant correlation *(r (27) = -.24, p= .23).* This finding is also demonstrated in figure 1.

Table 2. Correlational analysis between Age, Gender, Condition, Loneliness and Perceived Humanness

	Age	Gender	Condition	Loneliness	Perceived Humanness
Age	-				
Gender	.51**	-			
Condition	-.36	-.11	-		
Loneliness	-.13	.19	-.06	-	
Perceived Humanness	-.06	.02	.10	-.24	-

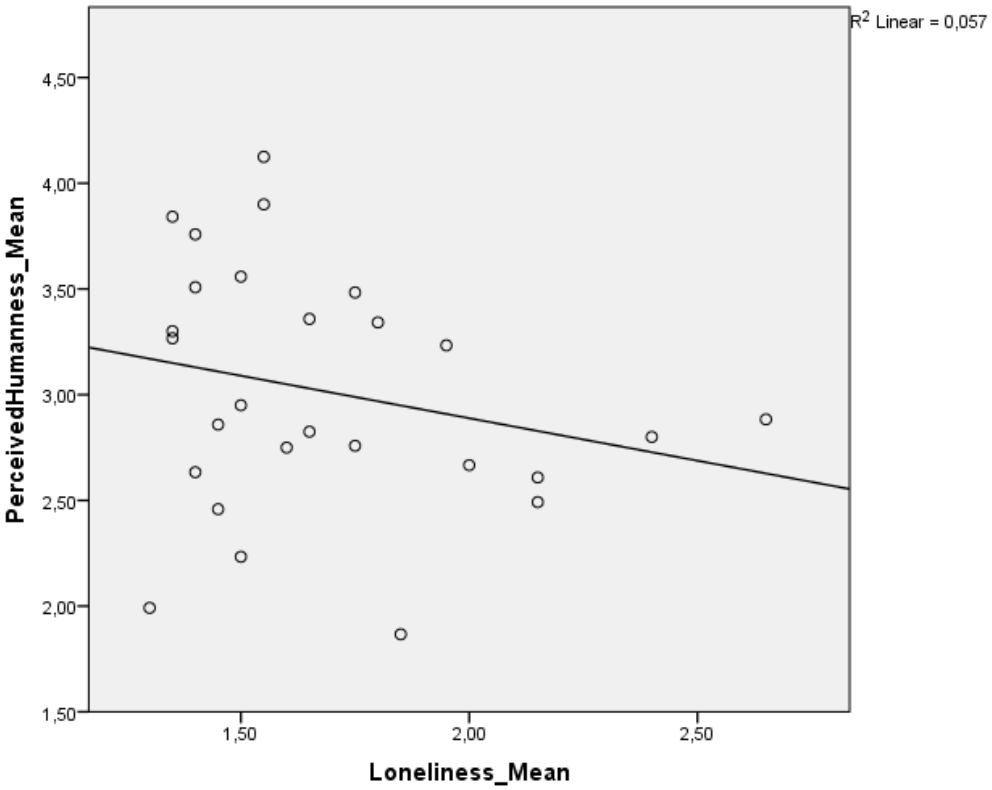

Figure 1. Negative correlation between 'Perceived Humaness' Mean and Loneliness Mean

