WHAT HAPPENS WHEN A ROBOT FAVORS SOMEONE?

HOW A MUSEUM-GUIDE ROBOT USES GAZE BEHAVIOR TO ADDRESS MULTIPLE PERSONS WHILE STORYTELLING ABOUT ART

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JANUARY 24, 2013

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by

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A THESIS SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF HUMAN MEDIA INTERACTION (MSc)
of the faculty of Electrical Engineering, Mathematics and Computer Science, Human Media Interaction

UNIVERSITY OF TWENTE

Thursday, January 24, 2013

Abstract

The following research is concerned with the effects of robotic gaze behavior and favoritism in storytelling. A group experiment was conducted to find the effects of both in some user experience aspects, human data recalling, and the robot's ability to guide a group of people visually.

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1. Introduction

The introduction chapter is intended to discuss the general aspects of the project such as the aim of the research, the motivation of the research and its contribution to science.

The following research will discuss gaze behavior and favoritism in non-humanoid robots and its effectiveness in storytelling to humans. This paper is intended as part of a larger research body, being produced by several researchers in different institutions across Europe for the project FROG (Fun Robotic Outdoor Guide).

FROG is an indoor/outdoor guide robot intended for museum and zoo guidance. It is designed specifically for the Royal Alcazar in Seville, Spain and the Lisbon Zoo in Lisbon, Portugal. The main aim of FROG is to facilitate information while providing an engaging and social experience to the museum or zoo visitors.

This research is intended to expand the knowledge and understanding of non-verbal behavior, specifically gaze behavior in non-humanoid robots. For the purpose of this research, a non-humanoid robot is a robot that was specifically designed to not resemble a human.

1.1 Aims

This research is aimed at directing people's attention with gaze, while addressing multiple users. This research is intended to be applied in FROG, and its purpose is to aid the improvement of the overall user experience of the robot. This research contains topics of robotic non-verbal behavior and proxemic behavior.

1.2 Motivation

The motivation of this research started with the idea of how should FROG-robot use its eyes when giving an exposition to a person in a museum or a zoo, and how can this improve the understanding and experience of the user. Additionally, we wanted to understand better how gaze behavior and favoritism works with human users.

There is a growing body of research regarding the robotic-gaze and user experience. *Kuno, Sekiguchi, Tsubota, & Moriyama, (2006)* have demonstrated that head movements are a method that humans use to communicate an idea. *Ford, Bugmann, & Culverhouse, (2010)* explored the blinking patterns and their communicative function in communication. (On a related note, *Mutlu, Forlizzi, & Hodgins. (2006)* explored the role of human gaze behavior in a humanoid robot for storytelling). Apart from gaze, there may be other methods of communicating a message without speech.

Significant research has been done regarding facial expressions. *Mutlu, Yamaoka, Kanda, Ishiguro & Hagita, (2009); Bartneck, Reichenbach & Breemen, (2004)* with their prototypes of "Robovie", and the "iCat robot" (respectively) are examples of research done in this field. Similarly *Breazeal & Scassellati, (1999); Gockley, Forlizzi, & Simmons, (2006)*; and *Scheeff, Pinto, Rahardja, Snibbe, & Tow, (2002)* have explored the role of gaze cues in non-verbal communication in a robot to human interaction context. All these studies find in one way or another the great potential of using facial expressions for the purpose of communicating messages. The use of gaze happens to play a significant role in all of them.

1.3 Contribution

This research is intended to contribute to a better understanding of gaze behavior in non-humanoid robots and its relation to the user understanding and experience in robot storytelling. As well as a better understanding of how robots should address multiple users in small groups. We intend to examine the dynamics of favoritism, as the robot picked a favorite person in its speech.

To the best of our knowledge there has been no research regarding robotic favoritism in storytelling. An experiment was designed and conducted to prove or disprove a series of hypotheses regarding robot gaze behavior in storytelling for the purpose of indoors and outdoors museum/zoo guidance.

The findings in this research can potentially be applied to other non-humanoid robot designs to improve the human-robot interaction and therefore the experience of humans while interacting with a non-humanoid robot.

1.4 Report Structure

The different concepts related to robot gaze, robot storytelling and user experience are described in the Theoretical Background. An experiment is introduced and described in the Experiment Design chapter, where all the hypotheses are described. The results of this experiment are reported and analyzed in the Analysis & Results chapter and conclusions are drawn in the Conclusion chapter. Every major chapter contains a brief description about the contents of the chapter, to allow the reader to get the general idea of the contents in it.

1.4.1 Report terminology

Throughout the whole report, the reader will find a series of acronyms that make the distinction between Human to Human (HtH), and Robot to Human (RtH). The mentioned acronyms are important for the understanding of this research, since most of the sources in this report fall under one of those contexts.

Humans communicate, in both verbal and non-verbal ways. The expressive behavior of humans is rather complex. And it makes mostly an unconscious use of a variety of methods to transmit a message apart from spoken language as *Knapp & Hall (2009)* explain. Robot to human (RtH) interaction presents a challenge to user experience researchers, engineers, designers and psychologists involved in the field of robotics, in their attempt to shape a robotic behavior that is socially and anthropomorphically acceptable.

It is generally assumed, that what works in HtH interaction, has a high potential of working in RtH interaction too. This, however, may not always be the case, and it is for this reason that research papers like this one, exist. Needless to say, the observations of HtH interaction can provide a good starting model for RtH interaction research and experimentation.

When the term “robot” is mentioned, it is assumed that we refer to a robot with social capabilities. A social robot, as *Duffy (2003)* explains, is a robot that can interact with a human under a social and emotional context. Unless explicitly stated, we do not refer to robots of a non-social nature (e.g. A car assembly robot).

2. Theoretical Background

The theoretical background chapter is intended to extend the knowledge of the reader, and provide a general theoretical base for the understanding of the research and the experiment design. The theoretical background has been divided into three main sections, the task of directing users attention by a robot, the task of addressing multiple users at once by a robot, and proxemic behavior in communication.

2.1 Directing user's attention

The following chapter contains topics about user attention guidance and direction in HtH and RtH communication in relation to user attention direction.

2.1.1 Directing user's attention through gaze and pointing

Sidner, Kidd, Lee & Lesh (2004) found that in a RtH context, people in general present a higher degree of engagement whenever a robot highlights objects of interest by using gestures. Studies such as the one of *Siegel, Breazeal, & Norton (2009)* and *Bennewitz, Faber, Joho, Schreiber & Behnke (2005)* have produced robots that imitate the human body and behavior to a certain degree. In the later study in particular, a robot with a head, a torso and two arms is shown to the participants. The robot has the capability to point at objects since it has arms and it does not have to rely entirely on its gaze.

Häring, Eichberg, & André, (2012) tested and compared three different modalities in a RtH interaction setting. The first one of a robot giving verbal instructions only. The second one of a robot giving verbal instructions with eye contact and looking at the puzzle pieces that the participant had to make. The third one was like the second one but with pointing gestures with an arm and gaze pointing as well. *Häring, et al. (2012)* found that there were positive trends favoring the use of the third modality.

Gaze can be coupled with head movements to allow a greater degree of flexibility.

Kuno, et al. (2006) suggest in their research that implementing head movements on a museum guide robot is an effective method to drag the attention of the user to the robot. *Sidner, et al. (2004)* have demonstrated that people tend to lend their attention to the robot more often when the robot moves its head than otherwise.

2.1.2 Human expertise in understanding of non-verbal gaze-cues

Humans are masters in the art of expressive non-verbal communication. *Ford, et.al. (2010)* in their robot design highlighted the expertise of humans in the art of using eye-movements for transmitting non-verbal messages. *Ford, et.al. (2010)* are quick to suggest that it is perhaps, because of this high human expertise in recognizing facial and gaze expressions, that the expectations for a social robot would be high, especially if the robot designers are aiming to mimic reality.

Mutlu, et al. (2009) research suggests that there is a significant relationship between pet ownership and the effective perception of gaze cues of a robot in a RtH interaction context. In other words, their research suggests that pet owners, have shown to be more sensitive to the gaze cues of a robot due to their previous experience with their pets.

2.1.3 Creating mutual gaze for increased user's recall of details

Previous research has been done on the subject of gaze, and the recall of details of a story by the participants. In a classroom setting (in a HtH interaction context), students who are looked at, will generally show a better recall of details than, students who are not looked at, as *Otterson, and Rodningotteson (1980)* suggested.

Additionally, *Mutlu, et al. (2006)* found that in a RtH context, the frequency of robot gaze, had an effect in the recalling performance by the human user, similar to what happens on a HtH context as *Otterson, and Rodningotteson (1980)* explored earlier, in their classroom experiment.

We do not intend to rely on the use of robotic arms due to our safety concerns with children. Since FROG is intended to interact with both children and adults, there is a possibility that children may

trespass the work envelope of FROG. Instead we intend to use gaze as a pointing tool.

We decided to test mutual gaze as a tool to direct our participants attention in the experiment, since gaze has shown to be a useful tool to guide the participant's attention. We expected our human participants to be able to read the gaze-cues of our robot.

2.2 Addressing multiple users

Based on the data collection produced by *Karreman, et al. (2012)* in the Royal Alcazar (in Seville, Spain) and the Lisbon Zoo (in Lisbon, Portugal). Four tour schedules (two on each site) by four human tour guides were observed and their actions were recorded. *Karreman, et al. (2012)* noted the following in their research:

- Many human museum guides chose to look at a particular visitor per exhibit. The museum guide focused on this particular visitor, and then shifted occasionally to other visitors.
- When a guide looked at a visitor. The visitor was often nodding, therefore giving feedback of the group's attention on the museum's guide, as *Best, (2012)* observed in her study.
- Often, the museum guide would use a deictic word in order to address the visitors seconds before the initiation of an exhibition or a section of it.
- Sometimes, the tour guide would start speaking, even when not all visitors were giving attention to the guide.
- The museum guide would usually take a position where he/she could point at an object being exposed while still facing the group of visitors.
- The museum guide would shift his gaze direction from the visitors to the object being exposed, whenever a detail of the object or the object itself required special emphasis.
- The museum guide would brake eye contact from the group of visitors and focus his/her attention into another object whenever he/she wanted to signal the end of a section of the exhibition.

Karreman, et al. (2012) gathered qualitative data through direct observations, video recordings, interviews with all four tour guides. Four different tours were observed and each one had a unique composition of visitors.

2.2.1 Distributing attention to multiple users

In HtH communication, gaze behavior has the ability to communicate the liking and status of members in a group. According to *Mehrabian (1968)*, people of lower status tend to be looked at less than members of higher status. Additionally, according to *Exline and Winters (1965),* as cited by *Mutlu, et al. (2006),* speakers tend to look more at the members of a group whom they like. Mutual gaze, according to *Brennan, (2004)* as cited by *Rich, Ponsler, Holroyd, & Sidner, (2010),* is an important and documented factor in HtH communication.

Conversely, *Mutlu, et al. (2006)* found in their group-based experiments that in robot to human interaction (RtH) the participants who were looked at more often by the robot, did not necessarily evaluate the robot more positively, especially women. Women indeed expressed a more positive outcome when the robot looked at them less.

Kleinke (1986), as cited by *Mutlu, et al. (2006),* mentioned that in HtH interaction, people who use their eyes to look at others are more likely to be perceived more competent, credible, assertive, socially skilled, friendly and overall more favorable.

We intend to design a robot that will be able to address multiple users, in the same way as a human tour guide as *Karreman, et al. (2012)* observed. Furthermore, we intend to investigate whether favored participants express a higher level of attraction towards the robot, reflecting the conclusion of HtH interactions, as *Kleinke (1986)* described.

2.3 Proxemics in communication

Robots, like any other object, require a space to interact with humans. Unlike many objects, robots have the ability to move autonomously and interact with the physical space of people. This fact opens the possibility for a robot, to invade what could be considered

the personal space of a person. Invasion of the personal space of a person is usually considered undesirable and may render poor results in poor satisfaction levels in people. Proxemics or the handling and management of space of people as *Hall, Birdwhistell, Bock, Bohannan, Richard, Durbin, Edmonson, et al. (1968)* explore in their research, is yet another consideration that robot designers should take into account.

Robots that do not show a proper distance behavior, may be regarded as disruptive, and even threatening by humans, as *Mutlu & Forlizzi, (2008)* suggest in their research.

2.3.1 Proxemics and user's gender

Aiello, (1977) and *Adler & Iverson, (1974)* found that women, at least in a HtH interaction context, have the tendency of maintaining on average, less distance between themselves, as opposed to males.

Aiello, (1977) also explored how eye-contact regulates the comfort interaction between people and the difference in between same-gender and cross-gender interaction in a human to human context. His research suggests that in HtH interactions, there is a visual equilibrium for physical proximity and mutual gaze in an interpersonal encounter. He suggests that gender has a significant effect in this equilibrium. He notes that males look at each other more as they are more distant to each other, while females look at each other more when there is an intermediate distance. Females also decrease their mutual gaze as the distance increases, as opposed to males, whom withdraw their mutual gaze as they get closer.

Mumm, & Mutlu, (2011) produced a more recent research, that focused on the RtH interaction in the context of four interpersonal distance models. *Mumm, & Mutlu, (2011)* found that when a robot increased the amount of time it gazed at an object with a person looking at the same object ("mutual gaze"), the person would distance himself/herself more, especially participants who reported disliking the robot. In other words, the "*likeability*" and the gaze behavior of a robot are deeply interconnected. This effect was more obvious in men than women. The finding shows consistency with the research of *Aiello, (1977)* and *Adler & Iverson, (1974)*. In other words, what is happening in a HtH interaction regarding gender and proxemics, happens as well in RtH interaction.

2.3.2 Other factors that affect proxemics

Additionally, other factors may also affect the proxemic behavior of an individual in HtH interaction, which may possibly also have an effect in RtH interaction. As cited by *Mumm, & Mutlu, (2011),* factors like the age and the membership of an ethnic group (*Baxter, 1970)*, the cultural background of a person (*Hall, 1966),* body orientation (*Hayduk, 1981; Ashton, Shaw, & Worsham, 1980),* and physical appearance and perception of attractiveness from one individual to another (*Kaplan, Firestone, Klein, & Sodikoff, 1983);* are factors that affect the proxemic behavior of a person in a HtH interaction context.

Mumm, & Mutlu, (2011) found in RtH interaction, that participants who liked the robot were more prone to get closer to it, while participants who disliked it, were more prone to distance themselves from the robot. Additionally, he found a relation between pet ownership and distancing from a robot. Pet owners tended to keep a larger distance from the robot.

Mumm, & Mutlu, (2011) found that the *compensation-equilibrium model* developed by *Argyle, & Dean, (1965)* (*where an individual increased his/her proximity by decreasing the distance between him/her towards a second individual, the second individual compensated this equilibrium by distancing himself/herself from the first individual*), was the best suited to describe the interaction that his participants experienced during his experiment. It's worth mentioning that all the models were initially developed in a HtH interaction context, and *Mumm, & Mutlu, (2011)* tested them within a HtR interaction context. *Mumm, & Mutlu, (2011)* found that participants distanced themselves more from the robot, when the participant and the robot established mutual gaze. They also found a partial support for the *attraction-transformation model* by *Firestone, (1977)* and *Kaplan, (1977)* (*where an individual that presents a high degree of attraction to another individual should maintain a short distance towards the other individual, regardless of whether the second individual moves*). The distance that the participants maintained in *Mumm, & Mutlu, (2011)* research was affected by whether the participants liked or disliked the robot. If participants liked the robot, they would not have a change in their distance, while participants who disliked the robot would increase their distance.

