MASTER

Using laugther as a automatic indicator of social interactions between humans and a robot

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Introduction

The idea of social machines that serve as companions and aids to humans has been present in our imaginations since Hero of Alexandria, a Greek mathematician and engineer, envisioned a machine that would pour wine for guests at his parties in 70 AD. In the last century revolutionary advancements in technology have carried the idea of the social robot out of our imaginations and into the realm of possibility. Research in this field has been growing and evolving consistently, and we are now facing into a century when intelligent, social robots will begin to enter into our homes as pets, companions, teachers, and caregivers. In the not so distance future we will witness the introduction, adaptation and acceptance of a new member of our families. Some will experience close connections and bonds with robots, and some will not, which highlights the importance of gaining a rich understanding of the social psychological mechanisms underpinning these complex human machine relationships. This project will focus on exploring this new relationship, using unconscious human social behavior as an indicator of the acceptance of a robot.

Social Robot Research

One of the driving forces behind current social robotics research is to tackle the increasing proportion of elderly people, and the concern that there will not be a sufficient amount of qualified healthcare personnel in the population to tend to the elderly in the near future. A substantial amount of research is now being carried out in an effort to design assistive robots that will suffice as caregivers for the elderly (Roy, et al., 2000; Wada & Shibata, 2007). Although there are some ethical concerns that this solution will result in a lack of human contact (Sharkey & Sharkey, 2010), assistive robots have been shown to have a positive influence on health, offering both rehabilitation and companionship to the elderly (Broekens, Heerink, & Rosendal, 2009).


Figure 1. Home Robot IROBI

Research is also being carried out to explore the potential of robot design for educational purposes. Results from a study conducted in Korea have shown that when an educational home robot was compared to other media assisted learning programs, the robot was superior in promoting and improving concentration, academic achievements, and was considered friendlier by students.

(Han, Jo, Park, & Kim, 2005; Han, Jo, Jones, & Jo, 2008). In a study to investigate the benefit of using an educational robot as a language instruction tool carried out by Hyun, Kim, Jang, and Park (2005) it was revealed that the language instruction robot outperformed the media assisted reading program. The children in the study improved significantly in linguistic ability when assisted by a robot in comparison to the reading program over the course of a four-week study. From these two studies we can conclude that the use of an interactive educational robot provided a more effective learning experience for the children, when compared to other media assisted learning programs. The presence of a responsive, social being led to an increase in the children's performance.

Another body of research being carried out demonstrates the value of social robots in helping people on the autism spectrum confront their issues with sociability. Robins, Dautenhahn, Boekhorst, and Billard (2005) conducted a longitudinal quantitative and qualitative study to identify the effects of a using small humanoid robot to encourage social interaction skills. Overall the results yielded positive effects, notably in the increased social interaction skills (imitation, turn-taking and role reversals). Similarly, in a longitudinal study carried out by Kozima, Nakagawa, and Yasuda (2005), a creature-like robot, Keepon, was designed and tested in an attempt to encourage children with autism and other related developmental disorders to engage in playful interactions. It was discovered that over time the children on the autism spectrum began to spontaneously engage in playful interactions with the robot. More importantly the children began engaging in playful interactions with other children and adults, where the robot acted as the instigator of this communication.

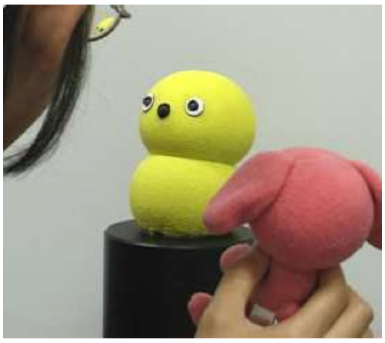

Figure 2. Keepon

Current advancements in the field of social/theraputic human-robot interaction have highlighted the benefits this new type of technology can offer. As we move closer to an era where social robots will be widely purchased by consumers, there is a growing need for gaining a rich understanding of the psychological implications of these new types of social interactions.

Research has shown that people behave in a social manner when interacting with virtual agents. Kramer, Kopp, Becker-Asano, and Sommer (2013) have demonstrated, for example, that humans smile back at a virtual agent. In a controlled experiment it was discovered that in a conversational situation, participants spent more time smiling in the condition where the agent was smiling compared to the control condition. This type of mimicking behavior is commonly found between humans, and it is clear that the same type of social behavior has been transferred to human-technology interactions.

The Media Equation

Research examining the social interactions between humans and computers has provided the foundations for further explorations in the field of human robot interaction. The so-called Media Equation (Reeves & Nass, 1997) has provided a framework for investigating the transfer of recognized human social behaviors into human computer interactions. The Media Equation can be applied to many social psychological domains, and is carried out by following the pre-defined structure :

1. Pick a social science finding (theory and method) which concerns behavior or attitude toward humans.
2. Change “human” to “computer” in the statement of the theory.
3. Replace one or more humans with computers in the method of the study.
4. Provide the computer with characteristics associated with human (a) language output (b) responses based on multiple prior inputs (c) the filling of roles traditionally filled by humans and (d) the production of human sounding voices.
5. Determine if the social rule still applies.

Experiments carried out by Reeves and Nass (1997) following this pre-defined structure, have established that when replacing a human actor with a media device, humans will still demonstrate the same social behaviors identified in human-human interaction. An example of the Media Equation in operation can be found when demonstrating that people are polite to computers. Politeness is a social behavior that is encouraged in most communities, as it helps maintaining social cohesion. Reeves and Nass chose the act of evaluation as a means of identifying polite behavior. Due to the fact that people are more likely to give a positive evaluation of an individual if the person being evaluated is present, and a more honest evaluation if the person is absent, Reeves and Nass decided to use a similar scenario using the Media Equation. In a number of controlled experiments, participants were asked to complete a task on a computer, and asked to complete a questionnaire to evaluate the performance of the computer either on the same computer or on a different one. Results from these experiments revealed that people were more likely to give a positive evaluation when answering the questionnaire on the computer that was being evaluated. A number of other examples of social behaviors being exhibited towards technology have been highlighted using the Media Equation, for example the discovery that people display a self-serving bias when flattered by a computer (Reeves & Nass, 1997). Nass, Moon, and Green (1997) also revealed that participants rated computers with male voices as being more competent in technical topics in comparison with computers with female voices, whereas the opposite was found for topics relating to love and relationships. In another study, Moon and Nass (1996) identified that participants inferred that a computer had a personality based on the type of language used (tentative vs. assertive) and other non-verbal cues (pitch, rate of speech). Similarly, a study carried out by Nass and Lee (2001) revealed that participants responded more positively to computers who were perceived to have a similar personality to their own. Moon (2000) also demonstrated that when a computer first provided information about its technical specifications, and then asked participants a number of questions, participants were more likely to answer with more intimate self-disclosures than when the computer did not provide any information prior to the questions.

The media equation succeeded in demonstrating that humans interact socially with computers in many controlled experiments. Although the equation itself appears to be robust, the cause of these behaviors still remains elusive. A large body of research has been carried out in an attempt to gain a better understanding these mechanisms, and is referred to as Computers as Social Actors (CASA) research. One explanation offered by Nass and Moon (2000) focusses on mindlessness as an explanation. The term mindlessness describes how contextual cues can lead to the activation of situational scripts (sometimes overly simplistic) that are drawn from the past. These scripts can lead to an incomplete interpretation of reality, due to the fact that our attention is drawn towards the information that is in line with our script, and away from the whole picture (Langer, 1989). Nass and Moon (2000) argue that individuals respond mindlessly to computers, in that they apply social scripts used in human-human interaction to human-computer interactions, thus ignoring the cues that identify the non-social nature of the computer. Nass and Moon (2000) elaborate by explaining that in order to evoke mindless behavior, an individual must be presented with a sufficient number of cues to trigger their social script. Examples of such cues include the use of vocal responses, or the interactivity of the computer.

The term anthropomorphism is used to describe the tendency to attribute human characteristics to anything other than a human being. The concept of anthropomorphism has been widely rejected as an explanation for the Media equation. The argument against this explanation states that anthropomorphism implies that individuals are acting on the belief that the computer is essentially a human. The majority of participants involved in the studies were experienced computer users who insisted, when being debriefed, that they would never act in a social way towards a computer (Nass, Steurer, & Henriksen, 1994; Nass, Fogg, & Moon, 1996; Nass and Moon, 2000).

Although the authors of the media equation have denied anthropomorphism plays a role in the explanation of their findings, the influence anthropomorphism has on how humans behave socially towards computer is still being investigated by many researchers.