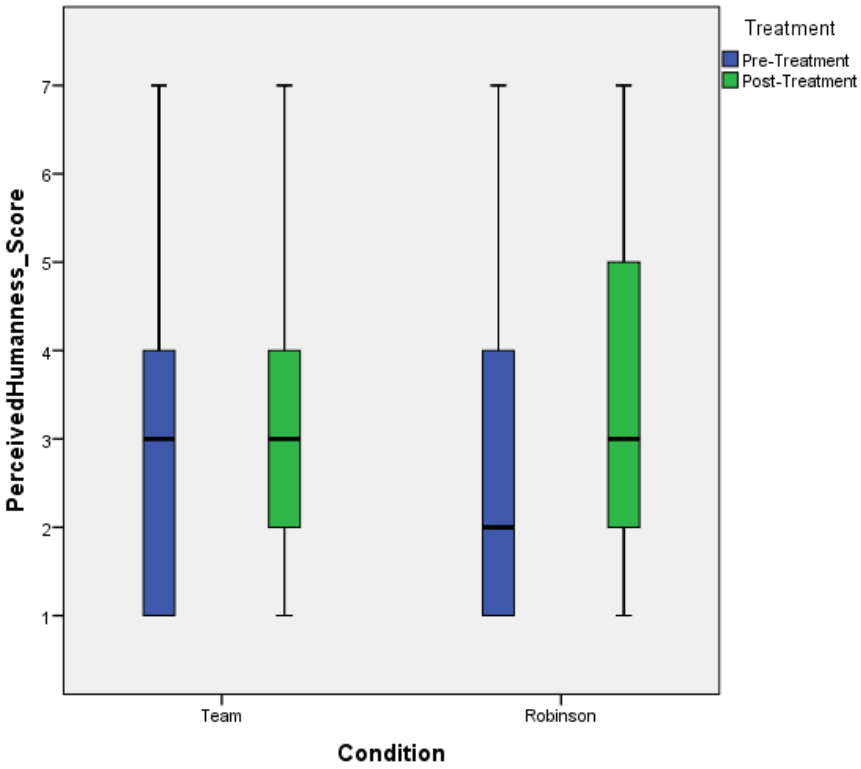

Figure 2. Boxplot 'PH' Responses sorted by the two conditions and divided in pre and post treatment

3.3 Linear Mixed Effects

The main and interaction effects were tested in a mixed linear effect regression to examine the effects between the predictors condition and treatment and the response of the 'Perceived Humanness' Scale and the variable Loneliness. The condition 'Team' and the pre treatment are used as the reference group. Further the z-score was used to standardize the variables and find differences between the effects. The linear mixed effects model tested the sub-hypothesis *"Socially disconnected people have a stronger tendency to anthropomorphize robots"*. A slightly positive, but moderate uncertain effect was found in the main effect post-condition (β=0.127, p= .07). A small negative effect was found between the two treatments 'Team' and 'Robinson' in the pre-condition, but with strong uncertainty of p=0.57 and β=-0.137. A negative effect was found in the main effect Loneliness, but with weak certainty (β=-0.234, p=.15). The biggest positive interaction effect was found between the post treatment and the condition 'Robinson' with a coefficient of 0.353 and a very strong certainty of p=.002. The interaction effect between Loneliness and post treatment is slightly positive, but with moderate certainty (β=0.115, p= .09). A positive effect was found in the interaction between the 'Robinson' condition and Loneliness, but with very strong uncertainty (β=0.101, p=.71). A moderate negative effect was found in three-way interaction of the post treatment , the condition 'Robinson' and Loneliness, but with no significant value (β= -0.041, p=.07). The interaction effects are listed in the *mixed effects* table 3.

Table 3. Mixed Linear Effects (Scores on the 'Perceived Humanness' Scale as dependent Variable)

			Confidence 95% Intervall	
Factor	Beta	P	Lower Bound	Upper Bound
(Intercept)	2.919	<.001***	2.291	3.697
Post_treat	0.128	.07	-0.009	0.280
ConditionRobinson	-0.137	.57	0.623	0.359
Loneliness	-0.235	.15	0.599	0.069
Post_treat*ConditionRobinson	0.353	.002**	0.166	0.553
Post_treat*Loneliness	0.116	.09	0.011	0.259
ConditionRobinson*Loneliness	0.101	.71	0.375	0.648
Post_treat*ConditionRobinson* Loneliness	-0.04	.70	0.242	0.169

**. Correlation is significant at the 0.001 level (2-tailed).

***. Correlation is significant below the 0.001 level (2-tailed).

4. Discussion

In this study we wanted to find a positive relationship between sociality motivation and the tendency to anthropomorphize nonhuman agents. Based on the found literature lonely people tend to substitute social bonds with other people and instead use nonhuman agents as social relationships. Based on the research of Epley et al. (2008) it was also found that putting people in social isolation leads to a higher tendency to anthropomorphize nonhuman agents. Concluding from the literature study we used two approaches to test loneliness with anthropomorphizing robots. The dispositional factor tested how lonely people are and the situational factor was distinguished in two conditions: one control and one manipulative condition. Another experiment from Epley et al. (2008) found that people in the loneliness condition were anthropomorphizing nonhuman agents higher. In the following paragraph we will discuss the results of the experiment and conclude if our study supports the findings of the previous researches or why our study does not support it.

