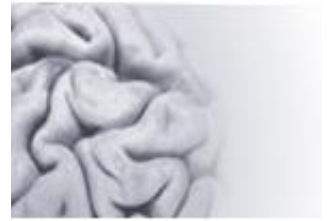




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Evil Pentagons and Crying Squares:

The Influence of Loneliness on the Perception and Prediction of Humanlike Features in Geometrical Shapes

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Abstract

The present study investigated whether loneliness influenced the degree of anthropomorphism toward geometrical shapes. Ninety-two participants watched and evaluated fifteen videos of geometrical shapes showing non-random harmful or helpful movements or random movements, after answering personality questions. We manipulated loneliness by providing participants feedback that their answers on the personality test indicated loneliness later in life. People in the control condition would always enjoy successful relationships. Participants then described the unfolding events in the videos and made a prediction about the shapes' behaviour during future actions. We counted all verbs and adjectives used in the descriptions and the number of behaviour-relevant predictions of shapes' future behaviour to determine degree of anthropomorphism. Participants in both conditions anthropomorphised harmful behaviour more than both helpful and random behaviour. Participants in the lonely condition predicted a significantly higher degree of helpful behaviour when making behaviour-relevant predictions. People in general seem to be biased towards negativity. Also, feeling lonely may have elicited a more positive prediction in order to balance these negative feelings.

Keywords: anthropomorphism, loneliness, need to belong, nonhuman agent

**Evil Pentagons and Crying Squares: The Influence of Loneliness on the Perception
and Prediction of Humanlike Features in Moving Geometrical Shapes**

People thrive on positive social contact with others. They have a remarkable talent for detecting, communicating with and understanding the mind of other humans (Thompson, Trafton, & McKnight, 2011). People need intimacy, a feeling of belonging, and the affirmation of their identity and value (Heinrich & Gullone, 2006). This desire for interpersonal attachments is considered a fundamental and universal motivation (Baumeister & Leary, 1995).

In the absence of social interaction, people may start to compensate by creating a sense of human connection with nonhuman objects. The Hollywood motion picture *Cast Away* (Hanks & Zemeckis, 2000) demonstrates this phenomenon, in which a man (played by Tom Hanks) is stranded on an uninhabited island after a plane crash. Deprived of human contact, he starts to attribute human characteristics to a volleyball by giving it a name and talking to it as a friend. Perhaps deprivation of social contact makes people inclined to search for human features in inanimate objects and behave toward them as if they were human.

Why is it desirous for people to make social contact and why do they have such a strong need to belong? According to several researchers, it has an evolutionary basis (Baumeister & Leary, 1995; Cacioppo & Hawkley, 2003). Forming social attachments has protective value and provides opportunities for reproduction. Thus, forming a group and staying together has always been a fundamental human motivation (Baumeister & Leary, 1995; Cacioppo & Hawkley, 2003). In line with this, Barrett and Hanks Johnson (2003) claim that detecting intentional agents may also have served as a survival tool:

understanding some other person's mind improves group coordination and aids in spotting danger. This is why humans are extremely sensitive to social cues in their environment. Even as infants, people are able to distinguish between humans and non-humans (Johnson, 2003; Johnson, Booth, & O'Hearn, 2001). Infants also interact more with real humans in comparison to inanimate objects, showing more gestures, sounds, and facial expressions (Johnson, 2003).

People can even attribute typically human intentionality and emotional states to nonhuman agents (Barrett & Hanks Johnson, 2003). This phenomenon is called the anthropomorphising of agents (Epley, Waytz, Akalis, & Cacioppo, 2008) and will be discussed below.

Individuals who have a relatively high need to belong are also more sensitive to social cues in their environment (Baumeister & Leary, 1995; Pickett, Gardner, & Knowles, 2004). Pickett et al. (2004) studied the capacity of people to perceive social cues like vocal tone and emotional facial expressions. Participants completed the Need to Belong Scale beforehand (Leary, Kelly, Cottrell, & Schreindorfer, 2013) and would be linked to another person to perform a group task. The researchers told half of the participants that none of the others wanted them as their partner to evoke a sense of social exclusion. The other participants were picked at random by a computer to work alone. Pickett et al. (2004) then presented their participants with pictures of faces expressing certain emotions and words pronounced in either a negative or a positive tone of voice. People had to name the matching facial expression and voice tone. Pickett et al. (2004) found that individual differences in the need to belong positively related to the accuracy with which participants recognised vocal tone and facial expressions. People with a high

need to belong, being more sensitive to human cues, are more likely to be negatively affected by loneliness than people who have a less stronger need to belong.

Degrees of Mental State Attribution

Researchers define an object or organism as an agent if it displays a higher sense of cognitive processing or mental state, such as intentions, planning, self-control, and communication (Gray, Gray, & Wegner, 2007; Johnson, 2003; Pantelis et al., 2014; Waytz, Gray, Epley, & Wegner, 2010). In other words, agents are perceived to have a mind of their own.

Gray et al. (2007) found that there are several dimensions of mental state attribution: they provided their participants with the opportunity to attribute agency as well as experience to several life forms and objects (humans in a couple of age categories, God, three nonhuman animals, a dead person, and a sociable robot). Agency was defined in terms of having capacities that indicated the possession of a mind. Experience meant the extent to which certain emotions were experienced (for example hunger, fear, pain, pride, and joy). Participants thought of God as having much agency but only little experience (Gray et al., 2007). Mature humans were perceived to have both much agency and experience, whereas the animals were thought of as having little agency but quite a bit of experience. Apparently categories exist in terms of mental state attribution (Gray et al., 2007).

Being able to attribute intentions and emotional states to nonhuman agents does not even require the agent to have a humanlike form (Barrett & Hankes Johnson, 2003). In their famous research, Heider and Simmel (1944) presented participants with a short

movie fragment in which three two-dimensional geometrical shapes (a big triangle, small triangle, and a circle) moved around and inside an inanimate rectangle that could be opened. Participants were strongly inclined to attribute emotional states, intentions, personality traits, and even gender to the behaviour of the shapes (Heider & Simmel, 1944).