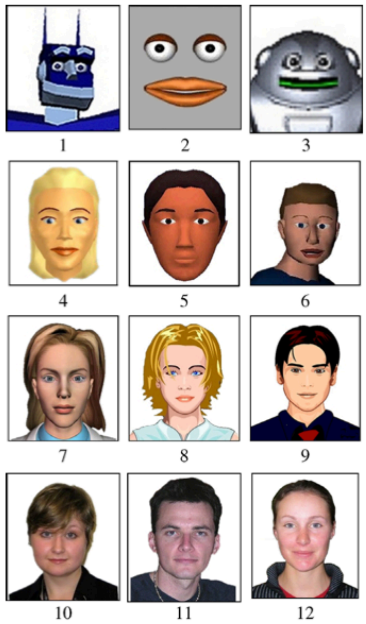

Figure 3. Anthropomorphic Faces

Gong (2007) conducted an experiment claiming to investigate the social effects of computer representations that varied in anthropomorphism. Participants were required to take part in a choice dilemma scenario, where their choice was prompted by a computer agent. Gong manipulated the anthropomorphic attributes of the agent between conditions by selecting images of faces which varied in realism. Results from this experiment stated that as the computer agent increased in anthropomorphism, participants' decisions were more influenced by them in the choice dilemma. As anthropomorphism increased, participants also rated the agent as being more trustworthy, having greater homophily, and more having more positive social judgments. These results are consistent with the notion that there is a linear relationship between anthropomorphism and social behavior.

In the same experiment, Gong (2007) also revealed that in the condition where individuals were presented with a text only prompt (no image), participants rated this interface as superior overall to all synthesized face images. Similar results have been yielded from other studies of anthropomorphism (Sproull, et al.,, 1996; Burgoon, et al., 2000) whereby the text interface is reported as being superior to the synthetic faces and/or voices. A number of explanations have been offered for this finding, none of which convincingly pinpoint the cause. Gong (2007) suggests that the synthetic human representation causes individuals to expect other human-related capabilities from the computer, and when the device fails to present these characteristics the individual becomes disappointed. Mori (1970) uses the term "uncanny valley" to explain that when robot or computer agent is considered high on the anthropomorphism scale, the imperfections become more salient, hindering people's perception of the technology.

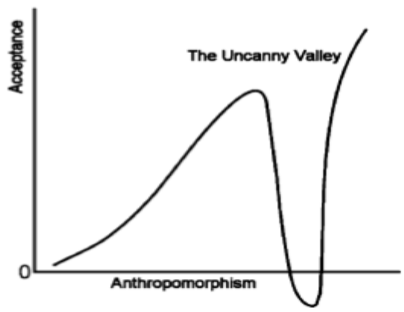

Figure 4. The Uncanny Valley

Although concrete explanations for results yielded from the Media Equation and the variations in anthropomorphism research are not yet within our grasp, research in the field so far has successfully identified some insightful discoveries, as well as some staggering inconsistencies. The relationship between humans and social machines is delicate and sometimes incongruent. From an evolutionary perspective, humans have only ever interacted socially, on an intellectual level, with their own race until now. Many of our social psychological behaviors occur as bottom-up processes that materialize as unconscious reactions to our environment. Technological advancements in the design of social machines have gathered considerable momentum in the past fifty years, which is forcing us to re-define how we interact with those around us (Reeves & Naas, 1996). We are designing sophisticated robots that have been equipped with artificial social behaviors, to ensure that our interactions seem natural and ubiquitous (Duffy, 2003). Modern robots are so elegantly designed that humans sometimes experience a degree of cognitive dissonance when trying to understand their social interactions. The aim of our research is to investigate this complex relationship further, using the automatic social behavior of laughter as a window into our true social interactions with robots.

Laughter

Laughter is generally regarded as an uncontrollable expression of joy or humor. Dr. Robert Provine has dedicated his career to unraveling the rules that govern this innate, intangible behavior. He set about gathering a large amount of observational data of laughing behavior, and extracted some surprising results. Contrary what one may expect, Provine has revealed that the majority of the laughter he observed was not in response to a structured attempt at humor, rather it occurred as punctuation between non-humorous remarks, such as "Are you sure, haha?" or "It was nice to meet you, haha" (Provine, 1996). Provine also points out that laughter rarely interrupts speech, reiterating that laughter functions as a form of punctuation. This use of laughter in this manner suggests that it is not merely a spontaneous utterance that occurs in response to humor, rather it is another form of communication or expression. When we think of verbal communication, the term implies a social interaction between humans. Laughter is comparable to this in that it occurs more frequently in social situations compared to in isolation. Provine (1996) claims that humans are 30 times more likely to laugh in a social situation than when they are alone. Chapman (1983) also researched the social use of laughter, explaining how it is used to signal group allegiances, communicate attitudes, and establish dominance in a status hierarchy. The social nature of laughter was observed in a controlled experiments almost a century ago, where Kenerdine (1931), when monitoring the laughing and crying behavior of preschool children, noted that of the 223 situations when laughter was recorded, only 14 occurred when the child was alone. Morrison (1940) reported a positive correlation between the number of laughs that occurred and the size of the audience observing a performance. Similarly, Young and Frye (1966) demonstrated that when participants were presented with a humorous event, overt laughter significantly increased in the group condition in comparison with the alone condition. Chapman (1973) also conducted an experiment to demonstrate that laughter can be socially facilitated. Children were presented with amusing material on headphones, and randomly assigned to one of three conditions: (i) they were tested in isolation, (ii) with a non-listening companion and (iii) with a companion who also listened to the material (confederate). Results from the experiment showed that the children spent the most amount of time laughing in condition when there was another child listening (condition iii), but they also spent more time laughing with a non-listening partner compared to the alone condition. These results are consistent with the notion that laughter is a social behavior, which occurs more in the company of others.

One may challenge the results of these experiments when recalling an instant when they laughed spontaneously when reading a book alone in the park, or the embarrassment they felt when accidently spluttering out a chortle in the library when reading a text message from a friend, however the laughter in these situations is often evoked by the presence of what Provine (1996) refers to as vicarious social stimuli. The presence of a narrative (found in books, films, emails) provides our brain with enough cues to experience the presence of another, which then triggers the social behavior of laughter. For a true indication of the social effects of laughter we must examine humorous events that occur in isolation, free from vicarious social stimuli.

Further examination of the social influences of laughing behavior reveals that laughter is more than a personal reaction to a humorous event, and a means of punctuating speech, but it is also contagious between people. In some instances the sound of laughter alone causes laughter. An extreme example the contagious power of laughter occurred in Tanganyika (now Tanzania) in 1962 at boarding school for girls. The laughter began with three girls, and spread quickly through the school affecting 95 students. For those affected, the laughter lasted between a few hours and 16 days, and the eventually the school was forced to close down. The girls were sent home but the laughter continued to spread to nearby villages, eventually affecting thousands of people and lasting over 18 months (Hempelmann, 2007) . The cause of this epidemic has never been fully understood. Provine (1992) carried out a controlled experiment examining contagious nature of laughter. One hundred and twenty-eight participants were required to listen to an 18 second sample of laughter from a “laugh box”. Their own laughter was recorded over the course of the ten trials. Results from this experiment revealed that laughter was indeed highly contagious for the first number of trials, but its power attenuated towards the end of the trials and participants reported that the laughter became obnoxious over time.

Having acknowledged some of the current social characteristics of laughter, we will now look at it from an evolutionary perspective and gain a better understanding of its roots. One theory claims that laughter originated as a form of "panting", which is described as a noisily punctuated inhalation and exhalation, which can also be observed in chimpanzees. The act of panting is used as a signal of social play (Ross, Owren, & Zimmerman, 2010), and this is believed to be where human laughter began. As the human race multiplied, so did our capacity to interact, communicate and behave socially. Dubbar (1998) found evidence for what is known as the social brain hypothesis. This hypothesis states that natural selection has favored larger brains with more cognitive capabilities as a way to adapt to the need for social interactions (Silk, 2007). Laughter is used as a way to access the bonding processes between humans, which also occurs in primates through grooming practices such as scratching, tickling, playing, and massaging, which activate neuropeptides and relaxing hormones of the neural reward system (Marijuán & Navarro, 2010; Shutt, MacLarnon, Heistermann, & Semple, 2007). Laughter is also an indication of a successful bond between people (Marijuán & Navarro, 2010).

Evidence of the social nature of laughter has been provided, and the value of this socially facilitated behavior will be used in an attempt to explore another dimension in the field of human-robot interaction. Reither, Hegel and Wrede (2012) have revealed that the presence of a robot can also instigate social facilitation. In their experiment, participants were required to complete a number of performance tasks in the presence of either a robot, a confederate, or while being alone. The robot and confederate both acknowledged the participant at the beginning of the experiment, and glanced towards the participant every three minutes for the duration of the experiment. Overall results revealed that the presence of the robot caused an increase in performance tasks compared to the alone condition, indicating the occurrence of social facilitation. In an experiment carried out by Jo, Hann, Chung, and Lee (2013), the social facilitation of a robot was found to influence participants' reported amusement when watching humorous video clips. The authors interpreted these results as an indication of empathy between humans and robots.

Following from Jo, Hann, Chung, and Lee's (2013) experiment, we hope to investigate the concept of a robot companion further. Rather than focusing on people's amusement ratings, we will measure their subconscious behavior. This experiment will investigate whether the social behavior of laughter can also be facilitated by the presence of a robot. We aim to use this unconscious behavior as a tool to identify if people perceive the robot as a social being. The framework for this investigation will be borrowed from the tried and tested Media Equation. We aim to modify a previous experiment demonstrating that laughter is socially facilitated, introducing a robot as a companion.