The main hypothesis *"sociality motivation has a positive influence on anthropomorphism"* could not completely be confirmed regarding to the two sub-hypotheses.

With regard to the sub-hypothesis *"Socially disconnected people have a stronger tendency to anthropomorphize robots"* a significant result could be found. A positive effect was found in the 'Robinson' group in the post-condition with a coefficient of 0.353 and a p-value of .002. Additionally Figure 2 visualizes the effect of the pre and post treatment in the 'Robinson' condition and shows a higher response on the 'Perceived Humanness' Scale in the post treatment. This result undermines the findings in the literature and strengthens the research of Epley. In his results, participants were more likely to anthropomorphize nonhuman – agents , when they were situated in mental states of loneliness (Epley, Akalis, Waytz, & Cacioppo, 2008). Epley used three different kinds of nonhuman – agents: Technological gadgets, God and greyhounds. Our experiment replicates Epley's experiment by examining the likeability to anthropomorphize nonhuman – agents in lonely situations. The difference is that we used robots and found similar results.

The pre- condition of the two groups 'Team' and 'Robinson had no interaction effect. This result controls if we had a good randomization among the two groups in the pre-condition and therefore no significant results should be found. The same counts for the interaction effect between the two groups 'Team' and 'Robinson' with variables pre-treatment and loneliness,

but in this case we find a difference. The ‘Team’ condition is negative and the ‘Robinson’ condition is slightly positive, but because both are in the pre-treatment, this effect just appeared by chance. The interaction between Loneliness, the ‘Team’ condition and in the post treatment had a positive effect. This may be caused by the fact that lonely people, who see others cheering, receive a stronger state of loneliness and therefore score higher on the ‘Perceived Humanness’ Scale. The three-way interaction effect between the Condition ‘Robinson’, post treatment and Loneliness had a weak negative effect with no significant value (β=-0.04, p=.71). So this interaction effect had no influence on the response of the ‘Perceived Humanness’ Scale.

With these findings we can further examine the influence on humanlike robots and humanlike behavior of robots in interaction with humans. The physical appearance of robots is the most visible attribute (Satake et al., 2010). Research found out that difference in the shape of humanlike robots evoked different responses by the participants, thus the social interaction (Fong, T., Nourbakhsh, I., & Dautenhahn, 2003). Another important point is that anthropomorphic design can improve the effectiveness of a robot (DiSalvo, 2002). People perform better on a task as the behavior of a robot seems more natural and familiar (Fong, T., Nourbakhsh, I., & Dautenhahn, 2003). As we can apply the three factor theory of anthropomorphism to robots, this will give us deeper insights on how to design socially interactive robots. Participants reported in an experiment in which they had to fulfill a desert survival task that they had a better task performance as more humanlike faces and voices emerge on the display (Epley et al., 2007). Further the acceptance of robots can be improved by anthropomorphism. Designers can attribute humanlike physical features like shape, facial expression and gestures as well as social interaction like speech to a robot. The aim is not to transform a robot into a human, but using anthropomorphism to facilitate social connection (Eyssel, 2010). People experience robots more pleasant as they respond to the emotional state of the human and have a polite voice than functional robots (Fink, 2012).

4.2 Limitations

In this paragraph several points will be discussed which might had an influence on the outcome and validity of the experiment. At first it need to be mentioned that we found a gender effect after the first linear mixed effects analysis, but as we examined the analysis we found that one female participants scored extreme low on the 'Perceived Humanness' Scale and had to be excluded. The next analysis without the female participant did not show gender differences anymore. This finding underlines the result of Epley et al. who also found no significant gender differences (Epley, Akalis, et al., 2008).