2.3.3 Gaze and proxemics for social robotics

In HtH communication, gaze behavior and proxemic behavior, tend to go hand in hand with each other. Specifically when the robot happens to have social features, and it is designed to interact with humans on an emotional level. These type of robots according to *Duffy (2003)*, are known as Social Robots. *Breazeal, (2003)* categorizes social robots in the following way:

- **Socially evocative:** Designed to encourage its users to anthropomorphize it for interaction purposes.
- **Social interface:** Robots that use human-like social cues that facilitates familiar interactions with humans. (*Breazeal, (2003)* specifically places tour-guide robots in this category).
- **Socially receptive:** Robots that learn from interaction with humans.
- **Sociable:** Robots with self goals or motivations that participate in interactive situations.

Gaze and proxemics are truly interconnected. Studies like *Mutlu, Forlizzi, & Hodgins, (2006)* that have focused on robotic gaze behavior, would typically include considerations in proxemics as well. Likewise, studies like *Mumm, & Mutlu, (2011)* that are focused on robotic proxemics (within the social robotics field), would typically include considerations in gaze behavior as well.

Proxemics observations while relevant for this study, were intentionally limited, in order to allow a greater focus in robotic gaze. Proxemics have the potential to tell us a deeper story about the perceived *likeability*. We expected our participants to get closer to the robot, when the robot act in a more human-like gaze behavior. We designed two gaze behaviors, that differ only on whether there is mutual gaze or not. In both behaviors, the robot favored a participant in the group.

3. Experiment Design

The experiment design chapter describes in detail the experiment conducted for the proof or refutal of the hypotheses in this research. It also serves as a base to the understanding of the results

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3.1 Hypotheses

The following section contains hypotheses that were put to test in the experiment. In summary, our experiment consisted of a robot that gives a speech to groups of three people. The robot has a couple of artworks behind him, and the speech is about the two artworks. While giving its speech, the robot looks at the participant to its left (*the favored*) considerably more than to the two other participants. The other two participants (*the non-favored*) receive less, but an equal amount of gaze-time. Additionally, the robot is set up in two modes. The *Participant-exclusive mode* (*PEMode*) which means that the robot looks at the participants only. And the *Distributed mode* (*DMode*) which means that the robot looks at the participants, and also occasionally mutually gazes at the artworks with the participants. Both patterns were based on the observations of *Karreman, et al. (2012)* and the research done by *Kuno, et al. (2006)*.

- **H1:** When a robot establishes mutual gaze with people, the people will have a more positive attitude toward the robot, will have better recall of details about the artwork and will come closer to the robot.

- **H2:** When a person in a group is favored by the robot, the favored person will have a more positive attitude toward the robot, than the non-favored people. The favored person will be able to recall details better than the non-favored people. Because of the more positive attitude towards the robot, the favored person should also get closer to the robot.

3.2 Constructs

In order to prove the validity of each hypothesis a set of variables was determined. Each variable played a role in the experiment and gave information about the validity (or lack thereof) of our hypotheses.

3.2.1 Manipulation

This chapter contains the list of variables that were manipulated during the experiment, and that were reliant to our design and planning of the experiment.

- **Type of gaze behavior** plays an important role in the user perception about the robot. Two behaviors were tested in this experiment:
  - Participant-exclusive mode (*PEMode*)
  - Distributed mode (*DMode*)

The testing of the two gazing behaviors in a robot should directly tell us something about hypotheses H1 and H2. In both scenarios, the robot spent more time looking the person to its left (from the robot's perspective) than the other two participants.

- **Favoritism** was a variable we manipulated during the experiment. The robot picked the person to its left, and it would look at him/her considerably more than at the other two participants in the group. As for the other two participants, the robot distributed an even amount of gaze-time.

3.2.2 Measures

This chapter contains the list of dependent variables or measurements, that were directly dependent on the participants and their input in the experiment. As such, we had no control over them. However, they provided valuable data for the proof or refutal of our hypotheses.

- **Participant's attitude towards the robot (user experience)** played a role in corroborating or refuting completely or partially, H1 and H2. This variable measures many different dimensions of the participant's experience: *perceived credibility, likeability, anthropomorphism, perceived safety, co-presence* and *attentional allocation*.

- **Participants' attention** is also part of both H1 and H2, and should tell us something about the participant's *attentional allocation*. This measure may have an indirect effect in the following measure.

- **Participants' recalling of story details** should indicate to us something about hypotheses H1 and H2. It is concerned with the amount of details that the participants could recall after their experience.

- **Participants' physical distance towards the robot** gave us information about the preferred distance that our participants took from the robot and H2. With the findings of *Mumm, & Mutlu, (2011)* it should tell us whether the participants felt attracted towards our robot.

3.3 Methodology

The following chapter will describe the particular elements of the experiment that played a role, in addition to a detailed walkthrough of the experiment.

In general terms, our experiment consists of two independent variables (*mode* and *favoritism*). Our setting took place in a controlled environment, and we had 57 participants, all students or staff of the University of Twente.

3.3.1 Participants

The participants of this research consisted of students and staff of the University of Twente, between 19 and 57 years old, They took part in the experiment in groups of 3 people per session.

3.3.2 Operationalization

This chapter contains the list of data collection methods and techniques that were utilized according to each dependent variable. Use of validated methods was an important consideration that we took into account in the design of the user experience block of questionnaire.

There is an ongoing debate on the measurability of user experience, through operationalized methods, such as a validated questionnaire. As *Law, (2011)* describes it; It is a classical debate of reductionists versus holists or qualitative design-based advocates versus quantitative model-based advocates. We have opted for a quantitative model-based approach due to its practicality. Fortunately, user experience is just one aspect of this research,

- The **participant's attitude towards the robot (user experience)** was collected through the questionnaire (*Block 1*) at the end of the experiment. The questionnaire in this section contained semantic differential questions of 7-scale points based on the *anthropomorphism, likeability,* and *perceived safety* blocks of the *Godspeed model* proposed by *Bartneck, et al. (2008)* and the *sociability, competence, composure,* and *character* blocks of the 15-item *Source Credibility Scale* by *McCroskey* as it appeared in the book *Communication Research Measures* by *Rubin, Palmgreen, & Sypher, (2004)*. Additional scales in the questionnaire were added in order to measure specific dimensions, ones that we thought to be useful for this research and that the selected validated scales did not address.

- For the **participants' attention** measurement, we made use of two portions of *Internal Consistency and Reliability of the Networked Minds Social Presence Measure* by *Harms & Biocca, (2004)*. According to their research, this block addresses the participant's amount of attention that he or she allocates and receives from the person, (or in this case, the object) that the participant is interacting with. The two portions that we used of their

questionnaire were: The *attentional allocation* measure, and the *co-presence* measure.

- The **participants' recalling of story details** data was collected through the questionnaire (*Block 2*). This part of the questionnaire was "home-brewed", in order to match the robot's speech. Three types of questions were asked.
    - About the mentioned details of the story such as names, places or concepts.
    - About the mentioned physical features of the artwork, such as colors or objects displayed in the artwork.
    - About the unmentioned physical features of the artwork.
- The **participants' physical distance towards the robot** data was collected through direct annotation. The floor where the participants stood was marked every 30cm. We annotated the initial position of the participant, the position in the middle of the narrative and the position at the end of the narrative.

3.3.3 Instrumentation

The following chapter will describe the tools used during the experiment, as well as each element that played a role in the experiment, such as the setting of the controlled environment.

3.3.3.1 Setting

The experiment as shown in *Fig.1* was carried out in a controlled environment. With two pieces of artwork over two blue poster boards.

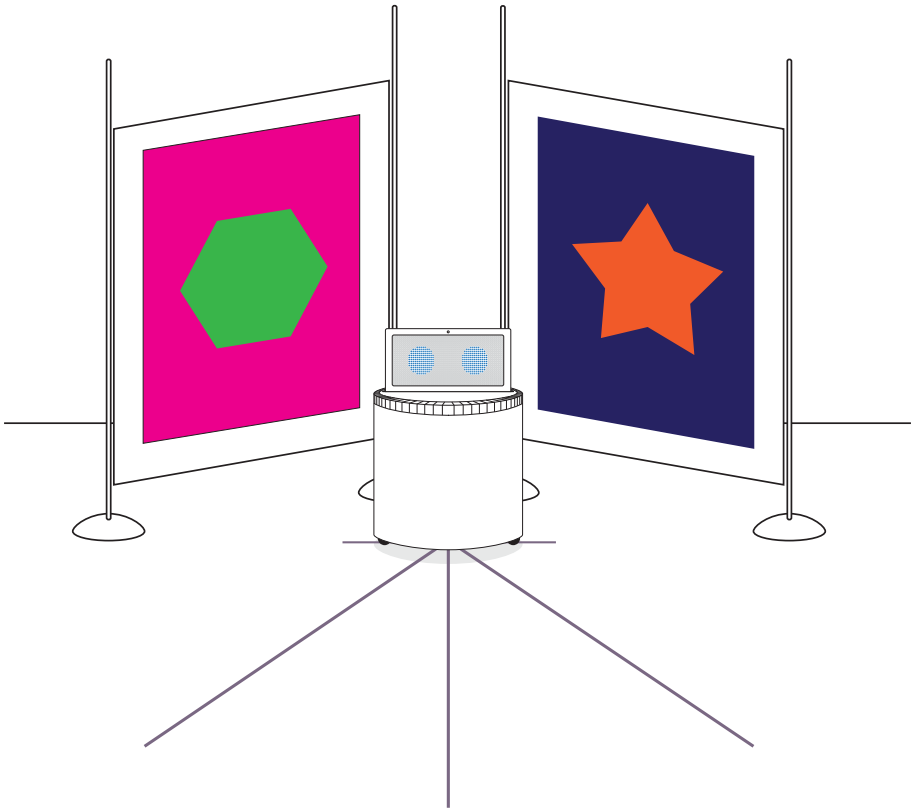

Fig.1 Illustration representing the setting of the experiment. The artworks displayed in the illustration are not the actual artworks that were displayed in the experiment. The robot is at the middle of both artworks as the center of attention.

The participants signed their consent forms outside the controlled area. Once inside, the robot began its narrative, by talking to the participants. After that, the participants were asked to answer the questionnaire behind the interaction area. This was done to prevent the participants from seeing the artworks, since the questionnaire contained questions about the visual aspects of both artworks. *Fig.2* displays a map of the setting from an aerial view.

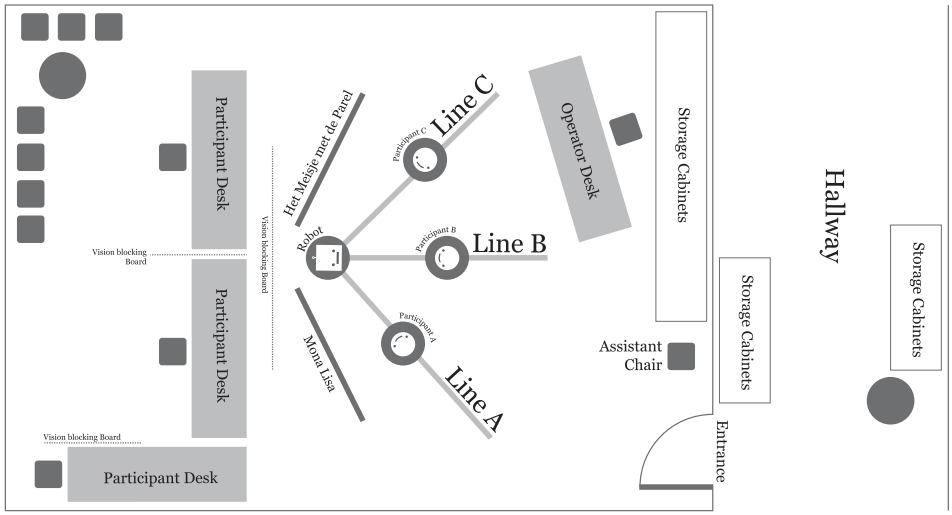

Fig.2 Illustration representing the setting from an aerial perspective.

3.3.3.2 Tools

The following chapter will describe the tools required to conduct the experiment.

3.3.3.2.1 Video recorders

During the whole experiment, audiovisual recordings were carried out to gather data for further research in the experiment. A single camera was placed under the ceiling of the room, right behind the artworks and near where the robot was placed. The recordings were intended to capture the gaze direction of the participants throughout the experiment. Additionally, a fish-eye camera was placed over the area were the robot was rotating. This was done to record any changes in the distance between the robot and the participants.

3.3.3.2.2 Artwork

Two well known artworks were placed on the poster boards, for the robot to explain a story about them. The artwork and the stories were related. The two artworks presented were the *Mona Lisa* by *Leonardo Da Vinci*, and the *Girl with the Pearl Earring* by *Johannes Vermeer*.

3.3.3.2.3 Stories

Two stories were exposed by the robot to the visitors. Each story was related with one of the artworks. The Mona Lisa story or first story was shorter and with less details, while the Girl with the Pearl Earring or second story was longer and with more details. Both were exposed by the robot to the visitors.

3.3.3.2.4 Robot

For the experiment, we made use of a robotic table called *Magabot* that would represent the body of the robot. The eyes of the robot were displayed over a notebook screen. The robot made use of its body to turn from left to right.

Our robot is not intended to look like a human, as demonstrated in *Fig.4*. Indeed, the purpose of this research is to find if some of the gaze behavior findings in humanoid robots can effectively be used in non-humanoid robots. We don't have to worry about the *Uncanny valley* of *Mori, (1970)* due to the non-humanoid nature of our robot. The *Uncanny valley* describes how a robot that looks too close to a human can be perceived as creepy if it doesn't act as natural as a human.

Despite our general research context, and our desire to make our robot look non-humanoid rather than humanoid; We have decided that some human, and mammal anthropomorphic features had to be used. These features were used in order to take advantage of some of the communication cues that our participants are already familiar with. Naturally, the expressions that the robot had to be able to perform required human-like features, such as having a pair of horizontally-aligned eyes, distanced by an area where an imaginary nose could be placed. This allowed our participants to quickly identify the eyes of the robot, and therefore make our observations related with gaze behavior. We decided to take a conservative approach, and not present a robot with a very radical visual aspect or anthropomorphic features (e.g. 6 vertically-aligned eyes, a single eye, no eyes, etc) in order to have a more robust external validity of our conclusion.

Further work could explore the possibilities of non-humanoid robots and their impact in human interaction and user experience. We have decided to limit the anthropomorphic facial features in our robot, with some human-like (also common to mammals) anthropomorphic characteristics. We made our robot as simple as possible, with a featureless face and body, except for the eyes. *Fig.4* demonstrates a sketch of the robot.

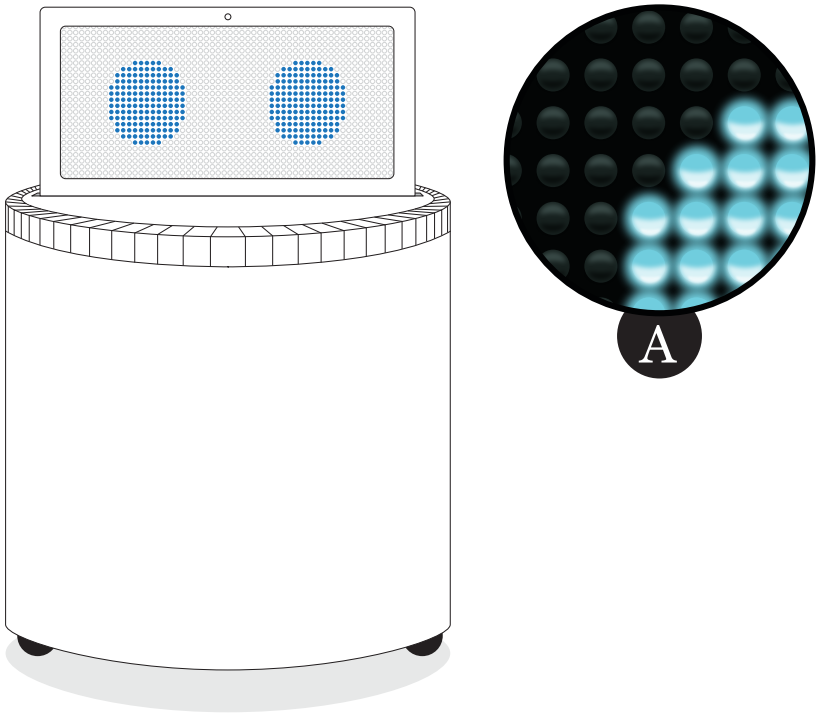

Fig.4 Illustration demonstrating overall look of the robot. The robot had roughly the shape of a cylinder. (A) The screen of the robot displayed a LED matrix in its screen. The LED matrix was selected because of its simplicity and potential to mimic the reality of future versions of the robot.