Interestingly enough, in the case of an extremely high degree of human resemblance, the effect of human attribution declines to make way for a feeling of eeriness. Near-perfect human likeness can sometimes be perceived as unpleasant or discomfoting, a phenomenon called the “uncanny valley” (Burleigh, Schoenherr, & Lacroix, 2013; Gray & Wegner, 2012; Press, 2011; Thompson et al., 2011). If the human resemblance starts to approach “perfection”, people’s emotional reactions toward the object become extremely negative. The cause of the uncanny valley still remains unclear. Possible explanations range from the evolutionary need for self-preservation and protection against disease to the realisation that artificial humans call into question the superiority of real ones (MacDorman, Green, Ho, & Koch, 2009).

When does Attributing Humanness to Agents occur?

Under some circumstances, people are even likely to attribute humanness to nonhuman agents (Press, 2011). First, having no sense of control over the nonhuman agent makes it seem more humanlike. Researchers have argued that the need for control over the environment is one of the most essential needs of humans (Epley, Waytz et al., 2008). It also is known that people who have a stronger need for control, tend to anthropomorphise more when presented with unpredictable behaviour of a nonhuman

animal. Epley, Waytz et al. (2008) presented their participants with a short movie of two dogs, one performing predictable behaviour, the other unpredictable behaviour. As expected, the unpredictable dog induced more anthropomorphic inferences (Epley, Waytz et al., 2008).

Moving by itself is a second determinant of the attribution of humanness to agents. This phenomenon is referred to as animacy (Johnson, 2003; Meyerhoff, Huff, & Schwan, 2012; Scholl & Tremoulet, 2000). Animacy and a lack of control are topics that are highly interconnected. If people have no control over the movements of the objects or shapes, they will perceive the shapes as being more animate (Meyerhoff et al., 2012).

Barrett and Hanks Johnson (2003) performed an experiment using an interactive electromagnetic puzzle. They provided participants with the opportunity to control an electromagnet that moved marbles along a trajectory. Participants lacking control over the magnet were more inclined to attribute agency to the (now apparently self-moving) marbles (Barrett & Hanks Johnson, 2003). Franconeri and Simons (2003) add that moving objects especially capture people's attention if they seem to be goal-directed.

In addition, people are known to base their mind attribution to an agent on the speed of movement. Actions taking place at a speed quite similar to human movement are more likely to be perceived as intentional acts (Morewedge, Preston, & Wegner, 2007). Agents moving at a speed slower or faster than human tempo do not tend to elicit strong mental state attributions. If movement takes place too slow to be noticeable (like a plant growing toward the sunlight), people often do not ascribe mental states to the agent. On the other hand, moving too quickly does not give the observer time to attribute any intentions to the agent. Thus, speed of movement is essential (Morewedge et al., 2007).

Furthermore, attaching humanoid parts to an agent can make it seem more anthropomorphic. Osawa, Matsuda, Ohmura, and Imai (2012) provided a cart with a voice, eyes and/or a mouth and let participants engage in a simple conversation with the cart. They discovered that voice was a key factor in making the cart seem anthropomorphic (Osawa et al., 2012). Experiments with infants demonstrated that they were more likely to focus their attention on a moving inanimate object if it either had a face (Farah, Wilson, Drain, & Tanaka, 1998; Johnson, 2003) or reacted with beeps to their own vocalisations (Johnson, 2003).

Anthropomorphism sometimes occurs in order to cope with stress that is triggered during interaction with technical devices (Luczak, Roetting, & Schmidt, 2003). A high majority of participants in the research by Luczak et al. (2003) reported “interacting” frequently with their computer, car, television set, or other technical appliances around the house. People employed aggressive behaviours such as hitting or scolding the apparatus if it failed to function as expected. Other forms of interaction were more positive, for instance talking to the device appealingly and feeling that it had to be “motivated” in order to work as planned. Luczak et al. (2003) conclude that talking to (and thus anthropomorphising) a malfunctioning device can be a stress-reducing tool.

Finally, being in a state of loneliness makes people more likely to attribute humanness to agents. This is explained in more detail below.

What is Loneliness?

The concept of loneliness is defined by Jones (1981) as a mental state in which a person’s social network is smaller or less satisfying than desired by that person.

Loneliness can either be studied as the objective amount of social interaction (by measuring time spent with other people or number of friends) or as the subjective perception of loneliness of the lonely person him- or herself. Jones (1981) favours the subjective interpretation, because the quality of the interactions may matter more than the quantity. Other research has confirmed that loneliness can even be felt by people who have a widespread network of social relationships (Hawkley & Cacioppo, 2010; Miller, 2011). In this case, people strongly feel a lack of emotional intimacy with others (Shiovitz-Ezra & Ayalon, 2010). This finding points to a distinction between social isolation and loneliness. People can be socially isolated, yet not feel lonely (Miller, 2011; Shiovitz-Ezra & Ayalon, 2012).

According to Shiovitz-Ezra and Ayalon (2010), two types of loneliness exist. Situational loneliness refers to the temporary state of feeling lonely after experiencing a stressful life event like the death of a spouse or moving to another city. Even though the psychological distress that these events bring about can be severe, recovery from situational loneliness can in time be achieved (Shiovitz-Ezra & Ayalon, 2010). In contrast, chronic loneliness is defined as a more stable state that is reached if a person is incapable of forming intimate and satisfying social relationships. In this case, coping and recovery become more problematic (Heinrich & Gullone, 2006; Shiovitz-Ezra & Ayalon, 2010).

Researchers have extensively studied the circumstances under which loneliness is likely to occur (Victor, Scambler, Bowling, & Bond, 2005). People who are particularly and independently vulnerable for experiencing loneliness are those who have become a widow(er), have seen an increase in loneliness in the preceding decade, have a poor

current health, and have a poorer health in old age than expected (Victor et al., 2005).