Table 1. The Media Equation

The Media Equation	This Study
1. Pick a social science finding relating to behavior or attitude towards humans.	1. Humans laugh more in the company of others when compared to alone.
2. Change "human" to "media" in the statement of the theory.	2. Humans laugh more in the company of a robot when compared to alone.
3. Replace the human with media in the method of the study.	3. Conduct experiment replacing a human with a robot.
4. Provide the media with the characteristics associated with the human	4. Provide the robot with the ability to laugh with the human.
5. Determine if the social rule still applies to in the results.	5. Determine whether people laugh more in the company of the robot compared to alone.

The goal of this research is to get a better understanding of the complex relationship between humans and robots. We hope to further investigate how we behave in the presence of robots, using an automatic social response as a measure. A number of media equation studies results have hinged on explicit input and evaluations from the participants. Conclusions from these studies are drawn based on self-report measures gathered after the human-computer interaction has taken place. Self-report measures are often prone to bias and memory distortions, which can influence the results yielded from a study. For this reason we chose to use an automatic behavioral response as our measure, as it provides a time-continuous indication of participants' social acknowledgment of the robot. In this study we implement a new method of measuring social interactions in human-robot interaction research, and use this method to investigate the extent to which our automatic social laughter behavior translates when interacting with a social robot. Based on the results presented human-computer/robot interaction and laughter research, we have formulated the following hypotheses.

H 1 :People will laugh more in the company of another person compared to in isolation.

H 2 : People will laugh more in the company of a laughing robot compared to in isolation.

H 3 : There will be individual differences between people's anthropomorphic experience of the robot, and these differences will influence their social laughter.

Methods

The Pilot

An initial pilot study was carried out to investigate the feasibility of conducting the main experiment. Fifteen participants participated in the pilot study. The purpose of the pilot was to investigate (i) whether it was possible to instigate laughter behavior in an experimental setting (ii) to gain insight into the type of humor that is most popular within the student population, and (iii) identify if there is indeed an increase in the laughter behavior when participants are in pairs in comparison to being alone. Six video clips were selected from the video sharing website www.youtube.com , and placed in series using Final Cut Pro editing software. Using a pen and paper questionnaire, participants were asked to rate the humorousness of each clip on a 5-point Likert scale. Participants were recorded using a hidden camera. Twelve participants were recruited to participate, 4 were assigned to the alone condition and 8 (4 pairs) were assigned to the together condition. Three variables were identified and coded from the video data, (i) smirks (ii) smiles and (iii) laughs. A smirk was recorded when participants smiled but showed now teeth. A smile was identified when participants smiled and their teeth were visible. A laugh was identified when participants were observed to have a smiling mouth and their shoulders moved up and down. Each time a participant laughed, it was coded as a single laughter event regardless of duration. Due to the low number of observations, a statistical test was not warranted, however an observation of the means provided sufficient confidence to continue with the main experiment.

Focusing specifically on the laughter data, mean amount of laughs in the alone condition was 0, and the mean amount of laughs in the paired condition was 7.33. From these results we were confident that (i) it was possible to instigate laughter in this type of controlled experimental setting, and (ii) that laughter was indeed a social behavior that could be observed. We were also provided with insightful information relating to the content of the clips, as were able to use participants' evaluations and laughing behavior as an indication of the type of humorous videos that would cause the most laughter in the future.

Main Experiment

Participants

Participants were recruited using the HTI participant database available at the TU/e. Participants were also notified about the experiment using social networking websites and flyers. A total of 109 participated in this study (64 males, 45 females). The mean age of all participants was 23 (ranging from 15 to 60). Participants were given €7 compensation for taking part.

Design

The experiment was carried out using an independent measures design whereby participants were randomly assigned to one of four conditions. The experimental title was “Humor Rating”, and participants were told that the purpose of the experiment was to gather data relating to personal humor preferences toward funny movie clips, however the true variable being measured was their laughter behavior. The independent variables were the four conditions, and the dependent variable was laughter behavior.

In the first condition (Alone Condition, N=25), on entering the experimental room participants were asked to observe movie clips on a television, and asked to indicate on a digital questionnaire using an Ipad tablet device, their subjective opinion of how funny each clip was on a Likert scale from one to five (one representing not at all funny, and five being hilarious). In the second condition (Paired Condition, N=41), participants were asked to complete the same task, however in pairs. In the third condition (Robot Without Laughter Condition, N=22) participants were accompanied by the robot, Myro. Participants were told that the robot would also be observing the video clips, as the researchers were attempting to program a humor algorithm.

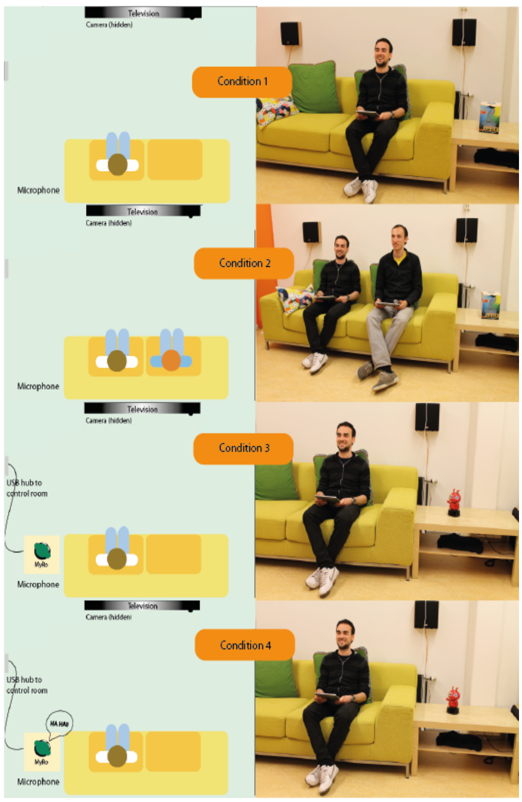

Figure 5. Conditions

The fourth condition (Robot with Laughter Condition N=21) was identical to the third condition, however in this condition the robot also laughed at the movie clips.

Apparatus

The interactive intelligent robot used for this experiment (Myro) was created by WittyWorx© robotics company. The robot was placed on a table at a distance from the participant that equated the distance between the paired participants sitting side by side in (Paired Condition). The robot was connected to the control room via a hidden USB wire that was built into the table. The speaker used for the vocalizations from the robot was also built into the table directly underneath the robot. The robot was controlled using a Wizard of Oz setup, whereby the experimenter manipulated the robot's behavior remotely from the control room. Each participant in the Robot with Laughter Condition was subjected to a unique pattern of laughter, which was taken directly from the laughter behavior of participants in the Paired Condition.

The experiment room consisted of a couch facing a television screen. The television was connected via HDMI to the control room where the video clip footage was stored and played from. A digital video camera was hidden in a basket below the television to record the behavioral data. The video signal was recorded and displayed in real time in the control room. A Rode NT5 condenser microphone was hidden within range of the participant to record the laughter data, which was also connected to a speaker in the control room.

The control room consisted of two desktop computers and two laptops and a mono signal speaker. Computer 1 displayed and recorded the real-time video footage from the experiment room. Computer 2 stored and played the video clips in the experiment room. Laptop 1 contained the interface required for controlling the robot's laughter and movements. Laptop 2 was used to display a large stopwatch and stored the laughter behavior required for the Wizard of Oz setup. The audio signal was paired with the video input, and both signals were recorded simultaneously on Computer 1.

Figure 6. Camera

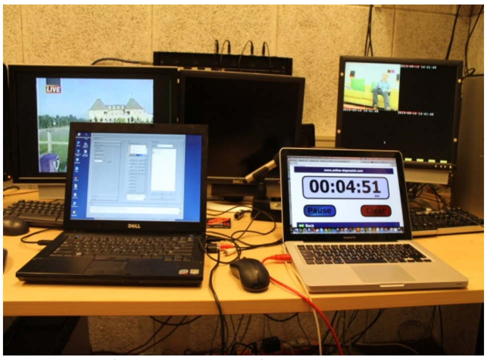

Figure 7. Control Room

The videos used for the experiment were carefully selected, as the authors were aware that the majority of humorous videos are rampant with vicarious social stimuli (characters, narratives etc). Another important aspect to avoid in the video clips was the presence of what is known as "canned laugher" or a "laughing track", which often accompanies humor in television. For this reason, the videos displayed to the participants consisted of 8 clips downloaded from the video sharing website www.youtube.com that contained little or no dialog and no laughter. The clips were trimmed, arranged and amalgamated into one video using Final Cut Pro editing software.

Procedure

On arrival participants signed a consent form at a desk in the lobby between the experiment room and the control room. They were then brought in to the experiment room, asked to take a seat on the couch. Participants were given an Apple iPpad tablet device for the duration of the experiment to complete the questionnaires. Two questionnaires were provided using the Limesurvey online survey software. The first questionnaire asked participants to rate the humorousness of each clip on a scale of 1 – 5. The experimenter instructed participants to observe the video clips on the television and rate the humor of the clip during the clip or at the short pause between clips. Participants were asked to return to the lobby once they had answered the last question. The purpose for this was to give the impression that the experimenter was oblivious to when they had finished, and give the idea that they were not being observed. In Conditions Two, Three and Four the experimenter briefly mentioned to participants that they would be watching the television together with their partner (robot or human). In the third and fourth condition, once the experimenter had left the room, the robot would introduce himself (controlled remotely from the control room). The experimenter would then start the video of clips which lasted nine minutes in total. Once the final video had finished, the experimenter would meet the participants at the desk in the lobby. For those participating in condition three and four (with the robot), participants were then asked to answer the anthropomorphism questionnaire. The final question asked to all participants was whether or not they were aware that they were being filmed. A final consent form was signed which asked participants to indicate whether they agreed to allow their video footage to be used for the purpose of the experiment.