The robot supports three gaze directions as demonstrated in *Fig.5* with the simple technique of turning on and off selected lights in the expression panel. This enabled the robot to point at things with its gaze.

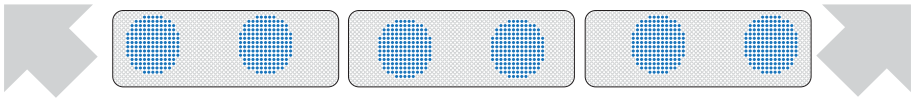

Fig.5 Illustration demonstrating the possible gaze directions that the robot supported for the experiment.

Additionally, some gaze expressions were added to the robot, to aid the narrative of the stories that were exposed. The gaze expressions are shown in *Fig.6*. The gaze expressions included the process of blinking itself.

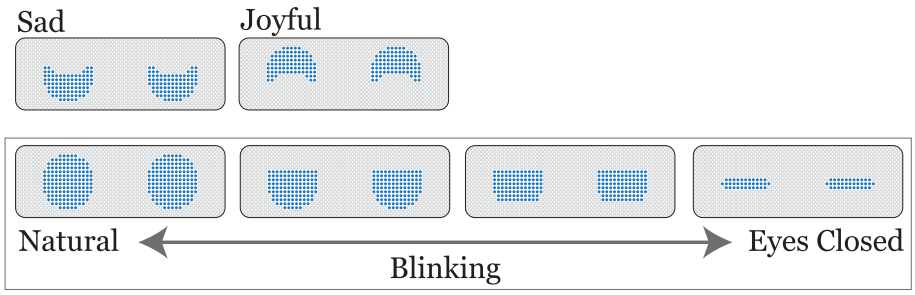

Fig.6 Illustration mapping all the possible gaze expressions that the robot supported while narrating the stories in the experiment.

While we recognize the obvious advantage of a robot with arms when it comes to pointing at an object, we have decided not to include arms in our prototype.

We have decided to make an armless robot due to the possible implications it can have in the reported participant's attitude towards the robot. FROG's final prototype will be used in settings where children are present, and may interact with the robot. Children will most likely be able to approach and enter into the robot's work envelope, making it potentially hazardous if the robot were to have arms.

An extensive explanation of our reasons to not include arms has been placed in the appendix (Chapter: Robotic Arms) for the reader, to better understand our reasons behind leaving the arms out of our design.

This research is focused on gaze behavior only. Adding arms to the robot would be a distraction from the main research question.

The robot had a height of approximately 60cm, and had the capability to transport its body within a confined space. Nevertheless, during the experiment the robot did not move to any direction.

Robot's moving parts

Mutlu, et al. (2006) expressed some concerns, regarding the noises that their robot produced every time the robot moved its arms. Unlike their prototype, our robot did not have arms. Nevertheless, our robot still has a body that rotates to the sides over an X axis which caused a limited amount of noise.

Robot's perceived gender

The perceived gender of a robot plays an important role in the user perception of it. *Siegel, et al. (2009)* revealed in their study, the complex relationship that the perceived gender of the robot plays with the gender of the user. *Siegel, et al. (2009)* found that cross-gender interaction (e.g. When the robot has a female voice and the user is a male or vice versa) yields a higher rate of credibility, engagement and trust than same-gender interaction.

Due to the findings of *Siegel, et al. (2009)* where they found that, men tend to be predominantly affected by the robot's perceived gender, while women showed little preference of robot's gender, we have decided to implement a women's voice in the robot.

3.3.3.3 Technical Implementation

For the robot, we used the Magabot platform (*http://magabot.cc/*) based in Arduino. The platform allowed us to place a portable computer on top, as *Fig.7* demonstrates. We placed a pair of speakers at the bottom of the structure. We wrapped the whole robot with a layer of metallic cardboard, and allowed only the screen to stick out of the shell.

Fig.7 Image of the Magabot robot without the shell. The speakers were placed on the lowest shelf.

We used a Wizard of Oz method, since the robot was operated by a human. It did not have a real intelligence. To ensure that the timing of the rotations was accurate, a video-guide was created. Every time the robot would receive an order to rotate to the right (from the robot's

perspective), the operator had to press “6” , to the left “4” and to stop “5”.

The video-guide as shown in *Fig.8* was inspired in the popular japanese game “Dance Dance Revolution” where the user of the game gets a series of orders to step over the down, left, right and up buttons with his/her feet, based on timing.

The same principle applied in this experiment, except that the orders were done with a single hand, over the numeric pad of a keyboard. Also the guide was meant to be the least challenging possible, so the operator could do the right movements at the correct time. Additionally, instead of arrows, numbers were displayed to eliminate any ambiguity. The orders were sent via Skype, and the robot responded instantaneously to them.

The animation of the eyes, including the blinks were all made a single video. The video of the eyes-animation was played at the same time as the video-guide, so the timing between the rotations and the eyes movement would be synchronized.

Fig.8 Example of the video-guide for the operator to produce the right movements and rotations. In this particular example the guide is telling the operator to press the key “6”, and to get ready to press they key “5” as well. There were a total of 21 steps, for the operator to anticipate the movement.

3.3.4 Procedure

The following chapter describes the experiment under a step to step basis. Each step has been numbered in a subchapter that contains the description of the step, the rationale of having that step in the experiment and the literal questions that were asked, or the material exposed to the participant. *Fig.9* illustrates a flowchart of our experiment.

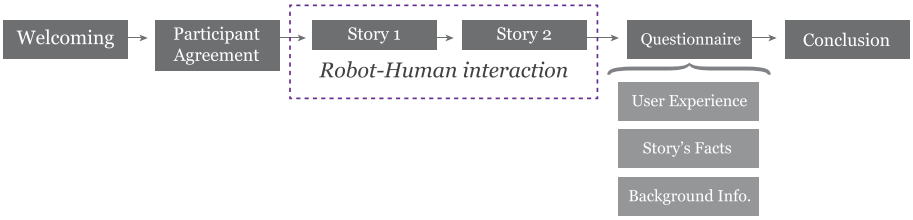

Fig.9 Diagram demonstrating the procedure of the experiment. (From left to right), The first step is the welcoming step, where the participant gets to know about the experiment. Then the participant agreement or consent form gets presented (second square). Then the participant is allowed to interact with the Robot (dotted purple square). The robot presents both stories. Then a Questionnaire is given to the participant. The questionnaire is divided in three sections, the User Experience portion first, followed by the Story Facts portion and then the Participant's background information. After this step, the experiment was concluded.

3.3.4.1 Introduction

The group of participants were told the nature of this experiment without bringing up specific details about the experiment. A participant agreement or consent form was given to each participant. The form granted us to collect personal data about the participant, including audiovisual recordings in both video and photographic format for our analysis.

Rationale: This is a standard step in all experiments that deals with data collection of human participants.

Materials presented: Since recordings and personal data was collected, a participant's agreement form had to be signed in order to take part in the experiment.

3.3.4.2 Welcoming

The participants were then allowed to approach the robot upon being informed that the robot would activate once they approach it. The robot initiated its speech once the participants approached the robot. The robot then went into it's introduction phase where it would greet everyone, then thank them for taking part in this experiment, and

then explain what it [the robot] was about to do. From this point on, audiovisual recordings were produced, up until the end of the conclusion section. The robot in this phase began its speech depending on the mode that it was set up to make its exposition.

Rationale: As with every formal presentation, there is always a space for greetings and introduction, before revealing the actual content. In Dutch tradition, it is expected to conduct a brief introduction of oneself and the list of contents of the presentation.

Materials presented: The welcoming section of the script in the form of robot speech. *The complete script can be found in the appendix (Chapter: Welcoming).*

3.3.4.3 Narration of story (1)

After a brief pause, the robot proceeded to narrate the first story. If the robot was set to expose the story in the *PMode*, the robot would only look at the participants. Otherwise, if the robot was set to expose the story in the *DMode*, the robot would make a initial eye gesture to point at the artwork in question. Additionally, regardless of the gaze mode, the robot verbally encouraged the participants to look at the artwork that was related with the story. This element in the robot speech was relevant due to its directive nature.

Rationale: This step allowed us to introduce the participant into the second part of the narrative. A formal narration of a story is the main task that museum guides perform. The robot intended to imitate how a human museum guide would expose a piece of artwork. The robot in this step could either be in a participant-exclusive gaze mode or in a distributed gaze mode.

Materials presented: The first story and its corresponding artwork was presented to the group of participants.

3.3.4.4 Narration of story (2)

After a brief pause, the robot proceeded to narrate the second story. As with the first part of the experiment, the robot verbally directed the view of the participants by encouraging them to look at the artwork in its speech. Depending on whether the gaze mode was directed or participant-exclusive, the robot would expose the second story in the same fashion. In other words, if the robot was set to expose in *PEMode* in the first story, the robot also had to narrate the second story in the same mode.

Rationale: This step served us, in order to compare the differences in the *type of gaze behavior*.

Materials presented: The second story was presented to the group of participants and its corresponding artwork.

3.3.4.5 Connection of narratives

After a brief pause to mark the end of the previous narrative, the robot proceeded to the third phase of the narrative block of the experiment. The robot exposed the connection or relation between the first and second stories. The robot would again verbally direct the view of the participants by the use of speech only, if the previous two stories were in *PEMode*. Otherwise the robot would verbally direct the view of the participants by the use of speech, its own gaze direction and head turning, if the previous two stories were exposed in the *DMode*.

Something worth mentioning is that this part of the script was written to use different degrees of encouragement. In other words, the script contained both suggestions for the participants to look in one direction and directives for the participants to look in one direction.

Rationale: This step was necessary to make a case for, how gaze can be used as a pointing tool for large objects in a robot.

Materials presented: The connection of narratives part of the speech, and the two artworks.

3.3.4.6 Conclusion of script

In this step, the robot concluded its tasks by marking an end to the experiment in its speech. The robot thanked the participants for being part of the exposition and wished them a great day. Then the robot invited the participants to fill up the questionnaire. The robot in this phase was in its corresponding gaze mode.

Rationale: As with every formal presentation, there is always a space for conclusion to mark the end of a presentation. This step enabled the robot to give instructions to the participants of what to do next, in a suggestive fashion, rather than a directive one.

Materials presented: The conclusion of the script..

3.3.4.7 Questionnaire

In this step, a questionnaire was presented to the participants for them to answer. *The questionnaire has been attached to the appendix (Chapter: Questionnaire)*. The questionnaire was divided into 3 blocks:

1. **User experience (Block 1):** The questions about the user experience and user perception of the robot. In 7-scale semantic differential format, and Likert scales.

For the design of the first block of the questionnaire we made use of the *Bartneck, et al. (2008)* model of the *Godspeed* questionnaire, the *Source Credibility Scale* by *McCroskey* as it appeared in the book of *Rubin et al. (2004)* and the *Social Presence Measure* by *Harms and Biocca (2004)*. *Table 1* contains the ordered list of items that were based on validated measurements, and that appeared in the questionnaire.

Measurement	*Number of items*	*Author's Cronbach's Alpha coefficent*
Source Credibility Scale: Sociability - *McCroskey*	3	0.860
Good-natured - irritable Cheerful - Gloomy Unfriendly - Firendly		
Source Credibility Scale: Competence - *McCroskey*	3	0.840
Expert - Inexpert Unintelligent - Intelligent Intellectual - Narrow		
Source Credibility Scale: Composture - *McCroskey*	3	0.800
Poised - Nervous Tense - Relaxed Calm -Anxious		
Source Credibility Scale: Character - *McCroskey*	3	0.640
Dishonest - Honest Unsympathetic - Sympathetic Good - Bad		

Measurement	*Number of items*	*Author's Cronbach's Alpha coefficent*
Godspeed: Anthropomorphism - *Bartneck, et al.*	5	0.878
Fake - Natural Machinelike - Humanlike Unconscious - Conscious Artificial - Likelike Moving rigidly - Moving elegantly		
Godspeed: Likeability - *Bartneck, et al.*	5	0.865
Dislike - Like Unfriendly - Friendly Unkind - Kind Unpleasant - Pleasant Awful - Nice		
Godspeed: Percieved Safety - *Bartneck, et al.*	2	0.910
Agitated - Calm Quiescent - Surprised		
Social Presence Measure: Co-Presence - *Harms and Biocca*	5	0.840
I noticed the robot. The robot's presence was obvious to me. My presence was obvious to the robot. The robot caught my attention. I caught the robot's attention.		
Social Presence Measure: Attentional Allocation - *Harms and Biocca*	6	0.810
I was easily distracted from the robot when other things were going on. The robot was easily distracted from me when other things were going on. I remained focused on the robot throughout our interaction. The robot remained focused on me throughout our interaction. The robot did not receive my full attention. I did not receive the robot's full attention.		

Table 1 Lists the all the validated measurements with their respective items that were used in the questionnaire. The second column contains the number of item per measurement, the third column contains the Chronback's Alpha coefficient according to the author,

The *Extroversion* block of the *Source Credibility Scale* by *McCroskey* as it appeared in the book of *Rubin et al. (2004)* was not used in this questionnaire. Similarly, the *Animacy* and *Perceived Intelligence* blocks of the *Godspeed* questionnaire by *Bartneck, et al. (2008)*. The

scale *Anxious - Relaxed* of the *perceived safety* block of the *Godspeed* questionnaire was not used either. This was due to it's considerable similarity to the *Tense - Relaxed* scale of the *Source Credibility Scale* by *McCroskey (Rubin, 2004)*. The *Perceived Message Understanding*, *Perceived Affective Understanding*, *Perceived Emotional Interdependence* and the *Perceived Behavioral Interdependence* blocks of the *Social Presence Measure* by *Harms and Biocca (2004)* were also not used for this questionnaire, in addition to the scale "*I noticed the robot"* of the *co-presence* block.

Additional custom "*home-brewed*" scales were added to be used in further analyses outside this main research paper. The *home-brewed* questions came in two formats, 7-point scale semantic differential, and 5-point likert scale. *Table 2* lists all the *home-brewed* questions.

Measurement	*Number of items*
Safety related questions	1
Safe - Threatening	
Personality related questions	3
Attentive - Careless Reliable - Unreliable Inviting - Rejecting	
Robotic favoritism	4
The robot looked too much at me. The robot hardly looked at me. I don't like how the robot looked at me. The robot ignored my presence.	
Robot's height	3
I had to look down all the time The robot was too tall. The robot's height was appropriate.	
Robot's appearance related questions	2
Ugly - Attractive Human - Technical	
Other aspects	4
Predictable - Unpredictable Novel - Ordinary Fast - Slow Short - Tall	

Table 2 Lists the all the home brewed measurements. Except for Safe - Threatening, all of them were meant to mask the intention of the section in the questionnaire, or are meant to be used in related analyses of other research papers.

2. **Knowledge questions (Block 2):** The questions about both stories were presented. First with the questions of the first narrative, then the questions of the second narrative. All questions were multiple choice, with one option right, two wrong, and a third one allowing the participant to state that he/she does not remember.

3. **Personal details (Block 3):** The questions about the participant's general background information.