Other factors are also associated with loneliness, for example living alone, having a history of anxiety and/or depression, size of social network, and lower income (Victor et al., 2005).

What about gender differences in loneliness? The results from various studies are seemingly contradictory, showing that women more frequently acknowledge being lonely, whereas men gain higher loneliness scores on self-reported scales (Borys & Perlman, 1985). These differences may originate from the prescriptive gender roles. Participants in the experiment were more rejecting towards a lonely man than a lonely woman. Borys and Perlman (1985) suggest that men are less likely than women to admit their feelings of loneliness because they do not want to be called unmanly, but that there are no gender differences in general.

Consequences of Loneliness for Health

Feeling lonely has proved to have a strong negative influence on both physical and mental health (Heinrich & Gullone, 2006). Lonely people have a higher number of cardiovascular health risks such as elevated blood pressure and cholesterol levels, and even an increased mortality rate (Cacioppo & Hawkley, 2003; Hawkley & Cacioppo, 2010; Miller, 2011; Shiovitz-Ezra & Ayalon, 2010). The reason for this is that being lonely in and of itself is a very stressful and unpleasant experience (Miller, 2011). Psychological stress can lead to physical health problems if the stress takes place too often and is not properly dealt with (Sapolsky, 2004).

Loneliness is also strongly associated with personality disorders, depressive symptoms, impaired cognitive performance, general fatigue and low energy, and even suicide (Hawkley & Cacioppo, 2010; Heinrich & Gullone, 2006; Miller, 2011; Neeleman & Power, 1994; Richman & Sokolove, 1992; Shiovitz-Ezra & Ayalon, 2012; Twenge, Baumeister, Tice, & Stucke, 2001). Depressed persons report feeling less social support than medical controls even if the actual amount of support is the same (Neeleman & Power, 1994). The negative impact of loneliness is strengthened if people do not have effective strategies for coping with their feelings (Revenson, 1981) and if loneliness is chronic (Shiovitz-Ezra & Ayalon, 2010). Heinrich and Gullone (2006) emphasise that instead of only focusing on loneliness as an appendage of other problems, the subject should deserve clinical attention in its own right.

Lonely people usually have a very hostile and threatening perception of their environment (Hawkley & Cacioppo, 2010; Park & Baumeister, 2015). Feeling socially connected to other people sustains and buffers the self-esteem, but self-esteem diminishes in the case of little social connection (Hawkley & Cacioppo, 2010). Low self-esteem can result in feeling pessimistic about social interactions, eliciting a self-fulfilling prophecy in which lonely people start to behave in a way that confirms their negative expectations. They also tend to remember any negative social information from social intercourse better. Altogether, this results in lonely people perceiving the world around them as unsafe (Hawkley & Cacioppo, 2010; Park & Baumeister, 2015) and being highly motivated to seek security. As Lambert, Fincham and Stillman (2012) claim, positive emotions such as curiosity create the urge to explore and gather new experiences. However, most lonely people no longer actively seek positive and rewarding outcomes,

but are very cautious to undertake any action that encompasses social risk (Park & Baumeister, 2015).

As a result of their having such a threatening world perspective, lonely individuals exhibit more aggressive behaviour, making it even harder to gain positive social experiences (Check, Perlman, & Malamuth, 1985). Check et al. (1985) gave participants the opportunity to punish an experimental confederate for rejecting them and being critical about their performance on a difficult task. This punishment consisted of giving the confederate aversive noise, an indicator of aggressive behaviour. Self-reported lonely males showed the highest rates of aggressive noise-giving. Twenge et al. (2001) replicated these results. Twenge et al. (2001) let participants partake in a personality questionnaire. Afterwards, they provided false personality information about the participants being at risk for ending up lonely later in life. When given the opportunity to evaluate an anonymous person who had given them an insulting and critical essay review, individuals in the “future alone” condition gave the highest negative rates of that person. Negative evaluation indicated aggression since it could prevent the anonymous person from getting a desired job (Twenge et al., 2001).

Relation between Loneliness and Anthropomorphisation

People in general have a strong sociality motivation, which means they are always on the lookout for connections to other people (Epley, Akalis, Waytz, & Cacioppo, 2008). In an attempt to achieve some kind of social connection, they may increasingly turn their attention to social cues in their environment (Epley, Akalis et al., 2008).

Although their primary goal may be to seek connection with other humans, a substantial

body of research suggests that people may even start to attribute humanlike features to nonhuman agents: a phenomenon called anthropomorphism (Epley, Akalis et al., 2008; Epley, Waytz et al., 2008; Kwan & Fiske, 2008; Luczak et al., 2003; Osawa et al., 2012; Waytz, Cacioppo, & Epley, 2010; Waytz, Morewedge et al., 2010). These characteristics may vary from a humanlike appearance to the inference of humanlike thoughts, emotional states, and motivations (Gray et al., 2007). Anthropomorphism not only involves a perception of the object as humanlike, but also entails acting toward the agent as though it actually is human (Epley, Waytz et al., 2008).

Lonely people by definition experience either a shortcoming of social interactions or a lack of satisfying and close relationships with others (Jones, 1981; Miller, 2011). To compensate for their social deficit they may be even more sensitive to social cues than people who are not lonely. This makes them highly susceptible towards detecting humanlike characteristics in agents. Epley, Waytz et al. (2008) tested this phenomenon by asking participants to evaluate pets on anthropomorphic traits related to social connection (such as thoughtful, considerate), traits unrelated to social connection (like creative, devious), and non-anthropomorphic traits that were just behavioural descriptions (such as energetic, aggressive). Self-reported lonely participants attributed the highest number of anthropomorphic traits related to social connection to their pets, indicating that they created social support in their pets themselves (Epley, Waytz et al., 2008).

Researchers found the same results (Epley, Akalis et al., 2008) when manipulating participants to feel lonely by letting them watch a fragment from the motion picture *Cast Away* (Hanks & Zemeckis, 2000).