The Wizard of Oz process began by observing the live video signal from condition two, and annotating the laughter behavior of one of the participants, using the time stamp by means of a stopwatch depicted on a laptop. In order to maintain consistency, the participant seated at the left hand side was always chosen. The experimenter observed their laughter behavior, and noted which type of laugh occurred at which moment in the video, for example. In the subsequent fourth condition, the experimenter would then monitor the stopwatch and match the correct category of laughter at the corresponding time intervals from the list generated in the Paired Condition.

Figure 8. Stopwatch

The robot was pre-programmed to contain six separate laughs. The audio files were created by recording human male laughter and increasing the pitch of the audio file using the audio software Audacity©, resulting in sound files which were androgynous, and neither entirely human nor entirely computerized. The sound files consisted of three categories: small, medium and big laughs. Within each category there were two laughs, which varied in length (long vs. short). The audio files were coupled with movements to create more realistic laughing behaviors.

This setup ensured that each participant in the robot condition was being exposed to laughter that had the same timing as genuine laughter behavior exhibited by a human participant.

Measures

Antropomorphism was assessed using a questionnaire provided by Van ’t Sant, Haam and Ruijten (Tu/e). There were twenty items on this questionnaire, providing participants with a range of questions which allowed them to express the amount of anthropomorphism they had experienced. An example of a question which was considered low on the anthropomorphism scale is: “*the robot can see*” and an example of a question falling high on the anthropomorphism scale is: “*the robot can be angry*”.

The behavioral analysis software package Noldus Observer© was used to aid the transition between video footage and laughter data. Some initial videos were observed and a coding scheme was derived. A number of participants were selected at random, and their videos were coded separately by the experimenter and a third party, using the coding scheme. A comparison between the two results identified


Figure 9. Noldus Observer

some inconsistencies in the initial coding scheme. After some discussion, the coding scheme was refined and new participants were selected to be re-coded. A comparison between results in the second attempt revealed that a satisfactory coding scheme had been designed. The duration of each laugh was coded and a number of identifiers were attached to each laugh, including whether it was a vocal or non-vocal laugh, whether it occurred together with their partner (either human or robot) or alone, and whether the participant had looked at their partner prior or during the laugh. The coded laughter data was exported to the SPSS software package for further analysis.

The data collected from the experiment was analyzed using the IBM SPSS software package. We examined whether laughter was socially facilitated in this experimental setting (H1). This was done by comparing the laughter behavior from the Paired Condition with that of the Alone Condition, and testing whether these conditions were significantly different. We then explored which characteristics of laughter provided the most clear indication of social facilitation in these two conditions. Once these parameters were identified, we then used them to investigate whether the presence of the robot had an influence on laughter behavior. This was achieved by comparing the laughter data from two robot conditions with that of the Alone Condition (H2) by examining whether the two conditions were significantly different. Finally we investigate whether there was a relationship between participants' anthropomorphic evaluation of the robot and their laughter behavior.

Results Section

In the following section, a number of statistical analyses will be presented in an attempt to test our hypotheses. The first section will present data revealing the extent to which our manipulation and experimental setting were successful. The second section will examine the contagiousness of laughter, and whether this social behavior was observed in this experimental setting. The most influential laughter variables will be selected for further use in the analysis of the robot conditions. The third section will address the influence of the robot on participants' laughter behavior, using the variables highlighted from section one. The last section will examine the relationship between participants' score on the anthropomorphism questionnaire and their laughter behavior.

The Experimental Setup

Analysis of the self-report measure collected after the experiment revealed that 65 participants (72%) were not aware that they were being observed. It was discovered that participants' laughter data was not normally distributed. For this reason, the decision was made to use non-parametric tests to explore the variations in the data. Non-parametric tests do not assume that the scores have been drawn from a normally distributed population. They are "distribution free" and require fewer qualifications (Siegel, 1956). The fundamental premise governing non-parametric statistical inferences is that scores are evaluated based on their rank rather than their numerical value Using Kruskal-Wallis Independent Samples non parametric test, it was used revealed that awareness of the camera did not have a statistically significant influence on any laughter variables. Analysis of the humor rating scores revealed a significant correlation between participants overall laughter and their humor rating scores using a non parametric correlation (Kendall's tau_b Correlation Coefficient 1.35, $p = 0.016$, Spearman's Rho Correlation Coefficient -.256, $p = 0.017$)

Is Laughter Contagious?

Social/contagious influence on laughter variables describing laughter behavior were explored, firstly laughter frequency and laughter duration. A comparison was made between the four conditions using the Kruskal-Wallis one-way analysis of variance by ranks. The frequency of laughter events did not differ significantly between the four conditions ($p = 0.312$). When comparing the overall amount of time spent laughter (duration), there was also no significant difference between the four conditions ($p = 0.236$). From this point we then looked more closely at the type of laughter. The laughter data was divided into vocalized and non-vocalized between conditions when comparing the total duration non vocalized laughs (p = 0.335). When a comparison was made between the duration of vocalized laughs between all four, a significant difference was reported (p = 0.018) – see Figure 10.

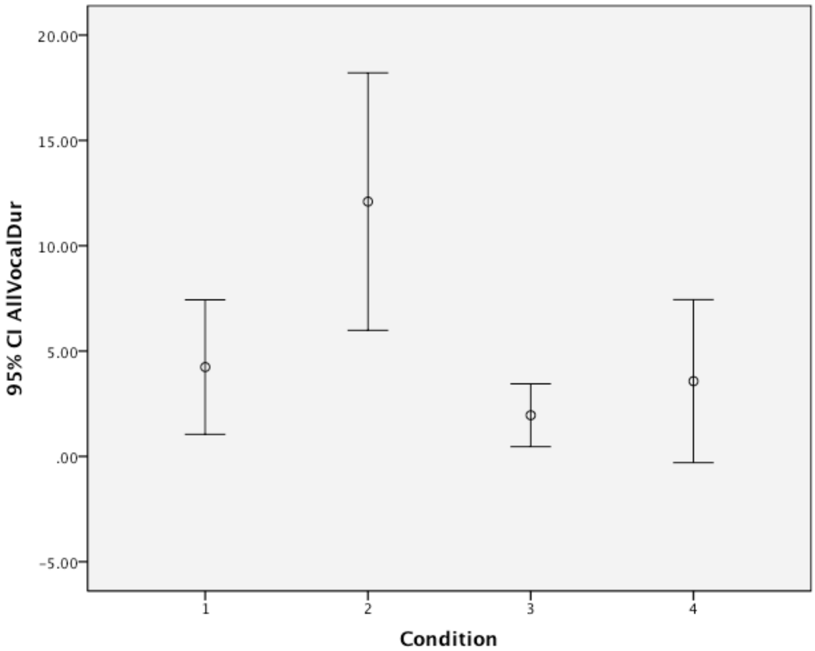

Figure 10. Vocalized Laughter

Laughing with the Robot – Testing the Media Equation

It was then clear that the duration of vocalized laughter was the most refined method of extracting the social influence on laughter. Using the non-parametric Mann Whitney U test which determines whether two groups have been drawn from the same population, comparisons were made in an attempt to look more closely at the difference between the four conditions. Hypothesis 1 states that there should be significantly more laughter behavior in condition two compared to condition one. The results from the Mann Whitney test revealed a significant difference (p = .027), which is in line with H1 (p = .027). Hypothesis 2 states that there should be significantly more laughter in conditions 3 and 4 (robot conditions) compared to condition 1. Results from the Mann Whitney test revealed no significant difference between condition 3 and condition 1 (p = 0.644) , or condition 4 and condition 1 (p = 0.475). Laughter behavior was also coded in terms of whether or not the participant was laughing together with their partner (robot or human) or laughing alone. A visual examination of the total duration of time spent laughing alone and together was carried out in an attempt to gain a better understanding of the difference between condition two and condition four.