Rationale: The first block of the questionnaire was designed to give us information about the individual elements of *the participant's attitude towards the robot*. The second block of the questionnaire was designed to gather data for *participant's recalling of the story details*, the third block of the questionnaire was intended to gather data, to better understand the demographics of our sample. *The questionnaire with all the actual questions as they were asked to the participants can be found in the appendix.*

Materials presented: The questionnaire.

3.3.5 Ethical considerations

The ethical measures that we took into consideration for this experiment were mainly concerned with the protection of the privacy of the participant. We wanted to be able to use the data gathered, for both analysis, and publishing purposes. But because we also had strong privacy considerations we decided to give the participant the option to take the experiment without the *publishing condition*. The *analysis condition* however, was required to be agreed upon at the beginning of the experiment.

The *analysis condition* granted us permission to collect data, and make recordings for analysis purposes only. **The *publishing condition*** granted us permission to use the recorded audiovisual material for publishing purposes.

To ensure that the participant's identity was anonymous, we assigned a unique number to each participant. The number was only present during the consent form which allowed us to link the groups of participants with their corresponding participant agreement forms. This was done in order to know which participants granted us the permission to use the material for publishing purposes, and which participants did not.

A copy of the participant's agreement form was provided to each participant, and information about how to contact the supervisors was placed at the end of the form. *The participant agreement form can be found in the appendix (Chapter: Participant's Agreement form).*

The form consisted of a single A4 page, and every participant was asked to fully read the form before taking the experiment. The

participant was informed through the agreement of what the experiment was about. The questionnaire was presented in a digital form (online questionnaire).

4. Analysis & Results

The evaluation chapter contains the results of the experiment. An analysis of the results is done in this chapter. The analysis is intended to aid the reader in understanding the conclusions.

4.1 Analysis

This chapter has been divided in two sections. The first one is concerned with the reliability of each measurement that we used during the experiment, while the second one contains the results and analysis of the experiment.

4.1.1 Reliability of measures

Our results were drawn from three different scales that measure different variables. All of our validated measurements scored a high Cronbach's Alpha coefficient *($\alpha > .700$),* as *Table 3* demonstrates.

Measurement	*Cronbach's Alpha coefficent*
Source Credibility Scale	0.828
Godspeed: Anthropomorphism	0.819
Godspeed: Likeability	0.829
Godspeed: Percieved Safety	0.704
Social Presence Measure: Co-Presence	0.752
Social Presence Measure: Attentional Allocation	0.811

Table 3 Lists the Cronbach's Alpha coefficients of each of the validated measurements done in the questionnaire.

4.1.1.1 Modifications to scales

Godspeed: Perceived Safety - Both the *Source Credibility Scale* by *McCroskey*, as presented by *Rubin et al. (2004),* and *Godspeed: Perceived safety* scale by *Bartneck, et al. (2008),* contained a question that had almost the exact same adjectives. According to the *Godspeed scale*, the participant had to rate the robot between *Anxious - Relaxed*,

whereas in the *Source Credibility Scale* by *McCroskey,* the participant had to rate the robot between *Tense - Relaxed*.

We determined that the scales were too close to each other, and that it did not make sense to use both scales. We determined, that we would use the *Tense - Relaxed* scale of the *Source Credibility Scale* by *McCroskey,* and use the results for the *Godspeed: Perceived safety* scale as well.

Additionally, we improved the original Alpha Coefficient of the *Godspeed: Perceived safety* by removing the scale *Quiescent - Surprised* and adding a highly related "home brewed" scale *Safe - Threatening*. Table 4 demonstrates the comparisons.

Measurement	*Cronbach's Alpha coefficent*
Godspeed: Perceived Safety with the *Quiescent - Surprised* scale.	0.428
Godspeed: Perceived Safety with both, the *Quiescent - Surprised* scale and the *Safe - Threatening* scale.	0.600
Godspeed: Perceived Safety without the *Quiescent - Surprised* scale.	0.616
Godspeed: Perceived Safety without the *Quiescent - Surprised* scale, and with *Safe - Threatening* scale.	0.704

Table 4 Demonstrates how the Cronbach's Alpha coefficient is improved by removing the Quiescent - Surprised scale, and adding the Safe -Threatening scale.

Semantic differentials: 5-point scale vs 7-point scale - Both *Godspeed* by *Bartneck, et al. (2008)* and the *Source Credibility Scale* by *McCroskey*, as presented by *Rubin et al. (2004)* are based on the semantic differential model. However, the earlier one, is based on a 5-point scale model, whereas the later one is based on a 7-point scale model. We opted for the 7-point scale model, since we used more scales from the *Source Credibility Scale* than the *Godspeed* scale.

Social Presence Measure: Co-presence - One scale of the 6, of the *co-presence* portion of the *Social Presence Measure* by *Harms & Biocca, (2004)* was not asked to the participant in the questionnaire. Despite this issue, the measure itself presents a high enough Cronbach's Alpha coefficient *(α = .752)*.

4.1.2 Manipulation check

Whether the robot favored someone: A question in the questionnaire asked the participant, who they thought the robot favored more during the experiment. 44 of 57 (77.2%) responded that Participant C was favored more than the other participants. Only 4 of 57 (7%) responded that Participant B was favored, and the remaining 9 (15.8%) responded by stating that they did not know who was favored more. The question contained four possible answers, the first three for participant A, B and C. And the last one for the -I don't know- answer. The answers were arranged alphabetically.

Whether the robot looked at the artwork: At the moment, we do not have a method to check whether our participants noticed that the robot looked at the artwork. For the analysis of this manipulation, we relied on video recordings, and the analysis of the recordings were part of a related but not finished research.

4.1.3 Results

The following chapter describes the results based on our data collected. The chapter is divided in three main sub-chapters. The first one is concerned about the participant's attitude towards the robot. The second one is concerned with the participant's recall of details, and the third one is concerned with the proxemics.

4.1.3.1 Attitude towards the robot

The analysis of the user experience, was divided into the following parts: *Perceived credibility*, *anthropomorphism*, *likeability*, *perceived safety*, *attentional allocation*, and *co-presence*. For the analysis of each measure, we used the Univariate general linear model (*ANOVA*). We analyzed the main effect of the mode (whether it was *DMode* or *PEMode*), the main effect of favoritism (whether the participant was favored or not), and the interaction effect between the two. This later one did not demonstrate any significant effect in any instance. *Table 5* lists all the *p-values* in an ordered fashion for quick readability.

***Perceived credibility*:** We found no significant effects of the mode, or of the favoritism. We were also unable to find any significant interaction effects. This means that both favored and non-favored participants perceived the robot in *DMode* just as credible as in *PEMode*.

***Anthropomorphism*:** *Anthropomorphism* was the only scale in which we were able to find a marginally significant main effect of mode *F(1, 53)=3.844, (p=0.055)*. *DMode (M=4.07, SD=1.12)* proved to be marginally more anthropomorphic than the *PEMode (M=4.57, SD=1.24)*. *Fig. 10* displays the values in a chart. In other words, participants who took the experiment in *DMode* attributed the robot marginally more human characteristics such as form and behavior to the robot than participants who took the experiment in *PEMode*.

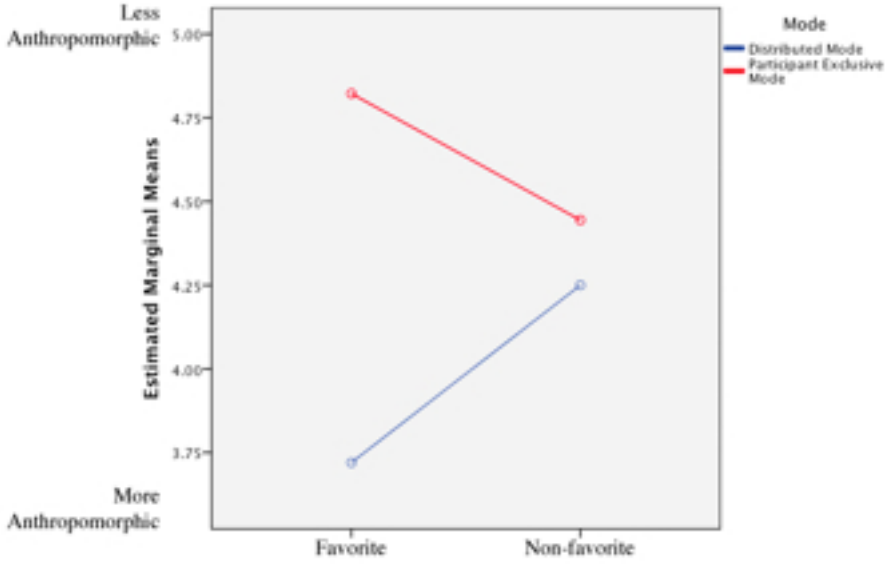

Fig 10 Estimated Marginal means of *anthropomorphism*. As shown in the figure, there was a significant difference on whether the participant interacted with the robot in *DMode* or *PEMode*.

***Likeability*:** We were able to find a marginally significant main effect of *favoritism F(1, 53)=3.737, (p=0.059)*. *Favored* participants reported a higher degree of *likeability* to the robot *(M=2.29, SD=0.68)* than the *Non-favored* participants *(M=2.67, SD=0.71)*. *Fig. 11* displays the results. Which means that favored participants perceived the robot marginally more likable than non-favored participants.

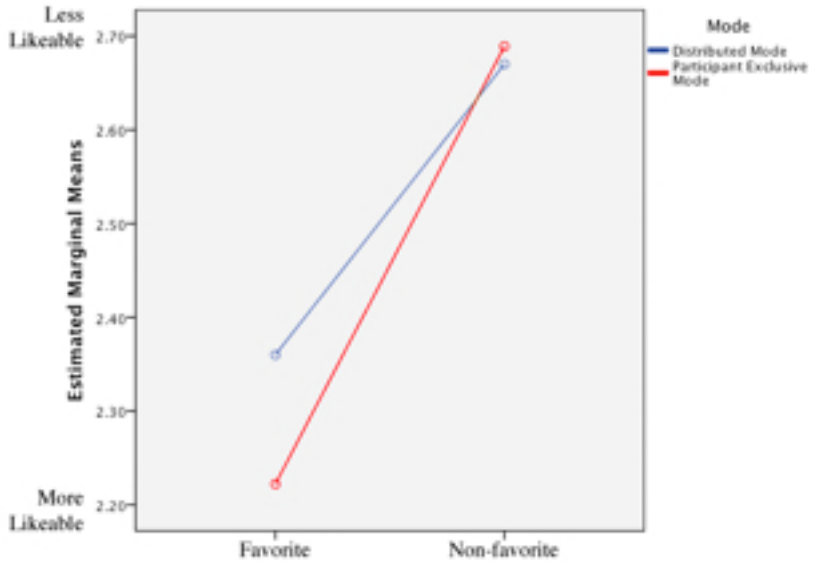

Fig 11 Estimated Marginal means of *likeability*. As shown in the figure, there was a marginally significant difference on whether the participants were favored or not by the robot,

Perceived safety: We found no significant effects on the *mode*, nor the *favoritism*. We also analyzed the effects of *gender* and *favoritism*, and gender and mode. Neither rendered significant results. In other words, both favored and non-favored participants in both modes did not differ much in how safe they perceived the robot.

Attentional allocation: We found a very significant effect of *favoritism F(1, 53)=91.740, (p=0.000)*. As *Fig. 12* displays, *Favored* participants reported a higher level of *attentional allocation (M=3.69, SD=0.53),* than *Non-favored* participants *(M=2.32, SD=0.49)*. This means that favored participants in both modes, felt that they allocated and received more attention from the robot, than non-favored participants.

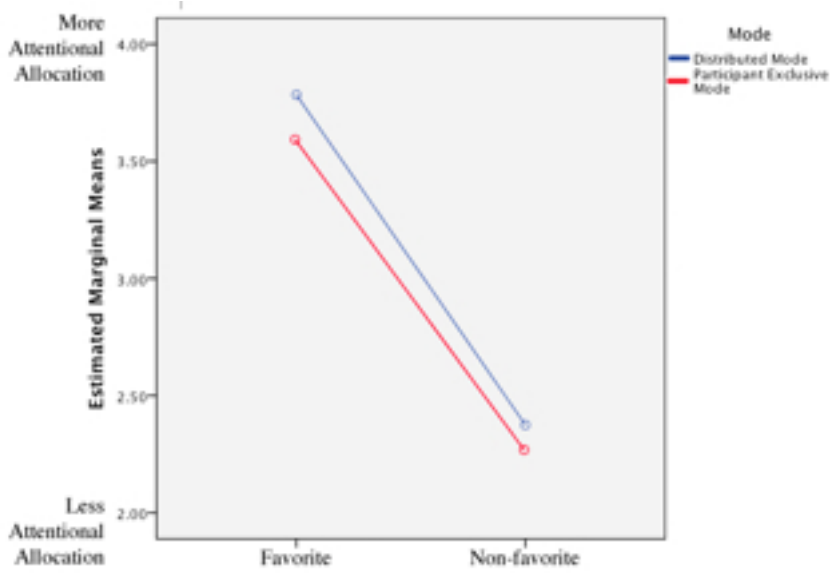

Fig 12 Estimated Marginal means of *attentional allocation*. As shown in the figure, there was a significant difference on whether the participants were favored or not by the robot,

***Co-presence*:** We were able to find a very significant effect of *favoritism F(1, 53)=37.786, (p=0.000)*. As *Fig. 13* displays, *Favored* participants reported a higher level of *co-presence (M=4.33, SD=0.34),* than *Non-favored* participants *(M=3.38, SD=0.61)*. *Co-presence* according to *Harms and Biocca (2004),* is the degree in which the participant believes to be not alone or secluded. And the degree in which the participant perceived the robot to be focally aware of the participant himself/herself. Our data suggests that, favored participants in both modes felt less secluded, and that the robot was more focally aware of them.

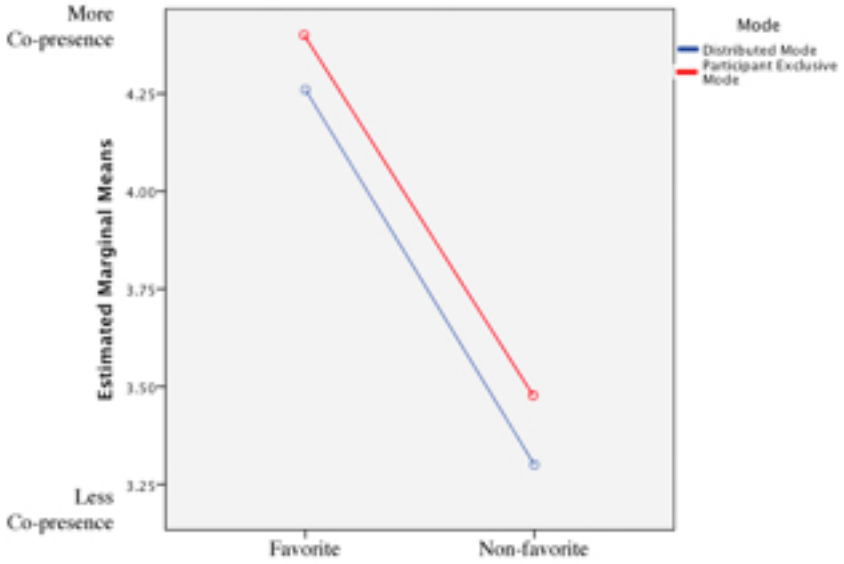

Fig 13 Estimated Marginal means of *co-presence*. As shown in the figure, there was a significant difference on whether the participants were favored or not by the robot,

	Effect of Mode	*Effect of Favoritism*	*Interaction Effect*
Percieved credibility	0.583	0.108	0.399
Anthropomorphism	*0.055*	0.819	0.176
Likeability	0.768	*0.059*	0.698
Perceived safety	0.783	0.675	0.246
Attentional Allocation	0.302	*0.000*	0.769
Co-presence	0.304	*0.000*	0.902

Table 5 Lists all the p-values of each effect. The significant effects have been highlighted by a dark green background, while the marginally significant effects have been highlighted by a light green background.