Present Research

It is very important to examine the topic of loneliness, since it involves so many negative consequences for people's mental and physical health (Cacioppo & Hawkley, 2003; Hawkley & Cacioppo, 2010; Miller, 2011). Furthermore, the prevalence rates of loneliness have shown a steady increase over the last decades. In the United States, a remarkable 17% of people aged fifty or older reported suffering from loneliness (Theeke, 2010). In the Netherlands, nearly forty percent of the adult people in 2012 reported feeling somewhat or extremely lonely in a study by the Dutch Governmental Institute of Public Health and Environment (Rijksinstituut voor Volksgezondheid en Milieu [RIVM], 2013). Being elderly, divorced, or having a disability further increased these rates. If we can understand under what circumstances loneliness emerges, we can formulate methods for prevention. Since mind perception of nonhuman agents is one of those circumstances, it is crucial to study this topic in depth.

The present research addressed the impact of loneliness on anthropomorphising of nonhuman agents. Participants viewed movies of moving geometrical shapes that either "helped", "harmed" or did not affect another shape and gave a description of the unfolding events in the movies. We expected these explanations to entail attributions of mental states. We chose helpful and harmful behaviours since these are archetypes of "good" and "bad" human conduct that require intentionality. We wanted to find out if behaviour type affected the degree of anthropomorphism.

Participants also predicted the likelihood of a variety of future behaviour by the shapes. People are known to automatically make trait inferences and predictions based solely on observed behaviour (McCarthy & Skowronski, 2011). Little research exists that

focuses on the prediction of anthropomorphic behaviour in nonhuman agents. Also, any prediction about future intentions indicates the attribution of personality traits to the shapes. Predicting a shape to intentionally display behaviour consistent with past actions can only occur if the shape is perceived to act according to its “character”. By asking participants to provide a description as well as a prediction, we measured two different aspects of anthropomorphism: both the attribution of mental states and personality traits.

The central research question to this experiment was whether lonely people were more inclined to perceive nonhuman agents as having human traits, in comparison to socially well-connected people. In order to investigate this, we divided participants into two groups. We made the first (experimental) group feel lonely by giving them the information that they would end up lonely later in life. We told the second (control) group that their social life would continue to flourish. We investigated the degree of anthropomorphisation by measuring the difference between all neutral and human verbs participants used to describe the videos. In addition, we processed the number of behaviour-consistent predictions of the future behaviour of the shapes. The research question was investigated in depth using the following hypothesis.

We expected that participants in the experimental condition would experience a sense of loneliness and therefore be more inclined to perceive the nonhuman shapes as human. They were expected to use a higher rate of human verbs and adjectives than their counterparts in the control condition and predict more anthropomorphic behaviour during future actions. This hypothesis is based on the theory that feeling lonely means having a lack of social cues and generates moving to nonhuman objects to still achieve some kind of social connection (Epley, Akalis et al., 2008; Pickett et al., 2004; Waytz, Cacioppo et

al., 2010). We had no expectations regarding the degree of mental state attributions of either harmful or helpful behaviour, so merely used these behaviour types to explore potential differences.

In line with this, we hypothesised that participants in the control condition would not experience a sense of loneliness and therefore be less inclined to perceive the nonhuman shapes as human, in comparison to the experimental condition. We nevertheless expected them to anthropomorphise to some degree. This is a very common reaction since people in general have the tendency to perceive beings as themselves (Waytz, Cacioppo et al., 2010).

Method

Participants

The final group of participants consisted of $N = 92$ (27 males, 65 females), ranging in age from 16 to 42 ($M = 21.86$, $SD = 3.18$). The high majority of participants were a Dutch native ($n = 85$) and had attained a high educational level ($n = 61$ graduates on VWO-level, $n = 22$ university bachelor or master graduates, $n = 9$ graduates on havo- or HBO-level). As for religious background, atheism was most often reported ($n = 48$) followed by being Christian ($n = 26$).

Instruments

We programmed the experiment itself using Qualtrics. To account for the participants' need for belonging prior to the experiment, we used the reliable Need to Belong Scale formulated by Leary et al. (2013). The Need to Belong Scale consists of ten

questions about the individual's urge for belonging, such as: "I do not like being alone" and "My feelings are easily hurt when I feel that others do not accept me". The higher the score on an item, the higher the Need to Belong of that particular person. Participants pointed out the degree to which the statement applied to them on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Moreover, we used the first thirty items of the Eysenck Personality Questionnaire translated in Dutch (Sanderman, Arrindell, Ranchor, Eysenck, & Eysenck, 2012).

Participants either agreed or disagreed to several personality-related questions. Even though the total questionnaire consists of 48 items, we did not implement all items since we exclusively used the questions to manipulate participants and not for data analysis.

For the manipulation check, people rated to what extent they felt six emotions at that moment on a five-point scale (1 being *absolutely disagree*, 5 *absolutely agree*). These emotions were sad, happy, lonely, at ease, tense, and satisfied.

Finally, participants had to make a prediction of the behaviour of the shapes by answering eight questions immediately following each video fragment. Four questions asked about positive behaviour showed in the videos: the likelihood of the shape helping the other shape to clear items away, climb a staircase, escape a closed space, and sorting elements in the future. The exact same questions addressed these behaviours in a negative way, asking about the likelihood of one shape preventing another shape from carrying out these four actions. Participants answered these questions on a five-point scale (1 meaning *highly unlikely*, 5 *highly likely*) each time after viewing a movie. The behaviour that was asked about was sometimes relevant to the preceding video (like asking about the likelihood of helping to clear items away when the preceding video showed the shape

doing exactly this). Other times, the behaviour was irrelevant either because we enquired after the same behaviour type (helping or hurting) but asked a non-matching prediction question, or because the opposite behaviour had been showed.

Procedure

We recruited participants by putting advertisements about the experiment on Facebook. Also, the word was spread among the researcher's friends and acquaintances. We did not inform people of the true nature of the experiment, but told them that it was about the individual perceptions of certain shapes. The only selection criteria were Dutch-speaking and to be eighteen years of age or older. We did not further specify these criteria in order to reach the highest possible variation in the sample.