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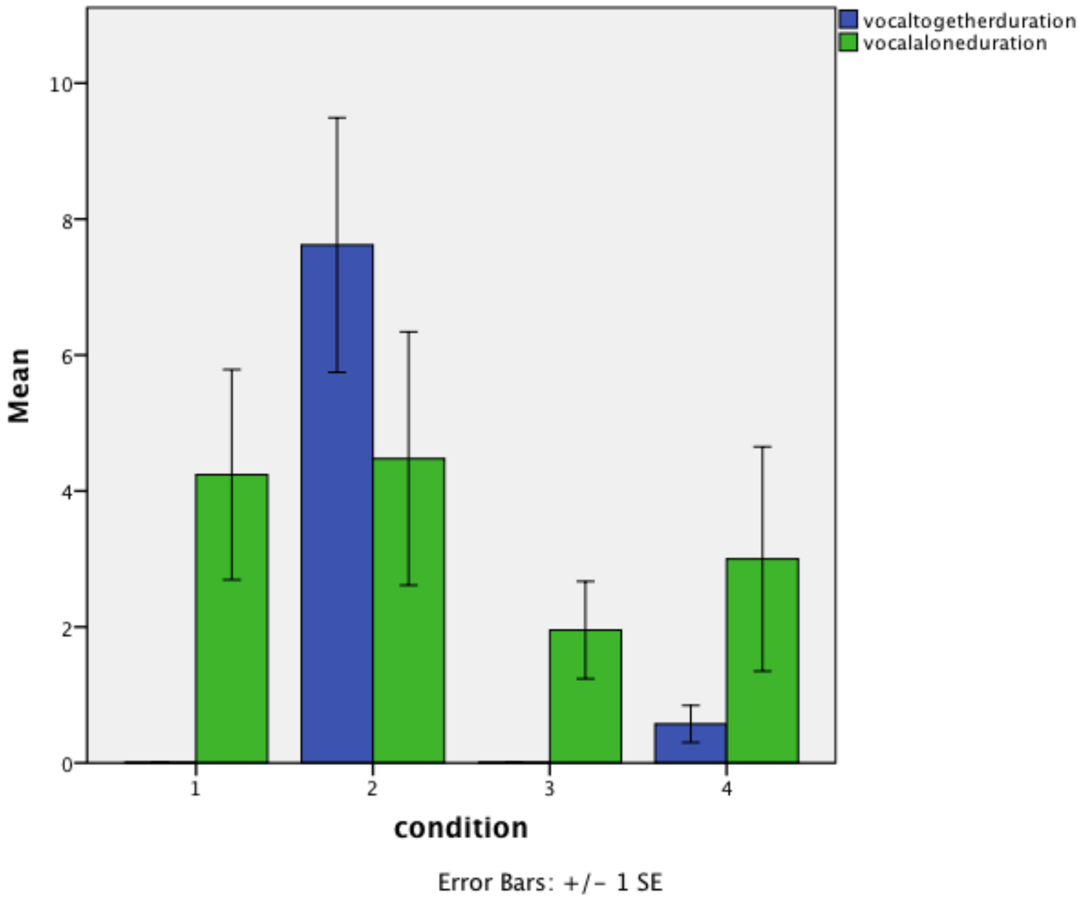


Figure 11. Contagious Laughter

The Y axis in this graph represents the mean value of either vocalized laughter together (blue bar) or vocalized laughter alone (green bar). It is clear from this visualization that participants spent considerably more time laughing together with a human partner in comparison to with a robot partner.

Anthropomorphism

The Rasch estimates were generated from the anthropomorphism questionnaire data. The psychometric Rasch model was used to generate an individual's anthropomorphism score based on their responses to the twenty questions The following figure (figure 12) depicts participants Rasch estimates (or anthropomorphism score) in the two Robot without Laughter Condition and Robot with Laughter Condition respectively. Two outliers were excluded from the analysis, participant 23 scoring extremely high on the anthropomorphism scale , and participant 13 scoring extremely low.

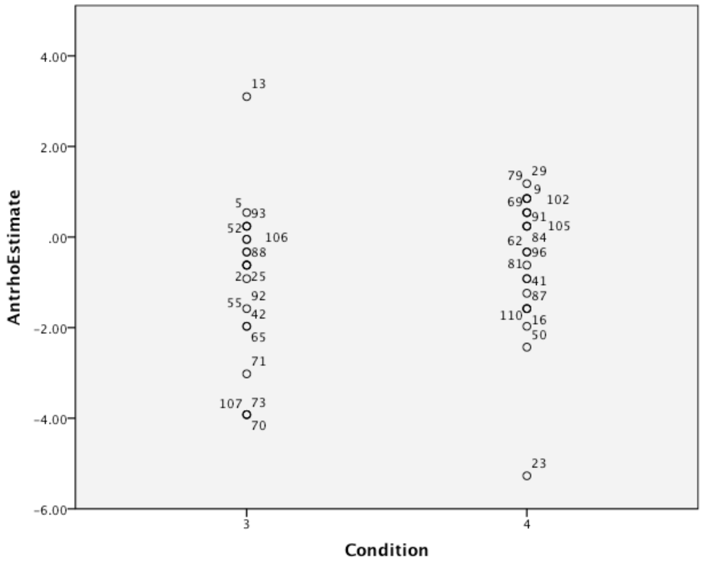


Figure 12. Anthropomorphism Estimates

A comparison was then made between condition 3 (robot no laughter) and condition 4 (laughing robot) to investigate whether the robot's laughter had an influence on participants' anthropomorphic evaluation. It was anticipated that the laughing robot would give a more human-like impression, and the results were consistent with this expectation. Using a one tailed Mann Whitney test, a significant difference was revealed between these two conditions (p = 0.03)

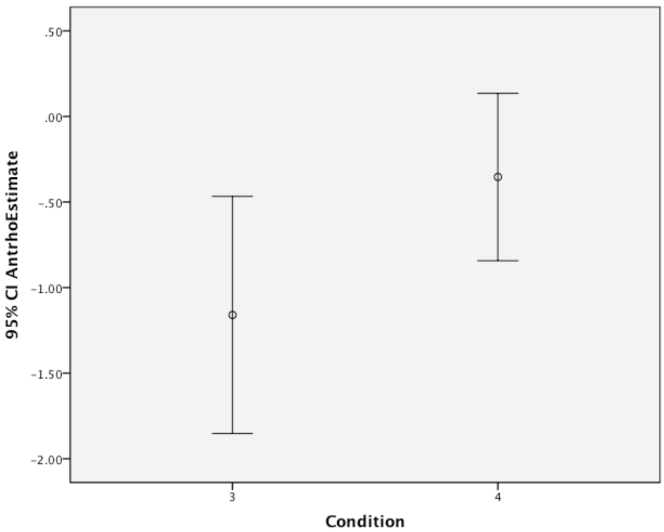


Figure 13. Anthropomorphism with Condition

The anthropomorphism score was then used to test hypothesis three, which states that participants who experienced the robot to be more human-like, would also laugh more. A non-parametric correlation was carried out between participants' anthropomorphic ratings of the robot, and their vocalized laughter duration. The results from this test revealed a significant correlation in the opposite direction that had been expected; Kendall's tau_b Correlation Coefficient -0.257, p = 0.044, Spearman's Rho Correlation Coefficient -0.317, p = 0.046). When the third and fourth condition were analyzed separately, it was revealed that participants anthropomorphism score did not significantly predict their vocalized laughter in Condition 3 (no laughing condition) (Kendall's tau_b Correlation Coefficient -0.212, p = 0.249, Spearman's Rho Correlation Coefficient -0.276, p = 0.239), however in Condition 4 (laughing condition) the results were closer to significance (Kendall's tau_b Correlation Coefficient -0.311, p = 0.09, Spearman's Rho Correlation Coefficient -0.366, p = 0.112).

Discussion

The results from this experiment have revealed some interesting insights. Vocalized laughter has been successfully identified as a social behavior, and used as a way of indicating the social acceptance of a robot. Following a strategy similar to the Media Equation (Nass & Moon, 1997), laughter was used a potential indicator of a robots ability to elicit a social human response. However, our results revealed that participants did not behave in a social manner towards the robot, in comparison with a human. It was also discovered that people who scored high on the anthropomorphism questionnaire, meaning they attributed more human characteristics to the robot, took part in less social laughter than those who scored low on the questionnaire.

Some of these results consistent with previous findings, however some discrepancies have also arisen. When reviewing our first hypothesis, which speculated that people would be likely to laugh more when observing humorous material in pairs compared to alone, we found results that were in line with this statement. In comparison to previous research, our study has provided a more robust method of revealing the social characteristics of laughing behavior. Participants remained oblivious to the true nature of the experiment and were free from vicarious social stimuli creating an environment where natural laughter was observed. The results revealed that there was no significant difference between the conditions when observing all laughter data together (vocalized and non-vocalized, both frequency and total duration). The importance of vocalized laughter when attempting to identify social influences became apparent when a significant difference was identified between the paired condition and all other conditions. This variable then became the flagship of social laughter identification for the remainder of the analysis.

Using the duration of vocalized laughter as an indicator, we subsequently compared the differences between the conditions where participants were accompanied by a robot, and the condition when they were alone. Our second hypothesis expected to find a significant difference between the alone condition (Condition 1) and the two robot conditions (Condition 3 and Condition 4). It was discovered that in this experimental setting, the presence of the robot did not lead to a significant increase in laughing behavior. These results reveal that people did not automatically behave in a social manner towards the robot, meaning that the robot did not provide a sufficient amount of social facilitation for human laughter.

In an attempt to get a more in-depth understanding of this result, the contagious nature of laughter between participants and the robot was investigated. After comparing the amount of time participants spent laughing with a human companion with that of a robot companion (Figure 11), it was clear that laughter was contagious between humans, and not at all contagious between humans and the robot. This result is valid due to the fact that all participants in the fourth condition (laughing robot) were subjected to an equal amount of laughter compared to those in the paired condition.