A first limitation was that the 'Perceived Humanness' index by MacDorman and the UCLA Loneliness Scale had to be translated into German and Dutch. Especially the item *"human-made – humanlike*" caused much confusion, because the participants did not really know the difference between the meanings of the words. In the UCLA Loneliness Scale respondents had many difficulties to understand the statements and that leads to different meanings of a word. In the case of the statement *"I do not feel alone"* a revised item was used and in connection with the given option *"Never"*, the participants could not figure out what their actual statement said over their opinion. This might lead to a weak validity of the translated versions.

A second limitation could be that not all videos contained humanlike robots and the appearance also found to be a problem. We also introduced animalistic robots, which for most participants did not have any humanlike features and were rated very low, in this case very mechanic. In contrast, robots which had a human shape and humanlike facial expression were rated very high on the 'Perceived Humanness' Scale. Mori et al (2012) found in his studies that android robot which for viewers seemed very humanlike evoked a positive emotional response. In some cases a human-human empathy level was reached (Mori, MacDorman, & Kageki, 2012). But Epley added pets to his experiment to examine an association between perceived loneliness and anthropomorphism and found significant results, This suggests that also other nonhuman agents have influence despite of humanlike robots (Epley, Akalis, et al., 2008).

A third limitation was the collected sample. Most of the loneliness scores are around the mean. Therefore the sample lacked of people who felt lonely and we could not really examine the relationship between chronicle lonely people and their tendency to anthropomorphize nonhuman agents. A suggestion would be to use Propensity Matching. In this case

participants are matched due to similar characteristics and then are compared to each other on an independent variable. With this technique confounding variables which might bias the outcome are reduced. This leads to a better comparison of the treatment condition.

The last limitation is referred to the 'uncanny valley' of Mori et al. (2012). Mori describes it in his research that androids that cannot be distinguished of humans evoke a negative emotional feeling and in some cases eeriness because of their appearance and the humanlike actions. On the other hand robots that do not resemble a human perfectly evoke a positive feeling and even empathy by the viewer. This suggests that the perceived humanness index cannot alone predict how humanlike a nonhuman agent is. Referring to Ho and MacDorman (2010) the affective components '*attractiveness', 'warmth'* and *'eeriness'* also need to be included to measure anthropomorphism.

4.3 Future research

The suggestions for further research are mainly based on the limitations. First of all a higher sample size and a propensity matching may lead to better significant results. Therefore a matching before the experiment is recommended to have an evenly distributed sample of lonely and socially connected people. Another suggestion is to use proper anthropomorphistic and loneliness measures. As seen in the experiment the UCLA Loneliness Scale, a few statements were not clear and lead to confusion. In this case using the improved third version of the UCLA Loneliness Scale may lead to better results. Therefore using an improved UCLA Scale and adding the affective components of the 'Perceived Humanness' Scale may lead to more significant results. Further using more humanlike robots in the videos and removing the animalistic videos lead to an improved understanding of the 'Perceived Humanness' Scale, because most respondents rated animalistic robots very low.

A possible next research question would be which features a robot must have or in what extent a robot has to be humanlike to be effective and socially accepted by its human counterpart. The new research may lead to deeper insights in the design of social robots.

4.4 Conclusion

In our study we could not completely confirm the main hypothesis *"Socially motivation has a positive influence on anthropomorphism"*. Further we were also not able to find significant results regarding the sub-hypothesis *"chronicle lonely people have a stronger tendency to anthropomorphize robots"*. But we were able to find a positive and significant effect according to the sub-hypothesis *"Socially disconnected people have a stronger tendency to anthropomorphize robots".* With this finding we could strengthen the key determinant sociality motivation in the 'three-factor theory of anthropomorphism' of Epley. We could even extent his experiment by adding robots to the nonhuman agents and verify that people situated in social isolation tend to give nonhuman agents more humanlike traits than people in the control condition.