We sent participants an internet link to be able to partake at any given time. They were asked to read the instructions carefully and put any distractions (such as telephones) away. Participation took place anonymously and on a voluntary basis. As a reward, people received €3,-. Participants had the right to quit the experiment at any desired moment without stating a reason for this. In that case, they would receive no reward. The experiment took approximately thirty minutes.

First of all, participants gave some demographic information: gender, age, nationality, religious background, and educational level. Afterwards, they received further instructions about the experiment itself. We asked them to answer all questions as honestly as possible without thinking too long about their answers. They were told that they had to fill out a questionnaire about their personality before viewing a couple of movie fragments involving geometrical shapes in motion. Participants gave a description

of these movies afterwards. We used no anthropomorphic terms to describe what would be showed to prevent participants from starting to anthropomorphise before they had seen any of the videos.

Subsequently, we asked participants to complete thirty items of the Eysenck Personality Questionnaire (Sanderman et al., 2012). When finished, we told them that their results were being processed and would add up to a short personality description. From this moment on, every single participant was randomly assigned to one of two conditions.

Conditions. In the experimental condition, participants read that their personality type was an indicator of becoming lonely later in life, stating: “You are the type of person who ends up lonely later in life. Even though you have friends and relationships now, they are not likely to hold in the future. Chances are that you will end up being alone more and more.”

On the other hand, participants in the control condition received the information that they would end up having lots of successful relationships and never be lonely: “You are the type of person who has rewarding relationships throughout life. The friends and relationships that you have now, are likely to hold in the future. Chances are that you will always have friends and people around who care about you.” We replicated both of these manipulations from the experiment by Twenge et al. (2001).

Manipulation check. The loneliness manipulation was immediately followed by a manipulation check, involving people’s ratings of six emotions felt by them at that very moment. These emotions were sad, happy, lonely, at ease, tense, and satisfied.

We then showed participants fifteen short movie fragments of moving geometrical shapes. The fragments always involved two shapes at the time. A square was present in every single movie. The other two shapes were a circle always engaging in “helping” behaviour and a pentagon always portraying “hurting” behaviour. In the random movies, the presence of either the pentagon or the circle was varied. The movies also showed inanimate objects used by the shapes, like a staircase or triangles that were put away in a box.

The “helping” behaviour consisted of the circle helping the square escape from a closed box, sorting objects, putting objects away, and climbing a staircase. The “hurting” behaviour entailed the pentagon disallowing the square to perform these actions. In the random videos, both shapes moved around the screen in a random motion. All participants viewed the same five movies of all three types of behaviour. Immediately following each video fragment, they described as accurately as possible what they had witnessed. We gave them a blank box on the screen to write down whatever they wanted without a time limit. Time pressure was therefore not an issue.

Prediction questions. The participants also had to make a prediction about the behaviour of the shapes by answering questions such as: “How likely is this shape to help the other shape to escape a trap? How likely is this shape to help the other shape climbing a staircase?” We also asked questions about hurting behaviour: “How likely is this shape to prevent the other shape from sorting objects? How likely is this shape to prevent the other shape from putting objects away?”

Finally, participants filled out a ten-item questionnaire about their need for belonging: the Need to Belong Scale (Leary et al., 2013). The experiment being now at

an end, we debriefed participants about its true purpose. We told them that the experiment was not about individual perceptions, but actually about the relation between feeling lonely and the tendency to perceive moving objects as human. People finally noted their bank account number, allowing the researcher to transfer the reward sum of €3,-.

Data Analysis Strategy

Manipulation check. We computed the manipulation check questions (rating of the six emotions) into two separate scales. The three positive emotions (happy, at ease, satisfied) were taken together and averaged, as were the three negative emotions (sad, lonely, tense). We then conducted reliability analysis for both scales.

Anthropomorphism in descriptions. Anthropomorphism and agency are terms often used interchangeably (Waytz, Cacioppo et al., 2010), but anthropomorphism goes beyond merely attributing life to an inanimate object or describing observable behaviour. The essence lies in qualities that people think of as distinctly human. We used the distinctions made by Epley, Waytz et al. (2008) and Waytz, Cacioppo et al. (2010) to determine the amount of anthropomorphising in the text descriptions. We defined words as anthropomorphic if they consisted of attributing personality traits or a humanlike mind to the shapes like emotions, intentions, and conscious awareness. We did not count words as anthropomorphic if they only described the shapes in terms of being alive and able to move by themselves. Although primary emotions like anger or happiness are not distinctly human, they are still part of the experience of being human (Demoulin et al., 2004). Therefore, we counted both primary and secondary emotions as anthropomorphic.

During data inspection, other terms came across that were indications of anthropomorphism, such as human actions (celebrating, giving a high five, crying when hindered) or the inference of a human relationship between shapes (siblings, friends, enemies, or parent and child). We did not count mental state words used by ourselves in the prediction questions as anthropomorphic (such as “help”, “hurt”, and “escape”) since participants did not come up with these words themselves.

We made a count of the number of anthropomorphic inferences in the text descriptions by listing all the verbs and adjectives. If participants used the same word more than once, it was counted individually each time. Verbs describe the actions of a person, whereas adjectives describe personal traits (Harris & Fiske, 2011; Semin & Fiedler, 1989) and control for the abstract nature of mental state verbs. We divided all verbs and adjectives into two groups: neutral words or mental state words. We divided the counts for mental state verbs by the counts for neutral verbs for each type of behaviour (helpful, harmful, and random). This created three separate columns showing the human verb counts for each type of behaviour. For the adjectives, we produced three columns in the exact same way.

Anthropomorphism in predictions. We computed three scores for relevant prediction behaviour by selecting the relevant prediction questions for each video. For instance, if the video showed a shape helping another shape escaping a closed box, we selected the relevant questions “How likely is it that this shape helps another shape escape a closed box?” and “How likely is it that this shape prevents another shape from escaping a closed box?”. The question concerning hurting behaviour was subtracted from the question about helping behaviour, computing a different score on each behaviour type

(helping, hurting, and random). For the videos showing random motion, we selected two prediction questions at random. We remained with three scales reporting the relevant prediction of the shapes' behaviour by calculating the average for each type of behaviour.