Anthropomorphism

Our third hypothesis stated that participants that believed that the robot had more human characteristics (scored higher on the anthropomorphism scale) would behave in a more social manner towards the robot, and thus laugh more in his presence. It was discovered that the laughing robot (Condition 4) was perceived as being more anthropomorphic than the non-laughing robot (Condition 3) as we had anticipated. When we observed the correlation between participants' anthropomorphism scores and their laughter behavior, we discovered the opposite effect to what had been hypothesized. There was a negative linear relationship between participants' anthropomorphism ratings and their laughter behavior. These results reveal that individuals behaved less socially with the robot when they believed it to be more human.

When considering the definition of anthropomorphism, it is revealed to have a number of interpretations. It is often used to refer to the physical form of an inanimate object; an anthropomorphic robot often refers to a robot that has a humanlike appearance, however we argue that a more scrupulous interpretation addresses an individual's personal experience of the robot. Consider for example, the experiment carried out by Gong (2007) whereby the researchers claimed to manipulate anthropomorphism by varying the level of realism of the conversational agents. Although a positive linear trend was identified between the realism of the agents and their influence on people's decisions, it cannot be assumed that the quality of the image had a direct effect on the participants' anthropomorphic experience. Anthropomorphism is the attribution of human characteristics to anything that is not human. These characteristics can be physical or behavioral, and the experience can occur consciously or unconsciously. Anthropomorphism occurs as an internal, subjective experience that varies from person to person.

Nass and Moon (2000) posited the hypothesis that "the more computers present characteristics that are associated with humans, the more likely they are the elicit social behavior", however they do not acknowledge that this hypothesis has any relation to anthropomorphism. Nass and Moon (2000) disregard anthropomorphism as an explanation for their findings from all media equation experiments, and claim that all participants in their media equation studies were consciously aware that the computers in the experiment were not human, and when questioned afterward denied the possibility that they had believed it to be human, therefore they could not have experienced anthropomorphism. We argue that the experience of anthropomorphism is far more ambiguous than Gong (2007) or Nass and Moon (2000) imply, and that it is indeed possible that their participants were experiencing anthropomorphism on a subconscious level.

Consider another study by Moon and Nass (1996) demonstrating that participants inferred that a computer had a personality based on the type of language and other non-verbal cues. We argue that the attribution of a personality to a computer is a clear indication that participants attributed a human characteristic to the computer, and thus experienced anthropomorphism. Whether or not the participants admitted to having been aware of their actions is irrelevant. The role that anthropomorphism plays in the results found in media equation studies cannot be ruled out, nor can it be attributed as the sole cause. We believe that the social acceptance of machines occurs in parallel with the experience of anthropomorphism.

Unfortunately the results from our experiment do not present clear evidence in favor or against our argument that anthropomorphism occurs in parallel with the social acceptance of machines. It was revealed that participants who rated the robot as being more anthropomorphic took part in less vocalized laughing behavior (social behavior), which is contrary to the linear relationship between anthropomorphism and social behaviors accepted by many researchers (Gong, 2008). There was a mismatch between the perceived anthropomorphic characteristics of the robot and the social laughing behavior of the participant. Despite believing that the robot was capable of carrying out complex cognitive tasks, such as being able to be angry, participants did not take part in social laughter, and their social behaviors were in fact negatively influenced. It is possible that the lack of connection or interaction between the participant and the robot necessary to instigate social acceptance, caused them to feel uncomfortable in its presence. These results are reminiscent of Mori's (1970) "uncanny valley", which states that the higher people's experience falls on the anthropomorphism scale, the more they become aware of imperfections, resulting in a more negative perception of the technology. Mori (1970) describes how a mismatch between human expectations and the robot's behavior leads to an eerie sensation. When considering our results, we observe that participant's vocalized laughter was negatively influenced based on their anthropomorphic experience of the robot, and this effect was more salient in the condition when it laughed. It was also discovered that participants considered the robot to be more anthropomorphic in the condition when it laughed in comparison with when it did not. These results are similar to those described by the Mori's uncanny valley, in that participants perceived the robot to be anthropomorphic, however the lack of interaction lead to a mismatch between their expectations and how the robot behaved. The robot in this experiment laughed at funny instances of the video clips, indicating that it was capable of complex cognitive tasks, however the robot failed to respond to any other stimuli in its environment. This mismatch between cognitive ability and interactivity may have lead to an eerie experience of the robot, and thus decreasing the likelihood of social laughter.

The results from our experiment have provided evidence that we have not yet gotten to the stage, (either psychologically or technologically) where we can walk into a room, share a humorous experience with a robot, and laugh loudly in their company as though we were accompanied by another human. These results are inconsistent with what was predicted following the instructions from the media equation, and we will now attempt to offer some possible explanations for our results.

Reeves and Nass argue that the results yielded from media equation studies can be explained in terms of human evolution. They argue that our species has not evolved fast enough to fully comprehend this new form of interaction between humans and intelligent machines. This argument provides rationalization for the complex and sometimes inconsistent ways in which humans behave in the company of computers and robots. Up until the last century, humans have been by far and beyond the most intelligent species on our planet. We sometimes behave socially towards animals, however much of this behavior is caused by our attribution of human characteristics to the creature (anthropomorphism). We are very aware however, that animals do not possess the same level of intellectual ability as we do, for example if we read Shakespeare to a horse, we know he would not appreciate the use of iambic pentameter. Since the introduction of the computer, humans have learned to accept that machines can now outperform our intellectual abilities in terms of memory and complex computations, giving us a new intelligent species to compete with. People are of the understanding that computers exist to expand our cognitive ability, acting as our computational slaves, and take comfort in the fact that we are still in the driving seat. Once computers and robots start to respond independently to our actions, and give us the impression that it can understand what we are saying or doing, we no longer have a clear understanding of how we should behave in its presence, or what the computer is capable of.

Take for example the experiment carried out by Bartneck and Hu (2008) where participants were required to interact with a robot for a period of time, and then given a hammer and asked to smash it. The interaction involved shining a light on a table, and the robot followed the light. Participants were assigned to one of two conditions; in the first condition the robot had a high sensitivity to light and followed it very accurately, and in the second the robot had a low light sensitivity and did not perform as well. When participants were asked to "kill" the robot with the hammer, it was revealed that participants in the first condition were more hesitant, and did significantly less damage to the robot in comparison to the second condition. These results suggest that participants experienced a degree of cognitive dissonance when asked to smash the robot. They were consciously aware that the robot could not feel pain, however when the robot demonstrated that it was reacting to their behavior, and a connection was established, they felt less comfortable damaging it.

We offer the explanation that it was the lack of this cause and effect interaction between the human and the robot seen in Bartneck and Hu's (2008) experiment that lead to our surprising results. It may be the case that humans may need to be made aware that the robot is reacting to their actions in order to trigger these social responses. In our experiment however, this lack of interaction between the human and the robot was a necessity in order to maintain consistency across conditions. If such an interaction between participants and the robot had been instigated, then it would also be necessary to replicate this interaction in the human-human interaction (Condition 2), and due to the unpredictable nature of human free will, it would be impossible to control.

To elaborate on this possible explanation, we review the experiments where the media equation has been successfully demonstrated. In each instance, the human involved was interacting directly with the technology. For example, in an experiment carried out by Lee, Naas and Brave (2000), gender stereotypes were demonstrated based on a computers vocalizations. Upon arrival at this experiment, participants were told that they would work on some hypothetical social dilemma situations with the computer. Participants were first asked to read the dilemma that was presented in text on the computer screen. The computer then read the dilemma aloud in either a male or female voice. Participants were asked to speak their choice of solution for the dilemma to the computer, and the computer then verbally confirmed the participants' response. The experimenters made participants explicitly aware that their actions were perceived and understood by the computer. The results yielded were consistent with gender stereotypes, whereby the male voiced computer had a greater influence on the decision, and the female voiced computer was perceived as being more socially attractive and trustworthy. In this example of the media equation (and countless others) we see a distinct pattern in the structure of the experiment. Participants are consistently required to spend a specific period of time interacting with the computer before their social behaviors are evaluated. We suggest that it is this cause and effect dynamic that ignites the automatic social behaviors.

In our experiment, participants were provided with a number of cues in an attempt to instigate social behavior towards the robot. The robot had expressive eyes, it moved and it spoke to participants. The presence of these human-like characteristics provided participants with far more visual cues that suggested the robot should warrant social behavior, in comparison to the visual cues provided by the previously discussed media equation examples. In the fourth condition the robot also laughed at humorous moments in the video clips (seeing as the robot was mimicking a real person's laughing behavior) suggesting that the robot may be capable of understanding humor, and was indeed an intelligent being. Despite all of these cues, results have revealed that participants did not behave socially in the company of the robot. The missing cue in this experiment may have been the direct cause and effect relationship between the participants' actions and the robot's reactions. When recalling the minimalist experimental design provided by media equation researchers, and the large effects they have found, we are presented with more evidence to suggest the importance of the interaction itself as a mechanism required to evoke a social response.