4.1.3.2 Recall of details

The difference between the *PEMode* and the *DMode* showed no observable significance. Furthermore, favoritism did not produce any observable significant effect in the recall of details either.

To get to these results we counted the total number of questions that all participants scored right *(Ra)*, the total number of questions that all participants scored wrong *(Wa)*, in addition to the total number of questions all the participants admitted not knowing the answer *(Na)*. Then we added all the values according to case A or case B, as displayed in *Fig.14* and divided it by the number of participants that were on each sample *(pGT)*. The score was then divided by 19, which is the maximum possible score since there were a total of 19 knowledge questions in the questionnaire. Then to produce a score between 0 and 10, the score was multiplied by 10 to produce the Adjusted *Ra* score of the *group-type*.

Ⓐ

$$\frac{Ra}{pGT} = \left(\begin{matrix} Ra \text{ score of} \\ group\text{-}type \end{matrix} \Big/ 19 \right) * 10 = \begin{matrix} \text{Adjusted} \\ Ra \text{ score of} \\ group\text{-}type \end{matrix}$$

Ⓑ

$$\frac{(\ Wa + Na\ )}{pGT} = \left(\begin{matrix} Wa \text{ score of} \\ group\text{-}type \end{matrix} \Big/ 19 \right) * 10 = \begin{matrix} \text{Adjusted} \\ Wa \text{ score of} \\ group\text{-}type \end{matrix}$$

Fig 14 The two methods implemented to calculate the Score of group-type.
(A) Implementation when the Right answers Score of group-type. Represented in Table 6 in the left-hand column.
(B) Implementation when the Wrong answers Score of group-type. Represented in Table 6 in the right-hand column.

As a result, we got the "*mean of the group-type*" or the general score of the group of participants according to whether they took the experiment in *PEMode* or *DMode*, and whether they were favored by the robot or not as *Table 6* demonstrates.

	Right	***Wrong***
Distributed Mode and Favorite	5.84	4.16
Participant Exclusive and Favorite	5.56	4.44
Distributed and Non-Favorite	5.71	4.29
Participant Exclusive and Non-Favorite	5.76	4.24

Table 6 Lists the scores or means of each group-type. The maximum obtainable score is 19, due to the total number of questions.

The chart below in *Fig. 15* illustrates the values in a bar-chart.

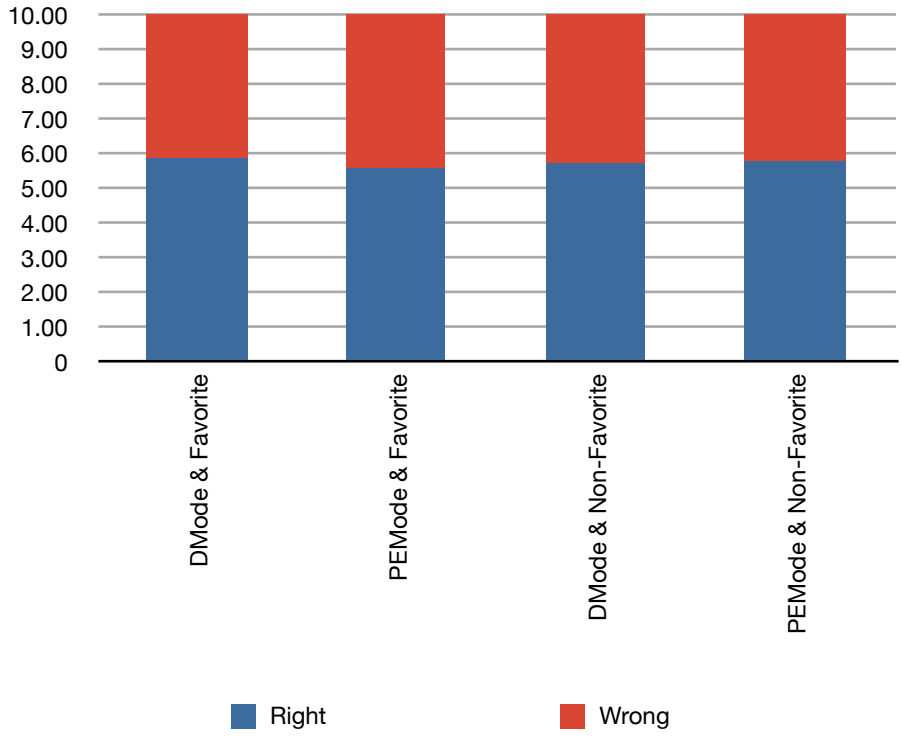

Fig 15 Lists the scores or means of each group-type and the proportion between right (blue or bottom bars) and wrong (red or top bars) answers.

As we can see in the chart of *Fig.15*. There is no significant difference in the scores of people who were in either mode. *Favoritism* was unable to produce any observable significant difference either. We also made an *analysis of variance* (*ANOVA*) of our two manipulations (*favoritism and mode*), and the score of the right answers, as well as the score of wrong answers in a separate *ANOVA*. All the *p-values* were greater than .050 *(p>0.670)*. This confirms our earlier observations, that contrary to H1 and H2, participants do not recall more data if the robot looks at the artwork or not. Also participants won't recall more data based on their favoritism.

Types of questions: The questionnaire contained three types of questions: Story details (*QType A*), Artwork details (*QType B*), and Unmentioned artwork details (*QType C*). Of the three types, the first two were always mentioned in the narrative of the robot.

Because the number of questions on each type of question (*QType)* were disproportionate (11 for *QType A,* 5 for *QType B*, 4 for *QType C*), we calculated the mean of each *QType* per participant. This allowed us

to get comparable results between each *QType*. e.g. Participant number 14 scored 14 right answers (*Ra*), 8 of *QType A*, 5 of *QType B*, and 1 of *QType C*. So, the number of right answers was divided by the number of questions in each *QType*. *8/11*, *5/5*, and *1/4* respectively. This produced the *mean of the QType A*, *B*, and *C* for the participant. The scores were then added according to the *group-type* and divided by the number of participants of in the *group-type (pGT)*. This gave us the total score for the four *group-types*. Those scores were then multiplied by 10 to produce the *adjusted group-type* score.. *Fig. 16* contains an example of the case of participant number 14. The only observable difference is that participants of *QType C* questions scored considerably lower regardless of their *mode* or *favoritism*. This is probably due to the fact that *QType C* questions were not mentioned, in any part of the speech of the robot.

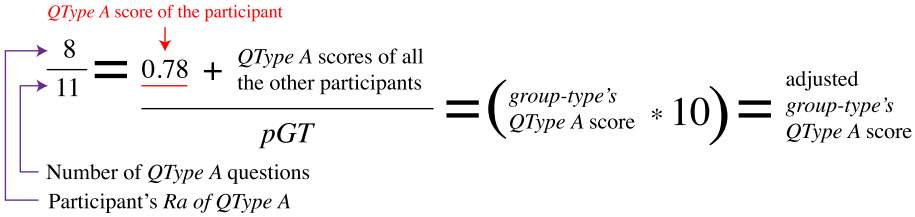

Fig 16 Lists the scores or means of each group-type. 10 was the maximum score that any group-type could have scored.

We were unable to find any observable significant difference. *Table 7* lists the final scores for each group-type, and *Fig.17* displays a chart with each score. We also conducted three different *ANOVA*. One for each *QType*. The two manipulations or independent variables were the mode and the favoritism. While the dependent variable was the score of the participant of each *QType*. All the *p-values* turned out greater than .300 *(p>0.350)*. This means that neither *mode*, nor *favoritism* had a significant effect on whether they answer particularly better, or worse on any *QType*. In other words, our data suggests, that H1 and H2 are not true for the recall of details.

	QType A	*QType B*	*QType C*
Distributed Mode and Favorite	6.09	5.60	4.00
Participant Exclusive and Favorite	5.35	6.00	4.17
Distributed and Non-Favorite	6.09	5.40	3.63
Participant Exclusive and Non-Favorite	5.96	5.67	3.89

Table 7 Lists the scores of each group-type according to the types of questions.

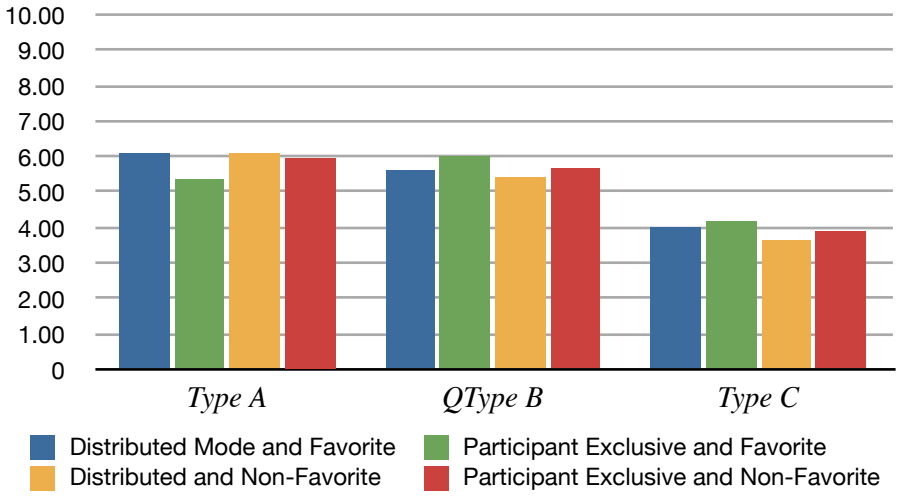

Fig 17 Lists the scores of each group-type, according to the type of question (*QType*). The score 10.00 means no errors in the answers, whereas 0 means the opposite. Most of the scores fall within 5.00 and 6.00, with the notable exception of *QType C* scores. This is probably due to the fact that *QType C* questions represent the group of questions where unmentioned details of the artwork were asked.

4.1.3.3 Proxemics

As we mentioned in our theoretical background, we expected that our manipulations has an effect in proxemics. This chapter describes such effect. We measured throughout the narrative of the robot, the distance between the robot and each participant, in three occasions. At the beginning of the narrative (*initial distance*), in the middle of the narrative (*middle distance*), and at the end of the narrative (*end*

distance). We used the *ANOVA* for each instance. Additionally, we made a fourth analysis with the participant's *mean distance*.

Initial distance: We were able to find a marginally significant main effect in the *mode F(1, 53)=3.543, (p=0.065)*. Participants in *DMode* were marginally more keen on getting closer than participants in *PEMode*.

Middle distance: We were able to find a significant main effect in the *mode F(1, 53)=4.167, (p=0.046)*. While we found no significant main effect in the *favoritism*. Like with the initial distance, we were also unable to find any significant interaction effect between our two manipulations. Participants in *DMode* were more keen to get closer than participants in *PEMode*.

End distance: Like the *initial distance*, we were able to find a marginally significant main effect in the *mode F(1, 53)=2.856, (p=0.097)*. While we found no significant main effect in the *favoritism,* and like the two previous distances, we found no significant interaction effect either. Participants in *DMode* were again more keen to get closer than participants in *PEMode*.

Mean distance: We were able to find a marginally significant main effect of the *mode F(1, 53)=3.595, (p=0.063)*. While we found no significant main effect in the *favoritism*, and no significant interaction effect. Participants in *DMode* were again more keen to get closer to the robot, than participants in *PEMode*. *Fig 18* illustrates the difference.

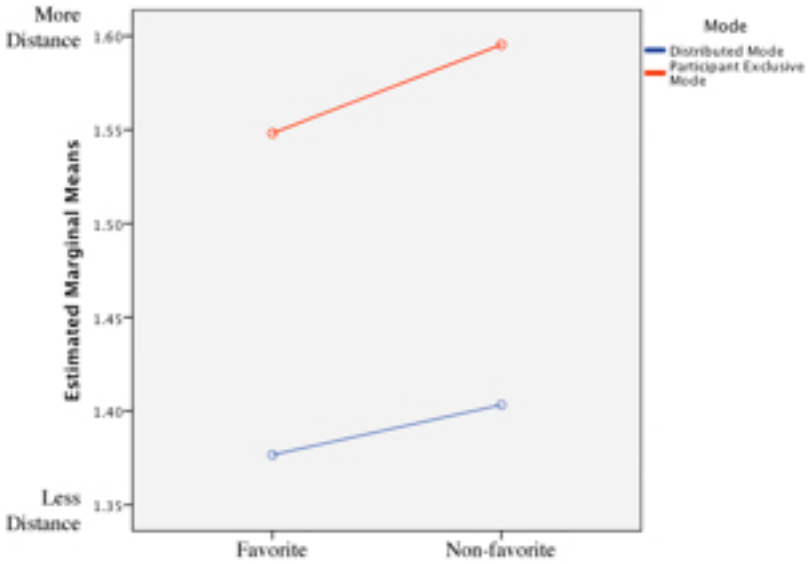

Fig. 18 *DEmode* (blue) had a marginally significant effect, in the mean distance, regardless of favoritism.

Mean distance and Gender: We further analyzed the relationship between gender and the mean distance. For this, we used two separate *ANOVA*s. The first one included gender and *favoritism* as fixed factors. While the second one included gender and *mode* as fixed factors. Both analyses included the mean distance of each participant as the dependent variable.

While we found no observable significant effect in gender or *favoritism*, or any significant interaction effect. We were able to find a marginally significant effect in our second *ANOVA*, that analyzed gender and *mode*. There was a marginally significant effect in *mode*, $F(1, 53)=3.330$, $(p=0.074)$. From our two *ANOVA*s we can deduct that while *favoritism* and gender didn't have any main effect in the mean distance of our participants, *mode* still had a marginal main effect. Meaning that *DMode* was more likely to bring participants closer to the robot than *PEMode*, regardless of the gender of the participant. As *Fig. 19* illustrates.

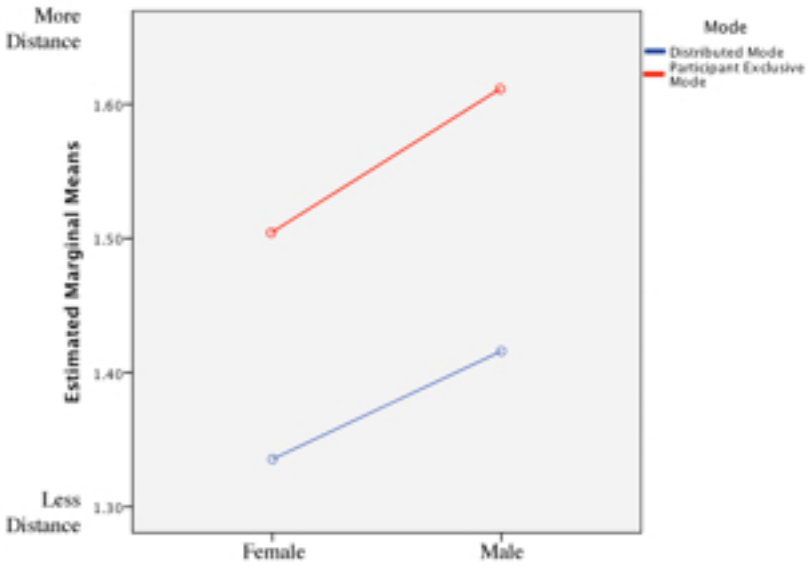

Fig 19 *DEmode* (blue) had a marginally significant effect, in the mean distance, regardless of the gender.

5. Conclusion

The conclusion chapter is intended to draw the findings of the research. It provides the reader the possibility to understand the research results and analysis in a textual way.