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6. Appendix

6.1 Syntax

Mixed Linear Model: Fixed effects: Subject,item, stimulus ; Random effects: Condition, pre/post treatment and gender, covariance: Loneliness

```
GET
  FILE='C:\Users\Privat\Downloads\long version complete.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
MIXED Response BY post_treat Condition Gender WITH Loneliness
  /CRITERIA=CIN(95) MXITER(100) MXSTEP(10) SCORING(1)
SINGULAR(0.000000000001) HCONVERGE(0,
    ABSOLUTE) LCONVERGE(0, ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
  /FIXED=post_treat Condition Gender Loneliness post_treat*Condition post_treat*Gender
    post_treat*Loneliness Condition*Gender Condition*Loneliness Gender*Loneliness
```

```
    post_treat*Condition*Gender post_treat*Condition*Loneliness post_treat*Gender*Loneliness
    Condition*Gender*Loneliness post_treat*Condition*Gender*Loneliness | SSTYPE(3)
  /METHOD=REML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(Subj) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(Stim) COVTYPE(VC)
  /RANDOM=INTERCEPT | SUBJECT(Item) COVTYPE(VC).
```

Correlation between Condition, UCLA Mean Score, PH Mean Score, Gender, Age

```
DATASET ACTIVATE DataSet2.
CORRELATIONS
  /VARIABLES=Condition UCLA_mean PH_mean Gender Age
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE.
```

Frequency correlation: Gender, Age and Condition

```
FREQUENCIES VARIABLES=Gender Age Condition
  /STATISTICS=STDDEV MEAN
  /BARCHART FREQ
  /ORDER=ANALYSIS.
```

6.2 Questionnaires

‘Perceived Humanness’ Index

Perceived Humanness Scale

In the following you find a number of word pairs. We would like to know what impression you have received from the robot/robots. Therefore we are asking you to mark but **one** of the seven digits that stand between the words. The procedure can be explained best through the following example:

What impression gave you the robot?

The Robot is/was: Fast 1 2 3 4 5 6 7 Slow

When you think that the robot is/was for example fast, than you mark digit 1. When you think that the robot is/was slow you mark digit 7. Of course, you may also make use of the digits in between. There is no right or wrong answer, as long as your answers represent the impressions you have received from the robot/robots.

The digits in this example mean the following:

1: fast

2: rather fast

3: a bit fast

4: a bit of both

5: a bit slow

6: rather slow

7: slow

Humanness index(6items):

Artificial	1	2	3	4	5	6	7	Natural
Human-made	1	2	3	4	5	6	7	Humanlike
Without definite lifespan	1	2	3	4	5	6	7	Mortal
Inanimate	1	2	3	4	5	6	7	Living
Mechanical movement	1	2	3	4	5	6	7	Biological movement
Synthetic	1	2	3	4	5	6	7	Real

UCLA Loneliness Scale

R – UCLA Loneliness Scale

Indicate how often you feel the way described in each of the following statements. Circle one number for each.

Statement	Never	Rarely	Sometimes	Often
1. I feel in tune with the people around me.	1	2	3	4
2. I lack companionship.	1	2	3	4
3. There is no one I can turn to.	1	2	3	4
4. I do not feel alone.	1	2	3	4
5. I feel part of a group of friends.	1	2	3	4
6. I have a lot in common with the people around me.	1	2	3	4
7. I am no longer close to anyone.	1	2	3	4

8. My interests and ideas are not shared by those around me.	1	2	3	4
9. I am an outgoing person.	1	2	3	4
10. There are people I feel close to.	1	2	3	4
11. I feel left out.	1	2	3	4
12. My social relationships are superficial.	1	2	3	4
13. No one really knows me well.	1	2	3	4
14. I feel isolated from others	1	2	3	4
15. I can find companionship when I want it.	1	2	3	4
16. There are people who really understand me.	1	2	3	4
17. I am unhappy being so withdrawn.	1	2	3	4
18. People are around me but not with me.	1	2	3	4
19. There are people I can talk to.	1	2	3	4
20. There are people I can turn to.	1	2	3	4