Robert Provine (1996) revealed that laughter is often used as a way to punctuate speech an facilitate communication in dialogue. When considering the level of interactivity required for humans to carry out a fluid vocal dialogue (turn taking, appropriateness of responses), it is clear that a vast amount of inherent social intelligence is required. It may be the case that participants became aware of that the robot's inability to meet the requirements necessary for a social vocal exchange, through language or laughter.

Although it is indeed the case that in the condition where two humans were present (Paired Condition), participants also took part in very little or no interactions, we argue that all participants had an immediate and automatic understanding of the cognitive and social capabilities of the other human, and that their actions would be perceived and reacted upon. These preconceptions could not be assumed in the robot condition, and thus it may be the case that participants needed some level of interaction with the robot to establish that it was worthy of social laughter. We argue that in an identical experimental setting, it would indeed be possible to observe that people laugh significantly more in the presence of a robot than alone. The only change necessary would be to use a robot that exhibits more interactive behavior than the one previously discussed. Once participants' are provided with a sufficient amount of information to make them conscious that the robot is aware of their behavior, and reacting on their actions, we hypothesize that these cues would trigger the social behavior of laughter due to social facilitation.

Another possible limitation of this experiment relates to the data gathering process. It was our original intention to use the amplitude of the sound waves as a way to distinguish between different types of laughter. A visual inspection of the sound waves and the computation of the peaks in the signal were to be used as a means of identifying and distinguishing laughter events. Although a directional microphone was used, it was later discovered that the audio signal from the humorous video clips interfered with the recordings of the laughter, and that relevant information was lost. Another limitation of our study was to omit a questionnaire relating to social presence. Data relating to participants' experience of the social presence of their partner (either the robot or the human) would have provided some valuable insights, and possibly helped further explain our results. Another limitation of this study may also relate to the physical appearance of the robot, MyRo. As this particular robot has been designed as an interactive toy for children, it's appearance may have influences participant's perception of its intelligence.

Despite these limitations, our experimental design has provided clear results pertaining to the social acceptance of the robot. In this experimental setting, it was discovered that people did not behave in an equally social manner in the company of a robot in comparison to a human. The relationship between humans and social robots is only in its infancy, and therefore it is no surprise that there are inconsistencies in our social behaviors. As we philosophize about possible explanations for these results, considering the lack of interactivity, or Mori's uncanny valley, the bottom line remains certain; we have not yet reached a place where we automatically behave in a social manner in the company of a robot. As technological advancements continue to drive forward, we are facing an era where robots will be introduced into our environment. This experiment has provided some evidence to suggest that the integration of social robots may take some time for adjusting, as we are not yet certain how to behave in the presence of these new types of form of life.

Conclusion

Laughter was successfully identified as social behavior in this experiment, and vocalized laughter was recognized as the most influential representation of social laughter. Results revealed that participants demonstrated more vocalized laughter in the company of another person when compared to being alone. It was also discovered people did not take part in more laughing behavior in the presence of the robot used, MyRo. Further explorations of participants' laughing behavior revealed that people spent a significant amount of time laughing together with their companion when it was a human, however did not laugh together with the robot.

In the field of social robotics, anthropomorphism is viewed as an effective mechanism for eliciting social interactions between humans and machines. Although the concept of anthropomorphism of technology remains relatively ambiguous, we argue that it's presence in the results from media equation studies cannot be entirely ruled out. It has been suggested that anthropomorphism occurs in parallel with the acceptance of a social robot, and enhances the experience.

The relationship between humans and robots has retained its air of mystery when contemplating our unexpected results. According to Reeves and Nass' Media Equation (1997), humans behave socially towards computers many situations. These social behaviors were not observed in our experimental setting, despite the presence of a robot that mimicked human laughter precisely. Results revealed that participants' that experienced the robot as highly anthropomorphic took part in even less social laughter. Mori's "Uncanny Valley" (1970) offers a possible explanation for the results yielded in this experiment, whereby the mismatch between the robots ability to laugh at the humorous video clips, and its failure to interact directly with the participant lead to a negative experience. This delicate relationship will evolve as the technology advances, and we predict that in the not so distant future we will become accustomed to social robots, and have an automatic assumption that robots are conscious of our actions and worthy of our social acceptance.

References

Bartneck, C., & Hue, J. (2008). Exploring the abuse of robots. *Interaction Studies*, *9*(3), 415-433.

Broekens, J., Heerink, M., & Rosendal, H. (2009). Assistive social robots in elderly care: a review. *Gerontechnology*, *8*(2), 94-103.

Burgoon, J. K., Bonito, J. A., Bengtsson, B., Cederberg, C., Lundeberg, M., & Allspach, L. (2000). Interactivity in human–computer interaction: A study of credibility, understanding, and influence. *Computers in Human Behavior*, *16*(6), 553-574.

Chapman, A. J. (1983). Humor and laughter in social interaction and some implications for humor research. In *Handbook of humor research* (pp. 135-157). Springer New York.

Duffy, B. R. (2003). Anthropomorphism and the social robot. *Robotics and autonomous systems*, *42*(3), 177-190.

Dunbar, R. I. M., & Bever, J. (1998). Neocortex size predicts group size in carnivores and some insectivores. *Ethology*, *104*(8), 695-708.

Gong, L. (2008). How social is social responses to computers? The function of the degree of anthropomorphism in computer representations. *Computers in Human Behavior*, *24*(4), 1494-1509.

Han, J., Jo, M., Park, S., & Kim, S. (2005, August). The educational use of home robots for children. In *Robot and Human Interactive Communication, 2005. ROMAN 2005. IEEE International Workshop on* (pp. 378-383). IEEE.

Jo, D., Han, J., Chung, K., & Lee, S. (2013, March). Empathy between human and robot?. In *Human-Robot Interaction (HRI), 2013 8th ACM/IEEE International Conference on* (pp. 151-152). IEEE.

Kenderdine, M. (1931). Laughter in the pre-school child. *Child Development*,*2*(3), 228-230.

Kozima, H., Nakagawa, C., & Yasuda, Y. (2005, August). Interactive robots for communication-care: A case-study in autism therapy. In *Robot and Human Interactive Communication, 2005. ROMAN 2005. IEEE International Workshop on* (pp. 341-346). IEEE.

Marijuan, P. C., & Navarro, J. (2010). The Bonds of Laughter: A Multidisciplinary Inquiry into the Information Processes of Human Laughter. *arXiv preprint arXiv:1010.5602*.

Moon, Y., & Nass, C. (1996). How “real” are computer personalities? Psychological responses to personality types in human-computer interaction.*Communication research*, *23*(6), 651-674.

Moon, Y. (1998). When the computer is the “salesperson”: Consumer responses to computer “personalities” in interactivemarketing situations. HBS Working Paper No. 99-041,Boston: Harvard Business School.

Mori, M. (1970). The uncanny valley. *Energy*, *7*(4), 33-35.

Morrison, J. (1940). A note concerning investigations on the constancy of audience laughter. *Sociometry*, *3*(2), 179-185.

Nass, C., Moon, Y., & Green, N. (1997). Are Machines Gender Neutral? Gender-Stereotypic Responses to Computers With Voices. *Journal of Applied Social Psychology*, *27*(10), 864-876.

Nass, C., & Lee, K. M. (2001). Does computer-synthesized speech manifest personality? Experimental tests of recognition, similarity-attraction, and consistency-attraction. *Journal of Experimental Psychology: Applied*, *7*(3), 171.

Nass, C., & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. *Journal of social issues*, *56*(1), 81-103.

Nass, C., Steuer, J., Henriksen, L., & Dryer, D. C. (1994). Machines, social attributions, and ethopoeia: performance assessments of computers subsequent to" self-" or" other-" evaluations. *International Journal of Human-Computer Studies*, *40*(3), 543-559.

Nass, C., Fogg, B. J., & Moon, Y. (1996). Can computers be teammates?.*International Journal of Human-Computer Studies*, *45*(6), 669-678.

Provine, R. R. (1996). Laughter. *American scientist*, *84*(1), 38-45.

Reeves, B., & Nass, C. (1997). *The Media equation: how people treat computers, television, and new media*. Cambridge University Press.

Riether, N., Hegel, F., Wrede, B., & Horstmann, G. (2012, March). Social facilitation with social robots?. In *Human-Robot Interaction (HRI), 2012 7th ACM/IEEE International Conference on* (pp. 41-47). IEEE.

Robins, B., Dautenhahn, K., Te Boekhorst, R., & Billard, A. (2005). Robotic assistants in therapy and education of children with autism: Can a small humanoid robot help encourage social interaction skills?. *Universal Access in the Information Society*, *4*(2), 105-120.

Rosenthal-von der Pütten, A. M., Wiering, L., & Krämer, N. (2013). Great minds think alike. Experimental study on lexical alignment in human-agent interaction.*i-com*, *12*(1), 32-38.

Ross, M. D., Owren, M. J., & Zimmermann, E. (2010). The evolution of laughter in great apes and humans. *Communicative & integrative biology*, *3*(2), 191-194.

Roy, N., Baltus, G., Fox, D., Gemperle, F., Goetz, J., Hirsch, T., ... & Thrun, S. (2000, July). Towards personal service robots for the elderly. In *Workshop on Interactive Robots and Entertainment (WIRE 2000)* (Vol. 25, p. 184).