5.1 Discussion

Our data suggests that there is no difference between *PEMode* and *DMode,* and the recall of the story details. We also found that favoritism does not have a significant effect in it either. We believe that there is a possibility to find a significant effect if our knowledge questions were to address the degree of how sure our participants were about their answers (measuring how much a participant guesses the answer). We know that at least a small portion of our participants were guessing some of their answers. Modifying the methodology in which we address our knowledge questions could reveal significant results.

It is worth noting that *attentional allocation* and *co-presence* were measured with a different scale than *likeability*. While *likeability* was measured with the *Godspeed* questionnaire of *Bartneck, et al. (2008),* the *attentional allocation* and *co-presence* were measured with the *Social presence measure* of *Harms and Biocca, (2004)*. The earlier one was presented in a 7-point semantic differential scale, while the later one was presented in a 5-point Likert scale. We believe that this difference may have had an effect in our results simply because the only two measures that showed a significant main effect were measured with the Likert scale method.

There was an interesting marginally significant main effect in *mode,* and proxemics. Both men and women were marginally more keen to get closer to the robot when the robot was set up in *DMode*. We cannot really explain this effect. But we also know that the only other measure where *mode* had a marginally significant effect was in the *anthropomorphism*. Perhaps a closer proximity is an effect of a the high degree of *anthropomorphism* of the robot, when it was set in *DMode*.

Overall H1 and H2 proved to be both true and false in part. This was expected since the hypotheses focused on multiple measures

within a manipulation. After all, both H1 and H2 considered the attitude towards the robot, distance between the participant and the robot, and participant's recall of details.

5.2 Conclusion

H1 and H2 seemed to be both partially right and partially wrong. H1 established that when a robot established mutual gaze with the participant, the participant was supposed to have a more positive attitude toward the robot, better recall of details about the artwork and even come closer to the robot. Meanwhile, H2 established that when a person in a group is favored by the robot, the favored person should have had a more positive attitude toward the robot, than the non-favored people. The favored person should have been able to recall details better than the non-favored people. Since the favored person had a better perceived the robot better than the non-favored participants. The favored person should have felt more confident to get closer to the robot,

Where neither the mode nor favoritism had an effect: Whether the participant took part in the experiment in *DMode*, or the *PEMode*, the *mode* had no observable effect on the level of *perceived credibility* or *perceived safety*. The participant's reported perceptions were not different enough to draw a conclusion.

As for the recall of the details, our data suggests that either there were not enough differences to find a significant result regarding the participant's recall of details, or that neither the favoritism, nor the mode had any effect in the participant's recall of details. This means that both H1 and H2 have been partially refuted, since neither the *mode, favoritism* or the combination of both showed an effect that was significant enough to note.

Where favoritism had an effect: *Favoritism* had a weak effect in the reported *likeability*. Participants in the favored position, albeit weakly, reported higher levels of *likeability* towards the robot. This effect partially supports H2.

Additionally, *favoritism* had a very strong effect on the reported *attentional allocation* and *co-presence*. The non-favored participants reported higher levels in both measures. Which means that favored participants did not feel secluded or alone during the interaction. It

also means that favored participants felt that the robot was focally aware of them. This partially supports H2 only.

Where mode had an effect: *Mode* had a marginal effect in the perceived *anthropomorphism* of the robot, as well as the distance by which the participants stood from the robot. Our data suggests that, albeit weakly, participants that took part in the experiment in *DMode* perceived the robot as more anthropomorphic than participants in *PEMode*. Additionally participants who took the experiment when the robot was set up in *DMode* had a weak (albeit consistent) tendency to approach the robot closer, than participants in *PEMode*. The data suggest that H1 is true, but weak.

Considering all what was mentioned above, we can conclude that making the robot look at both the artwork and participants, instead of a *participant-only approach*, will allow the participants to perceive it as slightly more anthropomorphic, albeit with a weak tendency. We were also able to find a weak tendency in proxemics. Our data suggests that, there is a weak tendency of participants getting closer to the robot when the robot was set up to look at the artworks, as well as the participants. This suggests that mutual gaze has the potential of making a robot more anthropomorphic, and perhaps because of that participants were more confident to get closer.

Meanwhile, making the robot to favor a person in a group through gaze, will make the favored person to like the robot more, albeit only marginally. Additionally, making the robot favor a person among a group, will make the favored person feel included or not alone, and it will make the favored person to feel that he/she allocates and receives more attention from the robot. We conclude that both H1 and H2 are partially true, and partially false.

5.3 Limitations

This research is limited to non-humanoid robots, and it was meant for a robot tour guide that is capable of addressing small groups of multiple users. Other social robots may perform different social tasks, where there is no expectation of favoring a person.

5.4 Further work

In this chapter, a series of suggestions will be made for the future work that may be based on this research. This chapter is intended for authors who are currently researching a topic along the lines of this research. This chapter has a retrospective nature, and it is intended to be used as a suggestion to improve and/or extend the work that has been done so far in the topic in question.

5.4.1 Video analysis and mutual gaze

Apart from the quantifiable data that we gathered during our experiment. There were video recordings for a qualitative analysis that will be analyzed in a related research.

5.4.2 More radical forms of robots

Further work has the potential to explore the efficacy of robotic behavioral gaze among more radical forms of non-humanoid robots, and their influence on the experience of the user (e.g. Cyclops robots, multiple-eyed robots, vertical alignment of multiple-eyed robots, etc).

5.4.3 Field studies

For future research, field studies could be carried out. Field studies have the potential to confirm or contradict the findings of this research, due to the fact that this research was carried out only in a controlled environment.

As opposed to the controlled environment approach, the field studies have the potential to reveal variables that may not appear or may not be quite evident in a controlled environment such as a laboratory.

Since this research is intended to be implemented in FROG, a museum guide robot that will be deployed in specific locations, field studies in those locations could provide rather useful data.

5.4.4 Mobile robot

A variable that was not present in this research, and that will most likely play an important role in the final prototype of FROG is mobility. Unlike FROG, our robot prototype did not have the ability to move to different points, making it impossible to create hypotheses based on the movement of the robot and its gaze behavior. Further work on this area could complement this research.

6. Acknowledgments

I would like to thank *Betsy Van Dijk, Daphne Karreman* and *Vanessa Evers*, for providing guidance and advice throughout the whole research. Without them, it would have been impossible to accomplish it. *T*he *University of Twente's Scholarship department* which made this research financially possible. Also to all the participants who took part of their daily time to participate in the experiment, thank you!

I would like to thank *Lynn Packwood* for donating some of her valuable time, and narrating the speech of the robot. Also to *Nathan Surrett* for taking some of his valuable time by editing this research paper. *Saskia Akkersijk* was also involved in the production of the robot. She volunteered, by helping to produce the external shell of the robot. *Sandra Bos,* and *Steven Gerritsen* lent some of their valuable time, by helping conduct the experiment. *Aarón Garza, Mark ter Maat, Hendri Hondorp, Edwin Dertien*, and *Dennis Reidsma* provided us with technical insight and guidance for the production of the robot. *Charlotte Bijron* and *Alice Vissers-Schotmeijer,* gave access to the work space, to experiment with the robot, before the real experiments took place.

Also, I would like to thank, *Kees de Jong, Ezra van der Eist, George Petrov, Kim Hietbrink, Yunyun Ni, Thiago Pereira, Mark Oude Veldhuis, the Pitkanen, van der Veen* and *Hudepohl* family, and my family for all their moral support.

Special thanks to *Jan Schut*, without his support and trust, this research would not be possible.

Ω

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8. Appendix

The appendix chapter contains extended information that wile relevant to this research, it is not elemental for the understanding of our conclusion. In this chapter, the reader may find extended versions of some of our chapters, materials such as graphics and scripts used in the research for the experiment design, and theoretical chapters that were not required for the reader to necessarily know, in order to understand our reasons behind our decisions in the design of the experiment.

8.1 Robotic Arms

As *Dhillon & Fashandi (1997)* point out, historically new technologies have been developed, and only after their development, safety measures were incorporated, due to accidents or unfortunate events. However, the demands of the present time require to consider safety upon the early stages of the development. As *Sugimoto & Houshi (1986)* said in their conference proceedings as cited by *Dhillon & Fashandi (1997):* "Safety is not the correction of accident that has already occurred and if a machine with no accident record has a potential hazard, safety measures should be instituted beforehand."

In other words, *Sugimoto & Houshi (1986)* state that safety must be addressed before accidents occur and, safety is a continuos process that must be addressed and improved constantly.

As the *Department of Labour (1987)* of the government of New Zealand points out, robots with arms can be a potential hazard for a variety of reasons. The document lists three categories of hazards that a robot with an arm or more than arm could have:

- **By Impact:** When a person is struck between a moving part of a robot and a barrier.
- **By Trapping:** When a person is trapped in one of the moving parts of a robot.
- **By Other reasons:** Any other non-mechanical reason such as electric shock, radiation, fume, burns, even noise.

The document points out that, there accidents may be due to people entering in the working area (work envelope) of a robot either because the robot does not seem to work or because it is working slowly and it suddenly accelerates. In every case, for an accident to happen, the robot must act without the person's knowledge, who is within the danger area.

According to *Dhillon & Fashandi (1997)* any type of robot hazards come from three sources: Caused by human error, caused by robots, caused by the environment in which the robot and the person interact with each other.

Even if the arms operated at a low speed, the robot could potentially be hazardous because the person may not be aware that the robot is moving behind the person's visual range. Implementing arms in FROG, may or may not have the potential to create a negative effect on the *perceived safety* of the product, specially among parents of children.

It is for this reason that we have decided to not rely on robotic arms to point at objects, we believe that gaze can, at least to some degree ,lead the attention of the user to an object.

8.2 Participant's Agreement form

The following chapter contains the participant's agreement form that granted us the collection of personal data, and audiovisual recordings in our experiment. The consent form has been divided in a number of bullets. The title on each of the bullets (marked in **bold** text) and the bullets themselves did not appear. The bullets and their titles have been added for organizational purposes, so the reader is able to identify the purpose of each paragraph.

8.2.1 Participant consent agreement

- **Welcome:** First and foremost welcome and thank you for taking part in this experiment. Please take some time reading and understanding each term in this consent form If you have any questions, please do not hesitate to ask the experiment supervisor. He or she will be there to assist you.

- **Purpose of the experiment:** In this experiment you will be interacting with a robot.

- **Aim:** For this reason we have selected a museum or art gallery. Where the robot Mu will give you a brief exposition of each artwork presented on the wall.

- **Procedure:** Mu will introduce itself and will carry on to its exposition tasks that it has been programmed to do. After the exposition is done, we will invite you to fill up a questionnaire about the experiment. There are no wrong answers, we expect that you answer the way you feel.

- **Risks:** We have not identified any possible risks that could occur during the experiment.

- **Time required:** The experiment takes about 15 minutes, depending on the time that you take answering the questionnaire.

- **Conditions:** You will take part in the experiment with 2 other people. The questionnaire is answered individually and we would like to request you, to not share any of your answers with the other participants, until they complete their own questionnaires.

- **Confidentiality:** We intend to produce audiovisual video-recordings of you and the other people taking part in the experiment. We also intend to keep track and analyze the answers that you provided us in the questionnaire. Your name will not be attached to any of our documents except this form. Instead you will be assigned a random number that will be used in place of your name. This number will be your identity in the experiment. Your name will not be stored in any database. We intend to use the audiovisual content to produce a qualitative analysis of our results.

- **Publishing:** We would like to include some photos and produce a demo-video of our experiment for the presentation of this research. As for now it is not possible to determine where and when this research will be published. But we would like to use some of the visual material to present it in some journals, conferences, related research papers made at the University of Twente, and Gilberto Sepúlveda Bradford's Master Thesis presentation at the University of Twente in Enschede, The Netherlands. Additionally, we would like to publish some of this material on www.Gilfolio.com which is the personal site of the author of this research. For this reason, we would like to ask for your permission to publish some photos and be included in the final production of a demo-video in the places mentioned above. If you appear in the demo-video or photos are

used to present this experiment, we guarantee that your face will not be visible.

- **People responsible:** If you have any complaints about the experiment, you can contact Dr. Betsy van Dijk (bvdijk@ewi.utwente.nl) or Daphne Karreman (d.e.karreman@utwente.nl), both are responsible for supervising the quality of this experiment. If you have any questions or requests please feel free to contact Gilberto Sepúlveda Bradford (g.u.sepulveda@student.utwente.nl).
- **Agreement:** Please check the permissions that you would like to grant us.

☐ I fully read and understood the Participant consent agreement, and I grant permission of using my data gathered through this experiment for analysis purposes.

☐ (Optional) I also grant permission to the authors of this research to use the audiovisual material gathered for publishing purposes.

Name:

Place: Enschede, The Netherlands Date:

8.3 Robot's Script

The following chapter contains the script as it was presented to the participants. Every line in the script is represented by a bullet symbol (" • "). Some of the lines in the script include an action that the robot has to produce during its speech. The actions are dependent on whether the robot was set up in *DMode* or *PEMode*. Each action depending on its scenario is represented by an arrow (" ➡ ") symbol. All the actions are narrated from the robot's perspective. In several instances the natural position is mentioned. This natural position happens when the robot is simply looking to the front and its head is also frozen to the front at 0° degrees of angle. Also, it is possible to find that in several instances, the alpha position is mentioned. This position refers to the robot turning its head slightly towards the left at 22,5° degrees of angle with the eyes slightly turned up in order to attempt to establish an eye contact with one of the participants. *Fig.20* depicts the angles in relation to the participants. All the experiments were restricted to groups of three people.

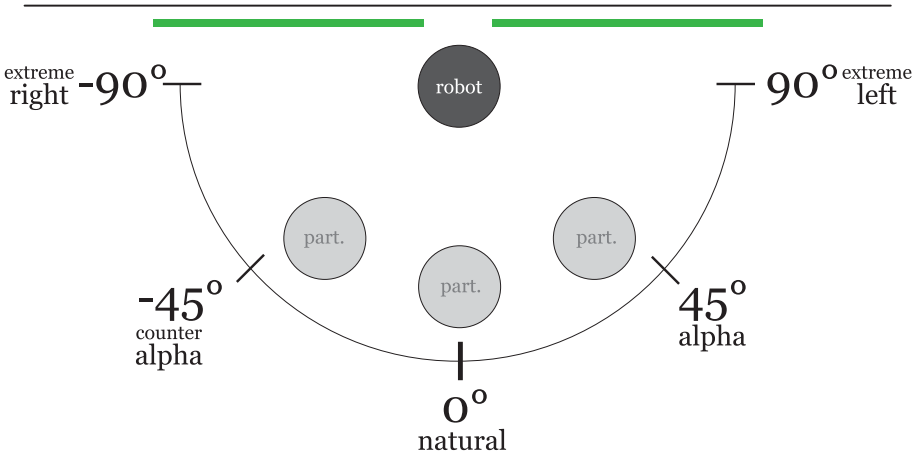

Fig.20 Digram depicting the common head rotations mentioned in the script. The alpha and the counter alpha positions are the exact middle between the natural position and the extremes. All the positions of the diagram are from the Robot's point of view. This is the reason why extreme right and extreme left are inverted. This diagram represents an aerial view of the setting.

A third layer of gaze information was added in the experiment. This was solely done for the purpose of improving the user experience. Eye expressions were added to the robot. Each expression has been marked in the script with a star symbol (" ✦ "). Each star bullet contains a line of dialog where the robot should change its expression. If the line in the script is not mentioned, then the robot should go to natural position.

8.3.1 Welcoming

• Welcome everyone, my name is Mu, and I am your museum tour guide, for this small art gallery. I am going to tell you two fantastic stories about these two wonderful artworks behind me.

➡ ***If PEMode:*** *Shift from neutral position to alpha after the phrase "these two wonderful artworks behind me".*

➡ ***If DMode:*** *When the phrase "these two wonderful artworks" comes up make the robot look to the extreme right (from the robot's perspective) and then direct the robot's body to the extreme left. Then go to the alpha position.*

• Please come closer so you will be able to see and hear me properly. You can choose a position on one of the three lines.