Belongingness measure. The first, third and seventh item on the Need to Belong Scale were reverse-coded. We computed the ten answers to the Need to Belong questions into one scale reporting the individual score of each participant.

Results

Manipulation Check

We conducted a reliability analysis for both the positive and negative emotion scale. The positive scale showed a Cronbach's $\alpha = .884$. As for the negative scale, Cronbach's $\alpha = .794$. α s would not have increased if one of the items would have been deleted. These findings indicate that the three emotions within each scale were highly interconnected and reliably formed a scale.

We performed a t -test to determine the influence of condition on experiencing emotions of loneliness. The Levene's Test for equal variances was not significant for the negative scale, $p = .068$, but significant for the positive scale, $p < .001$. However, the t -test is robust against violation of the equal variances assumption if $n < 15$. In this case, each cell contained at least 44 participants. Type of condition significantly influenced the answers on the positive scale, $t(90) = -4.254$, $p < .001$. People in the control condition reported significantly higher scores on the three positive emotions ($M = 4.06$, $SD = .67$) in comparison to participants in the lonely condition ($M = 3.26$, $SD = 1.09$). The

manipulation therefore proved to be effective in making participants in the lonely condition experience less positive emotions.

However, type of condition only marginally influenced the answering on the negative scale, $t(90) = 1.782$, $p = .078$. Participants in the lonely condition ($M = 2.58$, $SD = 1.15$) reported feeling marginally more negative emotions than individuals in the control condition ($M = 2.18$, $SD = 0.98$).

Explaining Behaviour

A large majority of the participants stuck to neutrally describing the movements and colours of the shapes, without inferring any anthropomorphic characteristics. If they did infer anything, they most often referred to emotions like anger or happiness.

Participants sometimes attributed human personality traits to the shapes, saying the pentagon was “unkind” or “evil”. The square was most often referred to as “slow” or “weak”, the circle in terms of being “strong” and “friendly”.

None of the participants attributed anthropomorphic characteristics to the props used in the videos (staircase, box, triangles). This is probably due to the objects not moving by themselves and thus not being viewed as animate, let alone human.

We performed three separate one-way ANOVAs of condition with the three types of verbs (helping, hurting, and random) as well as three ANOVAs of condition with the three adjectives types to see whether condition had affected the amount of anthropomorphic words. Condition did not significantly influence the amount of human verbs used for any of the three behaviour types, as depicted in Table 1. Condition did not have a significant effect on the amount of helping, hurting or random adjectives either

(see Table 2). This shows that participants in both conditions used about the same amount of anthropomorphic verbs and adjectives.

Even though these differences were not significant, participants did use more human verbs when describing the videos in which harmful behaviour was showed ($M = .21$, $SD = .15$), as opposed to helpful ($M = .12$, $SD = .07$) and random ($M = .00$, $SD = .02$) behaviour. In the case of the adjectives, we also found the highest amounts of human adjectives in the descriptions of the harmful behaviour ($M = .08$, $SD = .23$) compared to helpful ($M = .05$, $SD = .17$) and random ($M = .00$, $SD = .01$) behaviour.

Predicting Behaviour

We performed a 2 (relevant vs. not relevant behaviour) x 2 (shape behaviour: helping vs. hurting behaviour) x 2 (prediction behaviour: whether the shape would help or harm) x 2 (condition: lonely vs. not lonely) ANOVA to determine prediction behaviour. The main effects of relevant behaviour, shape behaviour, and questioned behaviour all were significant (see Table 3). Participants made the strongest predictions if the behaviour was relevant to the behaviour shown in the previous video ($M = 4.62$, $SD = .41$). Irrelevant behaviour elicited significantly less strong predictions. Behaviour could be irrelevant in the sense that behaviour type matched but prediction question did not ($M = 3.01$, $SD = 1.26$) or in the sense that the opposite behaviour type was displayed ($M = 1.68$, $SD = .69$). As for shape behaviour, participants made stronger predictions about the helping behaviour ($M = 3.88$, $SD = .81$) than the hurting behaviour ($M = 3.74$, $SD = .84$). If the displayed behaviour was actually questioned, participants also made stronger

predictions ($M = 2.96$, $SD = .44$) in comparison to if the behaviour was not asked about ($M = 2.34$, $SD = .97$).

Table 4 shows all interaction effects significant at a $p < .01$ level. The interaction of relevant behaviour and shape behaviour was significant. If the behaviour we asked about in the predictive questions was relevant to the behaviour displayed in the previous movie, participants made the strongest predictions ($M = 4.80$, $SD = .33$ for the helping behaviour, $M = 4.43$, $SD = .48$ for the hurting behaviour). Behaviour that was irrelevant because it was a different prediction question but the same type of behaviour resulted in less strong predictions ($M = 2.96$, $SD = 1.30$ for helping behaviour, $M = 3.05$, $SD = 1.21$ for hurting behaviour). If the asked behaviour was irrelevant in the sense that it mentioned the opposite behaviour type, participants produced the lowest prediction scores ($M = 1.68$, $SD = .72$ for helping behaviour, $M = 1.67$, $SD = .66$ for hurting behaviour).

Condition significantly interacted with relevant behaviour, $F(1, 90) = 9.491$, $p = .003$. Participants in the lonely condition made stronger predictions when asked about the relevant behaviour regardless of shape behaviour ($M = 2.97$, $SD = .48$) in comparison to their counterparts in the control condition ($M = 2.49$, $SD = .40$).

Condition also significantly interacted with shape behaviour, $F(1, 90) = 75.163$, $p < .001$. People in the lonely condition predicted more for the helpful behaviour ($M = 2.74$, $SD = .73$) than control participants ($M = 2.26$, $SD = .68$).