Siegel, S. (1956). Nonparametric statistics for the behavioral sciences. *McGraw-Hill*. (1956)

Sproull, L., Subramani, M., Kiesler, S., Walker, J. H., & Waters, K. (1996). When the interface is a face. *Human-Computer Interaction*, *11*(2), 97-124.

Shneiderman, B. (1997, January). Direct manipulation for comprehensible, predictable and controllable user interfaces. In *Proceedings of the 2nd international conference on Intelligent user interfaces* (pp. 33-39). ACM.

Shutt, K., MacLarnon, A., Heistermann, M., & Semple, S. (2007). Grooming in Barbary macaques: better to give than to receive? *Biology Letters*, *3*(3), 231-233.

Silk, J. B. (2007). Social components of fitness in primate groups. *Science*, *317*(5843), 1347-1351.

Siegel, S. (1956). Nonparametric statistics for the behavioral sciences.

Wada, K., & Shibata, T. (2007). Living with seal robots—its sociopsychological and physiological influences on the elderly at a care house. *Robotics, IEEE Transactions on*, *23*(5), 972-980.

Young, R. D., & Frye, M. (1966). SOME ARE LAUGHING; SOME ARE NOTâ€” WHY?. *Psychological Reports*, *18*(3), 747-754.

Appendix

Pilot Questionnaire

Participant Number :

M/F :

How would you rate the **humorousness** of each video clip

Clip 1 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 2 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 3 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 4 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 5 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 6 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 7 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before? :

Clip 8 :

Not at all funny   Somewhat funny   Average funny   Quite funny   Hilarious

Have you seen this clip before?   :

Pilot Consent Form

Form of Consent

The following recorded material will only be used for behavioral analysis by the experimenter. The data will stored anonymously and deleted after analysis. Please indicate if you agree to these conditions.

Signature : _________________________ Age : ________ Date : ______________

Pilot Results

	Laughs	Smiles	Smirks	Ratings
P1		4	2	20
P2		1	1	17
P3		1	7	25
P4		5	4	27
Total		**11**	**14**	
Mean	**0**	**2.75**	**3.5**	**22.25**
P5	11	10	6	27
P6	9	10	1	27
P7	3	21	3	27
P8	9	14	3	21
P9		5	8	22
P10		5	5	23
p11	3	7	5	17
P12	9	12	4	16
Total	**44**	**84**	**35**	**180**
Mean	**5.5**	**10.5**	**4.37**	**22.5**

Main Experiment Flyer

Do you have a good sense of humor?

Participants wanted for a fun experiment!

Where?	TU/e IPO gebouw
When?	22/04/2013 - 17/05/2013
How Long?	20 minutes **5 euro** TU/e & Fonty's
Language?	English **7 euro** other

Register :**http://htilabs.ieis.tue.nl/booking/**

Name of experiment : Humor Rating 1

(Please do not register If you have participated in Humor Rating 2 or 3)

Main Experiment Conditions

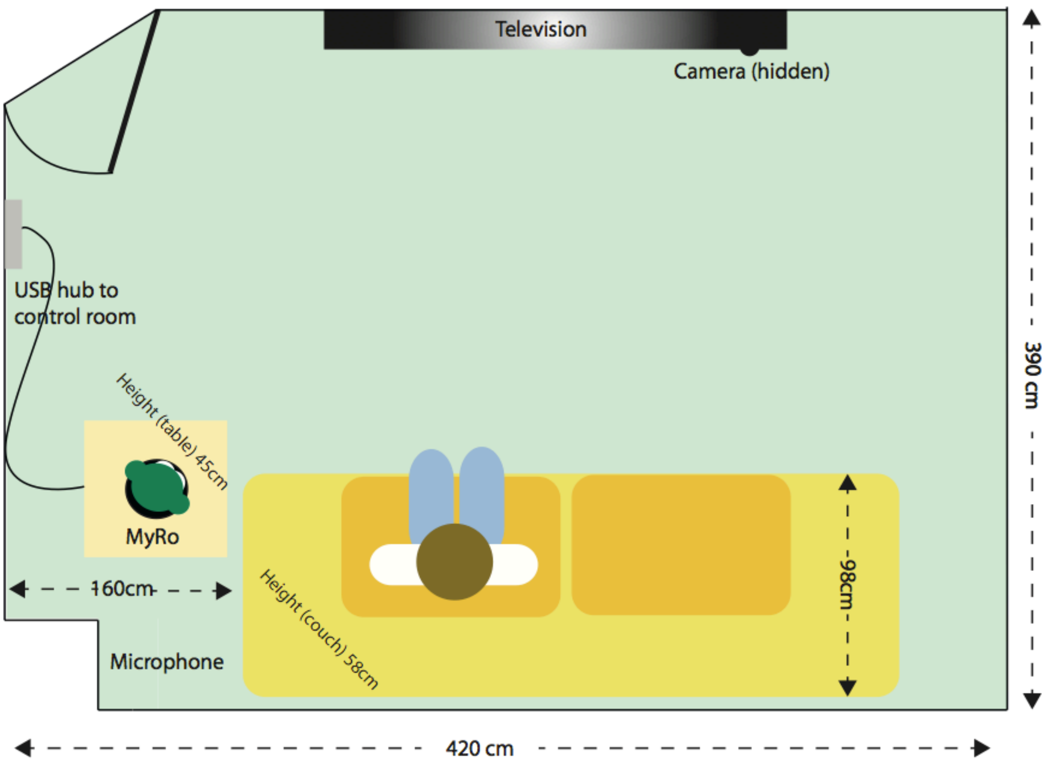
	Mon 22nd	Tues 23rd	Wed 24th	Thurs 25th	Fri 26th
12.00		C1	C3		C1
13.30	C4		C1	C4	
14.00	C1	C3		C1	C3
14.30	C3	C4	C4	C3	C4
15.00		C1	C3		C1
15.30	C4		C1	C4	
16.00	C1	C3		C1	C3
16.30	C3	C4	C4	C3	C4

	Mon 29th	Tues 30th	Wed 1st	Thurs 2nd	Fri 3rd
12.00			C3		C1
13.30			C1	C4	
14.00				C1	C3
14.30			C4	C3	C4
15.00			C3		C1
15.30			C1	C4	
16.00				C1	C3
16.30			C4	C3	C4

	Mon 6th	Tues 7th	Wed 8th	Thurs 9th	Fri 10th
12.00		C1	C3		
13.30	C4		C1		
14.00	C1	C3			
14.30	C3	C4	C4		
15.00		C1	C3		
15.30	C4		C1		
16.00	C1	C3			
16.30	C3	C4	C4		

	Mon 13th	Tues 14th	Wed 15th
12.00		C1	C3
13.30	C4		C1
14.00	C1	C3	
14.30	C3	C4	C4
15.00		C1	C3
15.30	C4		C1
16.00	C1	C3	
16.30	C3	C4	C4

Main Experiment Room Layout



Humor Rating Questionnaire

Welcome!

There are 30 questions in this survey

PPN

0

Ratings

Please give an indication of how funny you consider each clip.

Please rate how funny you find the 1st clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious *

Please choose **only one** of the following:

3 Please rate how funny you find the 2nd clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious *

4 Please rate how funny you find the 3rd clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

5 Please rate how funny you find the 4th clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

6 Please rate how funny you find the 5th clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

7 Please rate how funny you find the 6th clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

8 [7]Please rate how funny you find the 7th clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

9 [8]Please rate how funny you find the 8th clip

1: not at all 2: a little 3: somewhat 4: quite 5: hilarious

Anthropomorphism Questionnaire

In this experiment you have been accompanied by the robot MyRo on the table to your left. We are interested in gaining and understanding of your impressions of this robot. Try to answer the following statements about the robot. You can indicate whether you agree or disagree, and remember there are no wrong or right answers. Try not to think too hard, and just follow your instinct.

10 [1]

The robot can anticipate on its environment.

- Yes
- No

11 [2]

The robot can be angry.

- Yes
- No

12 [3]

The robot can calculate.

- Yes
- No

13 [4]

The robot can detect objects.

- Yes
- No

14 [5]

The robot can empathize with another.

- Yes
- No

15 [6]

The robot can estimate distances.

- Yes
- No

16 [7]

The robot can recognize voices.

- Yes
- No

17 [8]

The robot can see depth.

- Yes
- No

18 [9]

The robot can see.

- Yes
- No

19 [10]

The robot can solve riddles.

- Yes
- No

20 [11]

The robot can talk.

- Yes
- No

21 [12]

The robot can understand emotions of others.

- Yes
- No

22 [13]

The robot deliberately performs actions.

- Yes
- No

23 [14]

The robot feels responsible.

- Yes
- No

24 [15]

The robot is ambitious.

- Yes
- No

25 [16]

The robot is conscious about its environment.

- Yes
- No

26 [17]

The robot is conscious about itself.

- Yes
- No

27 [18]

The robot is purposeful.

- Yes
- No

28 [19]

The robot recognizes emotions of others.

- Yes
- No

29 [20]

The robot understands a language.

- Yes
- No

Camera

30 [12]Were you aware that you were being filmed? *

- Yes
- No

Thank you for your participation