➡ ***Both modes:*** *Stay in the alpha position for both cases.*

✦ *Blink once during this dialog.*

8.3.2 Narration of story (1)

• To your left you see the beautiful Mona Lisa by the Italian painter, Leonardo da Vinci.

➡ ***If PEMode:*** *Stay in alpha position.*

➡ ***If DMode:*** *Look to the extreme right when the phrase "To your left" comes up. Then return to the alpha position.*

• The Mona Lisa was painted in the 16th century and it is thought to be the portrait of Lisa Gherardini. Lisa Gherardini was born in Florence and in her teens she married a cloth and silk merchant called Francesco, who later became a local official.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "Francesco, who later became a local official." comes up. Then return to the alpha position.*

✦ *Blink once at the middle of this dialog and blink when it mentions Francesco*

• Lisa and her husband were neither poor nor rich. The couple lived a middle-class life in Florence. They had five children. Lisa outlived her husband by a number of years, and she died at the age of 63.

➡ ***Both modes:*** *Stay in Alpha position.*

✦ *"and she died at the age of 63": sad expression.*

✦ *Blink once when "Florence" is mentioned*

• Lisa and her family, like other Florentines, were art lovers and patrons.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase throughout this whole dialog. Then return to the alpha position.*

✦ *Blink once at the end of the sentence.*

• It is believed that Francesco, Lisa's husband, commissioned Leonardo da Vinci to paint the portrait of his wife Lisa to celebrate the purchase of their family home and the birthday of one of their children.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink twice at the middle of the dialog, place one blink after the other. Then blink once at the end of the dialog.*

• The Mona Lisa, like other similar artworks of the time, fulfilled the requirements of portraying a woman of virtue. Please take a look at her hands. Lisa is portrayed as a faithful wife as her right hand rests over her left one.

➡ ***If PEMode:*** *Stay in alpha position.*

➡ ***If DMode:*** *When the phrase "Please take a look" the robot should rotate its head towards the extreme right position, then in "her hands" its eyes should be looking towards the upper-right corner, then the robot should stay for a small amount of seconds like that, and then return to alpha position.*

• Leonardo presented Lisa as a fashionable and successful woman. Perhaps more than she really was.

➡ ***Both modes:*** *Stay in alpha position.*

✦*"Lisa as a fashionable and successful woman. Perhaps more than she really was": joyful expression.*

✦ *Blink once at the beginning of this dialog.*

• Please now look at Lisa's light brown eyes, and lack of eyebrows. It is believed that the original painting featured Lisa with eyebrows, but throughout time, the eyebrows were washed out by multiple restorations.

➡ ***If PEMode:*** *Stay in alpha position.*

➡ ***If DMode:*** *Look to the extreme right when the phrase "Please now look now look at Lisa's light brown eyes, and lack of eyebrows" comes up. Then return to the alpha position.*

✦ *Blink once after the words "with eyebrows"*

• The original Mona Lisa portrait is rather large compared to other portraits of the sixteenth century. Generally, at that time only wealthy families commissioned artists to create portraits of this size.

➡ ***Both modes:*** *Stay in alpha position*

➡ *Blink once after the word "century"*

• The extravagance of the size of the original portrait is perhaps a sign of Lisa and Francesco's social aspirations.

➡ ***Both modes:*** *Stay in alpha position.*

➡ *Blink once at the middle of the dialog.*

• Please look closely at the background behind Lisa. It is speculated that Leonardo placed a great deal of effort into the background of the picture, since Lisa was not a particularly beautiful woman.

➡ ***If PEMode:*** *Stay in alpha position.*

➡ ***If DMode:*** *Look to the extreme right when the phrase "Please look closely... ...behind Lisa" comes up. Hold the position for a few seconds, then return to the alpha-position.*

• Leonardo had no income at the time of the creation of the Mona Lisa. This is the most likely reason why he decided to pursue this project.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink twice at the middle of the dialog, place one blink after the other.*

• But later that year he was commissioned to a more lucrative project, so he had to delay his work on the Mona Lisa.

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once when the word "project" is mentioned.*

• Leonardo regarded the Mona Lisa as an unfinished work. And although Leonardo was commissioned for the painting, he was never paid for his work, so he never delivered the final work to his client.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *When the phrase "the Mona Lisa as an unfinished work... ...paid for his work" comes up, the robot should turn to the extreme right, and direct its eyes towards the upper-right corner. Then it should hold the position for a few seconds. After that, the robot must return to the alpha position.*

✦ *Blink once after the word "client"*

• The Mona Lisa traveled with him throughout his life, and probably he completed his work in France.

➡ ***Both modes:*** *Stay in alpha position.*

• The Mona Lisa was acquired by King Francis the first, and was later donated to the Louvre museum in Paris, France.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "later donated to the Louvre museum in Paris, France." comes up, then return to the alpha position.*

✦ *Blink once at the middle of this dialog, and blink again after the word "Paris".*

• It was once stolen by an employee of the museum, who kept the artwork in his apartment for two years. At that time it was thought that the painting was lost forever.

➡ ***Both modes:*** *Stay in the alpha position.*

✦*"At that time it was thought that the painting was lost forever": sad expression.*

• But two years later, the culprit was caught when he tried to sell the Mona Lisa to a Gallery in Florence.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the end of this dialog.*

• The Mona Lisa is perhaps the most famous artwork in western art history. It is now property of the French Republic and it is on permanent display in the Louvre museum.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *When the phrase "The Mona Lisa is perhaps the most famous artwork in western art history" comes, shift the rotation of the head of the robot towards the extreme right, then shift the robot towards the alpha position.*

8.3.3 Transition of narrations

• Now, let's go to the next artwork.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the beginning of this dialog.*

8.3.4 Narration of story (2)

• To your right you will find the delightful girl with bright red lips and a beautiful shiny earring.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *Look to the extreme left when the phrase "To your right.. ...shiny earring" comes up. Then go to the alpha position.*

✦ *Blink once after the word "earring"*

• The Girl with the Pearl Earring, in Dutch known as "Het Meisje met de Parel" is a masterwork of Johannes Vermeer, which he painted around 1665 during the Dutch Golden Age.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog. Then blink again after the word "Age"*

• The Girl with the Pearl Earring had a complicated start and little is known about its origins. While Johannes Vermeer signed his artwork, he did not bother to date it. However, it was definitely produced in the 17th century.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink twice at the middle of the dialog, place one blink after the other.*

• It is unclear whether this artwork was commissioned by anyone and due to its appearance, it does not seem that Vermeer meant it as a conventional portrait either.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "It is unclear whether this artwork was commissioned by anyone" comes up, then return to the alpha position.*

✦ *Blink once after the word "either"*

• The legend says that the girl in the picture is a young Dutch girl whose name was Griet. She was born and raised in Delft in a protestant family.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog.*

• When Griet was 16 years old, she had to help her mother, blind father and siblings by taking a job as a maid in Vermeer's house.

➡ ***Both modes:*** *Stay in alpha position.*

➡ *Blink once when "house" is mentioned.*

• Her father suffered an accident that left him permanently blind, therefore, he was unable to sustain the family. Griet decided to help her parents due to the growing necessities.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "Her father suffered an accident that left him permanently blind, therefore he was unable to sustain his family" comes up, then return to the alpha position.*

✦ *Blink once at the middle of this dialog.*

• During the seventeenth century, the Netherlands was in a war with France, so there was widespread social instability in both countries.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *"so there was widespread social instability in both countries": sad expression.*

• Additionally, there was internal conflict between protestants and catholics in the country. Delft was among many other Dutch cities at that time, struggling with the protestant-catholic conflict.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog.*

• Catholics were tolerated, but weren't allowed to congregate in public spaces and worship was only allowed within their homes.

➡ ***Both modes:*** *Stay in alpha position.*

➡ *Blink once after the word "tolerated".*

• Vermeer and his wife were catholic. Not much is known about him, other than the fact that most of his income came from his mother-in-law Maria Thins.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog.*

• He was a rather introvert artist. He lived with his mother-in-law Maria and his wife Catherine, who gave birth to 14 children.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "He was a rather introvert artist. He lived with his mother-in-law Maria" comes up, then return to the alpha position.*

✦ *Blink once after the word "wife" is mentioned.*

• Vermeer took the young girl Griet as a maid in his house. At that time that was some sort of a social taboo since a protestant was never allowed to mix with a Catholic.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog.*

• Throughout the time that Griet was working in Vermeer's house, she was given the job to clean the kitchen and Vermeer's studio.

➡ ***Both modes****: Stay in alpha position.*

✦ *Blink once after the phrase "she was given" is mentioned.*

• It is perhaps due to his struggle with the relationship with his mother-in-law and his dependence on her that Vermeer decided to isolate himself in his art studio.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "is perhaps due to his struggle with the relationship with his mother-in-law, and his dependance on her" comes up, then return to the alpha position.*

✦ *Blink once at the end of this dialog.*

• It is believed that no one, not even his wife, was allowed to enter there. With the exception of the cleaning maid. And even she was just allowed to enter under special conditions.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once after the word "maid" is mentioned.*

• But as time went by, Griet and Vermeer started to find things in common through art.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once after the word "art".*

• Because of his anger against his mother-in-law, Vermeer once asked Griet to pose for his new piece, in exchange of extra money to help her struggling family. While hesitant to do so, Griet ended up accepting his offer. Probably due to her family's needs, or perhaps because of her personal admiration of Vermeer's art.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink twice at the middle of the dialog, place one blink after the other.*

• Please look at Vermeer's artwork, as he dressed her with his wife Carherine's fine brown coat, a luxurious turban and an expensive pair of pearl earrings brought from Indonesia.

➡ ***If PEMode:*** *Stay in alpha-position*

➡ ***If DMode:*** *Look to the extreme left when the phrase "Please look at Vermeer's artwork" comes up. Then go to the alpha position.*

✦ *Blink once after the word "Indonesia".*

• Griet had to pierce her ears in order to wear the earrings, probably just before Vermeer began painting her.

➡ ***Both modes:*** *Stay in alpha position.*

• This could be one reason why Griet had such a complicated facial expression while he was painting her. Please observe her grey eyes closely. You will be able to appreciate the complexity of her gaze as represented by Vermeer.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *Look to the extreme left when the phrase "Please observe her grey eyes" comes up. Then go to the alpha position.*

➡ *Blink once after the phrase "while he was painting her".*

• The artist tried his best to capture her beauty and soul in the painting. He tried to depict Griet as he saw her. He produced a rather unconventional portrait, as he incorporated features of innocence, and beauty.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once after the word "painting. Blink again at the middle of the dialog.*

• Look at her mouth... if you observe closely Vermeer has managed to capture a subtle impression of seduction due to her slightly open lips.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *Look to the extreme left when the phrase "loot at her mouth" comes up. Then go to the alpha position.*

✦ *"a subtle impression of seduction due to her slightly open mouth": joyful expression.*

✦ *Blink once after the word "lips".*

• Griet's portrait was highly untraditional and somewhat radical at the time. Vermeer managed to capture the deepness of her grey eyes and her mysterious, yet innocent, and seductive expression that could tell a thousand stories.

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once at the beginning of this dialog. Blink again at the end of the dialog.*

• Perhaps Vermeer knew this about his artwork, perhaps this was the reason why he decided to leave as little documentation as possible.

➡ ***Both modes:*** *Stay in the the alpha position.*

✦ *Blink once after the word "possible".*

• Please look at her yellow and blue turban. One interesting fact worth noting is that Vermeer always used the color ultramarine blue in all his artworks. This color was especially expensive to produce at the time.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *Look to the extreme left when the phrase "Please take a look at her yellow and blue turban" comes up. Then go to the alpha position.*

✦ *Blink once after the phrase "all his artworks".*

• After Vermeer's death, a local patron purchased much of his artworks. And it wasn't until the 19th century, that Vermeer was rediscovered as a great artist by a German art historian and a French art critic.

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once at the middle of this dialog.*

• Under the advice of Victor de Stuers, who tried to prevent Vermeer's artworks being sold to parties abroad, a wealthy Dutchman, des Tombe, purchased this artwork in an auction in The Hague in 1881.

➡ ***If PEMode:*** *Stay in the alpha position.*

➡ ***If DMode:*** *Look to the extreme left when the phrase "Vermeer's artworks being sold to parties abroad" comes up. Then go to the alpha position.*

✦ *Blink once after the word "Stuers" is mentioned.*

• Des Tombe donated the artwork of Vermeer to the Mauritshuis in The Hague, 21 years later.

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once at the beginning of this dialog.*

• Since then, the Girl with the Pearl Earring has been preserved there.

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once after the word "there" is mentioned.*

8.3.5 Connection of narratives

• As you may see, the Mona Lisa and the Girl with the Pearl Earring are wonderful masterpieces of art.

➡ ***If PEMode:*** *Stay in alpha position.*

➡ ***If DMode:*** *Look to the extreme right then the phrase "Mona Lisa" comes up, then quickly shift to the extreme left when the phrase "Girl with the Perl Earrings" comes up, then go to alpha position.*

• They come from different times, different artists and different backgrounds.

➡ ***Both modes:*** *Stay in alpha position.*

✦ *Blink once at the middle of this dialog.*

• By looking at them you may wonder, What was on their mind?, What were they looking at?, and What is the story that lead to this event?

➡ ***Both modes:*** *Stay in the alpha position.*

✦ *Blink once after the phrase "mind?".*

• The Girl with the Pearl Earring and the Mona Lisa have many things in common, yet they are vastly different. Both enjoy a large amount of acclaim worldwide. And both are fine examples of master artworks.

➡ ***Both modes:*** *Dedicate some time looking at each participant when the phrase "The Girl with the Pearl Earring and the Mona Lisa, have many things in common" comes up, then return to the alpha position.*

✦ *Blink once after the word "different", blink again after the word "artworks".*

8.3.6 Conclusion of script

- Thank you so much for coming to my art exhibition.

    ➡ ***Both modes:*** *Stay in alpha position*

    ✦*"thank you so much for coming to my art exposition": joyful expression.*

- Now, I would like to ask you to take a look behind you. We would like you to answer a few questions about this experience.

    ➡ ***Both modes:*** *Stay in the alpha position.*

- Have a delightful day.

    ➡ ***Both modes:*** *Stay in the alpha position.*

    ✦ *"have a delightful day": joyful expression.*

- Tot ziens.

    ➡ ***Both modes:*** *Stay in the alpha position.*

    ✦*"tot ziens": joyful expression. Then go to normal mode and then to sleep.*

    ✦ *Stay in normal mode for some seconds, then go to sleep.*

8.3.7 Sources of the Script

The information in the script was not required to be accurate, and its sources did not affect the validity of this research. But due to the fact that content from the script was directly borrowed from Wikipedia, we have decided to include the sources as shown below and give the proper credits to the authors of the entries. Not all the information is accurate to the events behind each particular artwork.

Lisa del Giocondo. (n.d.).*Wikipedia*. Retrieved September 11, 2012, from http://en.wikipedia.org/wiki/Lisa_del_Giocondo

Mona Lisa. (n.d.).*Wikipedia*. Retrieved September 11, 2012, from http://en.wikipedia.org/wiki/Mona_Lisa

Chevalier, T. (n.d.). About Johannes Vermeer. Retrieved September 11, 2012, from http://www.tchevalier.com/gwape/vermeer/index.html

Girl with a Pearl Earring. (n.d.).*Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Girl_with_a_Pearl_Earring

Johannes Vermeer. (n.d.).*Wikipedia*. Retrieved September 11, 2012, from http://en.wikipedia.org/wiki/Johannes_Vermeer

8.4 Questionnaire

This chapter contains the questionnaire as it was given to the participant of the experiment. All the lines of text followed by two dashes "//" represent a comment by the authors of this research. None of the comments appeared in the actual questionnaire that the participant answered. The participant did not see this line in his/her questionnaire. The questionnaire is based in the *Godspeed model* proposed by *Bartneck, et al. (2008)* modifications were done such as the removal of number in each individual rate, and the left-right (negative-positive) order of each scale presented in the experiment. This was done to prevent the user from answering a scale without reading. The scales were added with three intentions.