We found a significant three-way interaction of condition, relevant behaviour, and shape behaviour. People in the lonely condition significantly predicted more helpful

behaviour when asked about the relevant helpful behaviour ($M = 3.11$, $SD = 1.21$) than participants in the control condition ($M = 2.83$, $SD = .37$).

Discussion

The importance of studying the topic loneliness is widely recognised (Cacioppo & Hawkley, 2003; Check et al., 1985; Epley, Waytz et al., 2008; Hawkley & Cacioppo, 2010; Heinrich & Gullone, 2006; Revenson, 1981). Being in a lonely state has clinical significance, since it can evoke aggressive behaviour and result in a deteriorated mental and physical health.

The present research attempted to demonstrate the effect of loneliness on degree of anthropomorphisation. We expected participants in the loneliness condition to anthropomorphise more than their counterparts in the control condition. We based this hypothesis on the theory that being lonely comprises a lack of social interaction, making lonely people more likely to detect human characteristics in nonhuman objects in their environment (Epley, Akalis et al., 2008; Pickett et al., 2004; Waytz, Cacioppo et al., 2010). The manipulation proved to be effective in diminishing the experience of positive emotions. Participants in both conditions anthropomorphised to some degree. This was expected, given that people generally tend to search for humanness in the world around them (Waytz, Cacioppo et al., 2010).

Limitations

The wording used in the predictive questions may be a limitation of the present research. Participants were asked how likely the shapes were to either “help” or “prevent”

another shape from performing a series of actions, such as “escaping” a closed space. These words in themselves suggest intention and the possession of a mental state. Although we did not count the words as anthropomorphic, they may have given the participants some clue about the behaviour actually tested, which as a result might have guided their answers. But even if this effect has played a role, we presume it to be of little consequence. Even if participants were guided in their answers, they still anthropomorphised the harmful behaviour more than the helpful or random behaviour.

The experiment being conducted online and at home may have had a negative influence on people’s engagement. Perhaps participants did not direct their full attention to the experiment due to potential distractions. This may have led to people not answering truthfully or according to their actual thoughts, but simply to finish the study. This however seems hard to believe, since participants generally spent at least thirty minutes to finish the experiment instead of rushing it. Participants also used an average of 519 words in their descriptions of the fifteen videos, indicating genuine effort.

Negativity Bias

The text descriptions demonstrated that participants in both groups made more human inferences about the hurting behaviour than the helping or random behaviour. This so-called positive-negative asymmetry effect or negativity bias is widely recognised (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Hamilton & Huffman, 1971; Pietri, Fazio, & Shook, 2012; Pietri, Fazio, & Shook, 2013; Rocklage & Fazio, 2014; Rozin & Royzman, 2001). Although individual differences do exist, people in general give more weight to negatives rather than positives (Pietri et al., 2012).

Rozin and Royzman (2001) offer multiple explanations for the negativity bias. They argue that it is instigated by the human search for perfection and purity. People have an innate urge to judge things in terms of their distance to perfection. Polluting that perfection can be easily elicited and is often seen as irreversible, such as losing one's purity through premarital sex (Rozin & Royzman, 2001). On the other hand, reaching the stage of perfection is a long and enduring process. This makes humans more alert towards faulty rather than socially acceptable behaviour and more likely to put a heavier weight on negative situations. It may even be that the heavier weight of negative events has an adaptive value (Rozin & Royzman, 2001). Many negative occurrences are more threatening and irreversible than positive events.

Moreover, negative characteristics provide more information about a person since they show the unique way in which that person deviates from normality (Hamilton & Huffman, 1971). Therefore, an amount of negative attributes is weighted more heavily than the same amount of positive ones (Baumeister et al., 2001; Hamilton & Huffman, 1971). It is plausible that, to the participants in the present study, the harmful behaviour stood out more than the helpful behaviour. As a result, they may have found it more necessary to describe these features in human terms. As for the helping behaviour, participants may have described this in less humanised terms because to help someone might be regarded "normal" and less worth mentioning. The random behaviour did not elicit any anthropomorphism.

Prediction Results

There was a three-way interaction between the loneliness manipulation, relevant prediction behaviour, and type of shape behaviour (helpful, harmful or random).

Participants in the lonely condition predicted a significantly higher degree of helpful behaviour in the prediction questions when asked about the relevant behaviour. These were the participants who reported significantly lower scores on happiness, satisfaction and being at ease than individuals in the control condition. It is remarkable that all participants reported more anthropomorphic words when describing harmful behaviour, yet made stronger human predictions about the helpful behaviour in the loneliness condition. Making any prediction about a shape performing an action in the future, is a sign of attributing intentional features to that shape. The presumption rises that people feeling less positive, had the urge to predict another's behaviour to be particularly positive. They may have wanted to 'make up' for their negative feelings by projecting helpfulness in the presented shape.

Jordan et al. (2011) point out that people generally underestimate the prevalence of negative emotions in others. People are reluctant to admit their negative emotional experiences assuming that doing so will result in rejection or misunderstanding by others. This causes the social misperception that others have less negative emotional experiences than oneself. In particular, this line of thought occurs in people who feel lonely or depressed (Jordan et al., 2011). It is possible that participants in the lonely condition, because they themselves experienced less positive emotions, were more inclined to view the shape's behaviour as more positive and thus make a more favourable prediction of its intentions.

The interaction of relevant behaviour and shape behaviour was also significant. People made the strongest predictions if the behaviour asked about in the prediction questions was relevant to the shape behaviour just viewed. For instance, if the preceding movie fragment depicted the circle helping the square climb a staircase, participants strongly predicted the circle helping another shape climb a staircase in the future. Participants made much less strong predictions about the shape if they had just viewed it engaging in opposite behaviour. Apparently, people attributed positive or negative characteristics to the shape, making incongruent behaviour seem very improbable.