1. To mask the intention of the section of the questionnaire by placing the scales in a not-corresponding page. As *Bartneck, et al. (2008)* recommended to do.
2. In some cases to understand better the perception of the participant. Scales that we considered the standard *Godspeed model* was lacking of for our experiment.
3. In some cases to reconfirm results of the scales of the standard *Godspeed model,* for comparison purposes in the analysis of the results.

Added scales were marked with a star symbol ("✦") for readability pruposes. The symbol did not appear in the final questionnaire. Also, question numbers were added in this questionnaire, but were removed in the final version of the questionnaire. Question numbers appear in this questionnaire in brackets ("[ ]") right before the question itself.

// Block 0 - Initial information
// Beginning of Page 1

[1] Where did you stand while you took part in the experiment?
☐ Position A (in front of the Mona Lisa)
☐ Position B (between two other people)
☐ Position C (in front of the Girl with the Pearl Earring)

[2] Who did the robot put more attention to?

☐	To the person in position A (in front of the Mona Lisa)
☐	To the person in position B (in the middle)
☐	To the person in position C (in front of the Girl with the Pearl Earring)
☐	I don't know

// End of Page 1

// Block 1 - User Experience

// Beginning of Page 2

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers “1” and “7” a very strong feeling. Numbers “2” and “6” indicate a strong feeling. Numbers “3” and “5” indicate a fairly weak feeling. Number “4” indicates you are undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1	2	3	4	5	6	7	
[3]	✦ Safe	☐	☐	☐	☐	☐	☐	☐	Treatening
[4]	✦ Novel	☐	☐	☐	☐	☐	☐	☐	Ordinary
[5]	Irritable	☐	☐	☐	☐	☐	☐	☐	Good-natured
[6]	Friendly	☐	☐	☐	☐	☐	☐	☐	Unfriendly
[7]	Calm	☐	☐	☐	☐	☐	☐	☐	Anxious
[8]	Moving Elegantly	☐	☐	☐	☐	☐	☐	☐	Moving Rigidly

// End of Page 2

// Beginning of Page 3

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers “1” and “7” a very strong feeling. Numbers “2” and “6” indicate a strong feeling. Numbers “3” and “5” indicate a fairly weak feeling. Number “4” indicates you are undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1	2	3	4	5	6	7	
[9]	✦ Natural	☐	☐	☐	☐	☐	☐	☐	Fake
[10]	Inexpert	☐	☐	☐	☐	☐	☐	☐	Expert
[11]	Humanlike	☐	☐	☐	☐	☐	☐	☐	Machinelike
[12]	Conscious	☐	☐	☐	☐	☐	☐	☐	Unconscious
[13]	Ugly	☐	☐	☐	☐	☐	☐	☐	Attractive

// End of Page 3

// Beginning of Page 4

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers "1" and "7" a very strong feeling. Numbers "2" and "6" indicate a strong feeling. Numbers "3" and "5" indicate a fairly weak feeling. Number "4" indicates you are undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1	2	3	4	5	6	7	
[14]	Unreliable	☐	☐	☐	☐	☐	☐	☐	Reliable
[15]	Unfriendly	☐	☐	☐	☐	☐	☐	☐	Friendly
[16]	Gloomy	☐	☐	☐	☐	☐	☐	☐	Cheerful
[17]	Intelligent	☐	☐	☐	☐	☐	☐	☐	Unintelligent
[18]	Narrow	☐	☐	☐	☐	☐	☐	☐	Intellectual
[19]	Human	☐	☐	☐	☐	☐	☐	☐	Technical
[20]	Awful	☐	☐	☐	☐	☐	☐	☐	Nice

// End of Page 4

// Beginning of Page 5

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers "1" and "7" a very strong feeling. Numbers "2" and "6" indicate a strong feeling. Numbers "3" and "5" indicate a fairly weak feeling. Number "4" indicates you are

undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1	2	3	4	5	6	7	
[21]	Dislike	☐	☐	☐	☐	☐	☐	☐	Like
[22]	Artificial	☐	☐	☐	☐	☐	☐	☐	Lifelike
[23]	Kind	☐	☐	☐	☐	☐	☐	☐	Unkind
[24]	Pleasant	☐	☐	☐	☐	☐	☐	☐	Unpleasant
[25]	Short	☐	☐	☐	☐	☐	☐	☐	Tall
[26]	Careless	☐	☐	☐	☐	☐	☐	☐	Attentive
[27]	Nervous	☐	☐	☐	☐	☐	☐	☐	Poised

// End of Page 5

// Beginning of Page 6

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers “1” and “7” a very strong feeling. Numbers “2” and “6” indicate a strong feeling. Numbers “3” and “5” indicate a fairly weak feeling. Number “4” indicates you are undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1	2	3	4	5	6	7	
[28]	Inviting	☐	☐	☐	☐	☐	☐	☐	Rejecting
[29]	Relaxed	☐	☐	☐	☐	☐	☐	☐	Tense
[30]	Predictable	☐	☐	☐	☐	☐	☐	☐	Unpredictable
[31]	Sympathetic	☐	☐	☐	☐	☐	☐	☐	Unsympathetic
[32]	Bad	☐	☐	☐	☐	☐	☐	☐	Good

// End of Page 6

// Beginning of Page 7

On the scales below, please indicate your feelings about the robot. Select the number between the adjectives which bests represents your feelings about the robot. Numbers “1” and “7” a very strong feeling.

Numbers “2” and “6” indicate a strong feeling. Numbers “3” and “5” indicate a fairly weak feeling. Number “4” indicates you are undecided or do not understand the adjectives themselves. Please work quickly. There are no wrong or right answers.

		1 2 3 4 5 6 7	
[33]	Calm	☐ ☐ ☐ ☐ ☐ ☐ ☐	Agitated
[34]	✦ Fast	☐ ☐ ☐ ☐ ☐ ☐ ☐	Slow
[35]	Honest	☐ ☐ ☐ ☐ ☐ ☐ ☐	Dishonest
[36]	Quiescent	☐ ☐ ☐ ☐ ☐ ☐ ☐	Surprised

// End of Page 7

// Beginning of Page 8

Please indicate the degree to which each statement applies to you.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
[37]	✦ The robot looked too much at me.	☐	☐	☐	☐	☐
[38]	The robot remained focused on me throughout our interaction.	☐	☐	☐	☐	☐
[39]	I noticed the robot	☐	☐	☐	☐	☐
[40]	The robot caught my attention.	☐	☐	☐	☐	☐
[41]	My presence was obvious to the robot.	☐	☐	☐	☐	☐
[42]	✦ The robot was too tall.	☐	☐	☐	☐	☐

// End of Page 8

// Beginning of Page 9

Please indicate the degree to which each statement applies to you.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
[43]	I don't like how the robot looked at me.	☐	☐	☐	☐	☐
[44]	I caught the robot's attention.	☐	☐	☐	☐	☐
[45]	✦ The robot hardly looked at me.	☐	☐	☐	☐	☐
[46]	I was easily distracted from the robot when other things were going on.	☐	☐	☐	☐	☐
[47]	The robot's presence was obvious to me.	☐	☐	☐	☐	☐
[48]	✦ The robot's height was appropriate.	☐	☐	☐	☐	☐

// End of Page 9
// Beginning of Page 10

Please indicate the degree to which each statement applies to you.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
[49]	I remained focused on the robot throughout our interaction.	☐	☐	☐	☐	☐
[50]	The robot did not receive my full attention.	☐	☐	☐	☐	☐
[51]	The robot was easily distracted from me when other things were going on.	☐	☐	☐	☐	☐
[52]	I did not receive the robot’s full attention.	☐	☐	☐	☐	☐
[53]	The robot ignored my presence.	☐	☐	☐	☐	☐

[54]	✦ I had to look down all the time.	☐	☐	☐	☐	☐

// End of Page 10
// Block 2 - Story Facts
// Beginning of Page 11: Mona Lisa

Please answer according to what you can remember.

[55] What is the name of the lady depicted in the Mona Lisa portrait?

- ☐ Lisa Germini
- ☐ Lisa Gherardini
- ☐ Lisa Pausini
- ☐ I can’t remember

[56] Why did Da Vinci painted the Mona Lisa?

- ☐ Because he loved the lady depicted in the portrait.
- ☐ Because he did not have enough money.
- ☐ Because he was planning to give it as a present.
- ☐ I can’t remember

[57] Where did Da Vinci began his artwork?

- ☐ In Venice
- ☐ In Rome
- ☐ In Florence
- ☐ I can’t remember

[58] Which is the color of the eyes of the woman in the Mona Lisa?

- ☐ Light brown

☐	Dark brown
☐	Black
☐	I can’t remember

[59] Why is the lady depicted in the Mona Lisa considered a portrait of a woman of virtue and a faithful wife?	
☐	Because her right hand rests over her left hand.
☐	Because of her black veil at her head.
☐	Because of her sitting position relative to the artist.
☐	I can’t remember

// End of Page 11

// Beginning of Page 12: Mona Lisa - Part 2

[60] Why is the woman in the Mona Lisa without eyebrows?	
☐	Because her eyebrows were washed out in later restorations.
☐	Because fashionable Florentine women would pluck all their eyebrows at the time.
☐	Because Florentine married women at the time would pluck their eyebrows as a symbol of their commitment.
☐	I can’t remember

[61] Why did Da Vinci place many details in the background?	
☐	Because, he was inspired by asian art.
☐	Because, the woman in the Mona Lisa was dressed in black.
☐	Because, the woman in the Mona Lisa was not particularly pretty.
☐	I can’t remember

[62] How did the Mona Lisa end up, in the Museum of Louvre?

- ☐ It was acquired by King Philip the first and later donated to the museum.
- ☐ It was acquired by Lord Luis the the third and later donated to the museum.
- ☐ It was acquired by King Francis the first and later donated and later donated to the museum.
- ☐ I can't remember

[63] How many fingers of the woman depicted in the Mona Lisa can be seen?

- ☐ 10
- ☐ 9
- ☐ 8
- ☐ I can't remember

[64] Which object was in the background of the Mona Lisa artwork?

- ☐ A church
- ☐ A wheat field
- ☐ A bridge
- ☐ I can't remember

[65] What's the texture of the hair of the woman depicted in the Mona Lisa?

- ☐ Straight hair
- ☐ Curly hair
- ☐ Non-visible hair

☐ I can't remember

// *End of Page 12*

// *Beginning of Page 13: Het Meisje met Parel*

Please answer according to the facts that you can remember.

[66] Which is the color of the coat of girl in Vermeer's artwork?

☐ Brown

☐ Orange

☐ Blue

☐ I can't remember

[67] Why did Vermeer paint the Girl with the Pearl Earring portrait?

☐ Because he did not love his wife anymore.

☐ Because he was angry at his mother in law.

☐ Because the girl in the portrait paid him to do so.

☐ I can't remember

[68] Which is the color of the eyes of the girl depicted in Vermeer's artwork?

☐ Brown

☐ Blue

☐ Grey

☐ I can't remember

[69] Where did Vermeer began his artwork?

☐ In Amsterdam

☐ In Utrecht

☐	In Delft
☐	I can’t remember

[70] Why is the lady depicted in the Girl with the Pearl Earring considered an unconventional portrait with a seductive feature?

☐	Because the lady depicted in the artwork is posing in her back.
☐	Because the lady depicted in the artwork has her mouth slightly open.
☐	Because the lady depicted in the artwork has brightly colored red lips.
☐	I can’t remember

// End of Page 13
// Beginning of Page 14: Het Meisje met Parel - Part 2

[71] Which are the two colors that Vermeer used to paint the turban of the girl?

☐	Brown and Ultramarine blue
☐	Yellow and Ultramarine blue
☐	Beige and Ultramarine blue
☐	I can’t remember

[72] Which direction is the Girl with the Pearl Earring’s body facing?

☐	To the left
☐	To the right
☐	To the front
☐	I can’t remember

[73] What's the color of the hair of the Girl with the pearl earring

- ☐ Blond
- ☐ Light brown
- ☐ Her hair couldn't be seen
- ☐ I can't remember

[74] How did the Girl with the Pearl Earring end up, in the Mauritshuis?

- ☐ It was auctioned and acquired by Des Tombe, who later donated it to the museum.
- ☐ It was auctioned and acquired by Der Geest, who later donated it to the museum.
- ☐ It was auctioned and acquired by Des Sluis, who later donated it to the museum.
- ☐ I can't remember

// End of Page 14
// Block 3 - Personal Details
// Beginning of Page 15

Please answer the questions below.

[75] Please select your gender.

- ☐ Female
- ☐ Male
- ☐ Other
- ☐ Prefer not to disclose

[76] What is your current age?

- ____ years.
- ☐ Prefer not to disclose

[77] What is your current height?

____ cm.

[78] Have you ever studied or worked in any of the following fields? *(Feel free to select more than one if necessary)*

- ☐ Arts
- ☐ Design
- ☐ Engineering
- ☐ Mechanics
- ☐ Philosophy
- ☐ Robotics
- ☐ Technology
- ☐ None of the above

[79] Do you currently live with pets, or have you lived with pets in the past 12 months for a period of time?

- ☐ Yes, I live with pets.
- ☐ No, I don't live with pets.
- ☐ Yes, I have lived with pets in the past 12 months for a period of time, but not anymore

// End of Page 15
// Beginning of Page 16

[80] How often do you play videogames?

- ☐ Often
- ☐ Seldom
- ☐ Never

[81] Before this experiment, did you know any specific information about any of the artworks exposed?

- ☐ No
- ☐ Yes, about the Mona Lisa only.
- ☐ Yes, about the Girl with the Pearl Earring only.
- ☐ Yes, about both artworks.

[82] Have you ever watched the movie "*Girl with a Pearl Earring"* directed by *Peter Webber,* and produced in the year 2003?

- ☐ Yes
- ☐ No

[83] Have you ever had any previous experience with Robots?

- ☐ Yes, I have much previous experience with Robots.
- ☐ Yes, I have little experience with Robots.
- ☐ No, I have no previous experience with Robots.
- ☐ Other / Prefer not to disclose

[84] Do you have any of the following conditions?

- ☐ Visual impairment
- ☐ Hearing impairment
- ☐ Memory loss or Amnesia
- ☐ Color blindness
- ☐ None of the above

// End of Page 16

// Beginning of Page 17

[85] [86] [87] What is the current or maximum level of education of you and your parents?

Me	Father	Mother	
☐	☐	☐	Primary school (Basisonderwijs)
☐	☐	☐	High School (VMBO)
☐	☐	☐	HAVO / VWO
☐	☐	☐	Some College (MBO)
☐	☐	☐	College degree (BA, BSc, HBO)
☐	☐	☐	Master's (WO)
☐	☐	☐	PhD (Promotie)
☐	☐	☐	Prefer not to disclose / Don't know

// End of Page 18

// Beginning of Page 19

[88] How would you rate your English language understanding?

	1	2	3	4	5	6	7	
Good	☐	☐	☐	☐	☐	☐	☐	Bad

[89] How would you rate your Classical Arts knowledge?

	1	2	3	4	5	6	7	
Few	☐	☐	☐	☐	☐	☐	☐	Vast

// End of Page 19

// Beginning of Page 20

[90] Do you have any additional comments?

// End of Page 20

// Beginning of Page 21

Thank you!

This is the end of the experiment, thank you so much for taking part in this experiment. If you have any questions, you can ask the experiment supervisors; or send an email to g.u.sepulveda@student.utwente.nl

// *End of Page 21*

// *End of questionnaire*.