Conclusion and Implications

Implications for loneliness. In the present research, we measured loneliness in a direct way by literally asking participants if they felt lonely. It may be that the direct measuring of loneliness has decreased participants' willingness to admit feeling lonely (Shiovitz-Ezra & Ayalon, 2012; Victor et al., 2005). As several studies point out, lonely people suffer from social stigmas such as being seen as weaker or less attractive by others (Borys & Perlman, 1985; Shiovitz-Ezra & Ayalon, 2012; Victor et al., 2005). They may be reluctant to own up to their potential feelings of loneliness. Perhaps even more significant results can be gained by measuring loneliness indirectly and inquiring after emotions that are indications of loneliness or social isolation, without once using the actual word (Shiovitz-Ezra & Ayalon, 2012; Victor et al., 2005). For example, items may evolve around the experience of 'not feeling close to anyone' or 'lacking companionship' (Russell, Peplau, & Cutrona, 1980). Future research can focus on more methods to measure feeling lonely without people resorting to socially desirable behaviour.

In addition, it is advisable to determine more circumstances under which loneliness is prevented or protected against. Revenson (1981) highlights the importance of problem-focused strategies involving positive thinking, taking action and having emotionally close relationships. It seems that internal attributions are at the core of experiencing loneliness (Revenson, 1981). This is an explanation for the fact that attempts to reduce loneliness via regular group activities were unsuccessful in the past (Hawkley & Cacioppo, 2010). These sessions were not targeted at changing the internalised paradigms of participants about social relationships. Over the last decades, researchers have wanted to find out more about potential protective factors (Revenson, 1981; Victor et al., 2005). Victor et al. (2005) discovered the independent and buffering effects of both advanced age and educational level for loneliness. Although advanced age can also be a vulnerability factor, Victor et al. (2005) claim that the power of adaption in older people protects them from succumbing to age-related misery like the losing of a spouse or meeting deteriorated health. Whether advanced age serves as a protective or vulnerability factor for loneliness, seems to be partly determined by individual differences. Given that the prevalence of loneliness is quite stable (Victor et al., 2005), future research can focus on expanding these circumstances.

Implications for anthropomorphism. The present research verified the ease and speed with which human inferences are made about nonhuman agents, especially if normally unacceptable (harmful) behaviour is concerned. It will become increasingly important to understand the circumstances under which anthropomorphisation takes place, as well as the effect of these inferences on people's behaviour towards nonhuman agents. Mechanical agents, such as robots, are more and more becoming part of daily life

(Press, 2011). Further care should therefore be taken to reduce the phenomenon uncanny valley: the ‘eerie’ feeling when coming face to face with an agent that shows near-perfect human resemblance (Burleigh et al., 2013; Thompson et al., 2011).

Besides, the ascription of moral capacities to an agent can have the dangerous consequence of lessening a person’s own sense of control and moral value over situations, for instance in the case of a religious agent (Epley, Waytz et al., 2008; Morewedge & Clear, 2008). People may not take full responsibility for their actions or fail to undertake the necessary steps in order to solve a situation. This involves the danger of important decisions not being made and acute problems not being solved.

Furthermore, implications for future research are to determine personality features that make a person especially vulnerable towards anthropomorphising. Noguchi et al. (2006) describe the difference between extraversion and neuroticism, personality characteristics that are partly mediated by attention to positive information and negative information respectively. Ambiguous situations are often interpreted according to people’s attention type. A person biased toward negativity, for example, is more likely to perceive an ambiguous situation as potentially threatening (Pietri et al., 2012). Airenti (2015) claims that empathy also plays an important role in the speed with which agents are being anthropomorphised. A highly empathic person is likely to be more emotionally affected by viewing hurting and helping behaviour, and as a consequence make more human inferences. Summarizing, it may be interesting to study personality differences in relation to degree of anthropomorphisation. Gaining more knowledge about these differences can aid in understanding and predicting people’s behaviour with respect to a nonhuman agent.

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Table 1

One-way ANOVAs of Condition on Human Verb Count

Source	Type	SS	df	MS	F	p
Helping verbs	Condition	.001	1	.001	.161	.689
	Error	.506	90	.006		
	Total	.507	91			
Hurting verbs	Condition	.001	1	.001	.063	.802
	Error	2.075	90	.023		
	Total	2.076	91			
Random verbs	Condition	.000	1	.000	.002	.962
	Error	.048	90	.001		
	Total	.048	91			

Note. *Significant at the $p < .05$ level.

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Table 2

One-way ANOVAs of Condition on Human Adjective Count

Source	Type	SS	df	MS	F	p
Helping adjectives	Condition	.002	1	.002	.062	.804
	Error	2.500	90	.028		
	Total	2.502	91			
Hurting adjectives	Condition	.110	1	.110	2.207	.141
	Error	4.506	90	.050		
	Total	4.616	91			
Random adjectives	Condition	.000	1	.000	1.092	.299
	Error	.015	90	.000		
	Total	.015	91			

*Note. *Significant at the $p < .05$ level.*

Table 3

Significant Main Effects of Relevant, Shape, and Questioned Behaviour

Source	SS	df	MS	F	p
Relevant behaviour	.681	1	.681	9.491	.003**
Error	6.457	90	0.72		
Shape behaviour	68.565	1	68.565	75.163	.000**
Error	82.099	90	.912		
Questioned behaviour	1.039	1	1.039	7.522	.007**
Error	12.434	90	.138		

Note. **Significant at the $p < .01$ level.

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Table 4

Significant Interaction Effects of Condition and Relevant, Shape, and Questioned

Behaviour

Source	SS	df	MS	F	p
Relevant * shape	1.795	1	1.795	39.534	.000**
Error	4.086	90	.045		
Relevant * shape * condition	.274	1	.274	6.038	.016**
Error	4.086	90	.045		
Relevant * questioned	995.236	1	995.236	757.387	.000**
Error	118.264	90	1.314		
Shape * questioned	2.899	1	2.899	46.476	.000**
Error	5.613	90	.062		
Relevant * shape * questioned	181.030	1	181.030	265.174	.000**
Error	61.442	90	.683		

*Note. **Significant at the $p < .01$ level.*